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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Norkin
Art Unit	
Examiner Name	
Attorney Docket Number	1009-0641 / P33966 US2

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	1	IKEDA, Masaru et al. "Parallel Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTCJ/SC29/WG, Document to JCT-VC, 11 4th Meeting. January 2011. pp 1-7	☐
	2	NARROSCHKE, Matthias. "Reduction of Operations in the Critical Path of the Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting. 20-28 January, 2011. pp 1-15.	☐
	3	NORKIN, Andrey et al. "CE12.1: Ericsson Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/I EC JTC1/SC29/WG, Document to JCT-VC, 11 5th Meeting: Geneva, 16-23 March 2011. pp. 1-17.	☐
	4	NORKIN, Andrey et al. "Development of HEVC Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting: Daegu, KR. 20-28 January 2011. pp. 1-4.	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Norkin
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1009-0641 / P33966 US2

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2013-08-26
Name/Print	Daniel P. Homiller	Registration Number	55275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

Siv/Susanne

2013 -05- 23

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Ericsson AB
Patent Unit Kista Device, Service & Media
SE-164 83 Stockholm
SUEDE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	21.05.2013

Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
P33966 WO1	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SE2011/051526	16.12.2011	01.03.2011

Applicant
TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	Poquet, Rosa Tel. +49 89 2399-2911

Form PCT/IPEA/416 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
P33966 WO1		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SE2011/051526	16.12.2011	01.03.2011

International Patent Classification (IPC) or national classification and IPC

INV. H04N7/26

Applicant

TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 8 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 17 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).
      ☐ sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).
      ☐ superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3*bis* of Annex C of the Administrative Instructions).

4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☒ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26.10.2012	21.05.2013

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0
Fax: +49 89 2399 - 4465

Authorized officer

Regidor Arenales, R

Telephone No. +49 89 2399-4091

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-36 as originally filed

   Claims, Numbers

   1-20 filed with telefax on 05-04-2013

   Drawings, Sheets

   1/11-11/11 as originally filed

   ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☒ the claims, Nos. 21, 22
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

5. ☐ This report has been established:
   - ☐ taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
   - ☐ without taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

6. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-20
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 MATTHIAS NARROSCHKE ET AL: "Reduction of operations in the critical path of the deblocking filter", 95. MPEG MEETING; 24-1-2011 - 28-1-2011; DAEGU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m18974, 22 January 2011 (2011-01-22), XP030047543,

D2 NORKIN A ET AL: "Development of HEVC deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/ IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP:// WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D377, 16 January 2011 (2011-01-16), XP030008416, ISSN: 0000-0013

D3 US 2010/142844 A1 (PEREIRA ROCHELLE [US] ET AL) 10 June 2010 (2010-06-10)

1 Independent Claims

1.1 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of **claim 1** does not involve an inventive step.

1.2 D3 is regarded as being the closest prior art and discloses (the references in parentheses applying to this document):

A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value (see abstract), said method comprising:

calculating a first filter decision value for said block (see N0 on paragraph [0071]) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame (see p0 on Figure 7), $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block

boundary (see p1 on Figure 7) and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary (see p2 on Figure 7);

calculating a second filter decision value for said block (see N1 on paragraph [0071]) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary (see q0 on Figure 7), $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary (see q1 on Figure 7) and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary (see q2 on Figure 7);

determining how many pixels in a line of pixels in said block to filter relative to said block boundary based on said first filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]), wherein

determining how many pixels in said line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]),

determining how many pixels in said line of pixels in said block to filter based on a comparison of said first filter decision value to a first threshold value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter based on a comparison of second filter decision value to a second threshold value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]).

1.3 The subject-matter of claim 1 therefore differs from this known filtering method in the equations for calculating the decision values.

1.4 The problem to be solved by the present invention may therefore be regarded as how to calculate the decision values.

1.5 The solution proposed in **claim 1** of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) because the same equations have already been used by D1 for the same purpose (see third paragraph on page 4 and Figure 7).

1.6 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent **claims 8 and 19**, which therefore are also considered not inventive.

2 Dependent Claims

The dependent claims do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty or inventive step.

2.1 **Claims 2 and 9** - D1 also uses pixels from two lines for calculating the decision values (see third paragraph on page 4 and Figure 7).

2.2 **Claims 3, 4, 10 and 11**- D1 discloses comparing ($|p2_5 - 2p1_5 + p0_5| + |q2_5 - qp1_5 + q0_5|$) with a threshold and applying a strong filter or a weak filter based on the result of the comparison (see third paragraph on page 4).

2.3 **Claims 5 and 12** - The threshold value in D1 is based on 'β' which also depends on the quantization parameter, as disclosed by the applicant (see page 3 lines 1-2 of the description).

2.4 **Claims 6 and 13 -** D2 discloses performing the same filter operations as in claim 7 (see section 2.1 "Filter description").

2.5 **Claims 7 and 14 -** D1 discloses comparing ($|p2_5 - 2p1_5 + p0_5| + |q2_5 - qp1_5 + q0_5|$) with a threshold (see third paragraph on page 4).

2.6 **Claims 15-18 and 20 -** The supplementary features of these claims are also known from the prior art and do not add anything of inventive significance to the subject-matter of any one of the preceding claims.

Re Item VI

Certain documents cited

The following document was published prior to the international filing date but later than the priority date claimed:

ANDREY NORKIN ET AL: "CE12.1: Ericsson deblocking filter", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19803, 19 March 2011 (2011-03-19), XP030048370,

Re Item VII

Certain defects in the international application

1 In order to meet the requirements of Rule 5.1(a)(ii) PCT, the relevant prior art, i.e. documents D1-D3 noted above, should be acknowledged by reference and briefly discussed in the introductory part of the description.

Re Item VIII

Certain observations on the international application

1 The term "said block (20)" used in **claim 1** is unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, since the reference sign does not correspond to "said block" but to the neighbouring block, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT.

2 The term "corresponding first line" used in **claim 1** is also unclear. It seems that both blocks must be located one next to the other one, so that the first line of the first block is adjacent to the first line of the neighboring block. This relationship seems to be an essential feature and must therefore be included in the claim.

3 The reference to "a line of pixels" used in **claim 1** is unclear. It seems that the referred line must be the first line mentioned during step S1. An amendment is required.

4 There are three steps in **claim 1** that describe how many pixels in a line of pixels are determined and another three steps that describe how many pixels in a corresponding line of pixels are determined but they all seem to be the same. The definition of the subject-matter of said claim is therefore unclear, Article 6 PCT.

ERICSSON

Date
Your Date
- -

Reference (Document No)
P33966 WO1
Your Reference

Attending to this matter
Susanne Ahlstrand +46107185725

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European Patent Office

80298 Munich
GERMANY

Response to second Written Opinion issued by the IPEA

Application Number: PCT/SE2011/051526
Applicant: Telefonaktiebolaget L M Ericsson (publ)
Our Reference: P33966 WO1

Enclosure(s):
Claims: Substitute claims number 1 - 20

Dear Sirs,

In response to the second Written Opinion of the IPEA, the Applicant hereby submits the following comments and enclosed amendments.

Amendments

Old claim 1 is amended wherein the features of old claim 2 are inserted to a new claim 1.

Old claim 9 is amended, wherein features of old claim 10 are inserted to a new claim 8.

Further amendments in the independent claims are done, wherein "at least" is removed, i.e.:
.....calculating (S1) a first filter decision vale for said block (10) based ~~at least~~ on:....

.....calculating (S2) a second filter decision vale for said block (20) based ~~at least~~ on:....

The independent claims also defines that it is determined how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and it is determined how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value. Support for the amendment can be found in the previous claims 4, 5, 12 and 13.

The remaining claims are renumbered.

Novelty and Inventive Step

D3: US 2010/0142844 A1

The present invention relates to asymmetric filter decisions to blocks of a video frame.

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A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value is provided.

A first filter decision value for said block (10) is calculated based at least on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10).

A second filter decision value for said block (20) is calculated based at least on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1).

It is determined how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and it is determined how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

In the new independent claim it is now clarified that it is determined (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and it is further determined how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

The number of pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter is based on a comparison (S20) of said first filter decision value to a first threshold value; and the number of pixels in said line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter is based on a comparison (S23) of said second filter decision value to a second threshold value.

That implies that one filter decision is determined for pixels on one side of a block boundary (pixels p0, p1,p2) based on the pixels that may be subject for deblocking filtering on the one side of the block boundary and another filter decision is determined for pixels (q0,q1,q2) on the other side of the block boundary based on the on the pixels that may be subject for deblocking filtering on the other side of the block boundary. Thus the filter decision takes into account only the pixels that can be subject for deblocking filtering.

D3 relates to a deblocking operation wherein a region of interest is determined which determines the number of pixels that should be filtered. The number of pixels can be different on either side of the block boundary. The region of interest is determined based on N0 (for block B0) and N1 (for block B1) which are calculated based on an activity metric and an artifact count. The artifact count is determined for each block and an activity is determined for each row and for each column of each block.

It is not disclosed in D3 that the number of pixels of a line is determined from filter decision values based on the pixels in the same line. In D3 the number of pixels in a region of interest is determined based on the entire block as disclosed in [0053], [0063]. Further N0 and N1 are used for determining the number of pixels while in the present invention the number of pixels is determined by comparing the filter decision values against respective thresholds.

D1 relates to a method for determining filter decisions. However in D1, pixels on both sides of the block boundary are used for determining one filtering decision, i.e. how many pixels that should be considered for deblocking, but the same filter decision is used for both sides of the block boundary. This is different from the present invention where one filter decision is determined for pixels (p0,p1,p2) on one side of the block boundary and another filter decision is determined for pixels (q0,q1,q2) on the other side of the block boundary. In the present invention, it is possible to apply deblocking on x number of pixels on one side of the block boundary and y number of pixels on the other side of the block boundary, where x can differ from y. This is in contrast to the present invention where the same number of pixels is filtered on both sides of the block boundary, although pixels on both sides are used for determining how many pixels that should be filtered.

Thus the subject matter of claim 1 is novel in view of D1 and D3, respectively.

When assessing whether the present invention involves an inventive step, D3 is considered to constitute the closest prior art since D3 provides the possibility to filter a first number of pixels on one side of the block border and a second number of pixels on the other side of the block border.

As mentioned above, it is not disclosed in D3 that the number of pixels of a line of pixels is determined from filter decision values based on the pixels in the same line of pixels. In D3 the number of pixels in a region of interest is determined based on the entire block as disclosed in [0053], [0063]. Further N0 and N1 are used for determining the number of pixels while in the present invention the number of pixels is determined by comparing the filter decision values against respective thresholds.

The technical effect achieved by the present invention is that the process is less complex.

The objective problem is to achieve an improved deblocking filtering control.

That is achieved by the asymmetric filtering provided by the present invention, i.e. by calculating the first and second filter decisions and determining how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and determining how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value. It is also defined how many pixels in said line of pixels in said block to filter by comparing the filter decision value to a threshold.
The filter decision values are only based on the pixels that are subject for filtering. To use the thresholds for making the filtering decision compared to the calculation of N0 and N1 in D3 is less

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complex as mentioned above. Further the decision is made only on the pixels that may be subject for filtering, which may make the decision more correct.

It is shown in D1 to determine a filter decision value for based on pixels in the same line of pixels. However, pixels on both side of the border are used, and the same number of pixels is filtered on both side. A skilled person would not be motivated to combine D3 with D1 to solve the objective problem, since there is nothing in D3 that would encourage a skilled person to only use pixels from one line of pixels, when deciding on the region of interest for improving the filtering control mechanism.

Furthermore, if a skilled person would combine D3 and D1, he would not end up in the present invention defined by the independent claims, since D1 uses pixels from both sides of the block border to make one single filter decision applicable to both sides of the border and D3 uses the entire block for determining the region of interest.

Therefore, a skilled person being faced with the objective problem would not be motivated by D3 to modify D3 to the present invention. A skilled person would neither be motivated to combine D3 with D1 and even if he would do such combination he would not arrive at the present invention.

Accordingly, the present invention according to the independent claims is novel and involves an inventive step.

Should the Examiner have any questions that may be favorable discussed over the telephone or deems further minor amendments to be needed before issuance of a positive IPRP, you are welcome to contact the case responsible patent engineer/patent attorney, Susanne Ahlstrand on +46107165725.

Yours faithfully,

for TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)

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CLAIMS

1. A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said method comprising:

calculating (S1) a first filter decision value for said block (10) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculating (S2) a second filter decision value for said block (20) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determining (S3) how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line

(22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value.

2. The method according to claim 1, wherein

calculating (S1) said first filter decision value comprises calculating (S1) said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

calculating (S2) said second filter decision value comprises calculating (S2) said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20),

said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

3. The method according to any of the claims 1 to 2, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

4. The method according to any of the claims 1 to 2, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23 ,25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

5. The method according to any of the claims 2 to 4, further comprising:

determining (S30) said first threshold value based on a quantization parameter associated with said block (10); and

determining (S31) said second threshold value based on said quantization parameter associated with said neighboring block (20).

6. The method according to any of the claims 2-5, further comprising:

calculating (S40) a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_j$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

modifying (S41) said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

modifying (S41) said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

calculating (S43), if said first filter decision value is below said first threshold value, a second offset based on $\frac{p0_J + p2_J - 2p1_J + 2\Delta}{4}$, wherein $p2_J$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

modifying (S44), if said first filter decision value is below said first threshold, said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

calculating (S46), if said second filter decision value is below said second threshold value, a third offset based on $\frac{q0_J + q2_J - 2q1_J - 2\Delta}{4}$, wherein $q2_J$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

modifying (S47), if said second filter decision value is below said second threshold, said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

7. The method according to any of the claims 1 to 6, further comprising comparing (S50) a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4), if said sum of said first filter decision value and

said second filter decision value is below said threshold value, how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

8. A filtering control device (100) comprising:

a first decision value calculator (110) configured to calculate a first filter decision value for a block (10) of multiple pixels (11, 13, 15, 17) in a video frame based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

a second decision value calculator (120) configured to calculate a second filter decision value for said block (10) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel determiner (130) configured to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

a second pixel determiner (140) configured to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120), wherein

said first pixel determiner (130) is configured to determine how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120), further comprising a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value.

9. The device according to claim 8, wherein

said first decision value calculator (110) is configured to calculate said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

said second decision value calculator (120) is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said

neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

10. The device according to any of the claims 8 to 9, further comprising:

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

11. The device according to any of the claims 8 to 10, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

12. The device according to any of the claims 8 to 11, further comprising a threshold determiner (170) configured to i) determine said first threshold value based on a quantization parameter associated with said block (10), and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block (20).

13. The device according to any of the claims 8-12, further comprising:

a first offset calculator (181) configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_j$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel modifier (190) configured to modify said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset calculated by said first offset calculator (181) to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a second pixel modifier (192) configured to modify said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset calculated by said first offset calculator (181) from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

a second offset calculator (183) configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator (180), a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

a third pixel modifier (194) configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator (180), said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset calculated by said second offset calculator (183) to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a third offset calculator (185) configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator (182), a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

a fourth pixel modifier (196) configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator (182), said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset calculated by said third offset calculator (185) to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

14. The device according to any of the claims 8 to 13, further comprising a third comparator (184) configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner (130) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

15. An encoder (40) comprising a filtering control device (100) according to any of the claims 8-14.

16. A user equipment (80) comprising:

a memory (84) configured to store video frames; and

an encoder (40) according to claim 15 configured to encode said video frames into encoded video frames, wherein said memory (84) is further configured to store said encoded video frames.

17. A decoder (60) comprising a filtering control device (100) according to any of the claims 8-14.

18. A user equipment (80) comprising:

a memory (84) configured to store encoded video frames;

a decoder (60) according to claim 17 configured to decode said encoded video frames into decoded video frames; and

a media player (86) configured to render said decoded video frames into video data displayable on a display (88).

19. A computer program (74) for filtering control of a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said computer program (74) comprises code means which when run on a computer (70) causes the computer (70) to:

calculate a first filter decision value for said block (10) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13,

15, 17, 19), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (13) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculate a second filter decision value for said block based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (23) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filer relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

wherein determine how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

determine (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and

determine (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value.

20. A computer program product (73) comprising computer readable code means and a computer program (74) according to claim 18 stored on said computer readable means.

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(54) Title: DEBLOCKING FILTERING CONTROL

(57) Abstract: A first filter decision value is calculated for a block (10) of pixels (11, 13, 15, 17) in a video frame based on pixel values of pixels (11, 13, 15) in a first line (12) of pixels (11, 13, 15, 17) in the block (10). A second filter decision value is also calculated for the block (10) based on pixel values of pixels (21, 23, 25, 27) in a corresponding first line (22) of pixels (21, 23, 25, 27) in a neighboring block (20) in the video frame. The first filter decision value is used to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in the block (10) to filter relative to a block boundary (1) between the block (10) and the neighboring block (20). The second filter decision value is used to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in the neighboring block to filter relative to the block boundary (1).

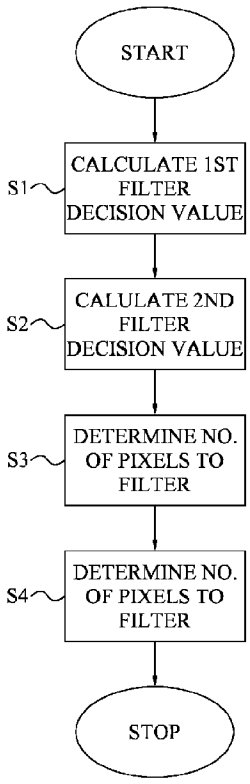


Fig. 1

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DEBLOCKING FILTERING CONTROL

TECHNICAL FIELD

The present embodiments generally relate to filtering control and in particular to controlling deblocking filtering over block boundaries in a video frame.

BACKGROUND

Deblocking filters are used in the video coding standards in order to combat blocking artifacts. The blocking artifacts arise because the original video frames are split into blocks which are processed relatively independently. The blocking artifacts can, for instance, arise due to different intra predictions of the blocks, quantization effects and motion compensation. Two particular variants of deblocking are described below.

In state of the art video coding, such as H.264, there is a deblocking filter, also denoted loop filter, after prediction and residual reconstruction, but before storage of the reconstruction for later reference when encoding or decoding the subsequent frames. The deblocking filtering consists of several steps such as filter decisions, filtering operations, a clipping function and changes of pixel values. The decision to filter the border or not is made based on evaluation of several conditions. Filter decisions depend on macroblock (MB) type, motion vector (MV) difference between neighboring blocks, whether neighboring blocks have coded residuals and on the local structure of the current and/or neighboring blocks.

Then the amount of filtering for a pixel depends, among others, on the position of that pixel relative to the block border or boundary and on the quantization parameter (QP) value used for residual coding.

The filter decision is based on comparing three pixel differences with thresholds. The thresholds are adapted to the quantization parameter (QP). For instance, assume a vertical block boundary of

a b c d | e f g h

where a, b c and d denote the pixel values of the pixels of a row of pixels in the current block and e, f, g and h denote the corresponding pixel values of the pixels of a corresponding row of pixels in the neighboring block. If the following conditions are fulfilled the filter decision is positive, e.g. abs(d-e)<thr1, abs(c-d)<thr2, and abs(e-f)<thr2, where thr1 and thr2 are adapted based on QP.

There are two filtering modes in H.264. In the first filtering mode, referred to as normal filtering, filtering can be described with a delta value with which filtering changes the current value. The filtering for the pixels closest to the block boundary is d' = d + delta and e' = e – delta, where delta has been clipped off to a threshold ±thr3 to a value that is constrained by the QP. More filtering is thereby allowed for high QP than for low QP. Clipping can be described as delta_clipped = max(-thr3, min(thr3, delta)), where thr3 is controlling the filter strength. A larger value of thr3 means that the filtering is stronger which means that a stronger low-pass filtering effect will happen.

The filter strength can be increased if any of the following two conditions also holds, e.g. abs(b-d)<thr2 and abs(e-g)<thr2. The filter strength is adapted by clipping the delta less, e.g. allow for more variation.

The second filtering mode, referred to as strong filtering, is applied for intra macroblock boundaries only, when the following condition is fulfilled abs(d-e)< thr1/4.

For more information of deblocking filtering in H.264 reference is made to List et al., Adaptive Deblocking Filter, *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 13, no. 7, July 2003.

In the draft HEVC (High Efficiency Video Coding) specification "Test Model under Consideration", ITU-T SG16 WP3 document, JCTVC-B205, Chapter 6.5 In-loop filter process, the deblocking filter works differently from H.264. The filtering is performed if at least one of the blocks on the side of the boundary is intra, or has non-zero coefficients, or the difference between the motion vector components of the blocks is greater or equal to one integer pixel. For example, when filtering the border between the blocks with a vertical block boundary of

$$p3_i\ p2_i\ p1_i\ p0_i\ |\ q0_i\ q1_i\ q2_i\ q3_i$$

with pj_i denoting the pixel value of pixel number j of row number i in the current block and qj_i denoting the pixel value of pixel number j of row number i in the neighboring block, i=0...7, j=0...3, then the following condition should also be satisfied:

$$d = |p2_2 - 2\times p1_2 + p0_2| + |q2_2 - 2\times q1_2 + q0_2| + |p2_5 - 2\times p1_5 + p0_5| + |q2_5 - 2\times q1_5 + q0_5| < \beta$$

where β depends on QP. In the above mentioned HEVC specification, there is a table of β, where β increases with QP.

If the conditions are fulfilled and filtering is done between the current block and the neighboring block, one of two types of filtering is performed, referred to as weak and strong filtering, respectively. The choice between the strong and the weak filtering is done separately for each line depending on the following conditions. For each line i=0…7, the strong filtering is performed if all the following conditions are true, otherwise, weak filtering is performed:

$$d < (\beta>>2)$$

$$(|p3_i - p0_i| + |q0_i - q3_i|) < (\beta>>3)$$

$$|p0_i - q0_i| < ((5\times t_C + 1)>>1)$$

where t_C and β depend on QP and >> denotes a right shift operator.

Weak filtering is performed based on the above conditions. The actual filtering works by computing an offset (Δ), adding it to the original pixel value and clip the sum to a filtered output pixel value in the range of 0-255:

$$\Delta = Clip(-t_C,t_C, (13\times(q0_i - p0_i) + 4\times(q1_i - p1_i) - 5\times(q2_i - p2_i)+16)>>5))$$

$$p0_i = Clip_{0\text{-}255}(p0_i + \Delta)$$

$$q0_i = Clip_{0\text{-}255}(q0_i - \Delta)$$

$$p1_i = Clip_{0\text{-}255}(p1_i + \Delta/2)$$

$$q1_i = Clip_{0\text{-}255}(q1_i - \Delta/2)$$

where the clip function Clip(A, B, x) is defined as Clip(A, B, x)=A if x<A, Clip(A, B, x)=B if x>B and Clip(A, B, x)=x if A≤x≤B and $Clip_{0\text{-}255}(x)$ is defined as Clip(0, 255, x).

Strong filtering mode is performed by the following set of operations:

$$p0_i=Clip_{0\text{-}255}((p2_i + 2\times p1_i + 2\times p0_i +2\times q0_i + q1_i + 4)>>3)$$

$q0_i=Clip_{0-255}((p1_i + 2\times p0_i + 2\times q0_i + 2\times q1_i + q2_i + 4)>>3)$

$p1_i=Clip_{0-255}((p2_i + p1_i + p0_i + q0_i +2)>>2)$

$q1_i=Clip_{0-255}((p0_i + q0_i + q1_i + q2_i +2)>>2)$

$p2_i=Clip_{0-255}((2\times p3_i + 3\times p2_i + p1_i + p0_i + q0_i + 4)>>3)$

$q2_i=Clip_{0-255}((p0_i + q0_i + q1_i + 3\times q2_i + 2\times q3_i + 4)>>3)$

Deblocking filtering decisions according to HEVC can lead to inaccurate deblocking filtering over block boundaries for certain blocks. In particular neighboring blocks having different levels of local structures could be handled incorrectly in HEVC by filtering one of the blocks too much to thereby represses and filter away local structures in the block.

SUMMARY

Hence, there is a need for an efficient deblocking filtering control that can be used to reduce blocking artifacts at block boundaries and that does not have the above mentioned drawbacks.

It is a general objective to provide an efficient deblocking filtering control.

It is a particular objective to provide asymmetric filtering decisions over a block boundary.

An aspect of the embodiments relates to a method for filtering control applicable to a block of multiple pixels in a video frame, where each pixel has a respective pixel value. The method comprises calculating a first filter decision value for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The method also comprises calculating a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. The first filter decision value is used to determine how many pixels in a line of

pixels in the block to filter relative to the block boundary and the second filter decision value is correspondingly used to determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary.

Another aspect of the embodiments defines a filtering control device comprising a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The filtering control device also comprises a second decision value calculator configured to calculate a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. A first pixel determiner is configured to determine how many pixels in a line of pixels in the block to filter relative to the block boundary based on the first filter decision value calculated by the first decision value calculator. The filtering control device further comprises a second pixel determiner configured to determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary based on the second filter decision value calculated by the second decision value calculator.

Further aspects of the embodiments relate to an encoder comprising a filtering control device as defined above and a decoder comprising a filtering control device as defined above. Yet another aspect defines a user equipment comprising a memory configured to store video frames and an encoder with a filtering control device as defined above to encode the video frames into encoded video frames, which are stored in the memory. A further aspect defines a user equipment comprising a memory configured to store encoded video frames and a decoder with a filtering control device as defined above to decode the encoded video frames into decoded video frames. A media player of the user equipment is configured to render the decoded video frames into video data displayable on a display.

Yet another aspect relates to a computer program for filtering control of a block of multiple pixels in a video frame, where each pixel has a respective pixel value. The computer program comprises code means which when run on a computer causes the computer to calculate a first filter decision value for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The computer also comprises code means which causes the computer to calculate a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. The computer program comprises code means which causes the computer to determine how many pixels in a line of pixels in the block to filter relative to the block boundary based on the first filter decision value and determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary based on the second filter decision value.

The embodiments achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig. 1 is a flow diagram of a method for filtering control according to an embodiment;

Figs. 2A and 2B illustrate two embodiments of neighboring blocks and a block boundary over which deblocking filtering can be applied;

Fig. 3 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to an embodiment;

Fig. 4 is a flow diagram illustrating an embodiment of the determining steps in Fig. 1;

Fig. 5 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to another embodiment;

Fig. 6 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 and an embodiment of the determining steps in Fig. 1;

Fig. 7 is a flow diagram illustrating an additional, optional step of the method in Fig. 1 according to an embodiment;

Fig. 8 is a schematic block diagram of an embodiment of a filtering control device;

Fig. 9 is a schematic block diagram of another embodiment of a filtering control device;

Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device;

Fig. 11 is a schematic block diagram of yet another embodiment of a filtering control device;

Fig. 12 is a schematic block diagram of a software implementation of a filtering control device in a computer according to an embodiment;

Fig. 13 is a schematic block diagram of an encoder according to an embodiment;

Fig. 14 is a schematic block diagram of a decoder according to an embodiment;

Fig. 15 is a schematic block diagram of a user equipment according to an embodiment;

Fig. 16 is a schematic block diagram of a user equipment according to another embodiment; and

Fig. 17 is a schematic overview of a portion of a communication network comprising a network device according to an embodiment.

DETAILED DESCRIPTION

Throughout the drawings, the same reference numbers are used for similar or corresponding elements.

The embodiments generally relate to filtering control and controlling deblocking filtering over block boundaries in a video frame. The filtering control of the embodiments provides asymmetric deblocking decisions with regard to block boundaries by making independent filtering decisions for the blocks of pixels separated by a block boundary. This means that the deblocking filtering can handle neighboring blocks having different levels of local structures to thereby adapt the particular deblocking filtering at each block based on its local structures.

As is well-known in the art, a video frame is divided into non-overlapping blocks of pixels that are encoded and decoded according to the various available intra and inter coding modes. Generally, a video frame is divided into non-overlapping macroblocks of 16×16 pixels. Such a macroblock can in turn be divided into smaller blocks of different sizes, such as 4×4 or 8×8 pixels. However, also rectangular blocks are possible according to the embodiments, such as, 4×8, 8×4, 8×16 or 16×8. The embodiments can be applied to any such block of pixels, including macroblocks or even larger blocks of pixels.

In the emerging High Efficiency Video Coding (HEVC) standard, coding units (CU), prediction units (PU) and transform units (TU) are used. The prediction units are defined inside a coding unit and contain the intra or inter prediction modes. Transform units are defined inside a coding unit and the largest transform size is 32×32 pixels and the smallest size is 4×4 pixels. The CU size is currently varying from 64×64 pixels (largest) to 8×8 pixels (smallest). In this way, the largest CU can be split into smaller CUs with the "level of granularity" depending on the local characteristics of the frame. That means that the largest CU may be split into smaller CUs of different sizes. The embodiments can also be used in connection with such coding units, which are regarded as being encompassed by the expression "block of pixels" as used herein.

Each pixel in the block has a respective pixel value. Video frames generally have color values assigned to the pixels, where the color values are represented in a defined color formats. One of the

common color formats uses one luminance component and two chrominance components for each pixel, although other formats exist, such as using red, green and blue components for each pixel.

Traditionally, luminance component filtering and chrominance component filtering are done separately, possibly employing different filtering decisions and different deblocking filters. It is, though, possible that the luminance filtering decisions are used in chroma filtering, like in H.264. The embodiments can be applied to filtering control for the luminance component, the chrominance component or both the luminance component and the chrominance component. In a particular embodiment, the embodiments are applied to control luminance or luma filtering. Filtering decisions, or parts of filtering decisions for one component, such as luma, can be then used when making the filtering decisions for other components, such as chroma.

Deblocking filtering is conducted over a boundary, edge or border between neighboring blocks. As a consequence, such boundaries can be vertical boundaries 1, see Fig. 2A, between two neighboring blocks 10, 20 present side by side in the video frame. Alternatively, the boundaries are horizontal boundaries 1, see Fig. 2B, between two neighboring block 10, 20, where one block 10 is positioned above the other block 20 in the video frame. In a particular embodiment, vertical boundaries are filtered first starting from the left-most boundary and proceeding through the boundaries towards the right-hand side in their geometrical order. Then, horizontal boundaries are filtered starting with the boundary on the top and proceeding through the boundaries towards the bottom in their geometrical order. The embodiments are, however, not limited to this particular filtering order and can actually be applied to any predefined filtering order. In a particular embodiment, the boundaries at the edge of the video frame are preferably not filtered and thereby excluded from the deblocking filtering.

Fig. 1 is a flow diagram of a method for filtering control applicable to a block of multiple pixels in a video frame according to an embodiment. The method of Fig. 1 generally starts in step S1 where a first filter decision value is calculated for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel 11 closest to, in a first line of pixels 11, 13, 15, 17 in the block 10, a block boundary 1 to a neighboring block 20 of multiple pixels 21, 23, 25, 27 in the video frame. $p1_i$ denotes a pixel value of a pixel 13 next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 1 and $p2_i$ denotes a pixel value of a pixel 15 second next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 10.

Step S2 correspondingly calculates a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in a corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20, the block boundary 1, $q1_i$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1 and $q2_i$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1.

The first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 belong to the same horizontal line of pixels, i.e. row of pixels, extending over a vertical boundary 1, see Fig. 2A, or belong to the same vertical line of pixels, i.e. column of pixels, extending over a horizontal boundary 1, see Fig. 2B. Hence, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 are perpendicular to the block boundary 1 between the block 10 and the neighboring block 20. Furthermore, the first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 have the same line number. For instance, if the block 10 and the neighboring block 20 each comprises *N*, such as eight, rows or columns of pixels, having row or column numbers i=0...N-1 then the first line 10 of pixels 11, 13, 15, 17 has line number i in the block 10 and the corresponding first line 20 of pixels 21, 23, 25, 27 also has line number i but in the neighboring block 20. Thus, first line 12 of pixels 11, 13, 15, 17 in the block and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 are opposing lines with regard to the block boundary 1.

According to the embodiments, “line of pixels” and “corresponding line of pixels” are employed to denote a “row of pixels” and a “corresponding row of pixels” in the case of a vertical block boundary as in Fig. 2A and denote a “column of pixels” and a “corresponding column of pixels” in the case of a horizontal block boundary as in Fig. 2B.

The first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could be predefined lines in the block 10 and the neighboring block 20, respectively. Thus, the first line 12 of pixels 11, 13, 15, 17 and the corresponding line 22 of pixels 21, 23, 25, 27 have a predefined and fixed line number i with regard to each block boundary 1 for which a filtering control is applied. Alternatively, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could

represent a current line and a current corresponding line, respectively, which is further discussed herein.

The calculation of the first filter decision value in step S1 and the calculation of the second filter decision value in step S2 can be performed serially in any order, i.e. step S1 preceding step S2 or step S2 preceding step S1, or at least partly in parallel. The results of these two steps S1, S2 is, thus, a first filter decision value that is calculated based on pixel values in the block 10 and a second filter decision value that is calculated based on pixel values in the neighboring block 20 on the other side of the block boundary 1 relative to the block 10. More preferably, the calculation of the first decision value is performed only based on pixel values in the block 10 and therefore not based on any pixel values in the neighboring block 20. Correspondingly, the second filter decision value is preferably calculated based only on pixel values in the neighboring block 20 and not based on any pixel values in the block 10.

The first filter decision value calculated in step S1 is then used in step S3 to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1. The second filter decision value is correspondingly used in step S4 to determine how many pixels in a corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1. Thus, separate filter decision values are calculated for each side or part of a row or column of pixels extending over the block boundary 1 and a respective filter decision is taken for each side or part based on the particular filter decision value calculated for that side or part.

This should be compared to the prior art where a single or a set of filter decision values is calculated for a line of pixels and the corresponding line of pixels and where this filter decision value or set of filter decision values is used to decide how many pixels to filter on both sides of the block boundary. Thus, in the prior art the same number of pixels is always filtered for the corresponding line of pixels in the neighboring block as is done for the matching line of pixels in the block.

The present embodiments instead enable an asymmetric filtering control and deblocking filtering by making a separate filter decision for the line 12 of pixels 11, 13, 15, 17 in the block 10 and another, different filter decision for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. This means that based on the particular first and second filter decision values different or the same number of pixels in the line 12 of pixels 11, 13, 15, 17 could be selected for deblocking filtering and

modification as the number of pixels in the corresponding line 22 of pixels 21, 23, 25, 27 that are selected for deblocking filtering and modification.

Generally, herein pX_y denotes the pixel value of pixel number X relative to the block boundary 1 in a line of pixels having line number y in the block 10. Correspondingly, qX_y denotes the pixel value of pixel number X relative to block boundary 1 in a corresponding line of pixels having line number y in the neighboring block 20.

Steps S3 and S4 can be performed serially in any order or indeed at least partly in parallel.

In a first embodiment, steps S1 and S2 could be performed once for a given block boundary 1 between the block 10 and the neighboring block 20 to thereby calculate a first filter decision value and a second filter decision value that applies to all lines 12 of pixels 11, 13, 15, 17 in the block 10 and to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20, respectively. In such approach the same first number of pixels are preferably filtered and modified in each line 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the block boundary 1, where this first number is determined based on the first filter decision value calculated in step S1. Correspondingly, the same second number of pixels are preferably filtered and modified in each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the block boundary 1, where this second number is determined based on the second filter decision value calculated in step S2.

Alternatively, in a second embodiment the first filter decision value and the second filter decision value applies to a subset of the lines 12 of pixels 11, 13, 15, 17 in the block 10 and to a corresponding subset of the corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20. For instance, a pair of filter decision values could be used for the first four lines 12 of pixels 11, 13, 15, 17 in the block and the first four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and with another pair of filter decision values used for the remaining four lines 12 of pixels 11, 13, 15, 17 in the block and the remaining four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

In a third embodiment the calculation in step S1 is performed for each line 12 of pixels 11, 13, 15, 17 in the block 10 and a separate determination in step S3 is then performed for each such line 12 of pixels 11, 13, 15, 17. In such a case, the calculation in step S2 is correspondingly performed for each

corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and a separate determination in step S4 is performed for each such corresponding line 22 of pixels 21, 23, 25, 27.

Thus, in the third embodiment step S3 comprises determining how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated in step S1. Step S4 comprises determining how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated in step S2.

The following part describes how the third embodiment is applied separately for each line (row or column) crossing the block boundary 1. In this example the first filter decision value is defined as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and the second filter decision value is defined as $d_{qi} = |q2_i - 2q1_i + q0_i|$. The method then comprises:

- Calculate d_{pi}, calculate d_{qi} for each line i crossing the block boundary.
- if $d_{pi} < thr1$
  - do normal filtering of line i of current block 10, e.g. filter and modify two pixels from the block border or boundary;
- else, i.e. if $d_{pi} \geq thr1$
  - do not filter the second pixel from the block border or boundary of line i of the current block 10 or do not filter any pixels at all on line i of the current block 10;
- if $d_{qi} < thr2$
  - do normal filtering of line i of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_{qi} \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 of line i of the neighboring block 20 or do not filter any pixels at all on line i of the neighboring block 20.

As is illustrated by the example above, the third embodiment of the method in Fig. 1 can calculate separate first and second filter decision values and therefore make separate determinations of how many pixels to filter for each row or column in the block 10 and the neighboring block 20 relative to the

block boundary 1. Thus, in this third embodiment the first and second filter decision values are line-specific filter decision values, i.e. calculated for each line 12 of pixels 11, 13, 15, 17 in the block 10 and for each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

In the first embodiment, block-specific filter decision values are used. Thus, in such a case a single first filter decision value could be calculated for the block 10 relative to the block boundary 1 and apply to all lines 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the particular block boundary 1. Correspondingly a single second filter decision value is calculated for the neighboring block 20 relative to the block boundary 1 and applies to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the particular block boundary 1.

A first example of this first embodiment involves calculating a first filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1.

The second filter decision value is then preferably calculated as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

The first filter decision value is then used for all lines 12 of pixels 11, 13, 15, 17 in the block 10 when determining how many pixels to filter and the second filter decision value is used for all corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 when determining how many pixels to filter.

In this first example of the first embodiment, the first line of pixels corresponds to line i=2 and the corresponding first line corresponds to corresponding line i=2 and the second line of pixels corresponds to line i=5 and the second corresponding line corresponds to corresponding line i=5. In this case the block 10 preferably comprises eight lines and the neighboring block 20 preferably also comprises eight lines, i.e. i=0-7.

The following part illustrates an implementation example of the first embodiment. In this implementation example the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is defined as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
  - do normal filtering of current block 10, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_p \geq thr1$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr2$
  - do normal filtering of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

In a second example of the first embodiment the first filter decision value is calculated as a block-specific filter decision value based on pixel values in line i=3 and line i=4 instead of line i=2 and line i=5. The corresponding lines i=3 and i=4 in the neighboring block 20 are preferably then used for calculating the second filter decision value. The first filter decision value could then be calculated as

$|p2_3 - 2p1_3 + p0_3| + |p2_4 - 2p1_4 + p0_4|$ and the second filter decision value is calculated as $|q2_3 - 2q1_3 + q0_3| + |q2_4 - 2q1_4 + q0_4|$, wherein $p0_3$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_3$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_3$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_4$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_4$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_4$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1 and $q0_3$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_3$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_3$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_4$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_4$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_4$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

In the second embodiment a first filter decision value and a second filter decision value are calculated for a group of four lines of pixels and four corresponding lines of pixels. This second embodiment can be suitable if the block and the neighboring block each have a size of 4×4 pixels. In addition, the second embodiment could also be used for larger blocks of pixels, such as 8×8 pixels. In the latter case, a pair of filter decisions is calculated for the first four lines pixels and first four corresponding lines of pixels and another pair of filter decisions is calculated for the remaining four lines of pixels and the remaining four corresponding lines of pixels.

A first example of the second embodiment calculates the first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and the second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision

value is calculated as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ and $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

A second example of the second embodiment calculates the first filter decision value as $|p2_1 - 2p1_1 + p0_1| + |p2_2 - 2p1_2 + p0_2|$ and the second filter decision value as $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision value is calculated as $|p2_1 - 2p1_1 + p0_1| + |p2_2 - 2p1_2 + p0_2|$ and $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_5 - 2p1_5 + p0_5| + |p2_6 - 2p1_6 + p0_6|$ and $|q2_5 - 2q1_5 + q0_5| + |q2_6 - 2q1_6 + q0_6|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

This concept of the second embodiment can be extended to the case where the first filter decision value is calculated based on the pixel values of pixels present in a subset of the lines of pixels in the block and the second filter decision value is calculated based on the pixel values of pixels present in a subset of the corresponding lines of pixels in the neighboring block. Thus, in this general concept of the second embodiment the first filter decision value could be calculated as $|p2_i - 2p1_i + p0_i| + |p2_j - 2p1_j + p0_j|$, wherein i, j represent different line numbers in the interval 0 to N-1, with N denoting the total number of lines of pixels in the block and the neighboring block and $i \neq j$. The second filter decision value is then preferably calculated as $|q2_i - 2q1_i + q0_i| + |q2_j - 2q1_j + q0_j|$. This concept can of course be extended with the subset containing more than two of the lines of pixels or the corresponding lines of pixels.

In a related example of the first or third embodiment, the first filter decision value is calculated as $\varpi_i|p2_i - 2p1_i + p0_i| + \varpi_j|p2_j - 2p1_j + p0_j|$ and the second filter decision value is calculated as $\varpi_i|q2_i - 2q1_i + q0_i| + \varpi_j|q2_j - 2q1_j + q0_j|$. ϖ_i, ϖ_j represent different line-specific weights. This concept can also be extended to the case with more than two lines of pixels and two corresponding lines of pixels. In a particular example, a line of pixels or corresponding line of pixels that is closer to the middle of the block or the neighboring block could then be assigned a comparatively higher weight as compared to a line or pixels or corresponding line of pixels that is closer to one of the edges of the block or the neighboring block.

In a fourth embodiment, a combination of block-specific and line-specific filter decision values is used to determine how many pixels to filter for the lines of pixels in the block and the corresponding lines of pixels in the neighboring block. Fig. 3 schematically illustrates such an embodiment. The method starts in step S10 where a third filter decision value is calculated as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the second line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the second line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a third line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the third line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the third line of pixels, the block boundary 1. The second line of pixels preferably corresponds to line number 2 in the block 10 and the third line of pixel preferably corresponds to line number 5 in the block 10, see Figs. 2A and 2B.

The next step S11 calculates a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a

corresponding third line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding third line of pixels, the block boundary 20 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding third line of pixels, the block boundary 1. The second corresponding line of pixels preferably corresponds to line number 2 in the neighboring block 20 and the third corresponding line of pixel preferably corresponds to line number 5 in the neighboring block 20, see Figs. 2A and 2B.

Steps S10 and S11 can be performed serially in any order or at least partly in parallel.

The next step S12 compares the third filter decision value calculated in step S10 with a third threshold value (T_3). If the third filter decision value is below the third threshold value the method continues to steps S1 and then S3 of Fig. 1. Thus, in such a case a respective line-specific or first filter decision value is calculated for each line i in the block 10, where i preferably is from 0 to 7. This first filter decision value is then calculated as $|p2_i - 2p1_i + p0_i|$ in step S1 of Fig. 1. Step S3 of Fig. 1 determines how many pixels in the line i of pixels in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated for the line i of pixels in step S1. This procedure is performed for each line of pixels in the block 10. Thus, with a block 10 as illustrated in Figs. 2A or 2B steps S1 and S3 will be performed eight times. The method then continues to step S13 of Fig. 3. Correspondingly, if the third filter decision value is not below the first threshold value in step S12 the method continues to step S13.

Step S13 compares the fourth filter decision value calculated in step S11 with a fourth threshold value (T_4). If the fourth filter decision value is below the fourth threshold the method continues to steps S2 and S4 of Fig. 1. A respective line-specific or second filter decision value is calculated for each corresponding line i in the neighboring block 20 as $|q2_i - 2q1_i + q0_i|$ in step S2 of Fig. 1. Step S4 of Fig. 3 determines how many pixels in the corresponding line i of pixels in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i of pixels in step S2. This procedure is performed for each corresponding line of pixels in the neighboring block 20. The method then ends. Correspondingly, if the fourth filter decision value is not below the second threshold value in step S13 the method ends.

The loop formed by steps S12, S1 and S3 can be performed sequentially in any order relative to the loop formed by steps S13, S2 and S4 or at least partly in parallel.

In an example of this fourth embodiment a combination of block-based and line-based asymmetric filter decisions is used. In this example the third filter decision value is calculated as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the fourth filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$. The line-specific filter decision values, i.e. the first and second filter decision values, are calculated as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and $d_{qi} = |q2_i - 2q1_i + q0_i|$ for line and corresponding line number i, respectively.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
  - for each line i
    - calculate d_{pi} for line i
    - if $d_{pi} < thr1$
      - do normal filtering of line i in current block 10, e.g. two pixels from the block border or boundary 1;
    - else, i.e. if $d_{pi} \geq thr1$
      - do not filter the second pixel from the block border or boundary 1 of line i of current block 10 or do not filter any pixels at all on line i of current block 10;
- else, i.e. if $d_p \geq thr1$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr1$
  - for each line i
    - calculate d_{qi} for line i
    - if $d_{qi} < thr2$
      - do normal filtering of line i in neighboring block 20, e.g. two pixels from the block border or boundary 1;

- else, i.e. if $d_{qi} \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 of line i of neighboring block 20 or do not filter any pixels at all on line i of neighboring block 20;
- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

In the above disclosed example the same threshold value has been used when comparing the third filter decision value and the first filter decision values, i.e. thr1, and the same threshold value has been used when comparing the fourth filter decision value and the second filter decision values, i.e. thr2. In an alternative approach, a third threshold value is used for the third filter decision value, a first threshold value is used for the first filter decision values, a fourth threshold value is used for the fourth filter decision value and a second threshold value is used for the second threshold values. In a particular embodiment, the third and fourth threshold values are equal and the first and second threshold values are equal.

Fig. 4 is a flow diagram illustrating a particular embodiment of the determining steps S3 and S4 of Fig. 1. The method continues from step S2 in Fig. 1. A next step S20 compares the first filter decision value (d_p) calculated in step S1 in Fig. 1 to a first threshold value (T_1). If the first filter decision value is below the first threshold value the method continues from step S20 to step S21. Step S21 determines to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. These two pixels are preferably the pixel 11 closest to the block boundary 1 and the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. However, if the first filter decision value is not below the first threshold in step S20 the method instead continues to step S22. A first embodiment of step S22 determines to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. This pixel 11 is preferably the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. A second embodiment of step S22 determines to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

Steps S23 to S25 perform the corresponding determination for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. Thus, step S23 compares the second filter decision value (d_q) calculated in step S2 in Fig. 1 with a second threshold value (T_2). If the second filter decision value is

below the second threshold value the method continues to step S24. Step S24 determines to filter two pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. These two pixels 21, 23 are preferably the pixel 21 closest to the block boundary 1 and the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. If the second filter decision value is not below the second threshold the method instead continues to step S25 from step S23. A first embodiment of step S25 determines to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. This pixel 21 is preferably the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. A second embodiment of step S25 determines to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block relative to the block boundary 1.

Steps S20, S21 and S22 can be performed prior to, following or at least in parallel to steps S23, S24 and S25.

This concept can be extended by using more than one threshold value per filter decision value. For instance, if $d_p<T_1$ two pixels are filtered in the line 12 of pixels 11, 13, 15, 17, if $T_1\leq d_p<T_1'$ one pixel is filtered in the line 12 of pixels 11, 13, 15, 17 and if $d_p\geq T_1'$ no pixels are filtered in the line 12 of pixels 11, 13, 15, 17. In this case $T_1<T_1'$. Correspondingly, if $d_q<T_2$ two pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27, if $T_2\leq d_q<T_2'$ one pixel is filtered in the corresponding line 22 of pixels 21, 23, 25, 27 and if $d_q\geq T_2'$ no pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27. In this case $T_2<T_2'$.

Thus, in a general aspect the closer the first or second filter decision value is to zero the more filtering is to be applied to the particular line or corresponding line of pixels by filtering and possibly modifying more pixels in the line or corresponding line of pixels as compared to a larger first or second filter decision value. This means that a zero or low first or second filter decision value implies no or few structures but rather a fairly uniform area in the video frame. Correspondingly, a high first or second filter decision value generally reflects local structures in the area in the video frame, which local structures should not be repressed or filtered away.

This embodiment decreases the computational complexity in connection with deblocking filtering since the filtering of the second pixel from the block border may happen less frequently as compared to the prior art HEVC solution.

The threshold values discussed in the foregoing and used to compare the different filter decision values are preferably dependent on the quantization parameter (QP) assigned to the block or to the neighboring block. Fig. 5 schematically illustrates such an approach. The method starts in step S30 where the first threshold value, to which the first filter decision value is compared (see step S20 in Fig. 4), is determined based on a quantization parameter associated with the block 10. Correspondingly, step S31 determines the second threshold value, to which the second threshold value is compared (see step S23 in Fig. 4), based on a quantization parameter associated with the neighboring block 20 and/or a quantization parameter associated with the block 10.

For instance, T_1 and T_2 are determined based on the parameter β, which is determined from the QP value of the block 10 or the neighboring block 20. In a particular embodiment, the parameter β is read from a table based on the QP value, see Table 1 below.

Table 1 - β and QP values

QP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
QP	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
QP	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
β	38	40	42	44	46	48	50	52	54	56	58	60	62	64	64	64	64	64	

In particular embodiments $T_1=T_2=\beta/6$ or $T_1=T_2=(\beta + \beta>>1)>>3$. As another variant of the embodiment, the thresholds can be read from separate tables, i.e. T_1=function(QP), T_2=function(QP). Also the above mentioned third and fourth threshold values are preferably determined based on the quantization parameter associated with the block and the neighboring block, respectively.

Fig. 6 is a flow diagram illustrating how the filtering control of the embodiments can be used in connection with a filtering process. The method starts in step S40 where a first offset or delta value Δ is calculated based on $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel 11 closest to, in a line 12 of pixels 11, 13, 15, 17, the block boundary 1, $p1_j$ denotes a pixel value of a pixel 13 next closest to, in the line 12 of pixels 11, 13, 15, 1), the block boundary 1, $q0_j$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in the corresponding line 22

of pixels 21, 23, 25, 27, the block boundary 1 and $q1_i$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1.

This first offset is used in step S41 to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value, i.e. $p0'_j = p0_j + \Delta$. Step S41 also modifies the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value, i.e. $q0'_j = q0_j - \Delta$. The method then continues to steps S1 and S2 of Fig. 1 where the first (d_p) and second (d_q) filter decision values are calculated. A next step S42 compares the first filter decision value to a first threshold value (T_1). This step S42 corresponds to step S20 in Fig. 4. If the first filter decision value is below the threshold the method continues to step S43.

Step S43 calculates a second offset or delta value Δ_p based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel 15 second next closest to, in the line 12 of pixels 11, 13, 15, 17, the block boundary 1. The second offset is then used in step S44 to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value, i.e. $p1'_j = p1_j + \Delta_p$.

The method then continues to step S45. The method also continues in Fig. 6 from step S42 to step S45 if the first threshold value is not below the first threshold.

Step S45 compares the second filter decision value with a second threshold (T_2). This step S45 corresponds to step S23 of Fig. 4. If the second filter decision value is below the second threshold the method continues to step S46. Step S46 calculates a third offset Δ_q based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1. The third offset is used in step S47 to modify the pixel value of the pixel 23 next closest to the block

boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value, i.e. $q1'_j = q1_j + \Delta_q$.

Steps S42, S43 and S44 can be performed serially in any order or at least partly in parallel with steps S45, S46 and S47.

In above, the first, second and third offsets are calculated based on particular equations of pixel values. This means that the first offset is calculated as a function of $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, the second offset is calculated as a function of $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$ and the third offset is calculated as a function of $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$. Different such functions are possible and can be used in steps S40, S43 and S46. Such functions could then be defined so that the calculations of the offsets are efficiently performed in hardware. In such a case, it is generally preferred not to have any divisions and/or define the functions so that the offsets will be an integer value. In an embodiment, (X+8)>>4 is used as an integer-expression of X/16, where >> denotes a right shift operation. Thus, in a particular embodiment step S40 calculates the first offset to be based on and preferably equal to $(9\times(q0_j - p0_j) - 3\times(q1_j - p1_j) + 8) >> 4$. Corresponding integer representations of the second and third offsets could be $(((p0_j + p2_j + 1) >> 1) - p1_j + \Delta) >> 1$ and $(((q0_j + q2_j + 1) >> 1) - q1_j - \Delta) >> 1$.

In an example the modified pixel values as a result of deblocking are calculated like in the following. In this example, the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

- $\Delta = \frac{9\times(q0 - p0) - 3\times(q1 - p1)}{16}$
- $p_0' = p_0 + \Delta$
- $q_0' = q_0 - \Delta$

- if $d_p < thrP$
  - $\Delta_p = \frac{p0 + p2 - 2p1_j + 2\Delta}{4}$
  - $p_1' = p_1 + \Delta_p$
- if $d_q < thrQ$
  - $\Delta_q = \frac{q0 + q2 - 2q1 - 2\Delta}{4}$
  - $q_1' = q_1 + \Delta_q$

Exact formulas for computation of the example above in the programming language can look like in the text below. Here, the Clip3 function is clipping of the output values to the range between the two first function arguments.

```
Int xCalcDP(Pel* piSrc, Int iOffset)
{
   return abs(piSrc[-iOffset*3]-2*piSrc[-iOffset*2]+piSrc[-
iOffset]);
}

Int xCalcDQ(Pel* piSrc, Int iOffset)
{
  return abs(piSrc[0]-2*piSrc[iOffset]+piSrc[iOffset*2]);
}

Int iDP=xCalcDP(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDP(piTmpSrc+iSrcStep*
(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iDQ=xCalcDQ(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDQ(piTmpSrc+iSrcStep*(
Idx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iSideThreshold=iBeta/6;

Bool bFilterP=(iDP<iSideThreshold);
Bool bFilterQ=(iDQ<iSideThreshold);
```

```
delta=(9*(m4-m3)-3*(m5-m2)+8)>>4;

if (abs(delta)<iThrCut)
{
  Int tc2=tc>>1;

  delta=Clip3(-tc, tc, delta);
  piSrc[-iOffset]=Clip((m3+delta));
  piSrc[0]=Clip((m4-delta));

  if(bFilterP)
  {
    Int delta1=Clip3(-tc2,tc2,(((m1+m3+1)>>1)-m2+delta)>>1));
    piSrc[-iOffset*2]=Clip((m2+delta1));
  }
  if(bFilterQ)
  {
    Int delta2=Clip3(-tc2,tc2,(((m6+m4+1)>>1)-m5-delta)>>1));
    piSrc[iOffset]=Clip((m5+delta2));
  }
}
```

Fig. 7 is a flow diagram illustrating additional optional steps of the method in Fig. 1. The method continues from step S2 in Fig. 1. A next step S50 compares a sum of the first decision value and the second decision value with a threshold value (T). If the sum is not below the threshold value, the method ends. Thus, in such a case no filtering at all is applied to block 10 and neighboring block 20 with regard to the particular block boundary 1. The block 10 and the neighboring block 20 then comprises at lot of local structures, which should not be filtered away. However, if the sum is below the threshold value the method continues to steps S3 and S4 in Fig. 1, where the determination of how many pixels to filter is performed based on the first filter decision value (step S3) or the second filter decision value (step S4).

This embodiment has an advantage that it does not require many additional computations as the values for the first and second filter decisions are also used for deciding whether to filter the block boundary at all.

The embodiments disclosed herein achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

Fig. 8 is a schematic block diagram of an embodiment of a filtering control device 100. The filtering control device 100 comprises a first decision value calculator 110 configured to calculate a first filter decision value for a block 10 in a video frame based at least on $|p2_i - 2p1_i + p0_i|$. The filtering control device 100 also comprises a second decision value calculator 120 configured to calculate a second, different filter decision value for the block 10 based on $|q2_i - 2q1_i + q0_i|$.

A first pixel determiner 130 or first pixel determining unit or processor is configured to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to a block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110. A second pixel determiner 140 or second pixel determining unit or processor is provided in the filtering control device 100 to determine how many pixels in a corresponding line 22 of pixel 21, 23, 25, 27 in a neighboring block 20 of the video frame to filter relative to the block boundary based on the second filter decision value calculated by the second decision value calculator 120.

In an embodiment, the first pixel determiner 130 is configured to determine how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the first line 12 of pixels 11, 13, 15, 17. The second pixel determiner 140 correspondingly determines in this embodiment how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated by the second decision value calculator 120 for the corresponding first line 22 of pixels 21, 23, 25, 27.

In another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second decision value calculator 120 is configured to calculate the second filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

In yet another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value of a first pair as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and the second decision value calculator 120 is configured to calculate the second filter decision value of the first pair as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. The first filter decision value calculator 110 is also configured to calculate the first filter decision value of a second pair as $|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ and the second filter decision value calculator 120 is also configured to calculate the second filter decision value of a the second pair as $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$.

Fig. 9 is a schematic block diagram of another embodiment of a filtering control device 100. The filtering control device 100 comprises, in this embodiment and in addition to the first decision value calculator 110, the second decision value calculator 120, the first pixel determiner 130 and the second pixel determiner 140, a third decision value calculator 150. The third decision value calculator 150 is then configured to calculate a third filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$. A fourth decision value calculator 160 is also implemented in the filtering control device 100 and configured to calculate a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

In this embodiment, the first filter decision value calculator 110 is configured to calculate the first filter decision value if the third filter decision value calculated by the third decision value calculator 150 is below a third threshold value. If the third decision value is below the third threshold, the first decision value calculator 110 calculates a first threshold value for each line i 12 of pixels 11, 13, 15, 17 in the block 10 as $|p2_i - 2p1_i + p0_i|$. The first pixel determiner 130 then determines, if the third filter decision value is below the third threshold value and for each line i 12 of pixels 11, 13, 15, 17 in the block 10, how many pixels in the line i 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the line i 12 of pixels 11, 13, 15, 17.

The second decision value calculator 120 is preferably responsive to a comparison between the fourth filter decision value and a fourth threshold value. Thus, if the fourth filter decision value calculated by the fourth decision value calculator 160 is below the fourth threshold the second decision value calculator 120 calculates a second filter decision value as $|q2_i - 2q1_i + q0_i|$ for each corresponding

line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20. The second pixel determiner 240 is configured to determine, if the fourth filter decision value is below the fourth threshold value and for each corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20, how many pixels in the corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i 22 of pixels 21, 23, 25, 27.

Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises a first comparator 180 configured to compare the first filter decision value calculated by the first decision value calculator 110 to a first threshold value. A second comparator 182 is correspondingly configured to compare the second filter decision value calculated by the second decision value calculator 120 to a second threshold value.

In this embodiment, the first pixel determiner 130 is configured to determine to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1 if the first filter decision value is below the first threshold value as determined by the first comparator 180. However, if the first filter decision value is not below the first threshold value the first pixel determiner 130 is instead configured to determine to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. Alternatively, the first pixel determiner 130 is instead configured to determine to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

The second pixel determiner 140 is configured to determine to filter two pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1 if the second filter decision value is below the second threshold value as determined by the second comparator 182. However, if the second filter decision value is not below the second threshold the second pixel determiner 140 is instead configured to determine to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. Alternatively, the second pixel determiner 140 is instead configured to determine to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1.

In an embodiment the filtering control device 100 of Fig. 10 comprises a first offset calculator 181 configured to calculate a first offset based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$. A first pixel modifier

190 of the filtering control device 100 is configured to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value of this pixel 11. A second pixel value modifier 192 is configured to modify the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 12 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value of this pixel 21.

A second offset calculator 183 is preferably implemented in the filtering control device 100 to calculate a second offset if the first filter decision value is below the first threshold value as determined by the first comparator 180. The second offset is then calculated based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$. A third pixel modifier 194 is operated if the first filter decision value is below the first threshold value. In such a case, the third pixel modifier 194 is configured to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value of this pixel 13.

A third offset calculator 185 is configured to calculate a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$ if the second filter decision value is below the second threshold value as determined by the second comparator 182. If the second filter decision value is below the second threshold value a fourth pixel modifier 196 of the filtering control device 100 is configured to modify the pixel value of the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value of this pixel 23.

The embodiments of the filtering control device 100 discussed in the foregoing in connection with Figs. 9 and 10 compares filter decision values to respective threshold values. In an embodiment, such threshold values are calculated by the filtering control device 100 for the particular block boundary 1. The filtering control device 100 then preferably comprises a threshold determiner 170 or threshold determining processor or unit configured to determine the first threshold value used by the first comparator 180 in Fig. 10 and the third threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the block 10. Correspondingly, the threshold determiner 170 correspondingly preferably determines the second threshold value used by the second comparator 182 in Fig. 10 and the fourth threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the neighboring block 20.

Fig. 11 is schematic block diagram of yet another embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises in this embodiment a third comparator 184 configured to compare a sum of the first filter decision value and the second filter decision value to a threshold value. If the sum is equal to or exceeds the threshold value the first and second pixel determiners 130, 140 will not determine any number of pixels to filter since no filtering is to be applied to the block 10 and the neighboring block 20 with regard to the particular block boundary 1. However, if the sum is below the threshold, the first and second pixel determiners 130, 140 are operated to determine the number of pixels to filter based on the first or second filter decision values, respectively.

The embodiments of the filtering control device 100 discussed in the foregoing and disclosed in Figs. 8-11 can be combined. For instance, the third value calculator 150 and fourth value calculator 160 of Fig. 9 can be implemented in any of the embodiments disclosed in Figs. 10 or 11. Correspondingly, the third comparator 184 of Fig. 11 can be implemented in any of the embodiments disclosed in Figs. 9 or 10.

Although the respective units 110-196 disclosed in conjunction with Figs. 8-11 have been disclosed as physically separate units 110-196 in the filtering control device 100, and all may be special purpose circuits, such as ASICs (Application Specific Integrated Circuits), alternative embodiments of the filtering control device 100 are possible where some or all of the units 110-196 are implemented as computer program modules running on a general purpose processor. Such an embodiment is disclosed in Fig. 12.

Fig. 12 schematically illustrates an embodiment of a computer 70 having a processing unit 72, such as a DSP (Digital Signal Processor) or CPU (Central Processing Unit). The processing unit 72 can be a single unit or a plurality of units for performing different steps of the method described herein. The computer 70 also comprises an input/output (I/O) unit 71 for receiving recorded or generated video frames or encoded video frames and outputting encoded video frame or decoded video data. The I/O unit 71 has been illustrated as a single unit in Fig. 12 but can likewise be in the form of a separate input unit and a separate output unit.

Furthermore, the computer 70 comprises at least one computer program product 73 in the form of a non-volatile memory, for instance an EEPROM (Electrically Erasable Programmable Read-Only Memory), a flash memory or a disk drive. The computer program product 73 comprises a computer

program 74, which comprises code means which when run on or executed by the computer 70, such as by the processing unit 72, causes the computer 70 to perform the steps of the method described in the foregoing in connection with Fig. 1. Hence, in an embodiment the code means in the computer program 74 comprises a first decision value calculating (DVC) module 310 for calculating the first filter decision value for a block, a second pixel value calculating module 320 for calculating the second filter decision value for the block, a first pixel determining (PD) module 330 for determining how many pixels in the line 12 of pixels 11, 13, 15, 17 to filter and a second pixel determining module 340 for determining how many pixels in the corresponding line 22 of pixels 21, 23, 25, 27 to filter. These modules 310-340 essentially perform the steps of the flow diagram in Fig. 1 when run on the processing unit 72. Thus, when the different modules 310-340 are run on the processing unit 72 they correspond to the corresponding units 110-140 of Figs. 8-11.

The computer program 74 may additionally comprise a third decision value calculating module, a fourth decision value calculating module, a threshold determining module, a first comparing module, second comparing module, a third comparing module, a first offset calculating module, a second offset calculating module, a third offset calculating module, a first pixel modifying module, a second pixel modifying module, a third pixel modifying module and/or a fourth pixel modifying module to perform the operation of the corresponding units 150-196 in Figs. 9-11.

The computer 70 of Fig. 12 can be a user equipment or be present in a user equipment. In such a case, the user equipment may additionally comprise or be connected to a display to display video data.

The filtering control device of Figs. 8-11 is preferably used in video coding. It functions and is therefore preferably implemented both in a video encoder and in a video decoder. The video decoder can be implemented preferably in hardware but also in software. The same holds for the video encoder.

Fig. 13 is a schematic block diagram of an encoder 40 for encoding a block of pixels in a video frame of a video sequence according to an embodiment.

A current block of pixels is predicted by performing a motion estimation by a motion estimator 50 from an already provided block of pixels in the same frame or in a previous frame. The result of the motion estimation is a motion or displacement vector associated with the reference block, in the case of inter prediction. The motion vector is utilized by a motion compensator 50 for outputting an inter prediction of the block of pixels.

An intra predictor 49 computes an intra prediction of the current block of pixels. The outputs from the motion estimator/compensator 50 and the intra predictor 49 are input in a selector 51 that either selects intra prediction or inter prediction for the current block of pixels. The output from the selector 51 is input to an error calculator in the form of an adder 41 that also receives the pixel values of the current block of pixels. The adder 41 calculates and outputs a residual error as the difference in pixel values between the block of pixels and its prediction.

The error is transformed in a transformer 42, such as by a discrete cosine transform, and quantized by a quantizer 43 followed by coding in an encoder 44, such as by entropy encoder. In inter coding, also the estimated motion vector is brought to the encoder 44 for generating the coded representation of the current block of pixels.

The transformed and quantized residual error for the current block of pixels is also provided to a inverse quantizer 45 and inverse transformer 46 to retrieve the original residual error. This error is added by an adder 47 to the block prediction output from the motion compensator 50 or the intra predictor 49 to create a reference block of pixels that can be used in the prediction and coding of a next block of pixels. This new reference block is first processed by a filtering control device 100 according to the embodiments in order to control any deblocking filtering that is applied to the reference block to combat any blocking artifact. The processed new reference block is then temporarily stored in a frame buffer 48, where it is available to the intra predictor 49 and the motion estimator/compensator 50.

Fig. 14 is a corresponding schematic block diagram of a decoder 60 comprising a filtering control device 100 according to the embodiments. The decoder 60 comprises a decoder 61, such as entropy decoder, for decoding an encoded representation of a block of pixels to get a set of quantized and transformed residual errors. These residual errors are dequantized in an inverse quantizer 62 and inverse transformed by an inverse transformer 63 to get a set of residual errors.

These residual errors are added in an adder 64 to the pixel values of a reference block of pixels. The reference block is determined by a motion estimator/compensator 67 or intra predictor 66, depending on whether inter or intra prediction is performed. A selector 68 is thereby interconnected to the adder 64 and the motion estimator/compensator 67 and the intra predictor 66. The resulting decoded block of pixels output form the adder 64 is input to a filtering control device 100 according to the embodiments in order to control any deblocking filter that is applied to combat any blocking artifacts. The filtered block of pixels is output form

the decoder 60 and is furthermore preferably temporarily provided to a frame buffer 65 and can be used as a reference block of pixels for a subsequent block of pixels to be decoded. The frame buffer 65 is thereby connected to the motion estimator/compensator 67 to make the stored blocks of pixels available to the motion estimator/compensator 67.

The output from the adder 64 is preferably also input to the intra predictor 66 to be used as an unfiltered reference block of pixels.

In the embodiments disclosed in Figs. 13 and 14 the filtering control device 100 controls deblocking filtering in the form of so called in-loop filtering. In an alternative implementation at the decoder 60 the filtering control device 100 is arranged to perform so called post-processing filtering. In such a case, the filtering control device 100 operates on the output frames outside of the loop formed by the adder 64, the frame buffer 65, the intra predictor 66, the motion estimator/compensator 67 and the selector 68. No deblocking filtering and filtering control is then typically done at the encoder.

Fig. 15 is a schematic block diagram of a user equipment or media terminal 80 housing a decoder 60 with a filtering control device. The user equipment 80 can be any device having media decoding functions that operates on an encoded video stream of encoded video frames to thereby decode the video frames and make the video data available. Non-limiting examples of such devices include mobile telephones and other portable media players, tablets, desktops, notebooks, personal video recorders, multimedia players, video streaming servers, set-top boxes, TVs, computers, decoders, game consoles, etc. The user equipment 80 comprises a memory 84 configured to store encoded video frames. These encoded video frames can have been generated by the user equipment 80 itself. Alternatively, the encoded video frames are generated by some other device and wirelessly transmitted or transmitted by wire to the user equipment 80. The user equipment 80 then comprises a transceiver (transmitter and receiver) or input and output port 82 to achieve the data transfer.

The encoded video frames are brought from the memory 84 to a decoder 60, such as the decoder illustrated in Fig. 14. The decoder 60 comprises a filtering control device 100 according to embodiments. The decoder 60 then decodes the encoded video frames into decoded video frames. The decoded video frames are provided to a media player 86 that is configured to render the decoded video frames into video data that is displayable on a display or screen 88 of or connected to the user equipment 80.

In Fig. 15, the user equipment 80 has been illustrated as comprising both the decoder 60 and the media player 86, with the decoder 60 implemented as a part of the media player 86. This should, however, merely be seen as an illustrative but non-limiting example of an implementation embodiment for the user equipment 80. Also distributed implementations are possible where the decoder 60 and the media player 86 are provided in two physically separated devices are possible and within the scope of user equipment 80 as used herein. The display 88 could also be provided as a separate device connected to the user equipment 80, where the actual data processing is taking place.

Fig. 16 illustrates another embodiment of a user equipment 80 that comprises en encoder, such as the encoder of Fig. 13, comprising a filtering control device according to the embodiments. The encoder 40 is then configured to encode video frames received by the I/O unit 82 and/or generated by the user equipment 80 itself. In the latter case, the user equipment 80 preferably comprises a media engine or recorder, such as in the form of or connected to a (video) camera. The user equipment 80 may optionally also comprise a media player 86, such as a media player 86 with a decoder and filtering control device according to the embodiments, and a display 88.

As illustrated in Fig. 17, the encoder 40 and/or decoder 60, such as illustrated in Figs. 13 and 14, may be implemented in a network device 30 being or belonging to a network node in a communication network 32 between a sending unit 34 and a receiving user equipment 36. Such a network device 30 may be a device for converting video according to one video coding standard to another video coding standard, for example, if it has been established that the receiving user equipment 36 is only capable of or prefers another video coding standard than the one sent from the sending unit 34. The network device 30 can be in the form of or comprised in a radio base station, a Node-B or any other network node in a communication network 32, such as a radio-based network.

The embodiments described above are to be understood as a few illustrative examples of the present invention. It will be understood by those skilled in the art that various modifications, combinations and changes may be made to the embodiments without departing from the scope of the present invention. In particular, different part solutions in the different embodiments can be combined in other configurations, where technically possible. The scope of the present invention is, however, defined by the appended claims.

CLAIMS

1. A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said method comprising:

calculating (S1) a first filter decision value for said block (10) based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculating (S2) a second filter decision value for said block (20) based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determining (S3) how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

2. The method according to claim 1, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

3. The method according to claim 1, wherein

calculating (S1) said first filter decision value comprises calculating (S1) said first filter decision value as:

$$\left|p2_2 - 2p1_2 + p0_2\right| + \left|p2_5 - 2p1_5 + p0_5\right|$$

wherein $p0_2$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_2$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_2$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_5$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_5$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

calculating (S2) said second filter decision value comprises calculating (S2) said second filter decision value as:

$$\left|q2_2 - 2q1_2 + q0_2\right| + \left|q2_5 - 2q1_5 + q0_5\right|$$

wherein $q0_2$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_2$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_2$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_5$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_5$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_5$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

4. The method according to any of the claims 1 to 3, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

5. The method according to any of the claims 1 to 3, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23 ,25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

6. The method according to any of the claims 3 to 5, further comprising:

determining (S30) said first threshold value based on a quantization parameter associated with said block (10); and

determining (S31) said second threshold value based on said quantization parameter associated with said neighboring block (20).

7. The method according to any of the claims 3 to 6, further comprising:

calculating (S40) a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

modifying (S41) said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

modifying (S41) said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

calculating (S43), if said first filter decision value is below said first threshold value, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

modifying (S44), if said first filter decision value is below said first threshold, said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by

adding said second offset to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

calculating (S46), if said second filter decision value is below said second threshold value, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

modifying (S47), if said second filter decision value is below said second threshold, said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

8. The method according to any of the claims 1 to 7, further comprising comparing (S50) a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

9. A filtering control device (100) comprising:

a first decision value calculator (110) configured to calculate a first filter decision value for a block (10) of multiple pixels (11, 13, 15, 17) in a video frame based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels

(11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

a second decision value calculator (120) configured to calculate a second filter decision value for said block (10) based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel determiner (130) configured to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

a second pixel determiner (140) configured to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

10. The device according to claim 9, wherein

said first pixel determiner (130) is configured to determine how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

11. The device according to claim 9, wherein

said first decision value calculator (110) is configured to calculate said first filter decision value as:

$$\left|p2_2 - 2p1_2 + p0_2\right| + \left|p2_5 - 2p1_5 + p0_5\right|$$

wherein $p0_2$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_2$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_2$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_5$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_5$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

said second decision value calculator (120) is configured to calculate said second filter decision value as:

$$|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$$

wherein $q0_2$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_2$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_2$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_5$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_5$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_5$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

12. The device according to any of the claims 9 to 11, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

13. The device according to any of the claims 9 to 11, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

14. The device according to any of the claims 11 to 13, further comprising a threshold determiner (170) configured to i) determine said first threshold value based on a quantization parameter associated with said block (10), and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block (20).

15. The device according to any of the claims 11 to 14, further comprising:

a first offset calculator (181) configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel modifier (190) configured to modify said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset calculated by said first offset calculator (181) to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a second pixel modifier (192) configured to modify said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset calculated by said first offset calculator (181) from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

a second offset calculator (183) configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator (180), a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

a third pixel modifier (194) configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator (180), said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset calculated by said second offset calculator (183) to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a third offset calculator (185) configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator (182), a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring

block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

a fourth pixel modifier (196) configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator (182), said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset calculated by said third offset calculator (185) to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

16. The device according to any of the claims 9 to 15, further comprising a third comparator (184) configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner (130) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

17. An encoder (40) comprising a filtering control device (100) according to any of the claims 9 to 16.

18. A user equipment (80) comprising:

a memory (84) configured to store video frames; and

an encoder (40) according to claim 17 configured to encode said video frames into encoded video frames, wherein said memory (84) is further configured to store said encoded video frames.

19. A decoder (60) comprising a filtering control device (100) according to any of the claims 9 to 16.

20. A user equipment (80) comprising:

a memory (84) configured to store encoded video frames;

a decoder (60) according to claim 19 configured to decode said encoded video frames into decoded video frames; and

a media player (86) configured to render said decoded video frames into video data displayable on a display (88).

21. A computer program (74) for filtering control of a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said computer program (74) comprises code means which when run on a computer (70) causes the computer (70) to:

calculate a first filter decision value for said block (10) based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17, 19), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (13) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculate a second filter decision value for said block based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (23) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filer relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

22. A computer program product (73) comprising computer readable code means and a computer program (74) according to claim 21 stored on said computer readable means.

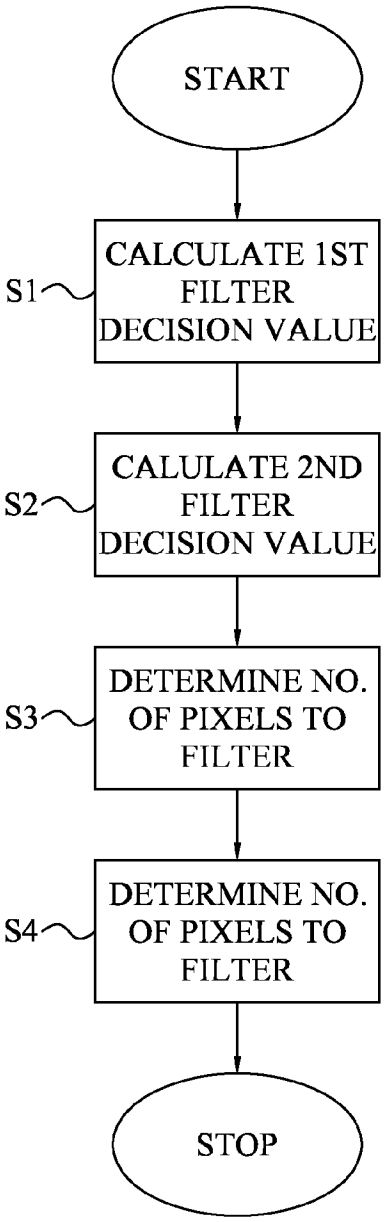


Fig. 1

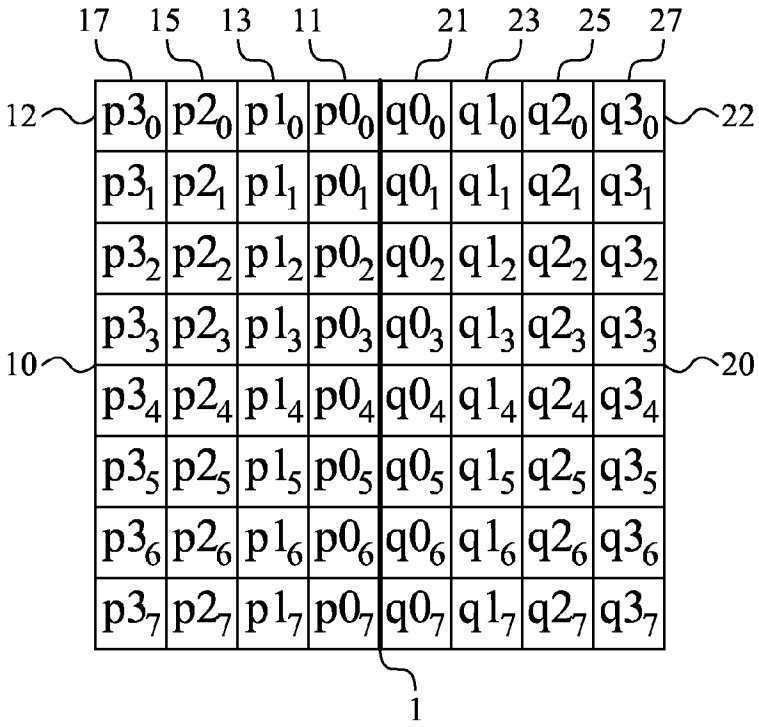


Fig. 2A

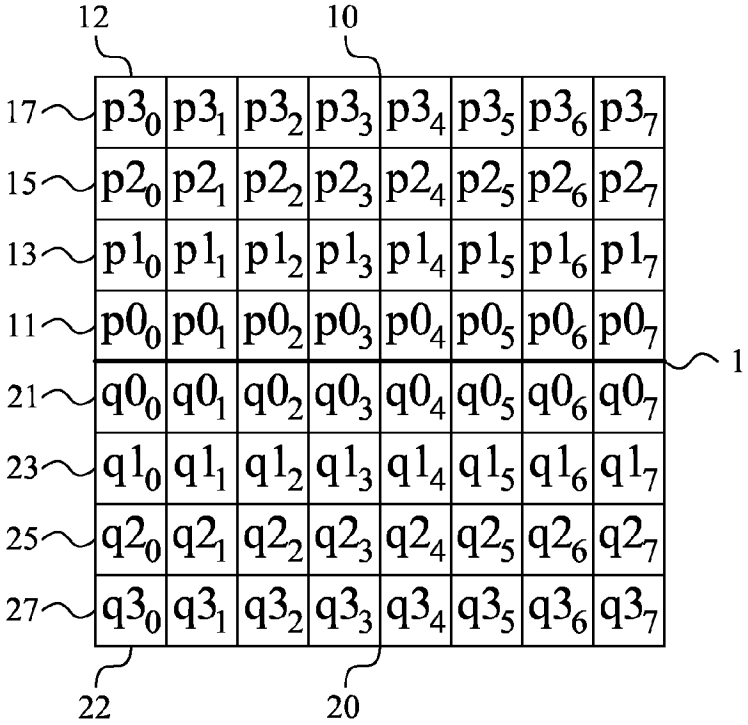


Fig. 2B

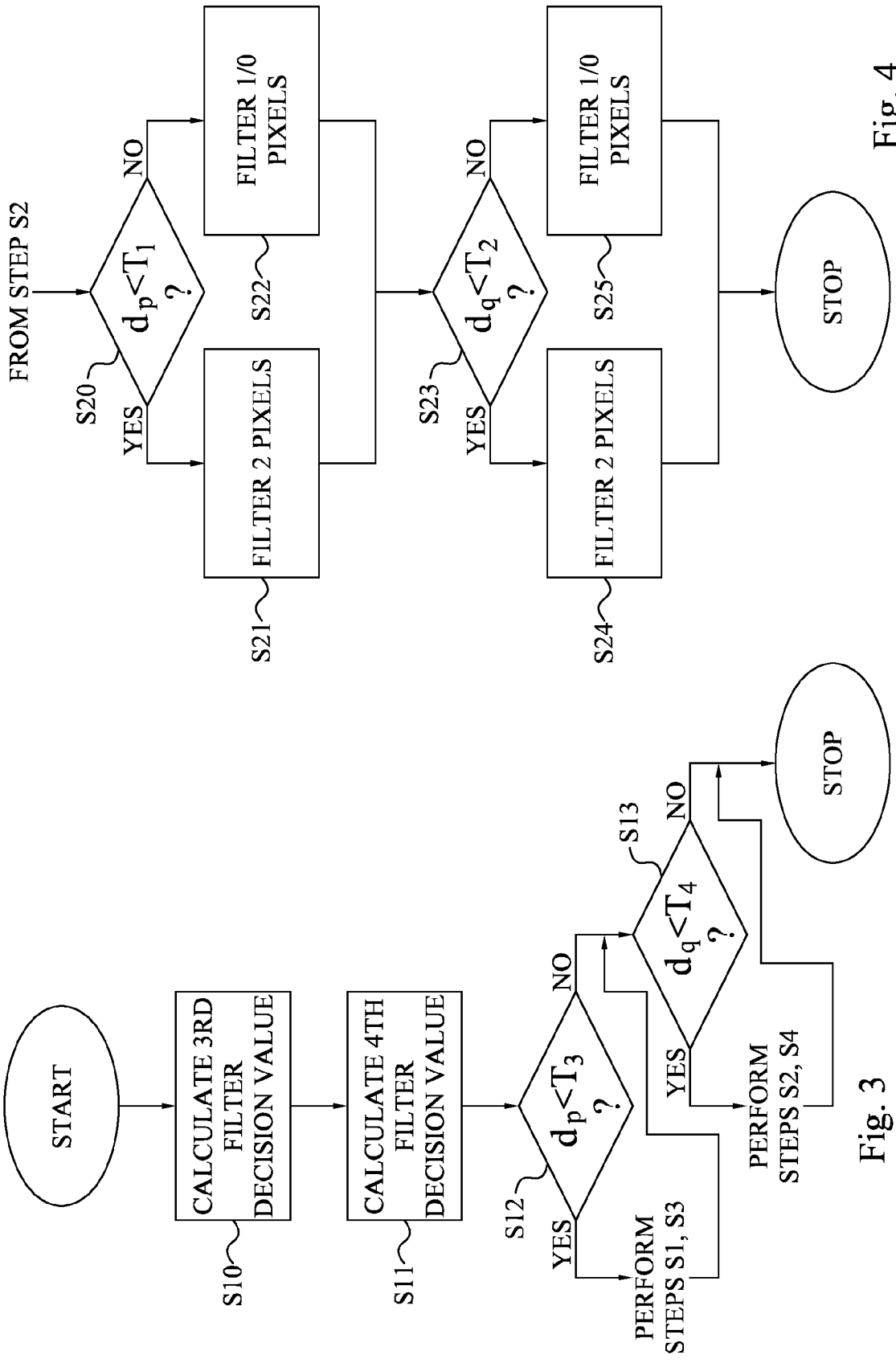

START
CALCULATE 3RD FILTER DECISION VALUE
S10
CALCULATE 4TH FILTER DECISION VALUE
S11
$d_p<T_3$?
S12
NO
YES
PERFORM STEPS S1, S3
$d_q<T_4$?
S13
NO
YES
PERFORM STEPS S2, S4
STOP
FROM STEP S2
$d_p<T_1$?
S20
NO
YES
FILTER 1/0 PIXELS
S22
FILTER 2 PIXELS
S21
$d_q<T_2$?
S23
NO
YES
FILTER 1/0 PIXELS
S25
FILTER 2 PIXELS
S24
STOP

Fig. 3

Fig. 4

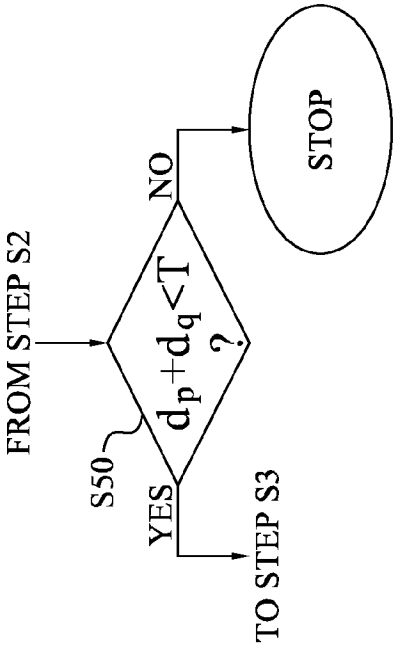

FROM STEP S2
S50
$d_p+d_q<T$?
YES
NO
TO STEP S3
STOP

Fig. 7

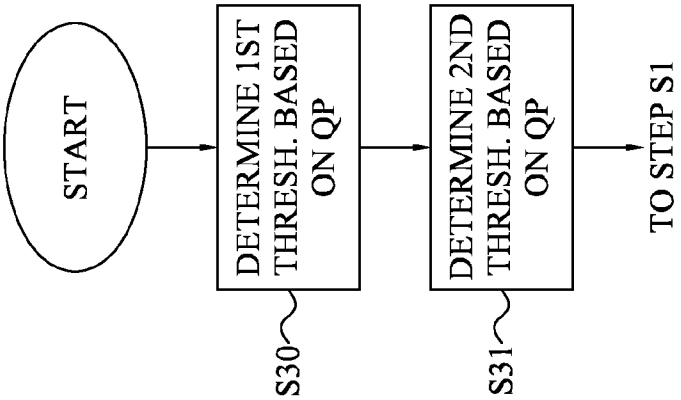

START
DETERMINE 1ST THRESH. BASED ON QP
S30
DETERMINE 2ND THRESH. BASED ON QP
S31
TO STEP S1

Fig. 5

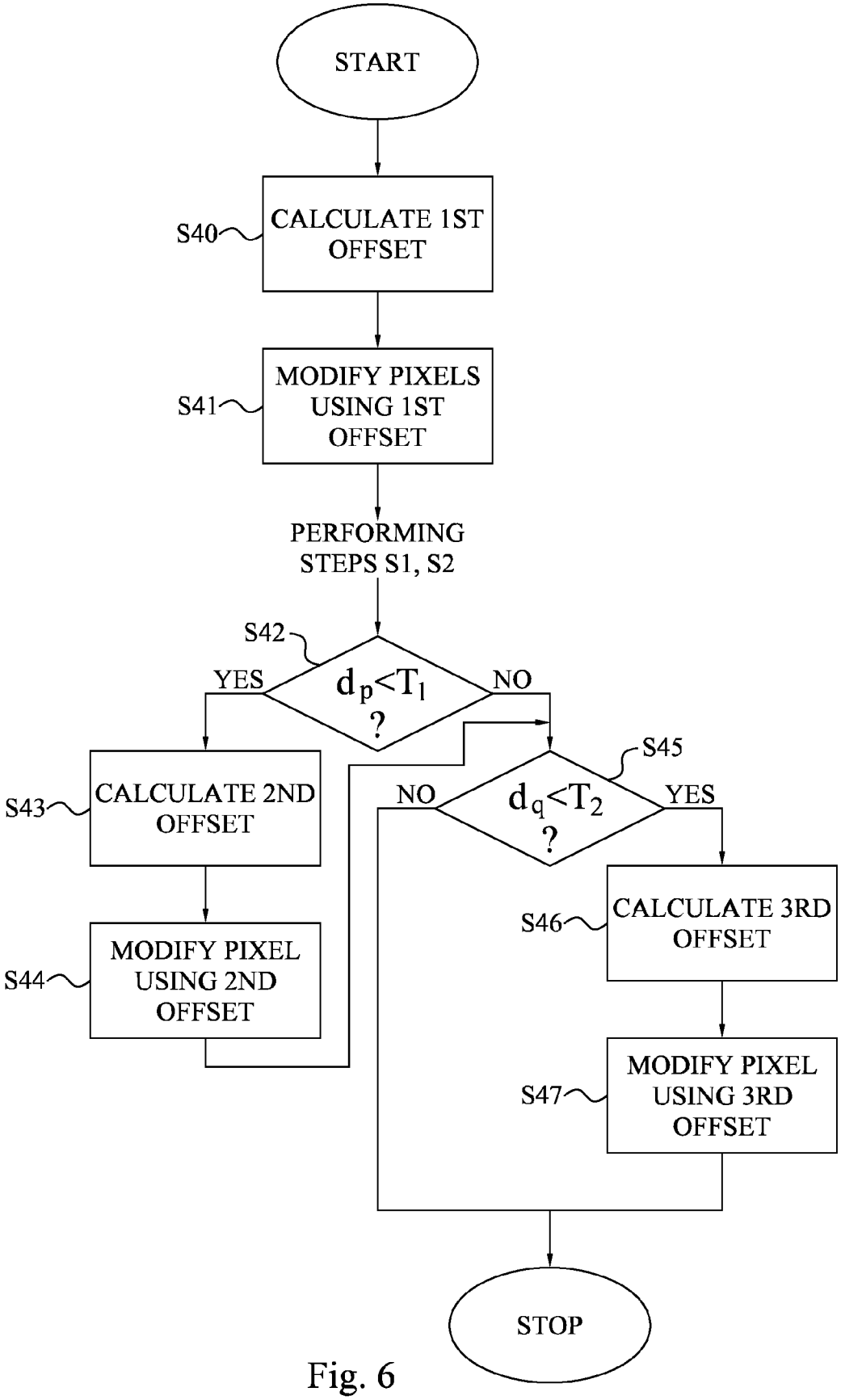

START
S40
CALCULATE 1ST OFFSET
S41
MODIFY PIXELS USING 1ST OFFSET
PERFORMING STEPS S1, S2
S42
$d_p < T_1$?
YES
NO
S43
CALCULATE 2ND OFFSET
S44
MODIFY PIXEL USING 2ND OFFSET
S45
$d_q < T_2$?
NO
YES
S46
CALCULATE 3RD OFFSET
S47
MODIFY PIXEL USING 3RD OFFSET
STOP

Fig. 6

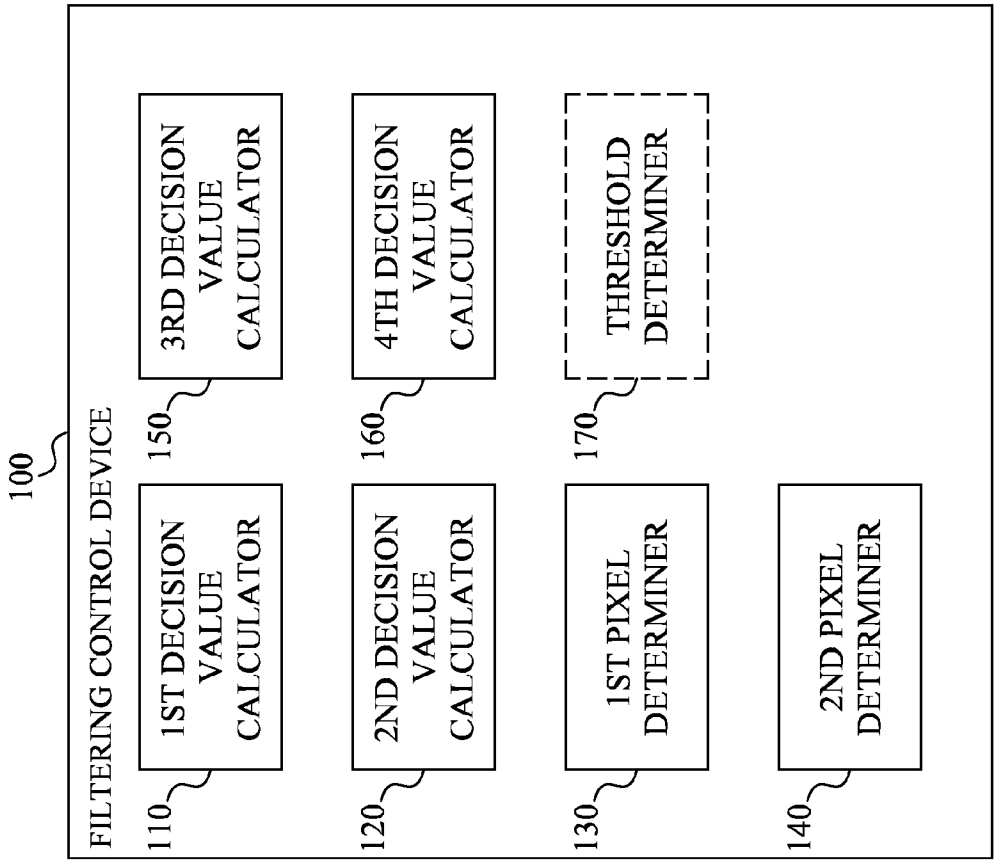

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER
150
3RD DECISION VALUE CALCULATOR
160
4TH DECISION VALUE CALCULATOR
170
THRESHOLD DETERMINER

Fig. 9

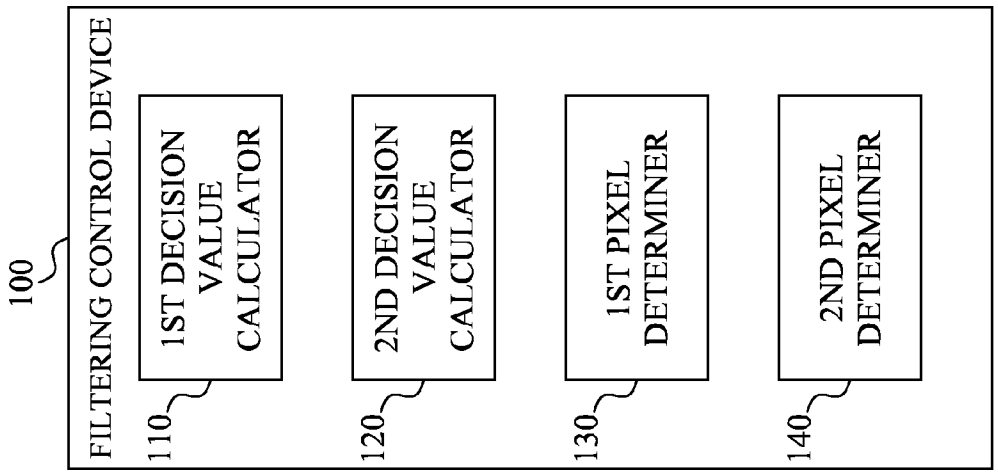

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER

Fig. 8

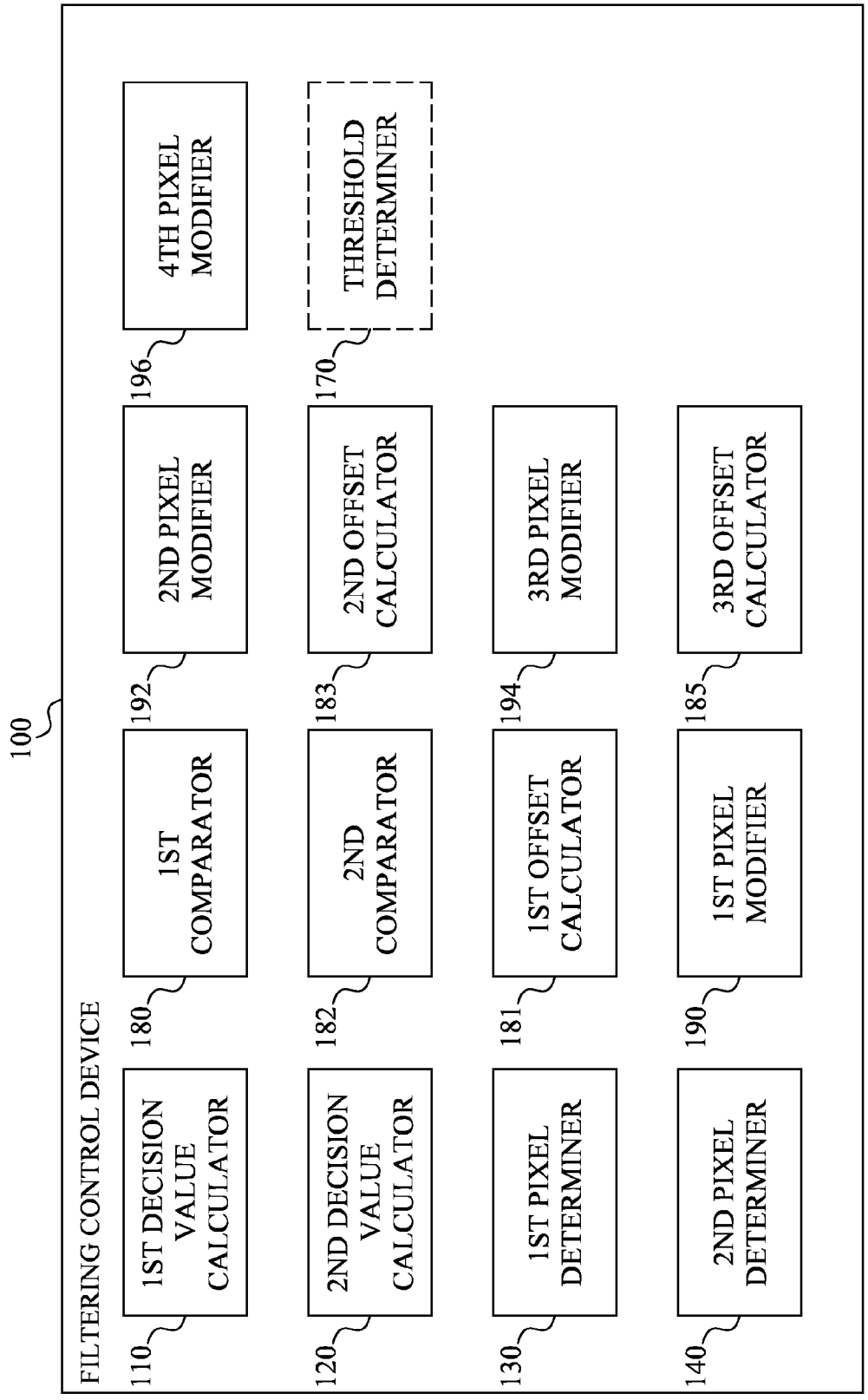

100
FILTERING CONTROL DEVICE
1ST DECISION VALUE CALCULATOR
110
1ST COMPARATOR
180
2ND PIXEL MODIFIER
192
4TH PIXEL MODIFIER
196
2ND DECISION VALUE CALCULATOR
120
2ND COMPARATOR
182
2ND OFFSET CALCULATOR
183
THRESHOLD DETERMINER
170
1ST PIXEL DETERMINER
130
1ST OFFSET CALCULATOR
181
3RD PIXEL MODIFIER
194
2ND PIXEL DETERMINER
140
1ST PIXEL MODIFIER
190
3RD OFFSET CALCULATOR
185

Fig. 10

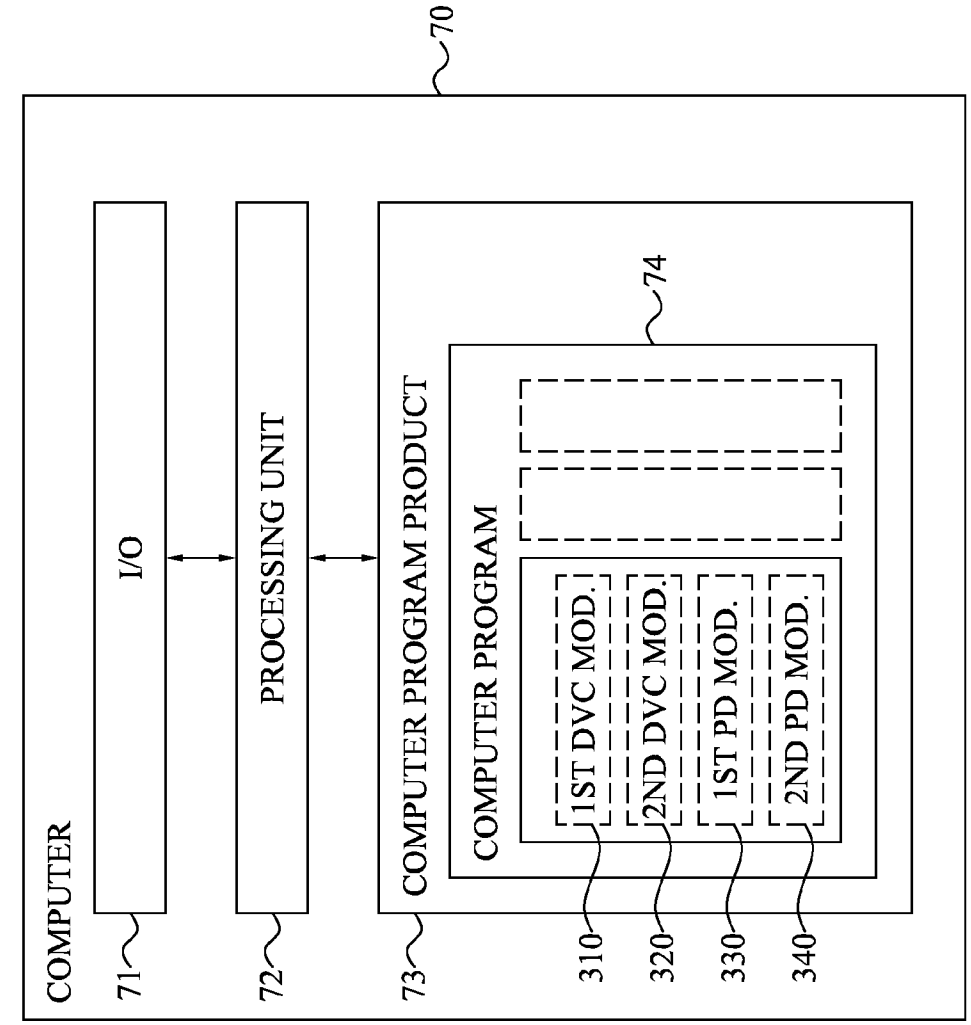

70
COMPUTER
I/O
PROCESSING UNIT
COMPUTER PROGRAM PRODUCT
COMPUTER PROGRAM
74
1ST DVC MOD.
2ND DVC MOD.
1ST PD MOD.
2ND PD MOD.
71
72
73
310
320
330
340

Fig. 12

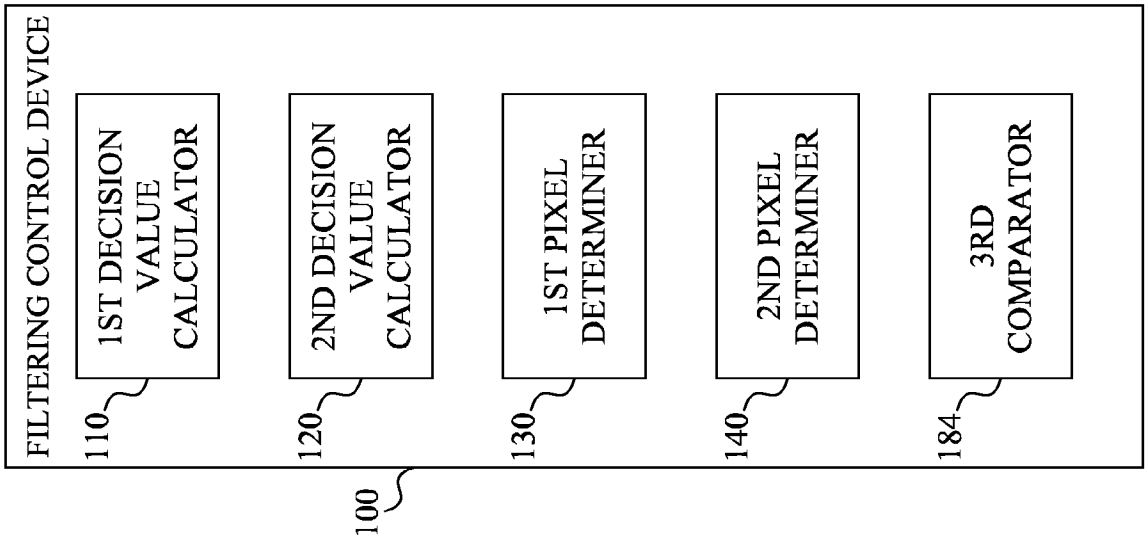

FILTERING CONTROL DEVICE
1ST DECISION VALUE CALCULATOR
2ND DECISION VALUE CALCULATOR
1ST PIXEL DETERMINER
2ND PIXEL DETERMINER
3RD COMPARATOR
110
120
130
140
184
100

Fig. 11

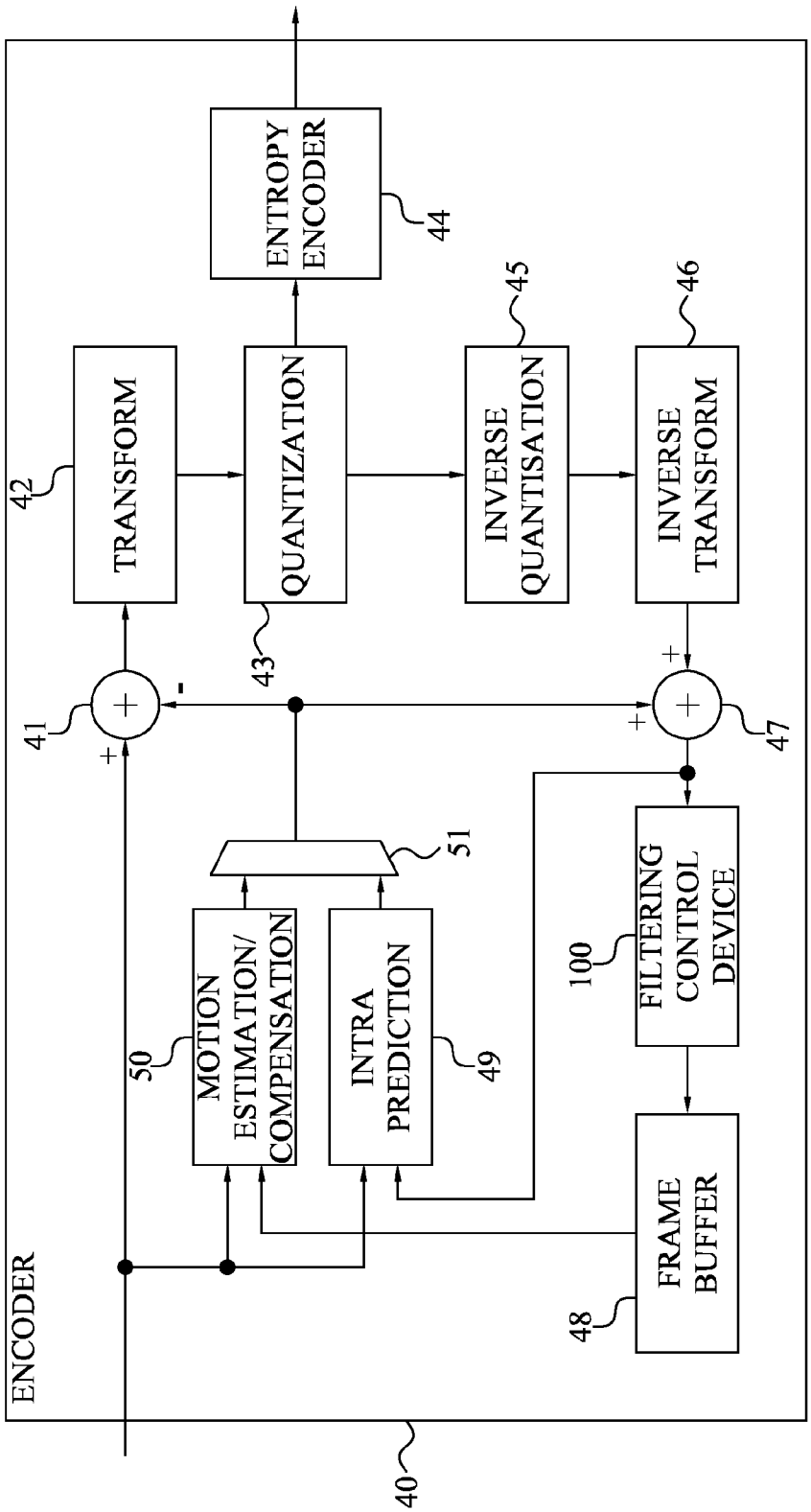

ENCODER
40
ENTROPY ENCODER
44
TRANSFORM
42
QUANTIZATION
43
INVERSE QUANTISATION
45
INVERSE TRANSFORM
46
41
47
51
MOTION ESTIMATION/ COMPENSATION
50
INTRA PREDICTION
49
FILTERING CONTROL DEVICE
100
FRAME BUFFER
48

Fig. 13

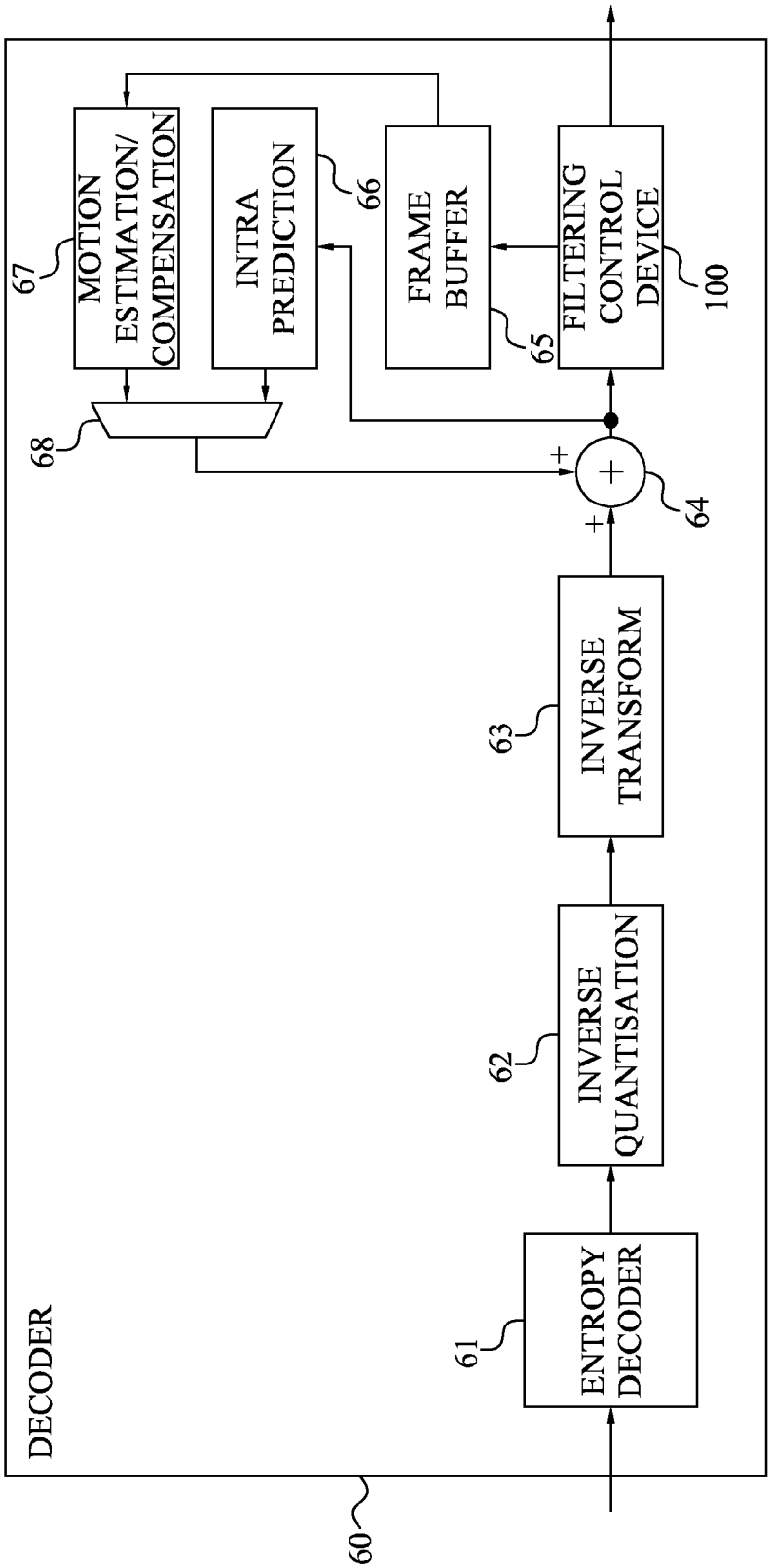

DECODER
60
ENTROPY DECODER
61
INVERSE QUANTISATION
62
INVERSE TRANSFORM
63
+
+
64
68
MOTION ESTIMATION/ COMPENSATION
67
INTRA PREDICTION
66
FRAME BUFFER
65
FILTERING CONTROL DEVICE
100

Fig. 14

Fig. 16

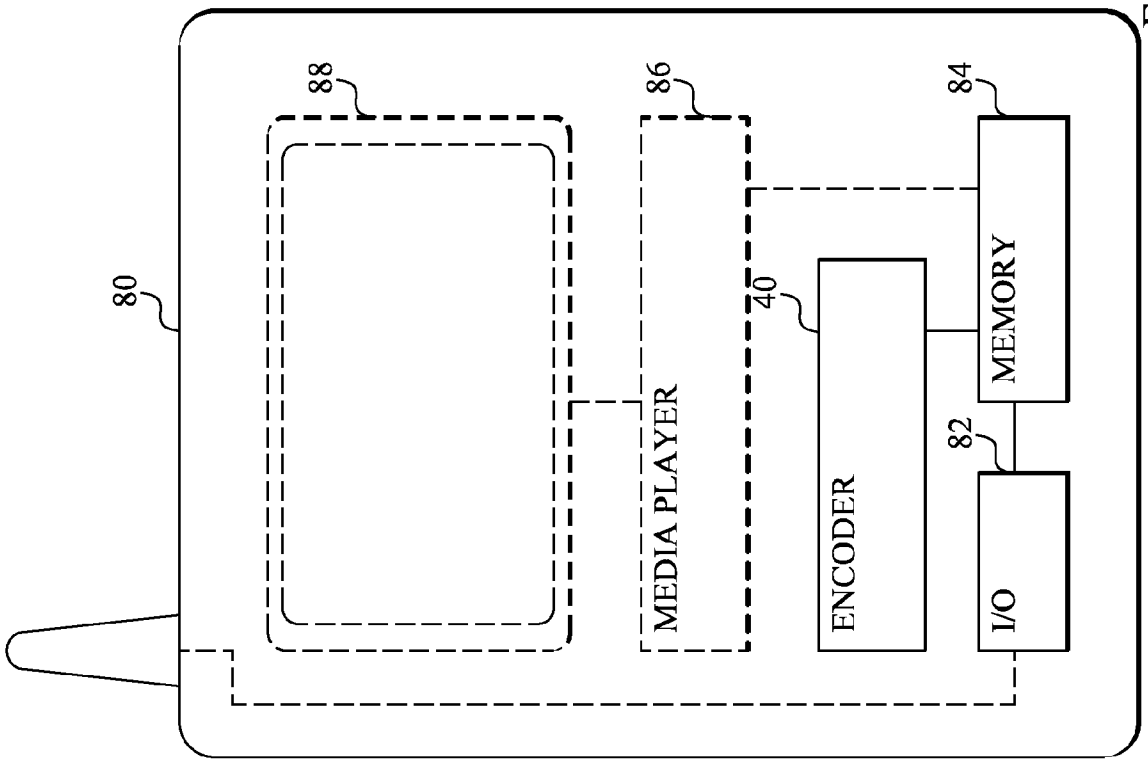
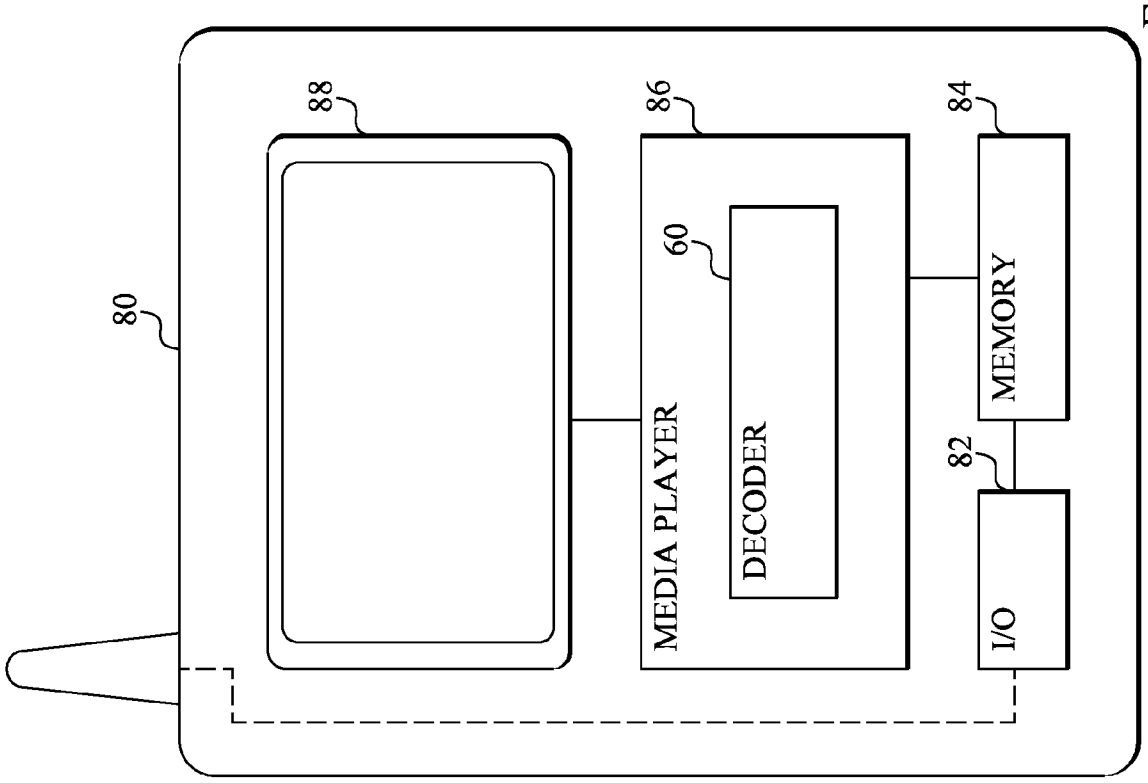

80
88
86
84
MEDIA PLAYER
40
ENCODER
MEMORY
82
I/O

Fig. 15


80
88
86
84
MEDIA PLAYER
60
DECODER
MEMORY
82
I/O

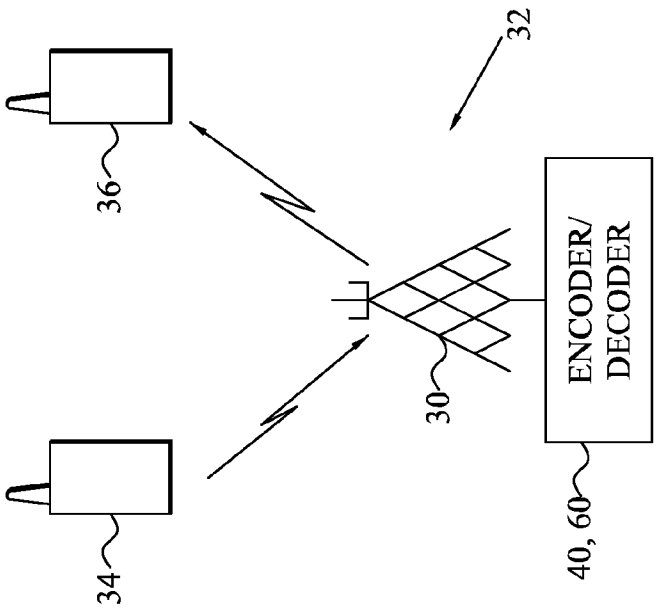


Fig. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2011/051526

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N7/26
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MATTHIAS NARROSCHKE ET AL: "Reduction of operations in the critical path of the deblocking filter", 95. MPEG MEETING; 24-1-2011 - 28-1-2011; DAEGU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m18974, 22 January 2011 (2011-01-22), XP030047543,	1,2,4-6, 8-10, 12-14, 16-22
Y	section 1 "Introduction"	7,15
A	third and fourth paragraphs on page 4 figure 7	3,11

-/--

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2012	10/04/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Regidor Arenales, R

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NORKIN A ET AL: "Development of HEVC deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D377, 16 January 2011 (2011-01-16), XP030008416, ISSN: 0000-0013	7,15
A	section 2.1 "Filter description"	1-6, 8-14, 16-22

X,P	ANDREY NORKIN ET AL: "CE12.1: Ericsson deblocking filter", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19803, 19 March 2011 (2011-03-19), XP030048370, the whole document	1-22

A	MASARU IKEDA ET AL: "Parallel deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D263, 15 January 2011 (2011-01-15), XP030008303, ISSN: 0000-0013 the whole document	1-22

1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Norkin et al.	)	
	)	Examiner: TBD
Application No.: TBD	)	
Filing Date: TBD	)	Confirmation No.: TBD
Title: Deblocking Filtering Control	)	
Attorney Ref.: 1009-0641 / P33966 US2	)	

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Please be advised that this is a **U.S. National Stage Filing of PCT Application PCT/SE2011/051526.**

Prior to examination, please amend the application as indicated below.

AMENDMENTS TO THE CLAIMS

1-17. (Canceled)

18. (New) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block based on $\left|p2_i - 2p1_i + p0_i\right|$,

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculating a second filter decision value for said block based on $\left|q2_i - 2q1_i + q0_i\right|$,

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

19. (New) The method of claim 18, wherein:

calculating said first filter decision value comprises calculating said first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$, wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block , said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$, wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block

boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

20. (New) The method of claim 18, wherein determining how many pixels in said line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

wherein determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

21. (New) The method of claim 18, wherein

determining how many pixels in said line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold

value; and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

22. A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame based on $\left|p2_i - 2p1_i + p0_i\right|$, wherein

$p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for said block based on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

23. (New) The device of claim 22:

wherein said first decision value calculator is configured to calculate said first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$, wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

wherein said second decision value calculator is configured to calculate said second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$, wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of

said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

24. (New) The device of claim 22, wherein:

said first pixel determiner is configured to i) determine to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

25. (New) The device of claim 22, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value;

wherein:

said first pixel determiner is configured to i) determine to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter no pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

26. (New) The device of claim 22, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

27. The device of claim 22, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second

offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding line of pixels.

28. (New) The device of claim 22, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

29. (New) An encoder comprising the filtering control device of claim 22.

30. (New) A user equipment comprising:

the encoder of claim 29; and

a memory configured to store video frames;

wherein said encoder is configured to encode said video frames into encoded video frames, and wherein said memory is further configured to store said encoded video frames.

31. (New) A decoder comprising the filtering control device of claim 22.

32. (New) A user equipment comprising:

the decoder of claim 31;

a memory configured to store encoded video frames; and

a media player configured to render decoded video frames into video data displayable on a display;

wherein the decoder is configured to decode said encoded video frames into the decoded video frames.

33. (New) A non-transitory computer-readable medium comprising a computer program stored thereon for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program comprises computer program instructions that when run on a computer cause the computer to:

calculate a first filter decision value for said block based on $\left|p2_i - 2p1_i + p0_i\right|$,

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said block based on $\left|q2_i - 2q1_i + q0_i\right|$,

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of

pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a line of pixels in said block to filter relative to said block boundary, based on said first filter decision value, wherein said determining how many pixels in said line of pixels to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary, based on said second filter decision value, wherein determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

REMARKS

Applicant submits the foregoing claim amendments prior to examination on the merits for consideration by the Examiner. The amendments cancel claims 1-17, and add new claims 18-33. The amendments are not made for reasons of patentability. Instead, the new claims 18-33 are substantially similar to the now canceled claims, but are written to eliminate multiple dependent claims and drawing reference numbers, and to ensure that the language of the claims better comports with U.S. practice. No new matter has been added.

Applicant respectfully requests that the Examiner enter the amendments prior to examination on the merits.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

/ Daniel P. Homiller, Reg. # 55,275 /

Dated: 26 August 2013

Daniel P. Homiller
Registration No.: 55,275

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Filer:	Daniel P. Homiller/Brittany Williams
Attorney Docket Number:	1009-0641 / P33966 US2

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	280	280
Natl Stage Search Fee - Report provided	1642	1	480	480
National Stage Exam - all other cases	1633	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1480**

Electronic Acknowledgement Receipt

EFS ID:	16687394
Application Number:	14001627
International Application Number:	PCT/SE11/51526
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	26-AUG-2013
Filing Date:	
Time Stamp:	16:31:19
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1480
RAM confirmation Number	3812
Deposit Account	505650
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Application Data Sheet	ADS.pdf	1421323 4e08e7abbe5665a901a7043df803e6ddefff89d7	no	5
Warnings:					
Information:					
2	Oath or Declaration filed	Declaration.pdf	1478520 93c1a7df434d109470b327193741da77c611b905	no	2
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	612366 2e2c4bc75fad0bc85d92f0ab51a0237d1ce6c995	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
4	Non Patent Literature	Ikeda.pdf	935407 5f8b8a2900946f23b966090592f0ab6fa0c64f2a	no	7
Warnings:					
Information:					
5	Non Patent Literature	Narroschke.pdf	2129121 ba2670f0776241802bdf74d6d84eee992f2d1ca2	no	15
Warnings:					
Information:					
6	Non Patent Literature	Norkin1.pdf	2023772 9086c60d8f9fe149a7051d5eb021161b69d34cec	no	17
Warnings:					
Information:					
7	Non Patent Literature	Norkin2.pdf	548494 52d6384324d05eb1a312b70850b48ffb8b48cf03	no	4
Warnings:					
Information:					
8	Documents submitted with 371 Applications	IPRP.pdf	2470096 a2f515d8b8636f1ba55139df6d05546ee8d0b39b	no	26
Warnings:					
Information:					

9		WO2012118421PCT.pdf	7028329 17518a1042d47beb3fb67ad7f06051df336f231e	yes	62

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Abstract	1	2
Specification	3	38
Claims	39	49
Drawings-only black and white line drawings	50	60
Documents submitted with 371 Applications	61	62

Warnings:

Information:

10	Preliminary Amendment	Preliminary_Amendment.pdf	59327 9d914d0713ff0fa59ee93f5115a726e609fb07f8	no	15

Warnings:

Information:

11	Fee Worksheet (SB06)	fee-info.pdf	33097 d6a5e6866c015a493660e9bc1c09281f3ee013ac	no	2

Warnings:

Information:

Total Files Size (in bytes):	18739852

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1009-0641 / P33966 US2
	Application Number	
Title of Invention	Deblocking Filtering Control	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrey		Norkin	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Solna	Country Of Residence[i]	SE
Citizenship under 37 CFR 1.41(b)[i]	RU		

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Address 2			
City	Solna	State/Province	
Postal Code	SE-16960	Country[i]	SE

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kenneth		Andersson	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Gävle	Country Of Residence[i]	SE
Citizenship under 37 CFR 1.41(b)[i]	SE		

Mailing Address of Applicant:

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Address 2			
City	Gävle	State/Province	
Postal Code	SE-802 63	Country[i]	SE

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Rickard		Sjöberg	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Stockholm	Country Of Residence[i]	SE

PTO/SB/14 (11-08)
Approved for use through 01/31/2014. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1009-0641 / P33966 US2
	Application Number	
Title of Invention	Deblocking Filtering Control	

Citizenship under 37 CFR 1.41(b) [i]	SE			
Mailing Address of Applicant:				
Address 1	Robert Almströmsgatan 9A			
Address 2				
City	Stockholm	**State/Province**		
Postal Code	SE-113 36	**Country**[i]	SE	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	102721		
Email Address	official@mbhiplaw.com	Add Email	Remove Email

Application Information:

Title of the Invention	Deblocking Filtering Control		
Attorney Docket Number	1009-0641 / P33966 US2	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	11	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1009-0641 / P33966 US2
	Application Number	
Title of Invention	Deblocking Filtering Control	
Customer Number	102721	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/SE2011/051526	2011-12-16
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
PCT/SE2011/051526	non provisional of	61447862	2011-03-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◯ Yes ◯ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☒

Organization Name	Telefonaktiebolaget L M Ericsson (publ)		
Mailing Address Information:			
Address 1	S-164 83		
Address 2			
City	Stockholm	**State/Province**	
Country [i] SE		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1009-0641 / P33966 US2
	Application Number	
Title of Invention	Deblocking Filtering Control	

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.					
Signature	/ Daniel P. Homiller, Reg. # 55,275 /			Date (YYYY-MM-DD)	2013-08-26
First Name	Daniel	Last Name	Homiller	Registration Number	55275

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

Declaration of inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv))
for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/ SE2011/051526 (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications: . . . . . .

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: NORKIN, Andrey

Residence: SWEDEN
(city and either US state, if applicable, or country)

Mailing Address: Blomgatan 6, SE-16960 SOLNA, SWEDEN

Citizenship: Russian Federation

Inventor's Signature: . . . . . Date: 2011-12-12
(The signature must be that of the inventor, not that of the agent)

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☒ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

Continuation of Box No. VIII (i) to (v) DECLARATION

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Application number: PCT/SE2011/051526 P33966WO1

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Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

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Declaration of inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv)) for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/ SE2011/051526 (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(The signature must be that of the inventor, not that of the agent)

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Continuation of Box No. VIII (i) to (v) DECLARATION

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Application number: PCT/SE2011/051526 P33966WO1

Name: SJÖBERG, Rickard

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Inventor's signature: .....Date: 2011-12-19.....
(The signature must be that of the inventor, not that of the agent)

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Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent (Rules 4.17(ii) and 51*bis*.1(a)(ii)), in a case where the declaration under Rule 4.17(iv) is not appropriate:

in relation to this international application, No. PCT/SE2011/051526

Telefonaktiebolaget L M Ericsson (publ)

is entitled to apply for and be granted a patent by virtue of the following:

An assignment from

NORKIN, Andrey,
ANDERSSON, Kenneth,
SJÖBERG, Rickard

to

Telefonaktiebolaget L M Ericsson (publ)

dated December 19, 2011

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APPLICATION NUMBER: ***61/447,862***
FILING DATE: ***March 01, 2011***

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US61/447,862***

By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office

T. Lawrence

T. LAWRENCE
Certifying Officer

Electronic Acknowledgement Receipt

EFS ID:	9560066
Application Number:	61447862
International Application Number:	
Confirmation Number:	7357
Title of Invention:	Asymmetric deblocking decisions
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	27045
Filer:	Steven Ware Smith/Pamela Ewing
Filer Authorized By:	Steven Ware Smith
Attorney Docket Number:	P33966-US1
Receipt Date:	01-MAR-2011
Filing Date:	
Time Stamp:	14:37:51
Application Type:	Provisional

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RAM confirmation Number	846
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

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1		P33966-US1_2011-03-01_11-3090_Provisional_Application_Package.pdf	118784 fbc5f49e8447ac373e4426edd66b85b36dc37371	yes	12

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Transmittal of New Application	1	3
Specification	4	12

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2	Fee Worksheet (PTO-875)	fee-info.pdf	29182 9679ae4fd4b62ab6d06a759f1b31f3ba7e9c7093	no	2

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. Transmitted Via EFS-Web

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Andrey	Norkin	Solna, Sweden
Rickard	Sjöberg	Stockholm, Sweden
Kenneth	Andersson	Gävle, Sweden

Additional inventors are being named on the _____ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max):

Asymmetric deblocking decisions

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ The address corresponding to Customer Number: 27045

OR

☐ Firm or Individual Name

Address

City	State	Zip
Country	Telephone	Email

ENCLOSED APPLICATION PARTS *(check all that apply)*

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number of CDs _____

☐ Drawing(s) *Number of Sheets* _____

☐ Other (specify) _____

☑ Specification (e.g. description of the invention) *Number of Pages* 9

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METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fee and application size fee (if applicable).

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☑ The Director is hereby authorized to charge the filing fee and application size fee (if applicable) or credit any overpayment to Deposit Account Number: 50-1379. A duplicative copy of this form is enclosed for fee processing.

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This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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SIGNATURE /Sidney L. Weatherford, Reg No 45,602/ Date March 1, 2011

TYPED or PRINTED NAME Sidney L. Weatherford REGISTRATION NO. 45,602 *(if appropriate)*

TELEPHONE 972-583-8656 Docket Number: **P33966-US1**

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Asymmetric deblocking decisions

1 Background

1.1 Technical Background/Existing Technology

Deblocking filters are used in the video coding standards in order to combat blocking artifacts. The blocking artifacts arise because the original video is split into blocks which are processed relatively independently. The blocking artifacts can arise due to different intra prediction of the block, quantization effects and motion compensation. Two particular variants of deblocking are described below.

These descriptions assume a vertical block boundary. The process is also done in the same way for horizontal block boundaries.

1.1.1 H.264 deblocking

In state of the art video coding such as H.264 there is an adaptive de-blocking filter/loop filter after prediction and residual reconstruction, but before storage of the reconstruction for later reference when encoding or decoding the subsequent frames. The deblocking filtering consists of several steps such as filter decisions, filtering operations, a clipping function and changes of pixel values. The decision to filter the border or not is made based on evaluating several conditions. Filter decisions depends on macro block (MB) type, MV difference between neighboring blocks, whether neighboring blocks has coded residuals and on the local structure of the current and/or neighboring blocks.

Then the amount of filtering for a pixel depends on the position of that pixel relative to the block border and on the quantization parameter value (QP value) used for residual coding.



Figure 1 Pixel values across a vertical block boundary

The filter decision is based on comparing three pixel differences with three thresholds. The thresholds are adapted to the quantization parameter (QP).

If the following conditions are fulfilled the filter decision is positive, e.g. abs(d-e)<thr1, abs(c-d)<thr2, and abs(e-f)<thr2, where thr1 and thr2 are adapted based on QP.

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There are two filtering modes in H.264. In the first filtering mode (normal filtering), filtering can be described with a delta value that the filtering change the current value with. The filtering for the pixel closest to the block boundary is

d' = d + delta and e' = e - delta

where delta has been clipped off to a threshold +/- thr3 to a value that is constrained by the QP. More filtering is allowed for high QP than for low QP.

Clipping can be described as:

delta_clipped = max(-thr3,min(thr3,delta))

where thr3 is controlling the filter strength. A larger values of thr3 means that the filtering is stronger which means that a stronger low-pass filtering effect will happen.

The filter strength can be increased if any of the following two conditions also holds, e.g. abs(b-d)<thr2 and abs(e-g)<thr2. The filter strength is adapted by clipping the delta less, e.g. allow for more variation.

The second (strong) filtering mode is applied for intra macroblock boundaries only, when the following condition is fulfilled: abs(d-e)< thr1/4.

1.1.2 Deblocking in HEVC draft

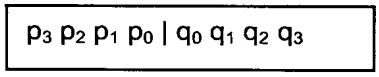


Figure 2 Pixel values across a vertical block boundary

In the draft HEVC specification, the deblocking filter works differently from H.264. The filtering is performed if at least one of the blocks on the side of the border is intra, or has non-zero coefficients, or the difference between the motion vector components of the blocks is greater or equal to one integer pixel. For example, if one is filtering the border between the blocks A and B from Figure 3, then the following condition should also be satisfied:

$$d = |p2_2 - 2*p1_2 + p0_2| + |q2_2 - 2*q1_2 + q0_2| + |p2_5 - 2*p1_5 + p0_5| + |q2_5 - 2*q1_5 + q0_5| < \beta$$

where β depends on QP. In the draft HEVC specification, there is a table for this where β increases with QP.

If the conditions are fulfilled and filtering is done between blocks A and B, one of two types of filtering (weak or strong filtering) is performed. The choice between the strong and the weak filtering is done separately for each line depending on the following conditions. For each line i = 0,7, the strong filtering is performed if all the following conditions are true, otherwise, weak filtering is performed.

- $d < (\beta>>2)$
- ***and*** $(|p3_i - p0_i| + |q0_i - q3_i|) < (\beta>>3)$

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- ***and*** $|p0_i - q0_i| < ((5*t_C + 1)>>1)$,

where t_C and β depends on qp. Their relations are shown in the table below. The t_C is calculated as t_C (qp+4) when A ***or*** B has PredMode==MODE_INTRA.

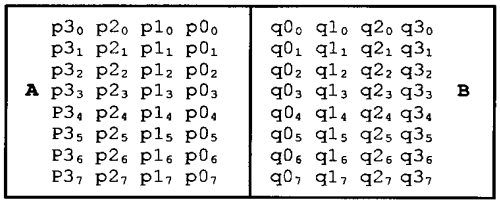


Figure 3 Notation of an 8 pixel part of a vertical edge for deblocking

The two filtering modes (weak and strong filtering) in the HEVC draft **Error! Reference source not found.** look like this:

Weak filtering

Weak filtering mode filtering is performed based on the above conditions. The actual filtering works by computing an offset (Δ), adding it to the original pixel value and clip the sum to a filtered output pixel value in the range of 0-255:

$\Delta = Clip(-t_C, t_C, (13*(q0_i - p0_i) + 4*(q1_i - p1_i) - 5*(q2_i - p2_i) + 16)>>5))$ i = 0,7

$p0_i = Clip_{0\text{-}255}(p0_i + \Delta)$ i = 0,7

$q0_i = Clip_{0\text{-}255}(q0_i - \Delta)$ i = 0,7

$p1_i = Clip_{0\text{-}255}(p1_i + \Delta/2)$ i = 0,7

$q1_i = Clip_{0\text{-}255}(q1_i - \Delta/2)$ i = 0,7

where Clip is defined as

x' = Clip(A, B, x) x'=x or if x<A x'=A or if x>B x'=B

and

$Clip_{0\text{-}255}(x)$ is defined as Clip(0, 255, x)

Strong filtering

Strong filtering mode is performed by the following set of operations.

$p0_0 = Clip_{0\text{-}255}((p2_i + 2*p1_i + 2*p0_i + 2*q0_i + q1_i + 4)>>3);$ i = 0,7

$q0_0 = Clip_{0\text{-}255}((p1_i + 2*p0_i + 2*q0_i + 2*q1_i + q2_i + 4)>>3);$ i = 0,7

$p1_0 = Clip_{0\text{-}255}((p2_i + p1_i + p0_i + q0_i + 2)>>2);$ i = 0,7

$q1_0 = Clip_{0\text{-}255}((p0_i + q0_i + q1_i + q2_i + 2)>>2);$ i = 0,7

$p2_0 = Clip_{0\text{-}255}((2*p3_i + 3*p2_i + p1_i + p0_i + q0_i + 4)>>3);$ i = 0,7

$q2_0 = Clip_{0\text{-}255}((p0_i + q0_i + q1_i + 3*q2_i + 2*q3_i + 4)>>3);$ i = 0,7

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1.2 Problems with Existing Solutions

Deblocking filtering in HEVC uses the same decision for both sides of the block border. It does not take into account that the structure on one side of the block border can be different and require different amount of filtering than the other side.

2 Basic Concept

In the current HEVC deblocking, the block boundary between the blocks A and B (Figure 3) is filtered, if the following condition is satisfied:

$$d = |p2_2 - 2*p1_2 + p0_2| + |q2_2 - 2*q1_2 + q0_2| + |p2_5 - 2*p1_5 + p0_5| + |q2_5 - 2*q1_5 + q0_5| < \beta$$

When calculating d, it is suggested to keep results at the intermediate steps, namely:

$$d_p = |p2_2 - 2*p1_2 + p0_2| + |p2_5 - 2*p1_5 + p0_5|$$

$$d_q = |q2_2 - 2*q1_2 + q0_2| + |q2_5 - 2*q1_5 + q0_5|$$

Then, these values can be used to decide how many pixels on the side of the block border that will be filtered. The values d_p and d_q are used in order to determine how many pixels to filter on each side of the block border. Lower values of d_p or d_q indicate that the structure on the respective side of the block border is more flat, therefore stronger filtering is allowed (or more pixels from the block border can be modified

The deblocking filter is used in video coding. It functions in both the video encoder and in the video decoder. The video decoder can be implemented preferably in hardware but also in software. The same holds for the video encoder.

The algorithm description is given in the following:

1. Calculate d_p, calculate d_q,
2. if ($d_p < thr1$)
3. {

   Do normal filtering of block A (e.g. two pixels from the block border)

4. }
5. else {
6. do not filter the second pixel from the block border (or do not filter any pixels at all)
7. }

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8. if ($d_q < thr2$)
9. {

    Do normal filtering of block B (e.g. two pixels from the block border)

10. }
11. else {
12. do not filter the second pixel from the block border (or do not filter any pixels at all)
13. }
14.

The embodiment also decreases the computational complexity of the filter. And the embodiment could also be used to make filtering decision for each line separately. In this case, the following conditions are used for filtering decisions at each line *i*.

$d_p = |p2_i - 2*p1_i + p0_i|$

$d_q = |q2_i - 2*q1_i + q0_i|$

In this case, the algorithm given above shall be applied for each horizontal line of pixels crossing the vertical block boundary (see Fig. 3). The same applies for vertical lines of pixels crossing the horizontal block boundary.

3 Detailed description

3.1 Embodiment 1

The modified pixel values as the result of deblocking are calculated like in the following:

$d_p = |p2_2 - 2*p1_2 + p0_2| + |p2_5 - 2*p1_5 + p0_5|$
$d_q = |q2_2 - 2*q1_2 + q0_2| + |q2_5 - 2*q1_5 + q0_5|$

$\Delta = (9*(q_0-p_0)-3*(q_1-p_1))/16$

$p_0' = p_0 + \Delta$

$q_0' = q_0 - \Delta$

if ($d_p < thrP$)
{

$\Delta_p = (p_0+p_2-2*p_1+2*\Delta)/4;$

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$$p_1' = p_1 + \Delta_p$$

}
if ($d_q < thrQ$)

{

$$\Delta_q = (q_0+q_2-2*q_1-2*\Delta)/4;$$

$$q_1' = q_1 + \Delta_q$$

}

The values of *thrP* and *thrQ* usually depend on QP. One solution is to use the same values of *thrP* and *thrQ* that are equal to the value of β with some multiplier. For example, the value $thrP = thrB = \beta/6$ can be used. The β is read from the table β(QP).

As another variant of the embodiment, the threshold can be read from a separate tables *thrP*(QP), *thrQ*(QP).

3.2 Embodiment 2

Exact formulas for computation of embodiment 1 in the programming language can look like in the text below. Here, the Clip3 function is clipping of the output values to the range between the two first function arguments.

```
Int xCalcDP( Pel* piSrc, Int iOffset)
{
  return abs( piSrc[-iOffset*3] - 2*piSrc[-iOffset*2] + piSrc[-iOffset] ) ;
}

Int xCalcDQ( Pel* piSrc, Int iOffset)
{
  return abs( piSrc[0] - 2*piSrc[iOffset] + piSrc[iOffset*2] );
}

Int iDP = xCalcDP( piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+2),
iOffset) + xCalcDP( piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),
iOffset);
Int iDQ = xCalcDQ( piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+2),
iOffset) + xCalcDQ( piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),
iOffset);

Int iSideThreshold = iBeta/6;

Bool bFilterP = (iDP < iSideThreshold);
Bool bFilterQ = (iDQ < iSideThreshold);

delta = (9*(m4-m3) -3*(m5-m2) + 8)>>4 ;

if ( abs(delta) < iThrCut )
{
    Int tc2 = tc>>1;

    delta = Clip3(-tc, tc, delta);
    piSrc[-iOffset] = Clip((m3+delta));
    piSrc[0] = Clip((m4-delta));
```


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```
if(bFilterP)
{
    Int delta1 = Clip3(-tc2, tc2, (( ((m1+m3+1)>>1)- m2+delta)>>1));
    piSrc[-iOffset*2] = Clip((m2+delta1));
}
if(bFilterQ)
{
    Int delta2 = Clip3(-tc2, tc2, (( ((m6+m4+1)>>1)- m5-delta)>>1));
    piSrc[ iOffset] = Clip((m5+delta2));
}
```

3.3 Embodiment 3

This part describes how the embodiment is applied separately for each line crossing the block boundary.

$d_{pi} = |p2_i - 2*p1_i + p0_i|$
$d_{qi} = |q2_i - 2*q1_i + q0_i|$

1. Calculate d_{pi}, calculate d_{qi}, for line i
2. if ($d_{pi} < thr1$)
3. {

   Do normal filtering of line *i* of block A (e.g. two pixels from the block border)

4. }
5. else {
6. do not filter the second pixel from the block border of line i of block A (or do not filter any pixels at all on line *i* of block A)
7. }
8. if ($d_{qi} < thr2$)
9. {

   Do normal filtering of line *i* of block B (e.g. two pixels from the block border)

10. }
11. else {
12. do not filter the second pixel from the block border of line *i* of block B (or do not filter any pixels at all on line *i* of block B)
13. }

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3.4 Embodiment 4

Here in this embodiment is used as a combination of block based and line based asymmetric filter decisions.

$d_{pi} = |p2_i - 2*p1_i + p0_i|$
$d_{qi} = |q2_i - 2*q1_i + q0_i|$
$d_p = |p2_2 - 2*p1_2 + p0_2| + |p2_5 - 2*p1_5 + p0_5|$
$d_q = |q2_2 - 2*q1_2 + q0_2| + |q2_5 - 2*q1_5 + q0_5|$

1. Calculate d_p, calculate d_q,
2. if ($d_p < thr1$)
3. {

For each line *i*

Calculate d_{pi} for line *i*

if ($d_{pi} < thr1$)

{

Do normal filtering of line *i* of block A (e.g. two pixels from the block border)

}

else {

do not filter the second pixel from the block border of line *i* of block A (or do not filter any pixels at all on line *i* of block A)

}

}

else {

4. do not filter the second pixel from the block border (or do not filter any pixels at all)

}

5. if ($d_q < thr2$)
6. {

For each line

Calculate d_{qi}, for line *i*

if ($d_{qi} < thr2$)

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{

Do normal filtering of line *i* of block B (e.g. two pixels from the block border)

}

else {

do not filter the second pixel from the block border of line i of block B (or do not filter any pixels at all on line i of block B)

}

}

else {

7. do not filter the second pixel from the block border (or do not filter any pixels at all)

}

3.5 Advantages of the embodiments

The embodiments make the HEVC deblocking filtering adaptive to the structure on each side of block boundaries. The amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary thus providing additional adaptation to the local structure. This improves the objective and subjective video quality. The embodiments do not require many additional computations, as the values for the decisions can be obtained on the previous steps when deciding whether to filter the block border. The embodiments also decrease the computational complexity, as filtering of the second pixel from the block border happens less frequently.

4 Abbreviations

HEVC – High Efficiency Video Coding, a new video compression standard under development jointly by two organizations (ITU-T's VCEG and ISO's MPEG).

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I	**Title of Invention**	**DEBLOCKING FILTERING CONTROL**
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VI-1-3	Country	US
VI-2	**Incorporation by reference :** where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.	
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IX-1	Request (including declaration sheets)	5	✓
IX-2	Description	36	✓
IX-3	Claims	11	✓
IX-4	Abstract	1	✓
IX-5	Drawings	11	✓
IX-7	TOTAL	64	
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IX-8	Fee calculation sheet	-	✓
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IX-19	Other	Pre-conversion archive	✓
IX-20	**Figure of the drawings which should accompany the abstract**	1	
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[Continued on next page]

(54) Title: DEBLOCKING FILTERING CONTROL

(57) Abstract: A first filter decision value is calculated for a block (10) of pixels (11, 13, 15, 17) in a video frame based on pixel values of pixels (11, 13, 15) in a first line (12) of pixels (11, 13, 15, 17) in the block (10). A second filter decision value is also calculated for the block (10) based on pixel values of pixels (21, 23, 25, 27) in a corresponding first line (22) of pixels (21, 23, 25, 27) in a neighboring block (20) in the video frame. The first filter decision value is used to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in the block (10) to filter relative to a block boundary (1) between the block (10) and the neighboring block (20). The second filter decision value is used to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in the neighboring block to filter relative to the block boundary (1).

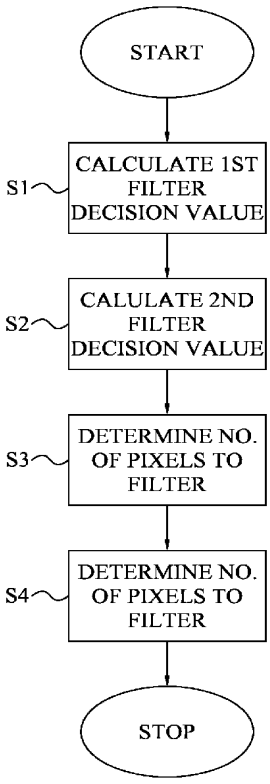


Fig. 1

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— *with international search report (Art. 21(3))*

DEBLOCKING FILTERING CONTROL

TECHNICAL FIELD

The present embodiments generally relate to filtering control and in particular to controlling deblocking filtering over block boundaries in a video frame.

BACKGROUND

Deblocking filters are used in the video coding standards in order to combat blocking artifacts. The blocking artifacts arise because the original video frames are split into blocks which are processed relatively independently. The blocking artifacts can, for instance, arise due to different intra predictions of the blocks, quantization effects and motion compensation. Two particular variants of deblocking are described below.

In state of the art video coding, such as H.264, there is a deblocking filter, also denoted loop filter, after prediction and residual reconstruction, but before storage of the reconstruction for later reference when encoding or decoding the subsequent frames. The deblocking filtering consists of several steps such as filter decisions, filtering operations, a clipping function and changes of pixel values. The decision to filter the border or not is made based on evaluation of several conditions. Filter decisions depend on macroblock (MB) type, motion vector (MV) difference between neighboring blocks, whether neighboring blocks have coded residuals and on the local structure of the current and/or neighboring blocks.

Then the amount of filtering for a pixel depends, among others, on the position of that pixel relative to the block border or boundary and on the quantization parameter (QP) value used for residual coding.

The filter decision is based on comparing three pixel differences with thresholds. The thresholds are adapted to the quantization parameter (QP). For instance, assume a vertical block boundary of

a b c d | e f g h

where a, b c and d denote the pixel values of the pixels of a row of pixels in the current block and e, f, g and h denote the corresponding pixel values of the pixels of a corresponding row of pixels in the neighboring block. If the following conditions are fulfilled the filter decision is positive, e.g. abs(d-e)<thr1, abs(c-d)<thr2, and abs(e-f)<thr2, where thr1 and thr2 are adapted based on QP.

There are two filtering modes in H.264. In the first filtering mode, referred to as normal filtering, filtering can be described with a delta value with which filtering changes the current value. The filtering for the pixels closest to the block boundary is d' = d + delta and e' = e – delta, where delta has been clipped off to a threshold ±thr3 to a value that is constrained by the QP. More filtering is thereby allowed for high QP than for low QP. Clipping can be described as delta_clipped = max(-thr3, min(thr3, delta)), where thr3 is controlling the filter strength. A larger value of thr3 means that the filtering is stronger which means that a stronger low-pass filtering effect will happen.

The filter strength can be increased if any of the following two conditions also holds, e.g. abs(b-d)<thr2 and abs(e-g)<thr2. The filter strength is adapted by clipping the delta less, e.g. allow for more variation.

The second filtering mode, referred to as strong filtering, is applied for intra macroblock boundaries only, when the following condition is fulfilled abs(d-e)< thr1/4.

For more information of deblocking filtering in H.264 reference is made to List et al., Adaptive Deblocking Filter, *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 13, no. 7, July 2003.

In the draft HEVC (High Efficiency Video Coding) specification "Test Model under Consideration", ITU-T SG16 WP3 document, JCTVC-B205, Chapter 6.5 In-loop filter process, the deblocking filter works differently from H.264. The filtering is performed if at least one of the blocks on the side of the boundary is intra, or has non-zero coefficients, or the difference between the motion vector components of the blocks is greater or equal to one integer pixel. For example, when filtering the border between the blocks with a vertical block boundary of

$$p3_i\ p2_i\ p1_i\ p0_i \mid q0_i\ q1_i\ q2_i\ q3_i$$

with pj_i denoting the pixel value of pixel number j of row number i in the current block and qj_i denoting the pixel value of pixel number j of row number i in the neighboring block, i=0…7, j=0…3, then the following condition should also be satisfied:

$$d = |p2_2 - 2\times p1_2 + p0_2| + |q2_2 - 2\times q1_2 + q0_2| + |p2_5 - 2\times p1_5 + p0_5| + |q2_5 - 2\times q1_5 + q0_5| < \beta$$

where β depends on QP. In the above mentioned HEVC specification, there is a table of β, where β increases with QP.

If the conditions are fulfilled and filtering is done between the current block and the neighboring block, one of two types of filtering is performed, referred to as weak and strong filtering, respectively. The choice between the strong and the weak filtering is done separately for each line depending on the following conditions. For each line i=0…7, the strong filtering is performed if all the following conditions are true, otherwise, weak filtering is performed:

$$d < (\beta >> 2)$$

$$(|p3_i - p0_i| + |q0_i - q3_i|) < (\beta >> 3)$$

$$|p0_i - q0_i| < ((5 \times t_C + 1) >> 1)$$

where t_C and β depend on QP and >> denotes a right shift operator.

Weak filtering is performed based on the above conditions. The actual filtering works by computing an offset (Δ), adding it to the original pixel value and clip the sum to a filtered output pixel value in the range of 0-255:

$$\Delta = Clip(-t_C, t_C, (13 \times (q0_i - p0_i) + 4 \times (q1_i - p1_i) - 5 \times (q2_i - p2_i) + 16) >> 5))$$

$$p0_i = Clip_{0\text{-}255}(p0_i + \Delta)$$

$$q0_i = Clip_{0\text{-}255}(q0_i - \Delta)$$

$$p1_i = Clip_{0\text{-}255}(p1_i + \Delta/2)$$

$$q1_i = Clip_{0\text{-}255}(q1_i - \Delta/2)$$

where the clip function Clip(A, B, x) is defined as Clip(A, B, x)=A if x<A, Clip(A, B, x)=B if x>B and Clip(A, B, x)=x if $A \leq x \leq B$ and $Clip_{0\text{-}255}(x)$ is defined as Clip(0, 255, x).

Strong filtering mode is performed by the following set of operations:

$$p0_i = Clip_{0\text{-}255}((p2_i + 2 \times p1_i + 2 \times p0_i + 2 \times q0_i + q1_i + 4) >> 3)$$

$q0_i=Clip_{0-255}((p1_i + 2\times p0_i + 2\times q0_i + 2\times q1_i + q2_i + 4)>>3)$

$p1_i=Clip_{0-255}((p2_i + p1_i + p0_i + q0_i +2)>>2)$

$q1_i=Clip_{0-255}((p0_i + q0_i + q1_i + q2_i +2)>>2)$

$p2_i=Clip_{0-255}((2\times p3_i + 3\times p2_i + p1_i + p0_i + q0_i + 4)>>3)$

$q2_i=Clip_{0-255}((p0_i + q0_i + q1_i + 3\times q2_i + 2\times q3_i + 4)>>3)$

Deblocking filtering decisions according to HEVC can lead to inaccurate deblocking filtering over block boundaries for certain blocks. In particular neighboring blocks having different levels of local structures could be handled incorrectly in HEVC by filtering one of the blocks too much to thereby represses and filter away local structures in the block.

SUMMARY

Hence, there is a need for an efficient deblocking filtering control that can be used to reduce blocking artifacts at block boundaries and that does not have the above mentioned drawbacks.

It is a general objective to provide an efficient deblocking filtering control.

It is a particular objective to provide asymmetric filtering decisions over a block boundary.

An aspect of the embodiments relates to a method for filtering control applicable to a block of multiple pixels in a video frame, where each pixel has a respective pixel value. The method comprises calculating a first filter decision value for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The method also comprises calculating a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. The first filter decision value is used to determine how many pixels in a line of

pixels in the block to filter relative to the block boundary and the second filter decision value is correspondingly used to determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary.

Another aspect of the embodiments defines a filtering control device comprising a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The filtering control device also comprises a second decision value calculator configured to calculate a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. A first pixel determiner is configured to determine how many pixels in a line of pixels in the block to filter relative to the block boundary based on the first filter decision value calculated by the first decision value calculator. The filtering control device further comprises a second pixel determiner configured to determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary based on the second filter decision value calculated by the second decision value calculator.

Further aspects of the embodiments relate to an encoder comprising a filtering control device as defined above and a decoder comprising a filtering control device as defined above. Yet another aspect defines a user equipment comprising a memory configured to store video frames and an encoder with a filtering control device as defined above to encode the video frames into encoded video frames, which are stored in the memory. A further aspect defines a user equipment comprising a memory configured to store encoded video frames and a decoder with a filtering control device as defined above to decode the encoded video frames into decoded video frames. A media player of the user equipment is configured to render the decoded video frames into video data displayable on a display.

Yet another aspect relates to a computer program for filtering control of a block of multiple pixels in a video frame, where each pixel has a respective pixel value. The computer program comprises code means which when run on a computer causes the computer to calculate a first filter decision value for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in the block, a block boundary to a neighboring block of multiple pixels in the video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in the first line of pixels, the block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in the first line of pixels, the block boundary. The computer also comprises code means which causes the computer to calculate a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in the neighboring block closest to, in a corresponding first line of pixels in the neighboring block, the block boundary, $q1_i$ denotes a pixel value of a pixel of the neighboring block next closest to, in the corresponding first line of pixels, the block boundary and $q2_i$ denotes a pixel value of a pixel in the neighboring block second next closest to, in the corresponding first line of pixels, the block boundary. The computer program comprises code means which causes the computer to determine how many pixels in a line of pixels in the block to filter relative to the block boundary based on the first filter decision value and determine how many pixels in a corresponding line of pixels in the neighboring block to filter relative to the block boundary based on the second filter decision value.

The embodiments achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig. 1 is a flow diagram of a method for filtering control according to an embodiment;

Figs. 2A and 2B illustrate two embodiments of neighboring blocks and a block boundary over which deblocking filtering can be applied;

Fig. 3 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to an embodiment;

Fig. 4 is a flow diagram illustrating an embodiment of the determining steps in Fig. 1;

Fig. 5 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to another embodiment;

Fig. 6 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 and an embodiment of the determining steps in Fig. 1;

Fig. 7 is a flow diagram illustrating an additional, optional step of the method in Fig. 1 according to an embodiment;

Fig. 8 is a schematic block diagram of an embodiment of a filtering control device;

Fig. 9 is a schematic block diagram of another embodiment of a filtering control device;

Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device;

Fig. 11 is a schematic block diagram of yet another embodiment of a filtering control device;

Fig. 12 is a schematic block diagram of a software implementation of a filtering control device in a computer according to an embodiment;

Fig. 13 is a schematic block diagram of an encoder according to an embodiment;

Fig. 14 is a schematic block diagram of a decoder according to an embodiment;

Fig. 15 is a schematic block diagram of a user equipment according to an embodiment;

Fig. 16 is a schematic block diagram of a user equipment according to another embodiment; and

Fig. 17 is a schematic overview of a portion of a communication network comprising a network device according to an embodiment.

DETAILED DESCRIPTION

Throughout the drawings, the same reference numbers are used for similar or corresponding elements.

The embodiments generally relate to filtering control and controlling deblocking filtering over block boundaries in a video frame. The filtering control of the embodiments provides asymmetric deblocking decisions with regard to block boundaries by making independent filtering decisions for the blocks of pixels separated by a block boundary. This means that the deblocking filtering can handle neighboring blocks having different levels of local structures to thereby adapt the particular deblocking filtering at each block based on its local structures.

As is well-known in the art, a video frame is divided into non-overlapping blocks of pixels that are encoded and decoded according to the various available intra and inter coding modes. Generally, a video frame is divided into non-overlapping macroblocks of 16×16 pixels. Such a macroblock can in turn be divided into smaller blocks of different sizes, such as 4×4 or 8×8 pixels. However, also rectangular blocks are possible according to the embodiments, such as, 4×8, 8×4, 8×16 or 16×8. The embodiments can be applied to any such block of pixels, including macroblocks or even larger blocks of pixels.

In the emerging High Efficiency Video Coding (HEVC) standard, coding units (CU), prediction units (PU) and transform units (TU) are used. The prediction units are defined inside a coding unit and contain the intra or inter prediction modes. Transform units are defined inside a coding unit and the largest transform size is 32×32 pixels and the smallest size is 4×4 pixels. The CU size is currently varying from 64×64 pixels (largest) to 8×8 pixels (smallest). In this way, the largest CU can be split into smaller CUs with the “level of granularity” depending on the local characteristics of the frame. That means that the largest CU may be split into smaller CUs of different sizes. The embodiments can also be used in connection with such coding units, which are regarded as being encompassed by the expression “block of pixels” as used herein.

Each pixel in the block has a respective pixel value. Video frames generally have color values assigned to the pixels, where the color values are represented in a defined color formats. One of the

common color formats uses one luminance component and two chrominance components for each pixel, although other formats exist, such as using red, green and blue components for each pixel.

Traditionally, luminance component filtering and chrominance component filtering are done separately, possibly employing different filtering decisions and different deblocking filters. It is, though, possible that the luminance filtering decisions are used in chroma filtering, like in H.264. The embodiments can be applied to filtering control for the luminance component, the chrominance component or both the luminance component and the chrominance component. In a particular embodiment, the embodiments are applied to control luminance or luma filtering. Filtering decisions, or parts of filtering decisions for one component, such as luma, can be then used when making the filtering decisions for other components, such as chroma.

Deblocking filtering is conducted over a boundary, edge or border between neighboring blocks. As a consequence, such boundaries can be vertical boundaries 1, see Fig. 2A, between two neighboring blocks 10, 20 present side by side in the video frame. Alternatively, the boundaries are horizontal boundaries 1, see Fig. 2B, between two neighboring block 10, 20, where one block 10 is positioned above the other block 20 in the video frame. In a particular embodiment, vertical boundaries are filtered first starting from the left-most boundary and proceeding through the boundaries towards the right-hand side in their geometrical order. Then, horizontal boundaries are filtered starting with the boundary on the top and proceeding through the boundaries towards the bottom in their geometrical order. The embodiments are, however, not limited to this particular filtering order and can actually be applied to any predefined filtering order. In a particular embodiment, the boundaries at the edge of the video frame are preferably not filtered and thereby excluded from the deblocking filtering.

Fig. 1 is a flow diagram of a method for filtering control applicable to a block of multiple pixels in a video frame according to an embodiment. The method of Fig. 1 generally starts in step S1 where a first filter decision value is calculated for the block based at least on $|p2_i - 2p1_i + p0_i|$, wherein $p0_i$ denotes a pixel value of a pixel 11 closest to, in a first line of pixels 11, 13, 15, 17 in the block 10, a block boundary 1 to a neighboring block 20 of multiple pixels 21, 23, 25, 27 in the video frame. $p1_i$ denotes a pixel value of a pixel 13 next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 1 and $p2_i$ denotes a pixel value of a pixel 15 second next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 10.

Step S2 correspondingly calculates a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in a corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20, the block boundary 1, $q1_i$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1 and $q2_i$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1.

The first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 belong to the same horizontal line of pixels, i.e. row of pixels, extending over a vertical boundary 1, see Fig. 2A, or belong to the same vertical line of pixels, i.e. column of pixels, extending over a horizontal boundary 1, see Fig. 2B. Hence, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 are perpendicular to the block boundary 1 between the block 10 and the neighboring block 20. Furthermore, the first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 have the same line number. For instance, if the block 10 and the neighboring block 20 each comprises *N*, such as eight, rows or columns of pixels, having row or column numbers i=0...N-1 then the first line 10 of pixels 11, 13, 15, 17 has line number i in the block 10 and the corresponding first line 20 of pixels 21, 23, 25, 27 also has line number i but in the neighboring block 20. Thus, first line 12 of pixels 11, 13, 15, 17 in the block and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 are opposing lines with regard to the block boundary 1.

According to the embodiments, “line of pixels” and “corresponding line of pixels” are employed to denote a “row of pixels” and a “corresponding row of pixels” in the case of a vertical block boundary as in Fig. 2A and denote a “column of pixels” and a “corresponding column of pixels” in the case of a horizontal block boundary as in Fig. 2B.

The first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could be predefined lines in the block 10 and the neighboring block 20, respectively. Thus, the first line 12 of pixels 11, 13, 15, 17 and the corresponding line 22 of pixels 21, 23, 25, 27 have a predefined and fixed line number i with regard to each block boundary 1 for which a filtering control is applied. Alternatively, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could

represent a current line and a current corresponding line, respectively, which is further discussed herein.

The calculation of the first filter decision value in step S1 and the calculation of the second filter decision value in step S2 can be performed serially in any order, i.e. step S1 preceding step S2 or step S2 preceding step S1, or at least partly in parallel. The results of these two steps S1, S2 is, thus, a first filter decision value that is calculated based on pixel values in the block 10 and a second filter decision value that is calculated based on pixel values in the neighboring block 20 on the other side of the block boundary 1 relative to the block 10. More preferably, the calculation of the first decision value is performed only based on pixel values in the block 10 and therefore not based on any pixel values in the neighboring block 20. Correspondingly, the second filter decision value is preferably calculated based only on pixel values in the neighboring block 20 and not based on any pixel values in the block 10.

The first filter decision value calculated in step S1 is then used in step S3 to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1. The second filter decision value is correspondingly used in step S4 to determine how many pixels in a corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1. Thus, separate filter decision values are calculated for each side or part of a row or column of pixels extending over the block boundary 1 and a respective filter decision is taken for each side or part based on the particular filter decision value calculated for that side or part.

This should be compared to the prior art where a single or a set of filter decision values is calculated for a line of pixels and the corresponding line of pixels and where this filter decision value or set of filter decision values is used to decide how many pixels to filter on both sides of the block boundary. Thus, in the prior art the same number of pixels is always filtered for the corresponding line of pixels in the neighboring block as is done for the matching line of pixels in the block.

The present embodiments instead enable an asymmetric filtering control and deblocking filtering by making a separate filter decision for the line 12 of pixels 11, 13, 15, 17 in the block 10 and another, different filter decision for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. This means that based on the particular first and second filter decision values different or the same number of pixels in the line 12 of pixels 11, 13, 15, 17 could be selected for deblocking filtering and

modification as the number of pixels in the corresponding line 22 of pixels 21, 23, 25, 27 that are selected for deblocking filtering and modification.

Generally, herein pX_y denotes the pixel value of pixel number X relative to the block boundary 1 in a line of pixels having line number y in the block 10. Correspondingly, qX_y denotes the pixel value of pixel number X relative to block boundary 1 in a corresponding line of pixels having line number y in the neighboring block 20.

Steps S3 and S4 can be performed serially in any order or indeed at least partly in parallel.

In a first embodiment, steps S1 and S2 could be performed once for a given block boundary 1 between the block 10 and the neighboring block 20 to thereby calculate a first filter decision value and a second filter decision value that applies to all lines 12 of pixels 11, 13, 15, 17 in the block 10 and to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20, respectively. In such approach the same first number of pixels are preferably filtered and modified in each line 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the block boundary 1, where this first number is determined based on the first filter decision value calculated in step S1. Correspondingly, the same second number of pixels are preferably filtered and modified in each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the block boundary 1, where this second number is determined based on the second filter decision value calculated in step S2.

Alternatively, in a second embodiment the first filter decision value and the second filter decision value applies to a subset of the lines 12 of pixels 11, 13, 15, 17 in the block 10 and to a corresponding subset of the corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20. For instance, a pair of filter decision values could be used for the first four lines 12 of pixels 11, 13, 15, 17 in the block and the first four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and with another pair of filter decision values used for the remaining four lines 12 of pixels 11, 13, 15, 17 in the block and the remaining four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

In a third embodiment the calculation in step S1 is performed for each line 12 of pixels 11, 13, 15, 17 in the block 10 and a separate determination in step S3 is then performed for each such line 12 of pixels 11, 13, 15, 17. In such a case, the calculation in step S2 is correspondingly performed for each

corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and a separate determination in step S4 is performed for each such corresponding line 22 of pixels 21, 23, 25, 27.

Thus, in the third embodiment step S3 comprises determining how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated in step S1. Step S4 comprises determining how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated in step S2.

The following part describes how the third embodiment is applied separately for each line (row or column) crossing the block boundary 1. In this example the first filter decision value is defined as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and the second filter decision value is defined as $d_{qi} = |q2_i - 2q1_i + q0_i|$. The method then comprises:

- Calculate d_{pi}, calculate d_{qi} for each line i crossing the block boundary.
- if $d_{pi} < thr1$
  - do normal filtering of line i of current block 10, e.g. filter and modify two pixels from the block border or boundary;
- else, i.e. if $d_{pi} \geq thr1$
  - do not filter the second pixel from the block border or boundary of line i of the current block 10 or do not filter any pixels at all on line i of the current block 10;
- if $d_{qi} < thr2$
  - do normal filtering of line i of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_{qi} \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 of line i of the neighboring block 20 or do not filter any pixels at all on line i of the neighboring block 20.

As is illustrated by the example above, the third embodiment of the method in Fig. 1 can calculate separate first and second filter decision values and therefore make separate determinations of how many pixels to filter for each row or column in the block 10 and the neighboring block 20 relative to the

block boundary 1. Thus, in this third embodiment the first and second filter decision values are line-specific filter decision values, i.e. calculated for each line 12 of pixels 11, 13, 15, 17 in the block 10 and for each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

In the first embodiment, block-specific filter decision values are used. Thus, in such a case a single first filter decision value could be calculated for the block 10 relative to the block boundary 1 and apply to all lines 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the particular block boundary 1. Correspondingly a single second filter decision value is calculated for the neighboring block 20 relative to the block boundary 1 and applies to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the particular block boundary 1.

A first example of this first embodiment involves calculating a first filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1.

The second filter decision value is then preferably calculated as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

The first filter decision value is then used for all lines 12 of pixels 11, 13, 15, 17 in the block 10 when determining how many pixels to filter and the second filter decision value is used for all corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 when determining how many pixels to filter.

In this first example of the first embodiment, the first line of pixels corresponds to line i=2 and the corresponding first line corresponds to corresponding line i=2 and the second line of pixels corresponds to line i=5 and the second corresponding line corresponds to corresponding line i=5. In this case the block 10 preferably comprises eight lines and the neighboring block 20 preferably also comprises eight lines, i.e. i=0-7.

The following part illustrates an implementation example of the first embodiment. In this implementation example the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is defined as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
  - do normal filtering of current block 10, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_p \geq thr1$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr2$
  - do normal filtering of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

In a second example of the first embodiment the first filter decision value is calculated as a block-specific filter decision value based on pixel values in line i=3 and line i=4 instead of line i=2 and line i=5. The corresponding lines i=3 and i=4 in the neighboring block 20 are preferably then used for calculating the second filter decision value. The first filter decision value could then be calculated as

$|p2_3 - 2p1_3 + p0_3| + |p2_4 - 2p1_4 + p0_4|$ and the second filter decision value is calculated as $|q2_3 - 2q1_3 + q0_3| + |q2_4 - 2q1_4 + q0_4|$, wherein $p0_3$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_3$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_3$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_4$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_4$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_4$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1 and $q0_3$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_3$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_3$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_4$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_4$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_4$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

In the second embodiment a first filter decision value and a second filter decision value are calculated for a group of four lines of pixels and four corresponding lines of pixels. This second embodiment can be suitable if the block and the neighboring block each have a size of 4×4 pixels. In addition, the second embodiment could also be used for larger blocks of pixels, such as 8×8 pixels. In the latter case, a pair of filter decisions is calculated for the first four lines pixels and first four corresponding lines of pixels and another pair of filter decisions is calculated for the remaining four lines of pixels and the remaining four corresponding lines of pixels.

A first example of the second embodiment calculates the first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and the second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision

value is calculated as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ and $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

A second example of the second embodiment calculates the first filter decision value as $|p2_1 - 2p1_1 + p0_1| + |p2_2 - 2p1_2 + p0_2|$ and the second filter decision value as $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision value is calculated as $|p2_1 - 2p1_1 + p0_1| + |p2_2 - 2p1_2 + p0_2|$ and $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_5 - 2p1_5 + p0_5| + |p2_6 - 2p1_6 + p0_6|$ and $|q2_5 - 2q1_5 + q0_5| + |q2_6 - 2q1_6 + q0_6|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

This concept of the second embodiment can be extended to the case where the first filter decision value is calculated based on the pixel values of pixels present in a subset of the lines of pixels in the block and the second filter decision value is calculated based on the pixel values of pixels present in a subset of the corresponding lines of pixels in the neighboring block. Thus, in this general concept of the second embodiment the first filter decision value could be calculated as $|p2_i - 2p1_i + p0_i| + |p2_j - 2p1_j + p0_j|$, wherein i, j represent different line numbers in the interval 0 to N-1, with N denoting the total number of lines of pixels in the block and the neighboring block and $i \neq j$. The second filter decision value is then preferably calculated as $|q2_i - 2q1_i + q0_i| + |q2_j - 2q1_j + q0_j|$. This concept can of course be extended with the subset containing more than two of the lines of pixels or the corresponding lines of pixels.

In a related example of the first or third embodiment, the first filter decision value is calculated as $\varpi_i|p2_i - 2p1_i + p0_i| + \varpi_j|p2_j - 2p1_j + p0_j|$ and the second filter decision value is calculated as $\varpi_i|q2_i - 2q1_i + q0_i| + \varpi_j|q2_j - 2q1_j + q0_j|$. ϖ_i, ϖ_j represent different line-specific weights. This concept can also be extended to the case with more than two lines of pixels and two corresponding lines of pixels. In a particular example, a line of pixels or corresponding line of pixels that is closer to the middle of the block or the neighboring block could then be assigned a comparatively higher weight as compared to a line or pixels or corresponding line of pixels that is closer to one of the edges of the block or the neighboring block.

In a fourth embodiment, a combination of block-specific and line-specific filter decision values is used to determine how many pixels to filter for the lines of pixels in the block and the corresponding lines of pixels in the neighboring block. Fig. 3 schematically illustrates such an embodiment. The method starts in step S10 where a third filter decision value is calculated as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the second line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the second line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a third line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the third line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the third line of pixels, the block boundary 1. The second line of pixels preferably corresponds to line number 2 in the block 10 and the third line of pixel preferably corresponds to line number 5 in the block 10, see Figs. 2A and 2B.

The next step S11 calculates a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a

corresponding third line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding third line of pixels, the block boundary 20 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding third line of pixels, the block boundary 1. The second corresponding line of pixels preferably corresponds to line number 2 in the neighboring block 20 and the third corresponding line of pixel preferably corresponds to line number 5 in the neighboring block 20, see Figs. 2A and 2B.

Steps S10 and S11 can be performed serially in any order or at least partly in parallel.

The next step S12 compares the third filter decision value calculated in step S10 with a third threshold value (T_3). If the third filter decision value is below the third threshold value the method continues to steps S1 and then S3 of Fig. 1. Thus, in such a case a respective line-specific or first filter decision value is calculated for each line i in the block 10, where i preferably is from 0 to 7. This first filter decision value is then calculated as $|p2_i - 2p1_i + p0_i|$ in step S1 of Fig. 1. Step S3 of Fig. 1 determines how many pixels in the line i of pixels in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated for the line i of pixels in step S1. This procedure is performed for each line of pixels in the block 10. Thus, with a block 10 as illustrated in Figs. 2A or 2B steps S1 and S3 will be performed eight times. The method then continues to step S13 of Fig. 3. Correspondingly, if the third filter decision value is not below the first threshold value in step S12 the method continues to step S13.

Step S13 compares the fourth filter decision value calculated in step S11 with a fourth threshold value (T_4). If the fourth filter decision value is below the fourth threshold the method continues to steps S2 and S4 of Fig. 1. A respective line-specific or second filter decision value is calculated for each corresponding line i in the neighboring block 20 as $|q2_i - 2q1_i + q0_i|$ in step S2 of Fig. 1. Step S4 of Fig. 3 determines how many pixels in the corresponding line i of pixels in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i of pixels in step S2. This procedure is performed for each corresponding line of pixels in the neighboring block 20. The method then ends. Correspondingly, if the fourth filter decision value is not below the second threshold value in step S13 the method ends.

The loop formed by steps S12, S1 and S3 can be performed sequentially in any order relative to the loop formed by steps S13, S2 and S4 or at least partly in parallel.

In an example of this fourth embodiment a combination of block-based and line-based asymmetric filter decisions is used. In this example the third filter decision value is calculated as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the fourth filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$. The line-specific filter decision values, i.e. the first and second filter decision values, are calculated as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and $d_{qi} = |q2_i - 2q1_i + q0_i|$ for line and corresponding line number i, respectively.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
  - for each line i
    - calculate d_{pi} for line i
    - if $d_{pi} < thr1$
      - do normal filtering of line i in current block 10, e.g. two pixels from the block border or boundary 1;
    - else, i.e. if $d_{pi} \geq thr1$
      - do not filter the second pixel from the block border or boundary 1 of line i of current block 10 or do not filter any pixels at all on line i of current block 10;
- else, i.e. if $d_p \geq thr1$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr1$
  - for each line i
    - calculate d_{qi} for line i
    - if $d_{qi} < thr2$
      - do normal filtering of line i in neighboring block 20, e.g. two pixels from the block border or boundary 1;

- else, i.e. if $d_{qi} \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 of line i of neighboring block 20 or do not filter any pixels at all on line i of neighboring block 20;
- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

In the above disclosed example the same threshold value has been used when comparing the third filter decision value and the first filter decision values, i.e. thr1, and the same threshold value has been used when comparing the fourth filter decision value and the second filter decision values, i.e. thr2. In an alternative approach, a third threshold value is used for the third filter decision value, a first threshold value is used for the first filter decision values, a fourth threshold value is used for the fourth filter decision value and a second threshold value is used for the second threshold values. In a particular embodiment, the third and fourth threshold values are equal and the first and second threshold values are equal.

Fig. 4 is a flow diagram illustrating a particular embodiment of the determining steps S3 and S4 of Fig. 1. The method continues from step S2 in Fig. 1. A next step S20 compares the first filter decision value (d_p) calculated in step S1 in Fig. 1 to a first threshold value (T_1). If the first filter decision value is below the first threshold value the method continues from step S20 to step S21. Step S21 determines to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. These two pixels are preferably the pixel 11 closest to the block boundary 1 and the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. However, if the first filter decision value is not below the first threshold in step S20 the method instead continues to step S22. A first embodiment of step S22 determines to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. This pixel 11 is preferably the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. A second embodiment of step S22 determines to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

Steps S23 to S25 perform the corresponding determination for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. Thus, step S23 compares the second filter decision value (d_q) calculated in step S2 in Fig. 1 with a second threshold value (T_2). If the second filter decision value is

below the second threshold value the method continues to step S24. Step S24 determines to filter two pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. These two pixels 21, 23 are preferably the pixel 21 closest to the block boundary 1 and the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. If the second filter decision value is not below the second threshold the method instead continues to step S25 from step S23. A first embodiment of step S25 determines to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. This pixel 21 is preferably the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. A second embodiment of step S25 determines to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block relative to the block boundary 1.

Steps S20, S21 and S22 can be performed prior to, following or at least in parallel to steps S23, S24 and S25.

This concept can be extended by using more than one threshold value per filter decision value. For instance, if $d_p<T_1$ two pixels are filtered in the line 12 of pixels 11, 13, 15, 17, if $T_1\leq d_p<T_1$' one pixel is filtered in the line 12 of pixels 11, 13, 15, 17 and if $d_p\geq T_1$' no pixels are filtered in the line 12 of pixels 11, 13, 15, 17. In this case $T_1<T_1$'. Correspondingly, if $d_q<T_2$ two pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27, if $T_2\leq d_q<T_2$' one pixel is filtered in the corresponding line 22 of pixels 21, 23, 25, 27 and if $d_q\geq T_2$' no pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27. In this case $T_2<T_2$'.

Thus, in a general aspect the closer the first or second filter decision value is to zero the more filtering is to be applied to the particular line or corresponding line of pixels by filtering and possibly modifying more pixels in the line or corresponding line of pixels as compared to a larger first or second filter decision value. This means that a zero or low first or second filter decision value implies no or few structures but rather a fairly uniform area in the video frame. Correspondingly, a high first or second filter decision value generally reflects local structures in the area in the video frame, which local structures should not be repressed or filtered away.

This embodiment decreases the computational complexity in connection with deblocking filtering since the filtering of the second pixel from the block border may happen less frequently as compared to the prior art HEVC solution.

The threshold values discussed in the foregoing and used to compare the different filter decision values are preferably dependent on the quantization parameter (QP) assigned to the block or to the neighboring block. Fig. 5 schematically illustrates such an approach. The method starts in step S30 where the first threshold value, to which the first filter decision value is compared (see step S20 in Fig. 4), is determined based on a quantization parameter associated with the block 10. Correspondingly, step S31 determines the second threshold value, to which the second threshold value is compared (see step S23 in Fig. 4), based on a quantization parameter associated with the neighboring block 20 and/or a quantization parameter associated with the block 10.

For instance, T_1 and T_2 are determined based on the parameter β, which is determined from the QP value of the block 10 or the neighboring block 20. In a particular embodiment, the parameter β is read from a table based on the QP value, see Table 1 below.

Table 1 - β and QP values

QP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
QP	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
QP	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
β	38	40	42	44	46	48	50	52	54	56	58	60	62	64	64	64	64	64	

In particular embodiments $T_1=T_2=\beta/6$ or $T_1=T_2=(\beta + \beta>>1)>>3$. As another variant of the embodiment, the thresholds can be read from separate tables, i.e. T_1=function(QP), T_2=function(QP). Also the above mentioned third and fourth threshold values are preferably determined based on the quantization parameter associated with the block and the neighboring block, respectively.

Fig. 6 is a flow diagram illustrating how the filtering control of the embodiments can be used in connection with a filtering process. The method starts in step S40 where a first offset or delta value Δ is calculated based on $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel 11 closest to, in a line 12 of pixels 11, 13, 15, 17, the block boundary 1, $p1_j$ denotes a pixel value of a pixel 13 next closest to, in the line 12 of pixels 11, 13, 15, 1), the block boundary 1, $q0_j$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in the corresponding line 22

of pixels 21, 23, 25, 27, the block boundary 1 and $q1_i$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1.

This first offset is used in step S41 to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value, i.e. $p0'_j = p0_j + \Delta$. Step S41 also modifies the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value, i.e. $q0'_j = q0_j - \Delta$. The method then continues to steps S1 and S2 of Fig. 1 where the first (d_p) and second (d_q) filter decision values are calculated. A next step S42 compares the first filter decision value to a first threshold value (T_1). This step S42 corresponds to step S20 in Fig. 4. If the first filter decision value is below the threshold the method continues to step S43.

Step S43 calculates a second offset or delta value Δ_p based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel 15 second next closest to, in the line 12 of pixels 11, 13, 15, 17, the block boundary 1. The second offset is then used in step S44 to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value, i.e. $p1'_j = p1_j + \Delta_p$.

The method then continues to step S45. The method also continues in Fig. 6 from step S42 to step S45 if the first threshold value is not below the first threshold.

Step S45 compares the second filter decision value with a second threshold (T_2). This step S45 corresponds to step S23 of Fig. 4. If the second filter decision value is below the second threshold the method continues to step S46. Step S46 calculates a third offset Δ_q based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1. The third offset is used in step S47 to modify the pixel value of the pixel 23 next closest to the block

boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value, i.e. $q1'_j = q1_j + \Delta_q$.

Steps S42, S43 and S44 can be performed serially in any order or at least partly in parallel with steps S45, S46 and S47.

In above, the first, second and third offsets are calculated based on particular equations of pixel values. This means that the first offset is calculated as a function of $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, the second offset is calculated as a function of $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$ and the third offset is calculated as a function of $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$. Different such functions are possible and can be used in steps S40, S43 and S46. Such functions could then be defined so that the calculations of the offsets are efficiently performed in hardware. In such a case, it is generally preferred not to have any divisions and/or define the functions so that the offsets will be an integer value. In an embodiment, (X+8)>>4 is used as an integer-expression of X/16, where >> denotes a right shift operation. Thus, in a particular embodiment step S40 calculates the first offset to be based on and preferably equal to $(9\times(q0_j - p0_j) - 3\times(q1_j - p1_j) + 8) >> 4$. Corresponding integer representations of the second and third offsets could be $(((p0_j + p2_j + 1) >> 1) - p1_j + \Delta) >> 1$ and $(((q0_j + q2_j + 1) >> 1) - q1_j - \Delta) >> 1$.

In an example the modified pixel values as a result of deblocking are calculated like in the following. In this example, the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

- $\Delta = \frac{9\times(q0 - p0) - 3\times(q1 - p1)}{16}$
- $p_0' = p_0 + \Delta$
- $q_0' = q_0 - \Delta$

- if $d_p < thrP$
  - $\Delta_p = \frac{p0 + p2 - 2p1_j + 2\Delta}{4}$
  - $p_1^{'} = p_1 + \Delta_p$
- if $d_q < thrQ$
  - $\Delta_q = \frac{q0 + q2 - 2q1 - 2\Delta}{4}$
  - $q_1^{'} = q_1 + \Delta_q$

Exact formulas for computation of the example above in the programming language can look like in the text below. Here, the Clip3 function is clipping of the output values to the range between the two first function arguments.

```
Int xCalcDP(Pel* piSrc, Int iOffset)
{
   return abs(piSrc[-iOffset*3]-2*piSrc[-iOffset*2]+piSrc[-
iOffset]);
}

Int xCalcDQ(Pel* piSrc, Int iOffset)
{
  return abs(piSrc[0]-2*piSrc[iOffset]+piSrc[iOffset*2]);
}

Int iDP=xCalcDP(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDP(piTmpSrc+iSrcStep*
(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iDQ=xCalcDQ(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDQ(piTmpSrc+iSrcStep*(
Idx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iSideThreshold=iBeta/6;

Bool bFilterP=(iDP<iSideThreshold);
Bool bFilterQ=(iDQ<iSideThreshold);
```

```
delta=(9*(m4-m3)-3*(m5-m2)+8)>>4;

if (abs(delta)<iThrCut)
{
  Int tc2=tc>>1;

  delta=Clip3(-tc, tc, delta);
  piSrc[-iOffset]=Clip((m3+delta));
  piSrc[0]=Clip((m4-delta));

  if(bFilterP)
  {
    Int delta1=Clip3(-tc2,tc2,((((m1+m3+1)>>1)-m2+delta)>>1));
    piSrc[-iOffset*2]=Clip((m2+delta1));
  }
  if(bFilterQ)
  {
    Int delta2=Clip3(-tc2,tc2,((((m6+m4+1)>>1)-m5-delta)>>1));
    piSrc[iOffset]=Clip((m5+delta2));
  }
}
```

Fig. 7 is a flow diagram illustrating additional optional steps of the method in Fig. 1. The method continues from step S2 in Fig. 1. A next step S50 compares a sum of the first decision value and the second decision value with a threshold value (T). If the sum is not below the threshold value, the method ends. Thus, in such a case no filtering at all is applied to block 10 and neighboring block 20 with regard to the particular block boundary 1. The block 10 and the neighboring block 20 then comprises at lot of local structures, which should not be filtered away. However, if the sum is below the threshold value the method continues to steps S3 and S4 in Fig. 1, where the determination of how many pixels to filter is performed based on the first filter decision value (step S3) or the second filter decision value (step S4).

This embodiment has an advantage that it does not require many additional computations as the values for the first and second filter decisions are also used for deciding whether to filter the block boundary at all.

The embodiments disclosed herein achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

Fig. 8 is a schematic block diagram of an embodiment of a filtering control device 100. The filtering control device 100 comprises a first decision value calculator 110 configured to calculate a first filter decision value for a block 10 in a video frame based at least on $|p2_i - 2p1_i + p0_i|$. The filtering control device 100 also comprises a second decision value calculator 120 configured to calculate a second, different filter decision value for the block 10 based on $|q2_i - 2q1_i + q0_i|$.

A first pixel determiner 130 or first pixel determining unit or processor is configured to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to a block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110. A second pixel determiner 140 or second pixel determining unit or processor is provided in the filtering control device 100 to determine how many pixels in a corresponding line 22 of pixel 21, 23, 25, 27 in a neighboring block 20 of the video frame to filter relative to the block boundary based on the second filter decision value calculated by the second decision value calculator 120.

In an embodiment, the first pixel determiner 130 is configured to determine how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the first line 12 of pixels 11, 13, 15, 17. The second pixel determiner 140 correspondingly determines in this embodiment how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated by the second decision value calculator 120 for the corresponding first line 22 of pixels 21, 23, 25, 27.

In another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second decision value calculator 120 is configured to calculate the second filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

In yet another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value of a first pair as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and the second decision value calculator 120 is configured to calculate the second filter decision value of the first pair as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. The first filter decision value calculator 110 is also configured to calculate the first filter decision value of a second pair as $|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ and the second filter decision value calculator 120 is also configured to calculate the second filter decision value of a the second pair as $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$.

Fig. 9 is a schematic block diagram of another embodiment of a filtering control device 100. The filtering control device 100 comprises, in this embodiment and in addition to the first decision value calculator 110, the second decision value calculator 120, the first pixel determiner 130 and the second pixel determiner 140, a third decision value calculator 150. The third decision value calculator 150 is then configured to calculate a third filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$. A fourth decision value calculator 160 is also implemented in the filtering control device 100 and configured to calculate a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

In this embodiment, the first filter decision value calculator 110 is configured to calculate the first filter decision value if the third filter decision value calculated by the third decision value calculator 150 is below a third threshold value. If the third decision value is below the third threshold, the first decision value calculator 110 calculates a first threshold value for each line i 12 of pixels 11, 13, 15, 17 in the block 10 as $|p2_i - 2p1_i + p0_i|$. The first pixel determiner 130 then determines, if the third filter decision value is below the third threshold value and for each line i 12 of pixels 11, 13, 15, 17 in the block 10, how many pixels in the line i 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the line i 12 of pixels 11, 13, 15, 17.

The second decision value calculator 120 is preferably responsive to a comparison between the fourth filter decision value and a fourth threshold value. Thus, if the fourth filter decision value calculated by the fourth decision value calculator 160 is below the fourth threshold the second decision value calculator 120 calculates a second filter decision value as $|q2_i - 2q1_i + q0_i|$ for each corresponding

line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20. The second pixel determiner 240 is configured to determine, if the fourth filter decision value is below the fourth threshold value and for each corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20, how many pixels in the corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i 22 of pixels 21, 23, 25, 27.

Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises a first comparator 180 configured to compare the first filter decision value calculated by the first decision value calculator 110 to a first threshold value. A second comparator 182 is correspondingly configured to compare the second filter decision value calculated by the second decision value calculator 120 to a second threshold value.

In this embodiment, the first pixel determiner 130 is configured to determine to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1 if the first filter decision value is below the first threshold value as determined by the first comparator 180. However, if the first filter decision value is not below the first threshold value the first pixel determiner 130 is instead configured to determine to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. Alternatively, the first pixel determiner 130 is instead configured to determine to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

The second pixel determiner 140 is configured to determine to filter two pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1 if the second filter decision value is below the second threshold value as determined by the second comparator 182. However, if the second filter decision value is not below the second threshold the second pixel determiner 140 is instead configured to determine to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. Alternatively, the second pixel determiner 140 is instead configured to determine to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1.

In an embodiment the filtering control device 100 of Fig. 10 comprises a first offset calculator 181 configured to calculate a first offset based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$. A first pixel modifier

190 of the filtering control device 100 is configured to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value of this pixel 11. A second pixel value modifier 192 is configured to modify the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 12 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value of this pixel 21.

A second offset calculator 183 is preferably implemented in the filtering control device 100 to calculate a second offset if the first filter decision value is below the first threshold value as determined by the first comparator 180. The second offset is then calculated based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$. A third pixel modifier 194 is operated if the first filter decision value is below the first threshold value. In such a case, the third pixel modifier 194 is configured to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value of this pixel 13.

A third offset calculator 185 is configured to calculate a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$ if the second filter decision value is below the second threshold value as determined by the second comparator 182. If the second filter decision value is below the second threshold value a fourth pixel modifier 196 of the filtering control device 100 is configured to modify the pixel value of the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value of this pixel 23.

The embodiments of the filtering control device 100 discussed in the foregoing in connection with Figs. 9 and 10 compares filter decision values to respective threshold values. In an embodiment, such threshold values are calculated by the filtering control device 100 for the particular block boundary 1. The filtering control device 100 then preferably comprises a threshold determiner 170 or threshold determining processor or unit configured to determine the first threshold value used by the first comparator 180 in Fig. 10 and the third threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the block 10. Correspondingly, the threshold determiner 170 correspondingly preferably determines the second threshold value used by the second comparator 182 in Fig. 10 and the fourth threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the neighboring block 20.

Fig. 11 is schematic block diagram of yet another embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises in this embodiment a third comparator 184 configured to compare a sum of the first filter decision value and the second filter decision value to a threshold value. If the sum is equal to or exceeds the threshold value the first and second pixel determiners 130, 140 will not determine any number of pixels to filter since no filtering is to be applied to the block 10 and the neighboring block 20 with regard to the particular block boundary 1. However, if the sum is below the threshold, the first and second pixel determiners 130, 140 are operated to determine the number of pixels to filter based on the first or second filter decision values, respectively.

The embodiments of the filtering control device 100 discussed in the foregoing and disclosed in Figs. 8-11 can be combined. For instance, the third value calculator 150 and fourth value calculator 160 of Fig. 9 can be implemented in any of the embodiments disclosed in Figs. 10 or 11. Correspondingly, the third comparator 184 of Fig. 11 can be implemented in any of the embodiments disclosed in Figs. 9 or 10.

Although the respective units 110-196 disclosed in conjunction with Figs. 8-11 have been disclosed as physically separate units 110-196 in the filtering control device 100, and all may be special purpose circuits, such as ASICs (Application Specific Integrated Circuits), alternative embodiments of the filtering control device 100 are possible where some or all of the units 110-196 are implemented as computer program modules running on a general purpose processor. Such an embodiment is disclosed in Fig. 12.

Fig. 12 schematically illustrates an embodiment of a computer 70 having a processing unit 72, such as a DSP (Digital Signal Processor) or CPU (Central Processing Unit). The processing unit 72 can be a single unit or a plurality of units for performing different steps of the method described herein. The computer 70 also comprises an input/output (I/O) unit 71 for receiving recorded or generated video frames or encoded video frames and outputting encoded video frame or decoded video data. The I/O unit 71 has been illustrated as a single unit in Fig. 12 but can likewise be in the form of a separate input unit and a separate output unit.

Furthermore, the computer 70 comprises at least one computer program product 73 in the form of a non-volatile memory, for instance an EEPROM (Electrically Erasable Programmable Read-Only Memory), a flash memory or a disk drive. The computer program product 73 comprises a computer

program 74, which comprises code means which when run on or executed by the computer 70, such as by the processing unit 72, causes the computer 70 to perform the steps of the method described in the foregoing in connection with Fig. 1. Hence, in an embodiment the code means in the computer program 74 comprises a first decision value calculating (DVC) module 310 for calculating the first filter decision value for a block, a second pixel value calculating module 320 for calculating the second filter decision value for the block, a first pixel determining (PD) module 330 for determining how many pixels in the line 12 of pixels 11, 13, 15, 17 to filter and a second pixel determining module 340 for determining how many pixels in the corresponding line 22 of pixels 21, 23, 25, 27 to filter. These modules 310-340 essentially perform the steps of the flow diagram in Fig. 1 when run on the processing unit 72. Thus, when the different modules 310-340 are run on the processing unit 72 they correspond to the corresponding units 110-140 of Figs. 8-11.

The computer program 74 may additionally comprise a third decision value calculating module, a fourth decision value calculating module, a threshold determining module, a first comparing module, second comparing module, a third comparing module, a first offset calculating module, a second offset calculating module, a third offset calculating module, a first pixel modifying module, a second pixel modifying module, a third pixel modifying module and/or a fourth pixel modifying module to perform the operation of the corresponding units 150-196 in Figs. 9-11.

The computer 70 of Fig. 12 can be a user equipment or be present in a user equipment. In such a case, the user equipment may additionally comprise or be connected to a display to display video data.

The filtering control device of Figs. 8-11 is preferably used in video coding. It functions and is therefore preferably implemented both in a video encoder and in a video decoder. The video decoder can be implemented preferably in hardware but also in software. The same holds for the video encoder.

Fig. 13 is a schematic block diagram of an encoder 40 for encoding a block of pixels in a video frame of a video sequence according to an embodiment.

A current block of pixels is predicted by performing a motion estimation by a motion estimator 50 from an already provided block of pixels in the same frame or in a previous frame. The result of the motion estimation is a motion or displacement vector associated with the reference block, in the case of inter prediction. The motion vector is utilized by a motion compensator 50 for outputting an inter prediction of the block of pixels.

An intra predictor 49 computes an intra prediction of the current block of pixels. The outputs from the motion estimator/compensator 50 and the intra predictor 49 are input in a selector 51 that either selects intra prediction or inter prediction for the current block of pixels. The output from the selector 51 is input to an error calculator in the form of an adder 41 that also receives the pixel values of the current block of pixels. The adder 41 calculates and outputs a residual error as the difference in pixel values between the block of pixels and its prediction.

The error is transformed in a transformer 42, such as by a discrete cosine transform, and quantized by a quantizer 43 followed by coding in an encoder 44, such as by entropy encoder. In inter coding, also the estimated motion vector is brought to the encoder 44 for generating the coded representation of the current block of pixels.

The transformed and quantized residual error for the current block of pixels is also provided to a inverse quantizer 45 and inverse transformer 46 to retrieve the original residual error. This error is added by an adder 47 to the block prediction output from the motion compensator 50 or the intra predictor 49 to create a reference block of pixels that can be used in the prediction and coding of a next block of pixels. This new reference block is first processed by a filtering control device 100 according to the embodiments in order to control any deblocking filtering that is applied to the reference block to combat any blocking artifact. The processed new reference block is then temporarily stored in a frame buffer 48, where it is available to the intra predictor 49 and the motion estimator/compensator 50.

Fig. 14 is a corresponding schematic block diagram of a decoder 60 comprising a filtering control device 100 according to the embodiments. The decoder 60 comprises a decoder 61, such as entropy decoder, for decoding an encoded representation of a block of pixels to get a set of quantized and transformed residual errors. These residual errors are dequantized in an inverse quantizer 62 and inverse transformed by an inverse transformer 63 to get a set of residual errors.

These residual errors are added in an adder 64 to the pixel values of a reference block of pixels. The reference block is determined by a motion estimator/compensator 67 or intra predictor 66, depending on whether inter or intra prediction is performed. A selector 68 is thereby interconnected to the adder 64 and the motion estimator/compensator 67 and the intra predictor 66. The resulting decoded block of pixels output form the adder 64 is input to a filtering control device 100 according to the embodiments in order to control any deblocking filter that is applied to combat any blocking artifacts. The filtered block of pixels is output form

the decoder 60 and is furthermore preferably temporarily provided to a frame buffer 65 and can be used as a reference block of pixels for a subsequent block of pixels to be decoded. The frame buffer 65 is thereby connected to the motion estimator/compensator 67 to make the stored blocks of pixels available to the motion estimator/compensator 67.

The output from the adder 64 is preferably also input to the intra predictor 66 to be used as an unfiltered reference block of pixels.

In the embodiments disclosed in Figs. 13 and 14 the filtering control device 100 controls deblocking filtering in the form of so called in-loop filtering. In an alternative implementation at the decoder 60 the filtering control device 100 is arranged to perform so called post-processing filtering. In such a case, the filtering control device 100 operates on the output frames outside of the loop formed by the adder 64, the frame buffer 65, the intra predictor 66, the motion estimator/compensator 67 and the selector 68. No deblocking filtering and filtering control is then typically done at the encoder.

Fig. 15 is a schematic block diagram of a user equipment or media terminal 80 housing a decoder 60 with a filtering control device. The user equipment 80 can be any device having media decoding functions that operates on an encoded video stream of encoded video frames to thereby decode the video frames and make the video data available. Non-limiting examples of such devices include mobile telephones and other portable media players, tablets, desktops, notebooks, personal video recorders, multimedia players, video streaming servers, set-top boxes, TVs, computers, decoders, game consoles, etc. The user equipment 80 comprises a memory 84 configured to store encoded video frames. These encoded video frames can have been generated by the user equipment 80 itself. Alternatively, the encoded video frames are generated by some other device and wirelessly transmitted or transmitted by wire to the user equipment 80. The user equipment 80 then comprises a transceiver (transmitter and receiver) or input and output port 82 to achieve the data transfer.

The encoded video frames are brought from the memory 84 to a decoder 60, such as the decoder illustrated in Fig. 14. The decoder 60 comprises a filtering control device 100 according to embodiments. The decoder 60 then decodes the encoded video frames into decoded video frames. The decoded video frames are provided to a media player 86 that is configured to render the decoded video frames into video data that is displayable on a display or screen 88 of or connected to the user equipment 80.

In Fig. 15, the user equipment 80 has been illustrated as comprising both the decoder 60 and the media player 86, with the decoder 60 implemented as a part of the media player 86. This should, however, merely be seen as an illustrative but non-limiting example of an implementation embodiment for the user equipment 80. Also distributed implementations are possible where the decoder 60 and the media player 86 are provided in two physically separated devices are possible and within the scope of user equipment 80 as used herein. The display 88 could also be provided as a separate device connected to the user equipment 80, where the actual data processing is taking place.

Fig. 16 illustrates another embodiment of a user equipment 80 that comprises en encoder, such as the encoder of Fig. 13, comprising a filtering control device according to the embodiments. The encoder 40 is then configured to encode video frames received by the I/O unit 82 and/or generated by the user equipment 80 itself. In the latter case, the user equipment 80 preferably comprises a media engine or recorder, such as in the form of or connected to a (video) camera. The user equipment 80 may optionally also comprise a media player 86, such as a media player 86 with a decoder and filtering control device according to the embodiments, and a display 88.

As illustrated in Fig. 17, the encoder 40 and/or decoder 60, such as illustrated in Figs. 13 and 14, may be implemented in a network device 30 being or belonging to a network node in a communication network 32 between a sending unit 34 and a receiving user equipment 36. Such a network device 30 may be a device for converting video according to one video coding standard to another video coding standard, for example, if it has been established that the receiving user equipment 36 is only capable of or prefers another video coding standard than the one sent from the sending unit 34. The network device 30 can be in the form of or comprised in a radio base station, a Node-B or any other network node in a communication network 32, such as a radio-based network.

The embodiments described above are to be understood as a few illustrative examples of the present invention. It will be understood by those skilled in the art that various modifications, combinations and changes may be made to the embodiments without departing from the scope of the present invention. In particular, different part solutions in the different embodiments can be combined in other configurations, where technically possible. The scope of the present invention is, however, defined by the appended claims.

CLAIMS

1. A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said method comprising:

calculating (S1) a first filter decision value for said block (10) based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculating (S2) a second filter decision value for said block (20) based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determining (S3) how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

2. The method according to claim 1, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

3. The method according to claim 1, wherein

calculating (S1) said first filter decision value comprises calculating (S1) said first filter decision value as:

$$|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$$

wherein $p0_2$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_2$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_2$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_5$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_5$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

calculating (S2) said second filter decision value comprises calculating (S2) said second filter decision value as:

$$|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$$

wherein $q0_2$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_2$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_2$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_5$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_5$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_5$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

4. The method according to any of the claims 1 to 3, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

5. The method according to any of the claims 1 to 3, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23 ,25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

6. The method according to any of the claims 3 to 5, further comprising:

determining (S30) said first threshold value based on a quantization parameter associated with said block (10); and

determining (S31) said second threshold value based on said quantization parameter associated with said neighboring block (20).

7. The method according to any of the claims 3 to 6, further comprising:

calculating (S40) a first offset Δ based on $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

modifying (S41) said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

modifying (S41) said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

calculating (S43), if said first filter decision value is below said first threshold value, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

modifying (S44), if said first filter decision value is below said first threshold, said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by

adding said second offset to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

calculating (S46), if said second filter decision value is below said second threshold value, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

modifying (S47), if said second filter decision value is below said second threshold, said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

8. The method according to any of the claims 1 to 7, further comprising comparing (S50) a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

9. A filtering control device (100) comprising:

a first decision value calculator (110) configured to calculate a first filter decision value for a block (10) of multiple pixels (11, 13, 15, 17) in a video frame based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels

(11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

a second decision value calculator (120) configured to calculate a second filter decision value for said block (10) based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel determiner (130) configured to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

a second pixel determiner (140) configured to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

10. The device according to claim 9, wherein

said first pixel determiner (130) is configured to determine how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

11. The device according to claim 9, wherein

said first decision value calculator (110) is configured to calculate said first filter decision value as:

$$\left|p2_2 - 2p1_2 + p0_2\right| + \left|p2_5 - 2p1_5 + p0_5\right|$$

wherein $p0_2$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_2$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_2$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_5$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_5$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

said second decision value calculator (120) is configured to calculate said second filter decision value as:

$$|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$$

wherein $q0_2$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_2$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_2$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_5$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_5$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_5$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

12. The device according to any of the claims 9 to 11, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

13. The device according to any of the claims 9 to 11, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

14. The device according to any of the claims 11 to 13, further comprising a threshold determiner (170) configured to i) determine said first threshold value based on a quantization parameter associated with said block (10), and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block (20).

15. The device according to any of the claims 11 to 14, further comprising:

a first offset calculator (181) configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel modifier (190) configured to modify said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset calculated by said first offset calculator (181) to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a second pixel modifier (192) configured to modify said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset calculated by said first offset calculator (181) from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

a second offset calculator (183) configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator (180), a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

a third pixel modifier (194) configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator (180), said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset calculated by said second offset calculator (183) to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a third offset calculator (185) configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator (182), a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring

block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

a fourth pixel modifier (196) configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator (182), said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset calculated by said third offset calculator (185) to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

16. The device according to any of the claims 9 to 15, further comprising a third comparator (184) configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner (130) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

17. An encoder (40) comprising a filtering control device (100) according to any of the claims 9 to 16.

18. A user equipment (80) comprising:

a memory (84) configured to store video frames; and

an encoder (40) according to claim 17 configured to encode said video frames into encoded video frames, wherein said memory (84) is further configured to store said encoded video frames.

19. A decoder (60) comprising a filtering control device (100) according to any of the claims 9 to 16.

20. A user equipment (80) comprising:

a memory (84) configured to store encoded video frames;

a decoder (60) according to claim 19 configured to decode said encoded video frames into decoded video frames; and

a media player (86) configured to render said decoded video frames into video data displayable on a display (88).

21. A computer program (74) for filtering control of a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said computer program (74) comprises code means which when run on a computer (70) causes the computer (70) to:

calculate a first filter decision value for said block (10) based at least on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17, 19), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (13) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculate a second filter decision value for said block based at least on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (23) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filer relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

22. A computer program product (73) comprising computer readable code means and a computer program (74) according to claim 21 stored on said computer readable means.

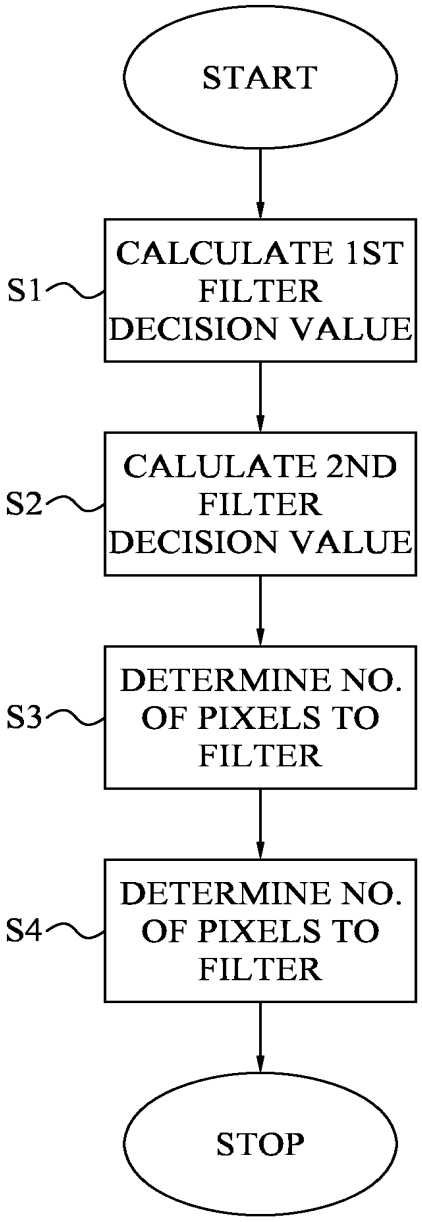


Fig. 1

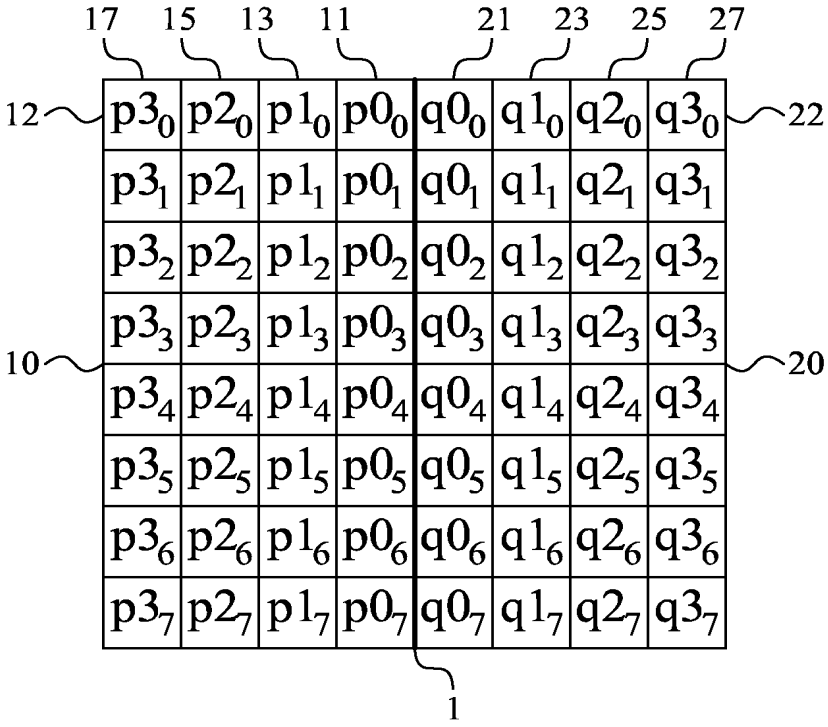


Fig. 2A

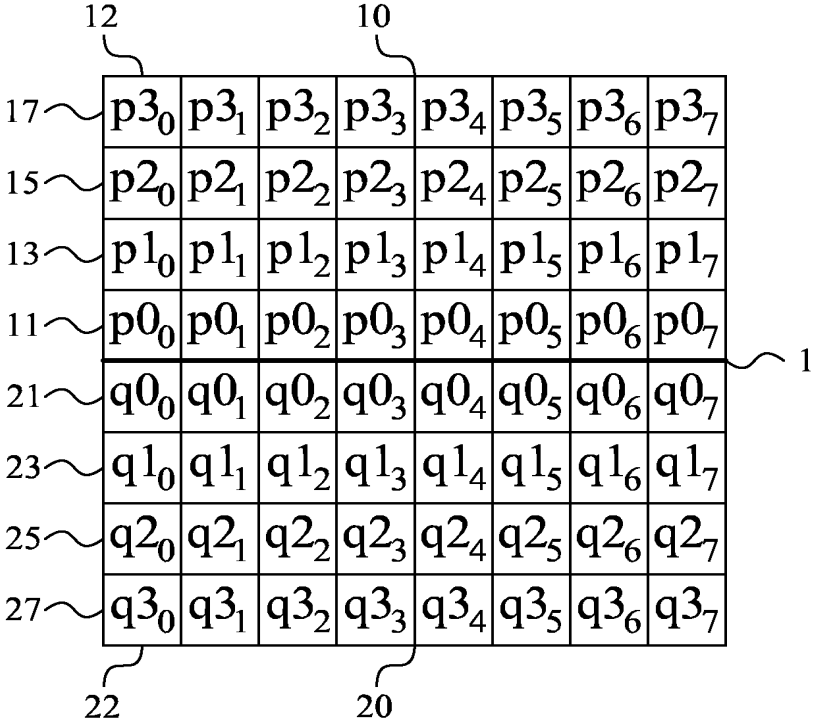


Fig. 2B

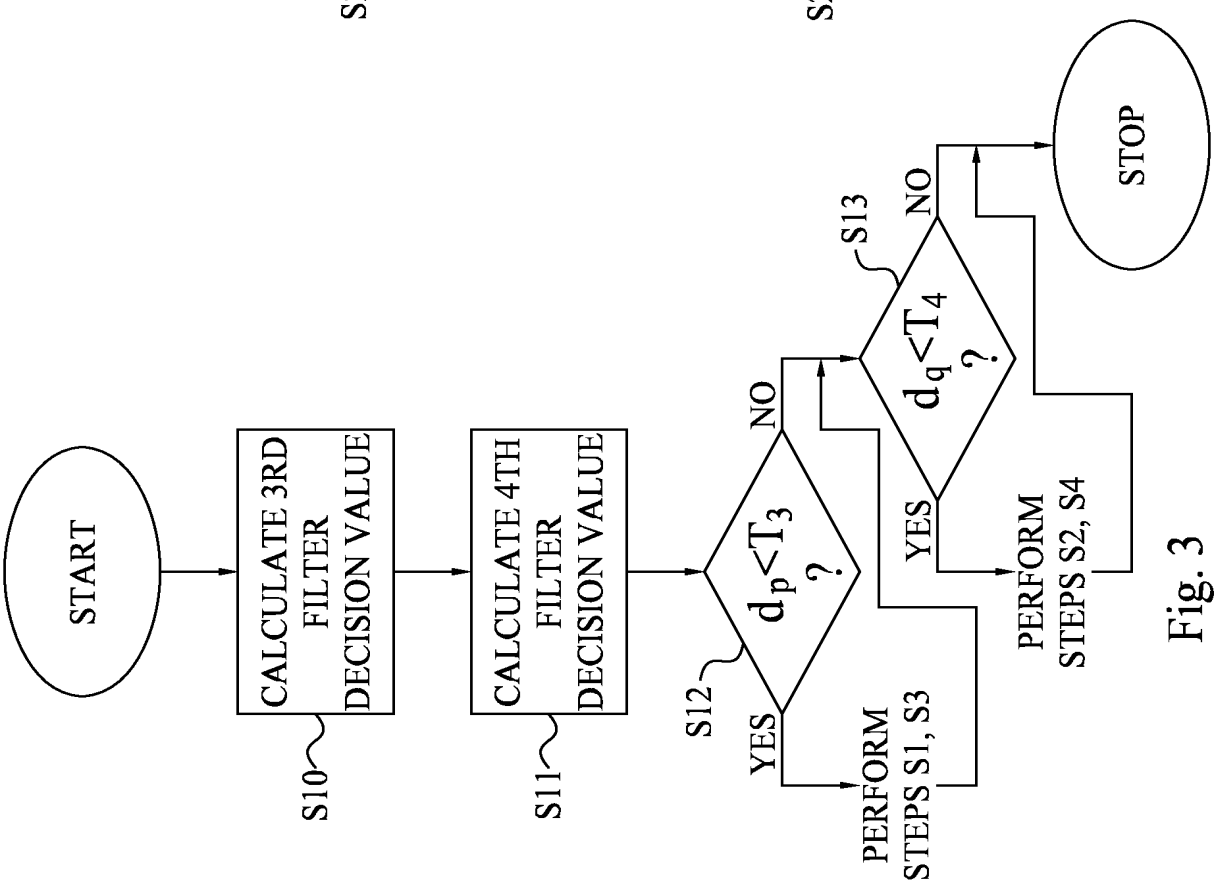

START
CALCULATE 3RD FILTER DECISION VALUE
S10
CALCULATE 4TH FILTER DECISION VALUE
S11
$d_p<T_3$?
S12
NO
YES
PERFORM STEPS S1, S3
$d_q<T_4$?
S13
NO
YES
PERFORM STEPS S2, S4
STOP

Fig. 3

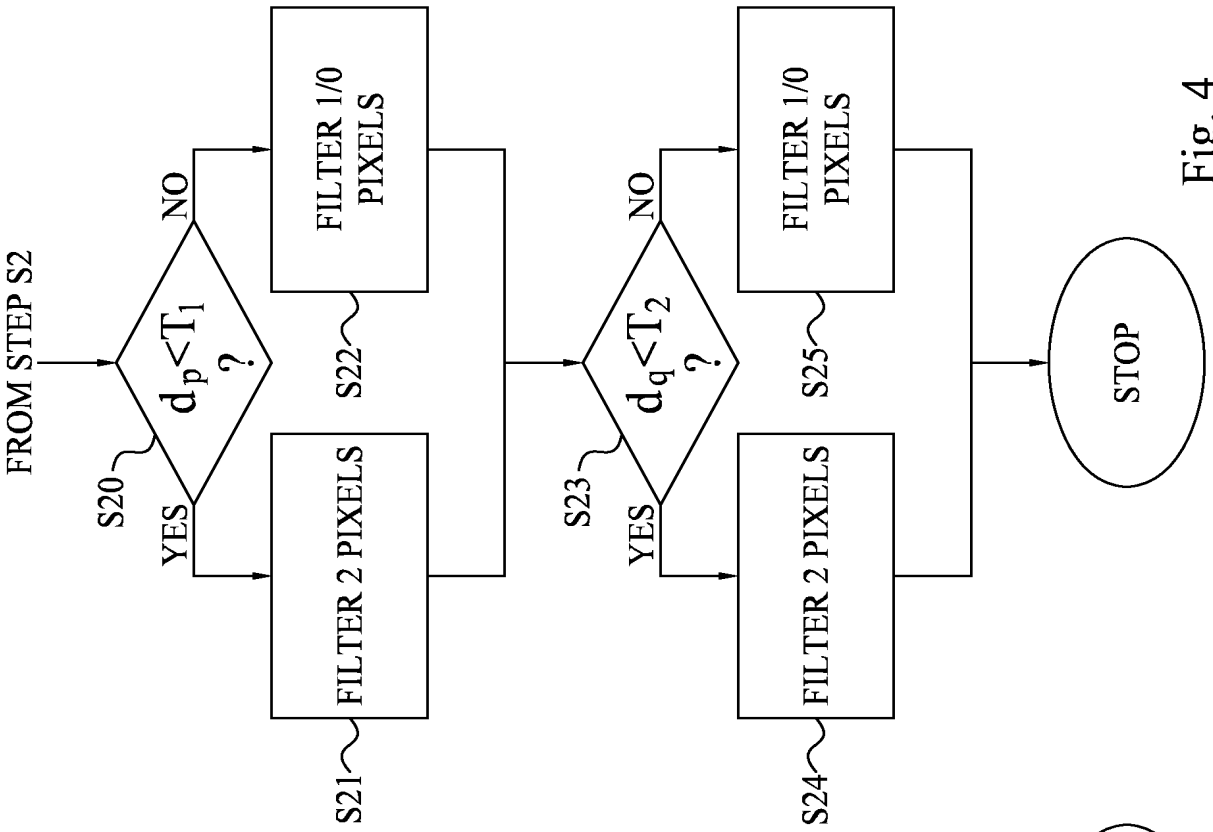

FROM STEP S2
$d_p<T_1$?
S20
NO
YES
FILTER 1/0 PIXELS
S22
FILTER 2 PIXELS
S21
$d_q<T_2$?
S23
NO
YES
FILTER 1/0 PIXELS
S25
FILTER 2 PIXELS
S24
STOP

Fig. 4

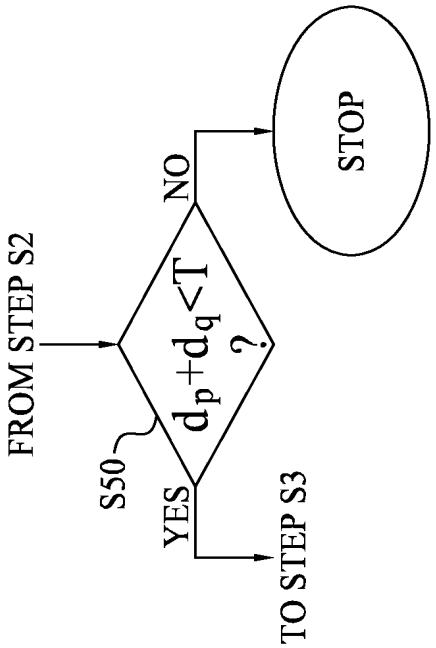

FROM STEP S2
S50
$d_p+d_q<T$?
YES
NO
TO STEP S3
STOP

Fig. 7

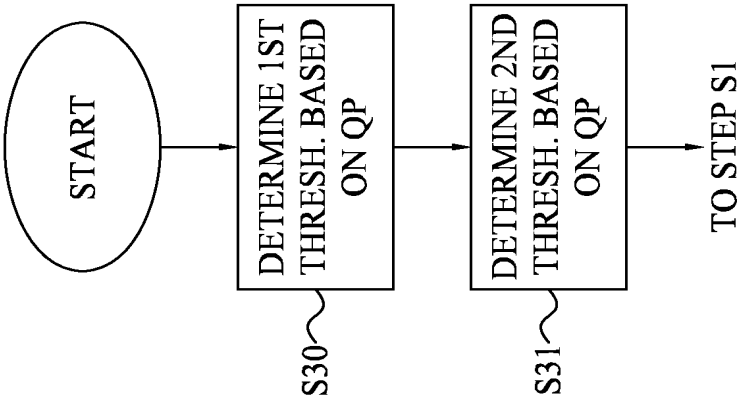

START
DETERMINE 1ST THRESH. BASED ON QP
S30
DETERMINE 2ND THRESH. BASED ON QP
S31
TO STEP S1

Fig. 5

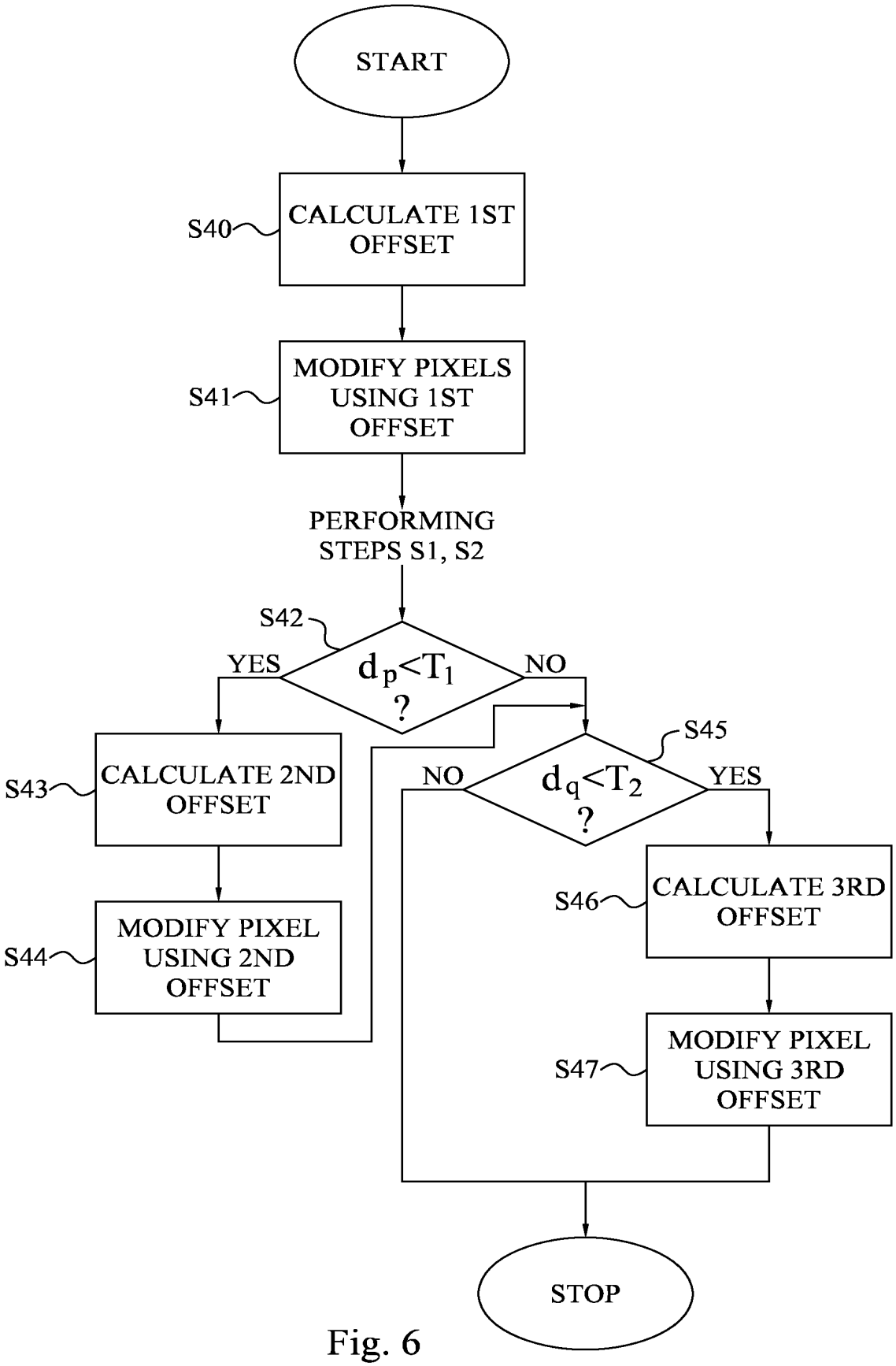

START
S40
CALCULATE 1ST OFFSET
S41
MODIFY PIXELS USING 1ST OFFSET
PERFORMING STEPS S1, S2
S42
$d_p < T_1$?
YES
NO
S43
CALCULATE 2ND OFFSET
S44
MODIFY PIXEL USING 2ND OFFSET
S45
$d_q < T_2$?
NO
YES
S46
CALCULATE 3RD OFFSET
S47
MODIFY PIXEL USING 3RD OFFSET
STOP

Fig. 6

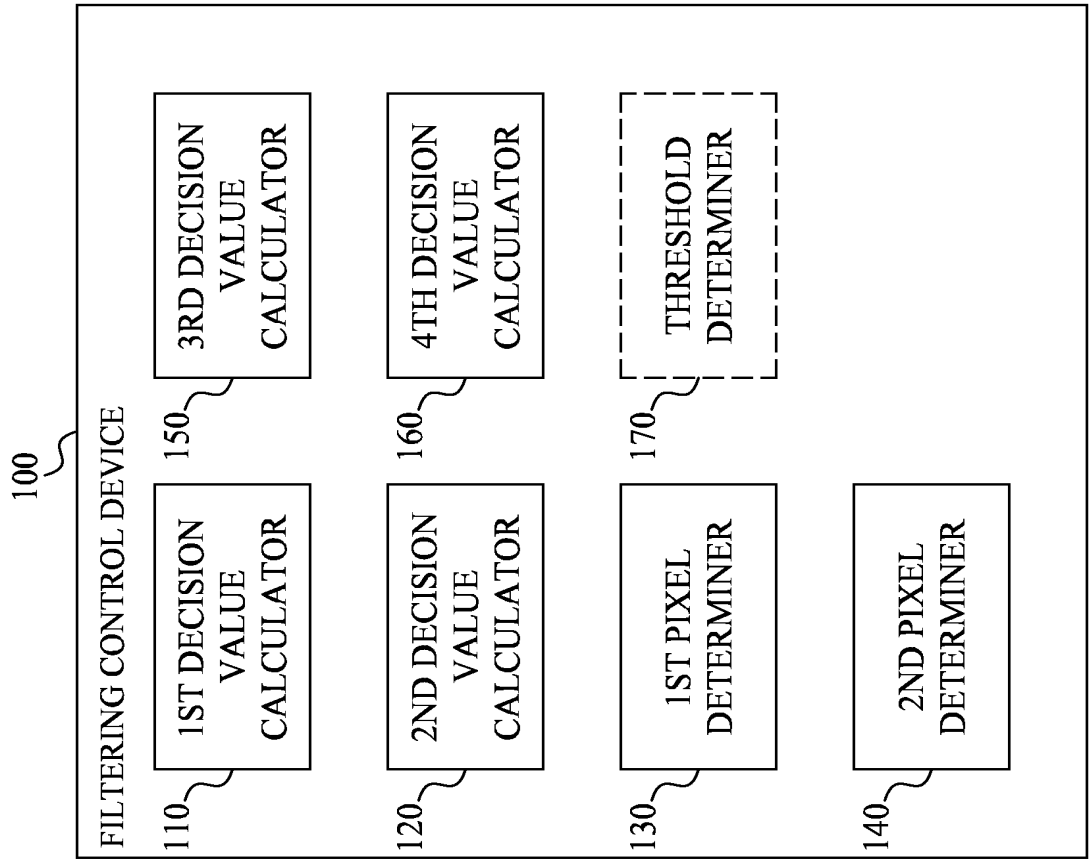

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER
150
3RD DECISION VALUE CALCULATOR
160
4TH DECISION VALUE CALCULATOR
170
THRESHOLD DETERMINER

Fig. 9

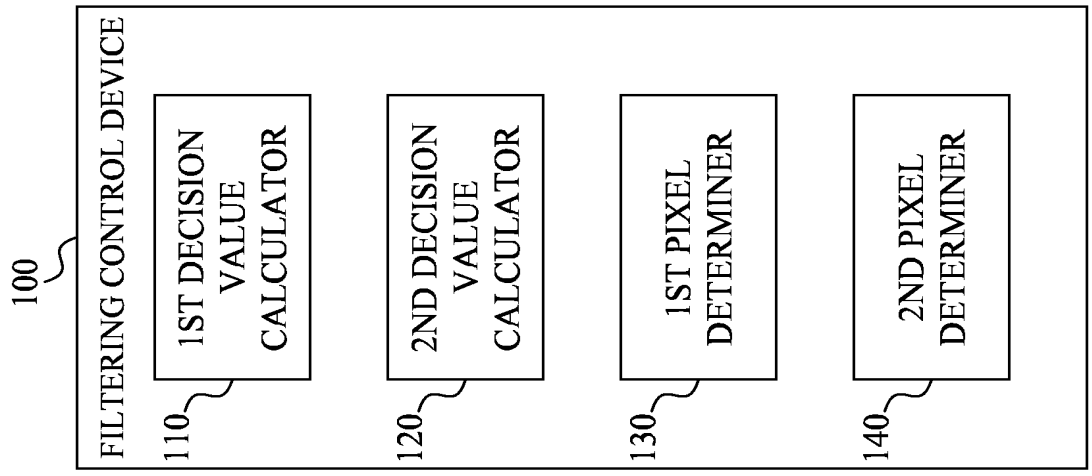

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER

Fig. 8

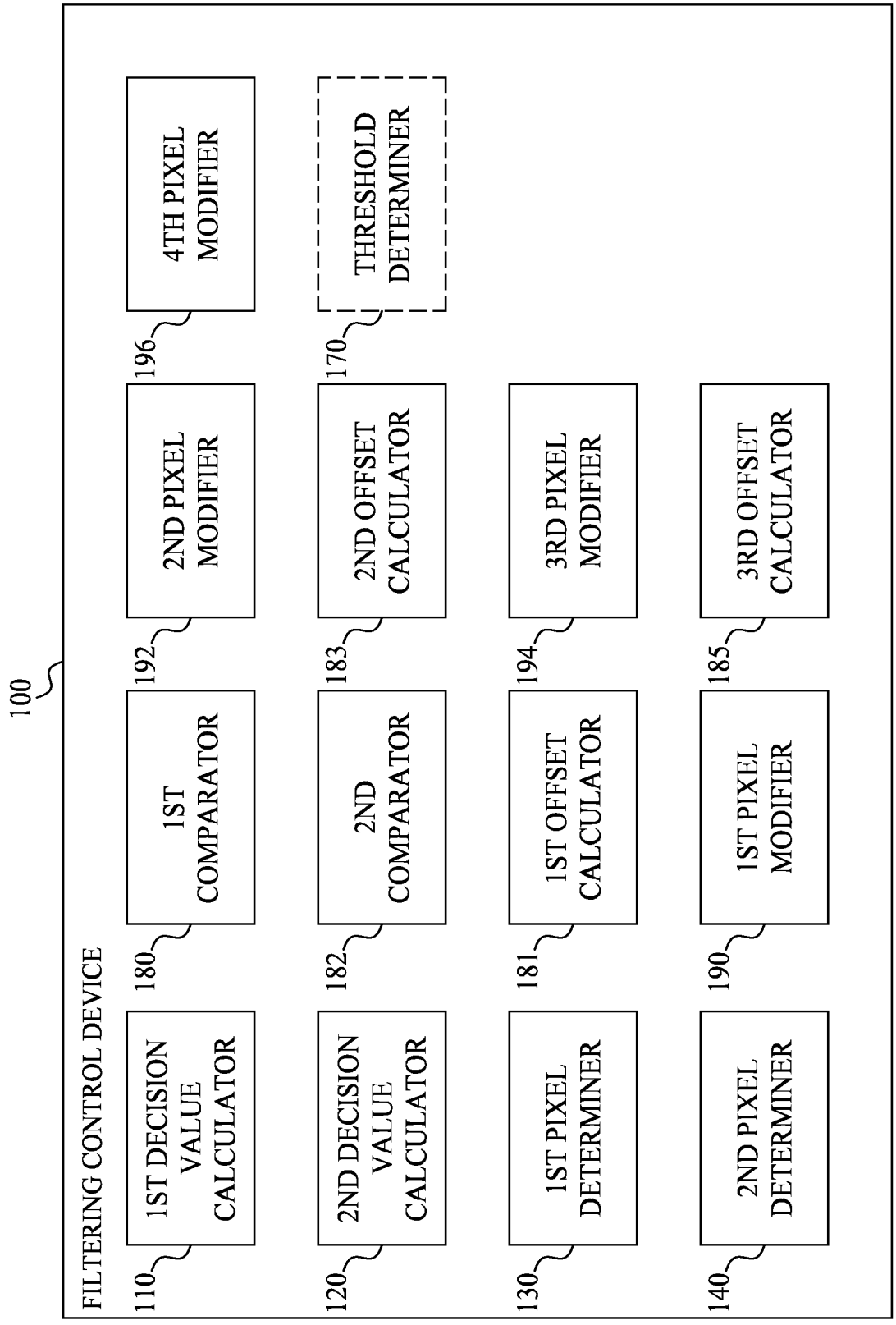

100
FILTERING CONTROL DEVICE
1ST DECISION VALUE CALCULATOR
110
1ST COMPARATOR
180
2ND PIXEL MODIFIER
192
4TH PIXEL MODIFIER
196
2ND DECISION VALUE CALCULATOR
120
2ND COMPARATOR
182
2ND OFFSET CALCULATOR
183
THRESHOLD DETERMINER
170
1ST PIXEL DETERMINER
130
1ST OFFSET CALCULATOR
181
3RD PIXEL MODIFIER
194
2ND PIXEL DETERMINER
140
1ST PIXEL MODIFIER
190
3RD OFFSET CALCULATOR
185

Fig. 10

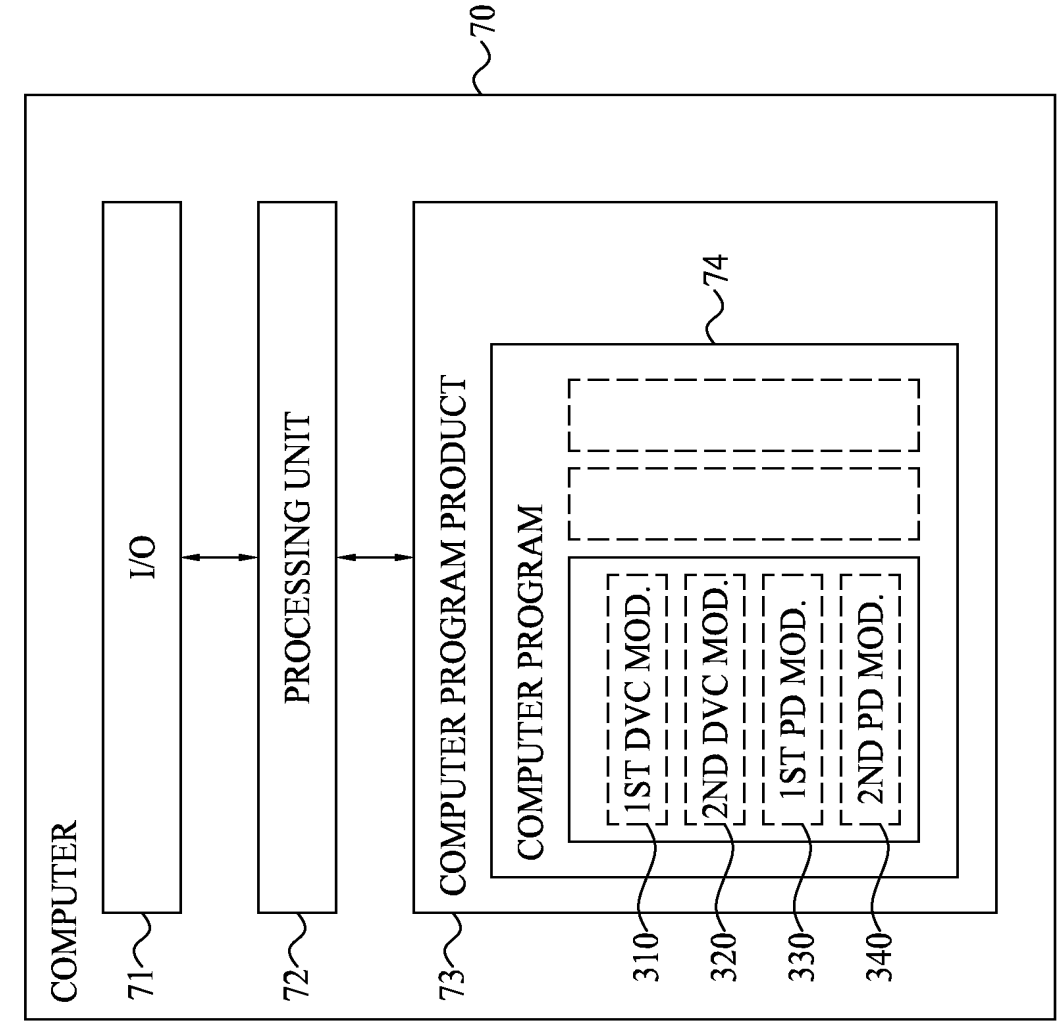

70
COMPUTER
I/O
71
PROCESSING UNIT
72
COMPUTER PROGRAM PRODUCT
73
COMPUTER PROGRAM
74
1ST DVC MOD.
2ND DVC MOD.
1ST PD MOD.
2ND PD MOD.
310
320
330
340

Fig. 12

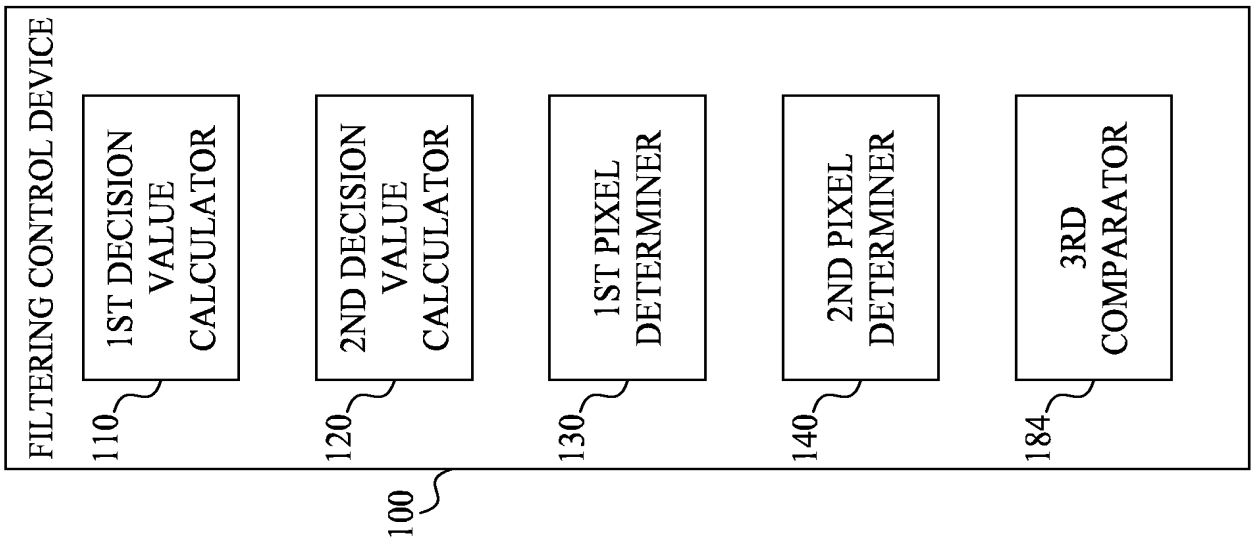

FILTERING CONTROL DEVICE
1ST DECISION VALUE CALCULATOR
110
2ND DECISION VALUE CALCULATOR
120
1ST PIXEL DETERMINER
130
2ND PIXEL DETERMINER
140
3RD COMPARATOR
184
100

Fig. 11

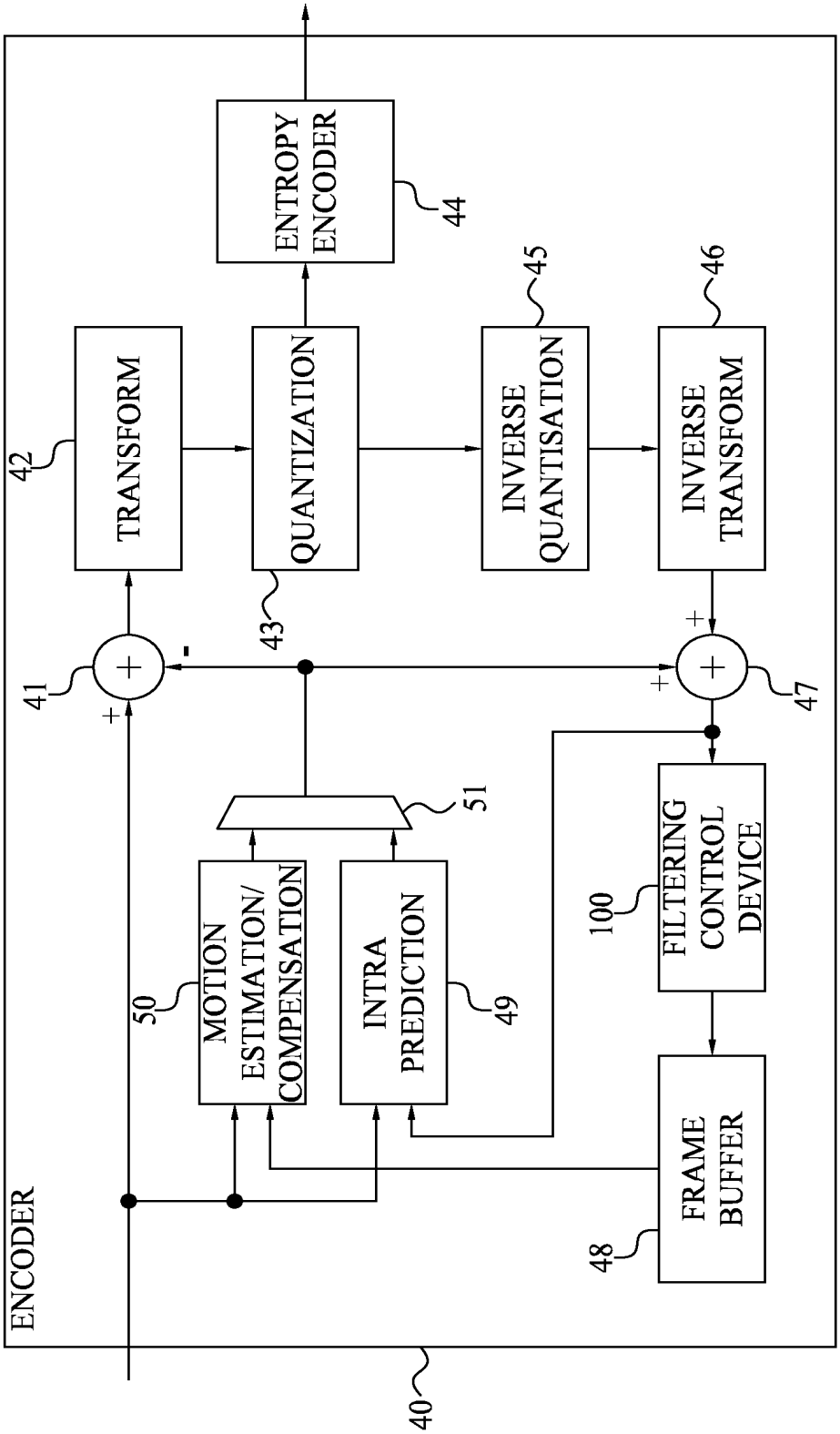

ENCODER
40
ENTROPY ENCODER
44
TRANSFORM
42
QUANTIZATION
43
INVERSE QUANTISATION
45
INVERSE TRANSFORM
46
41
47
51
MOTION ESTIMATION/ COMPENSATION
50
INTRA PREDICTION
49
FILTERING CONTROL DEVICE
100
FRAME BUFFER
48

Fig. 13

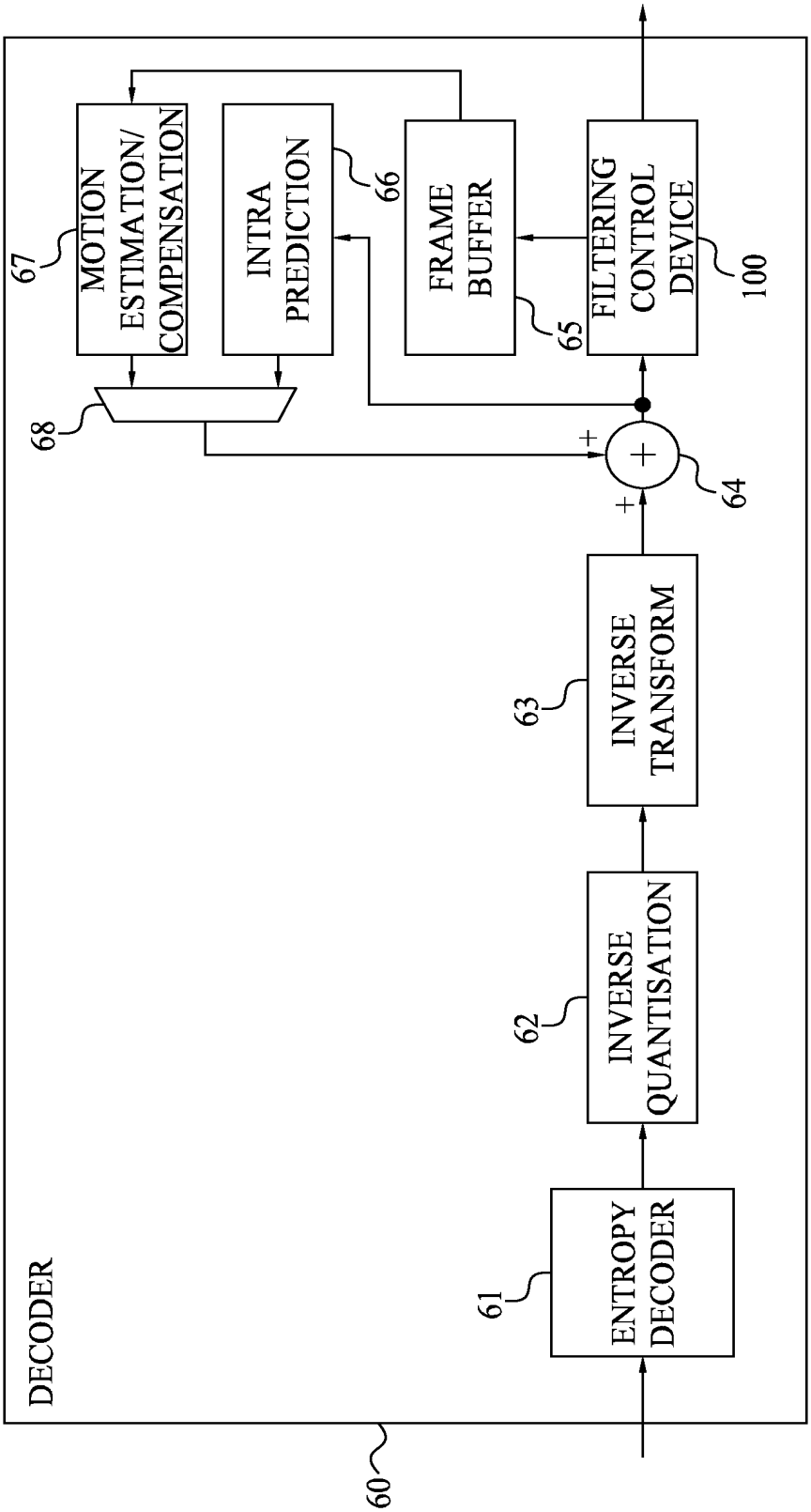

DECODER
60
ENTROPY DECODER
61
INVERSE QUANTISATION
62
INVERSE TRANSFORM
63
+
+
64
MOTION ESTIMATION/ COMPENSATION
67
INTRA PREDICTION
66
FRAME BUFFER
65
FILTERING CONTROL DEVICE
100
68

Fig. 14

Fig. 16

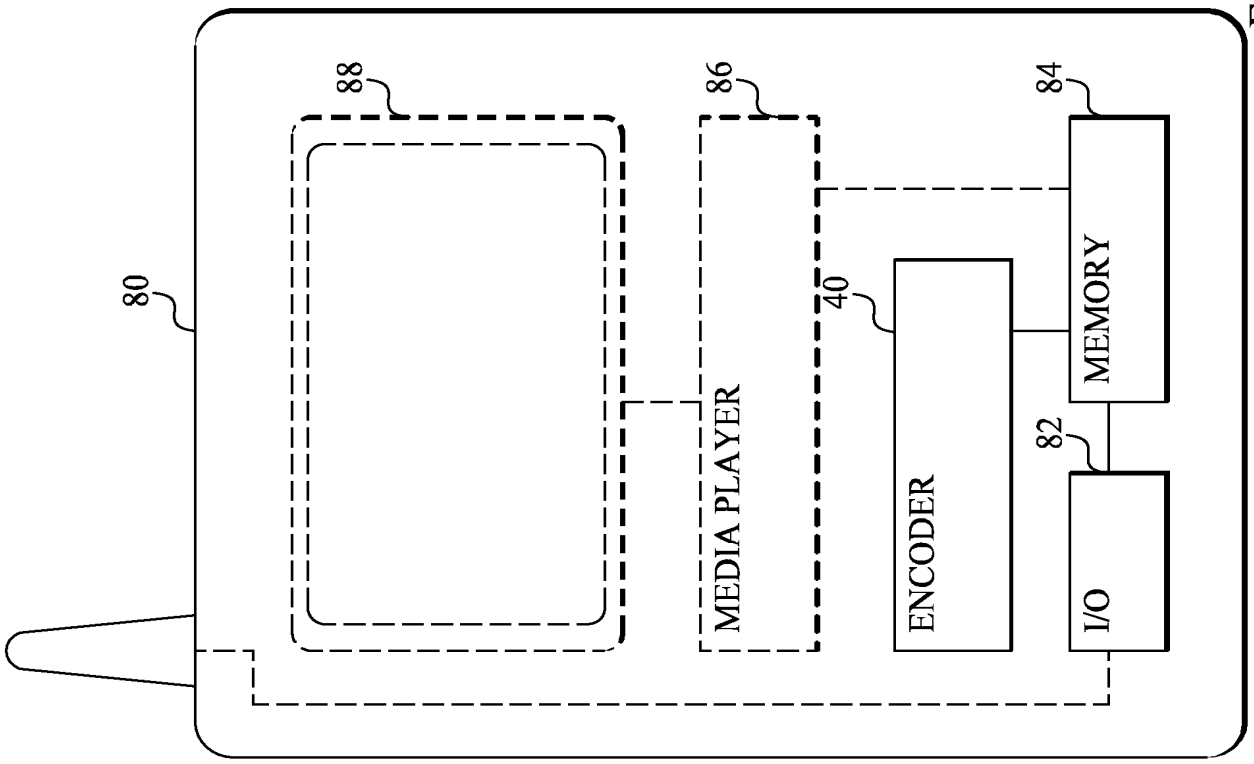
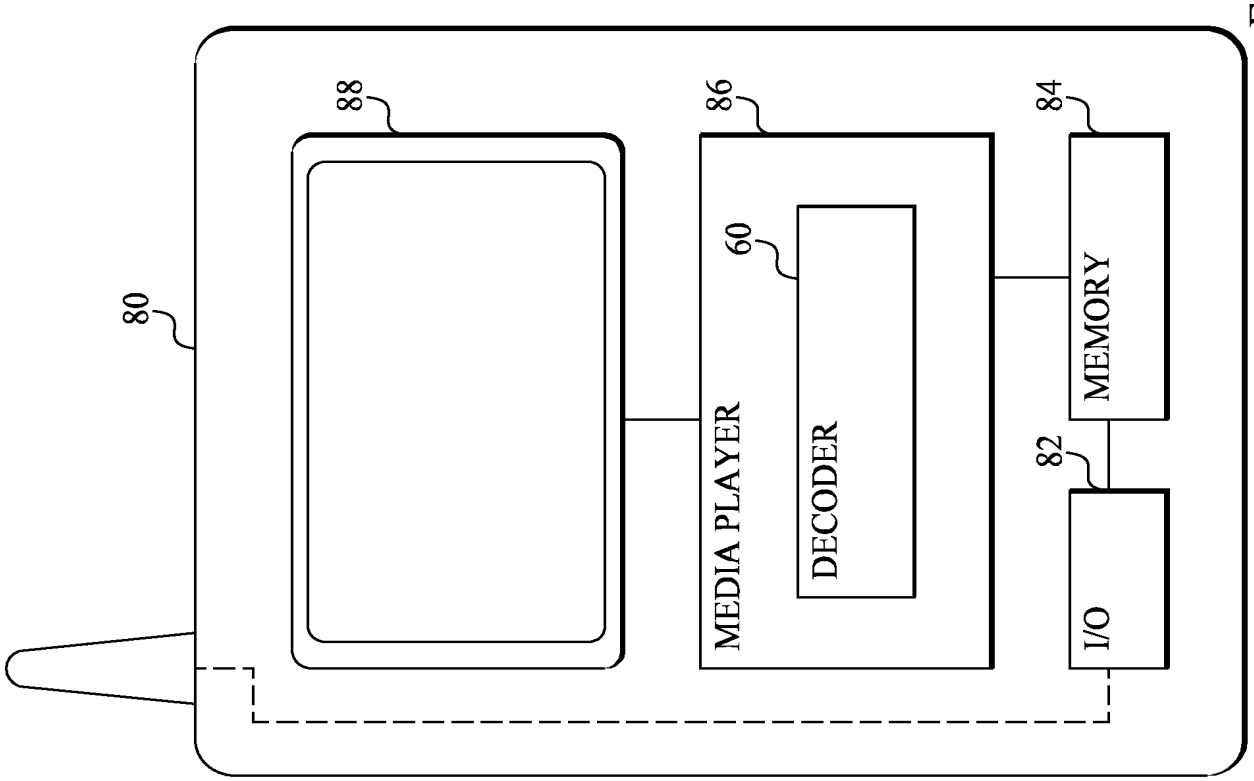

80
88
86
84
MEDIA PLAYER
40
ENCODER
MEMORY
82
I/O

Fig. 15


80
88
86
84
60
MEDIA PLAYER
DECODER
MEMORY
82
I/O

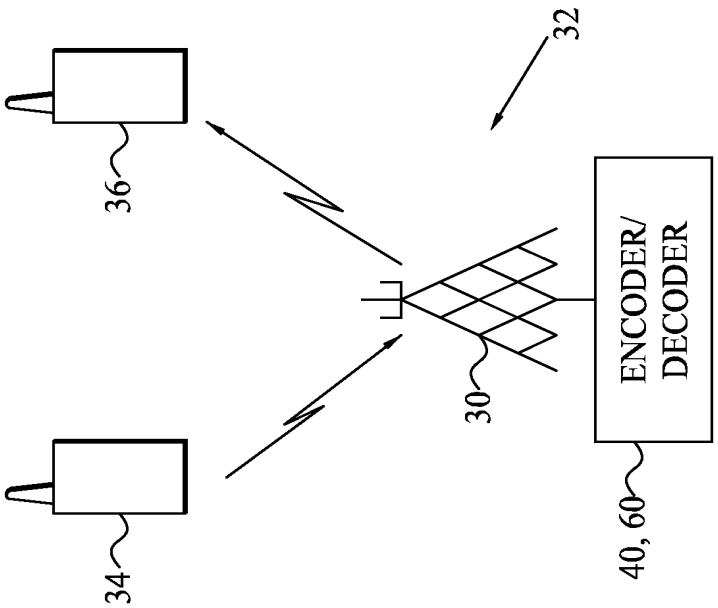


Fig. 17

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P33966 WO1	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/SE2011/051526	International filing date *(day/month/year)* 16.12.2011	Priority date *(day/month/year)* 01.03.2011

International Patent Classification (IPC) or national classification and IPC
INV. H04N7/26

Applicant
TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 8 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 17 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).
      ☐ sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).
      ☐ superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3*bis* of Annex C of the Administrative Instructions).

4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☒ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26.10.2012	21.05.2013

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Authorized officer
Regidor Arenales, R
Telephone No. +49 89 2399-4091

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-36 as originally filed

   Claims, Numbers

   1-20 filed with telefax on 05-04-2013

   Drawings, Sheets

   1/11-11/11 as originally filed

   ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☒ the claims, Nos. 21, 22
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

5. ☐ This report has been established:
   - ☐ taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
   - ☐ without taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

6. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-20
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 MATTHIAS NARROSCHKE ET AL: "Reduction of operations in the critical path of the deblocking filter", 95. MPEG MEETING; 24-1-2011 - 28-1-2011; DAEGU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m18974, 22 January 2011 (2011-01-22), XP030047543,

D2 NORKIN A ET AL: "Development of HEVC deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D377, 16 January 2011 (2011-01-16), XP030008416, ISSN: 0000-0013

D3 US 2010/142844 A1 (PEREIRA ROCHELLE [US] ET AL) 10 June 2010 (2010-06-10)

1 Independent Claims

1.1 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of **claim 1** does not involve an inventive step.

1.2 D3 is regarded as being the closest prior art and discloses (the references in parentheses applying to this document):

A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value (see abstract), said method comprising:

calculating a first filter decision value for said block (see N0 on paragraph [0071]) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame (see p0 on Figure 7), $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block

boundary (see p1 on Figure 7) and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary (see p2 on Figure 7);

calculating a second filter decision value for said block (see N1 on paragraph [0071]) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary (see q0 on Figure 7), $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary (see q1 on Figure 7) and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary (see q2 on Figure 7);

determining how many pixels in a line of pixels in said block to filter relative to said block boundary based on said first filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]), wherein

determining how many pixels in said line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]),

determining how many pixels in said line of pixels in said block to filter based on a comparison of said first filter decision value to a first threshold value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]); and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter based on a comparison of second filter decision value to a second threshold value (see "the selected filter is applied to N0 pixels in block B0 and to N1 pixels in block B1" on paragraph [0079]).

1.3 The subject-matter of claim 1 therefore differs from this known filtering method in the equations for calculating the decision values.

1.4 The problem to be solved by the present invention may therefore be regarded as how to calculate the decision values.

1.5 The solution proposed in **claim 1** of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) because the same equations have already been used by D1 for the same purpose (see third paragraph on page 4 and Figure 7).

1.6 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent **claims 8 and 19**, which therefore are also considered not inventive.

2 Dependent Claims

The dependent claims do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty or inventive step.

2.1 **Claims 2 and 9** - D1 also uses pixels from two lines for calculating the decision values (see third paragraph on page 4 and Figure 7).

2.2 **Claims 3, 4, 10 and 11**- D1 discloses comparing ($|p2_5 - 2p1_5 + p0_5| + |q2_5 - qp1_5 + q0_5|$) with a threshold and applying a strong filter or a weak filter based on the result of the comparison (see third paragraph on page 4).

2.3 **Claims 5 and 12** - The threshold value in D1 is based on 'β' which also depends on the quantization parameter, as disclosed by the applicant (see page 3 lines 1-2 of the description).

2.4 **Claims 6 and 13** - D2 discloses performing the same filter operations as in claim 7 (see section 2.1 "Filter description").

2.5 **Claims 7 and 14** - D1 discloses comparing ($|p2_5 - 2p1_5 + p0_5| + |q2_5 - qp1_5 + q0_5|$) with a threshold (see third paragraph on page 4).

2.6 **Claims 15-18 and 20** - The supplementary features of these claims are also known from the prior art and do not add anything of inventive significance to the subject-matter of any one of the preceding claims.

Re Item VI

Certain documents cited

The following document was published prior to the international filing date but later than the priority date claimed:

ANDREY NORKIN ET AL: "CE12.1: Ericsson deblocking filter", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19803, 19 March 2011 (2011-03-19), XP030048370,

Re Item VII

Certain defects in the international application

1 In order to meet the requirements of Rule 5.1(a)(ii) PCT, the relevant prior art, i.e. documents D1-D3 noted above, should be acknowledged by reference and briefly discussed in the introductory part of the description.

Re Item VIII

Certain observations on the international application

1 The term "said block (20)" used in **claim 1** is unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, since the reference sign does not correspond to "said block" but to the neighbouring block, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT.

2 The term "corresponding first line" used in **claim 1** is also unclear. It seems that both blocks must be located one next to the other one, so that the first line of the first block is adjacent to the first line of the neighboring block. This relationship seems to be an essential feature and must therefore be included in the claim.

3 The reference to "a line of pixels" used in **claim 1** is unclear. It seems that the referred line must be the first line mentioned during step S1. An amendment is required.

4 There are three steps in **claim 1** that describe how many pixels in a line of pixels are determined and another three steps that describe how many pixels in a corresponding line of pixels are determined but they all seem to be the same. The definition of the subject-matter of said claim is therefore unclear, Article 6 PCT.

ERICSSON

Date

Your Date

Reference (Document No)
P33966 WO1

Your Reference

Attending to this matter
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Response to second Written Opinion issued by the IPEA

Application Number: PCT/SE2011/051526
Applicant: Telefonaktiebolaget L M Ericsson (publ)
Our Reference: P33966 WO1

Enclosure(s):
Claims: Substitute claims number 1 - 20

Dear Sirs,

In response to the second Written Opinion of the IPEA, the Applicant hereby submits the following comments and enclosed amendments.

Amendments

Old claim 1 is amended wherein the features of old claim 2 are inserted to a new claim 1.

Old claim 9 is amended, wherein features of old claim 10 are inserted to a new claim 8.

Further amendments in the independent claims are done, wherein "at least" is removed, i.e.:
.....calculating (S1) a first filter decision vale for said block (10) based ~~at least~~ on:....

.....calculating (S2) a second filter decision vale for said block (20) based ~~at least~~ on:....

The independent claims also defines that it is determined how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and it is determined how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value. Support for the amendment can be found in the previous claims 4, 5, 12 and 13.

The remaining claims are renumbered.

Novelty and Inventive Step

D3: US 2010/0142844 A1

The present invention relates to asymmetric filter decisions to blocks of a video frame.

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A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value is provided.

A first filter decision value for said block (10) is calculated based at least on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10).

A second filter decision value for said block (20) is calculated based at least on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1).

It is determined how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and it is determined how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

In the new independent claim it is now clarified that it is determined (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and it is further determined how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

The number of pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter is based on a comparison (S20) of said first filter decision value to a first threshold value; and the number of pixels in said line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter is based on a comparison (S23) of said second filter decision value to a second threshold value.

That implies that one filter decision is determined for pixels on one side of a block boundary (pixels p0, p1,p2) based on the pixels that may be subject for deblocking filtering on the one side of the block boundary and another filter decision is determined for pixels (q0,q1,q2) on the other side of the block boundary based on the on the pixels that may be subject for deblocking filtering on the other side of the block boundary. Thus the filter decision takes into account only the pixels that can be subject for deblocking filtering.

D3 relates to a deblocking operation wherein a region of interest is determined which determines the number of pixels that should be filtered. The number of pixels can be different on either side of the block boundary. The region of interest is determined based on N0 (for block B0) and N1 (for block B1) which are calculated based on an activity metric and an artifact count. The artifact count is determined for each block and an activity is determined for each row and for each column of each block.

It is not disclosed in D3 that the number of pixels of a line is determined from filter decision values based on the pixels in the same line. In D3 the number of pixels in a region of interest is determined based on the entire block as disclosed in [0053], [0063]. Further N0 and N1 are used for determining the number of pixels while in the present invention the number of pixels is determined by comparing the filter decision values against respective thresholds.

D1 relates to a method for determining filter decisions. However in D1, pixels on both sides of the block boundary are used for determining one filtering decision, i.e. how many pixels that should be considered for deblocking, but the same filter decision is used for both sides of the block boundary. This is different from the present invention where one filter decision is determined for pixels (p0,p1,p2) on one side of the block boundary and another filter decision is determined for pixels (q0,q1,q2) on the other side of the block boundary. In the present invention, it is possible to apply deblocking on x number of pixels on one side of the block boundary and y number of pixels on the other side of the block boundary, where x can differ from y. This is in contrast to the present invention where the same number of pixels is filtered on both sides of the block boundary, although pixels on both sides are used for determining how many pixels that should be filtered.

Thus the subject matter of claim 1 is novel in view of D1 and D3, respectively.

When assessing whether the present invention involves an inventive step, D3 is considered to constitute the closest prior art since D3 provides the possibility to filter a first number of pixels on one side of the block border and a second number of pixels on the other side of the block border.

As mentioned above, it is not disclosed in D3 that the number of pixels of a line of pixels is determined from filter decision values based on the pixels in the same line of pixels. In D3 the number of pixels in a region of interest is determined based on the entire block as disclosed in [0053], [0063]. Further N0 and N1 are used for determining the number of pixels while in the present invention the number of pixels is determined by comparing the filter decision values against respective thresholds.

The technical effect achieved by the present invention is that the process is less complex.

The objective problem is to achieve an improved deblocking filtering control.

That is achieved by the asymmetric filtering provided by the present invention, i.e. by calculating the first and second filter decisions and determining how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and determining how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value. It is also defined how many pixels in said line of pixels in said block to filter by comparing the filter decision value to a threshold.
The filter decision values are only based on the pixels that are subject for filtering. To use the thresholds for making the filtering decision compared to the calculation of N0 and N1 in D3 is less

Date 2012-10-23 Reference (Document No) P33966 WO1

complex as mentioned above. Further the decision is made only on the pixels that may be subject for filtering, which may make the decision more correct.

It is shown in D1 to determine a filter decision value for based on pixels in the same line of pixels. However, pixels on both side of the border are used, and the same number of pixels is filtered on both side. A skilled person would not be motivated to combine D3 with D1 to solve the objective problem, since there is nothing in D3 that would encourage a skilled person to only use pixels from one line of pixels, when deciding on the region of interest for improving the filtering control mechanism.

Furthermore, if a skilled person would combine D3 and D1, he would not end up in the present invention defined by the independent claims, since D1 uses pixels from both sides of the block border to make one single filter decision applicable to both sides of the border and D3 uses the entire block for determining the region of interest.

Therefore, a skilled person being faced with the objective problem would not be motivated by D3 to modify D3 to the present invention. A skilled person would neither be motivated to combine D3 with D1 and even if he would do such combination he would not arrive at the present invention.

Accordingly, the present invention according to the independent claims is novel and involves an inventive step.

Should the Examiner have any questions that may be favorable discussed over the telephone or deems further minor amendments to be needed before issuance of a positive IPRP, you are welcome to contact the case responsible patent engineer/patent attorney, Susanne Ahlstrand on +46107165725.

Yours faithfully,

for TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)

Susanne Ahlstrand
ERICSSON AB
Patent Unit Kista DSM

CLAIMS

1. A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said method comprising:

calculating (S1) a first filter decision value for said block (10) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculating (S2) a second filter decision value for said block (20) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determining (S3) how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4) how many pixels in said corresponding first line

(22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value.

2. The method according to claim 1, wherein

calculating (S1) said first filter decision value comprises calculating (S1) said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

calculating (S2) said second filter decision value comprises calculating (S2) said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20),

said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

3. The method according to any of the claims 1 to 2, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

4. The method according to any of the claims 1 to 2, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;

determining (S21) to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and

determining (S22) to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;

determining (S24) to filter two pixels in said corresponding line (22) of pixels (21, 23 ,25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and

determining (S25) to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

6. The method according to any of the claims 2 to 4, further comprising:

determining (S30) said first threshold value based on a quantization parameter associated with said block (10); and

determining (S31) said second threshold value based on said quantization parameter associated with said neighboring block (20).

6. The method according to any of the claims 2-5, further comprising:

calculating (S40) a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_j$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

modifying (S41) said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

modifying (S41) said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

calculating (S43), if said first filter decision value is below said first threshold value, a second offset based on $\frac{p0_J + p2_J - 2p1_J + 2\Delta}{4}$, wherein $p2_J$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

modifying (S44), if said first filter decision value is below said first threshold, said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

calculating (S46), if said second filter decision value is below said second threshold value, a third offset based on $\frac{q0_J + q2_J - 2q1_J - 2\Delta}{4}$, wherein $q2_J$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

modifying (S47), if said second filter decision value is below said second threshold, said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

7. The method according to any of the claims 1 to 6, further comprising comparing (S50) a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

determining (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining (S3), if said sum of said first filter decision value and said second filter decision value is below said threshold value, how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determining (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining (S4), if said sum of said first filter decision value and

said second filter decision value is below said threshold value, how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value.

8. A filtering control device (100) comprising:

a first decision value calculator (110) configured to calculate a first filter decision value for a block (10) of multiple pixels (11, 13, 15, 17) in a video frame based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

a second decision value calculator (120) configured to calculate a second filter decision value for said block (10) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel determiner (130) configured to determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

a second pixel determiner (140) configured to determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120), wherein

said first pixel determiner (130) is configured to determine how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120), further comprising a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value.

9. The device according to claim 8, wherein

said first decision value calculator (110) is configured to calculate said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

said second decision value calculator (120) is configured to calculate said second filter decision value as;

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said

neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

10. The device according to any of the claims 8 to 9, further comprising:

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter one pixel in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter one pixel in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

11. The device according to any of the claims 8 to 10, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and

a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein

said first pixel determiner (130) is configured to i) determine to filter two pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter no pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter no pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

12. The device according to any of the claims 8 to 11, further comprising a threshold determiner (170) configured to i) determine said first threshold value based on a quantization parameter associated with said block (10), and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block (20).

13. The device according to any of the claims 8-12, further comprising:

a first offset calculator (181) configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q1_j$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1);

a first pixel modifier (190) configured to modify said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said first offset calculated by said first offset calculator (181) to said pixel value of said pixel (11) closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a second pixel modifier (192) configured to modify said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by subtracting said first offset calculated by said first offset calculator (181) from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27);

a second offset calculator (183) configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator (180), a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said line (12) of pixels (11, 13, 15, 17), said block boundary (1);

a third pixel modifier (194) configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator (180), said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17) by adding said second offset calculated by said second offset calculator (183) to said pixel value of said pixel (13) next closest to said block boundary (1) in said line (12) of pixels (11, 13, 15, 17);

a third offset calculator (185) configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator (182), a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

a fourth pixel modifier (196) configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator (182), said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27) by adding said third offset calculated by said third offset calculator (185) to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding line (22) of pixels (21, 23, 25, 27).

14. The device according to any of the claims 8 to 13, further comprising a third comparator (184) configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner (130) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

15. An encoder (40) comprising a filtering control device (100) according to any of the claims 8-14.

16. A user equipment (80) comprising:

a memory (84) configured to store video frames; and

an encoder (40) according to claim 15 configured to encode said video frames into encoded video frames, wherein said memory (84) is further configured to store said encoded video frames.

17. A decoder (60) comprising a filtering control device (100) according to any of the claims 8-14.

18. A user equipment (80) comprising:

a memory (84) configured to store encoded video frames;

a decoder (60) according to claim 17 configured to decode said encoded video frames into decoded video frames; and

a media player (86) configured to render said decoded video frames into video data displayable on a display (88).

19. A computer program (74) for filtering control of a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said computer program (74) comprises code means which when run on a computer (70) causes the computer (70) to:

calculate a first filter decision value for said block (10) based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25, 27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13,

15, 17, 19), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (13) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (10);

calculate a second filter decision value for said block based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (23) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);

determine how many pixels in a line (12) of pixels (11, 13, 15, 17) in said block (10) to filer relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in a corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

wherein determine how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value; and

determine how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value,

determine (S3) how many pixels in said line (12) of pixels (11, 13, 15, 17) in said block (10) to filter based on a comparison (S20) of said first filter decision value to a first threshold value; and

determine (S4) how many pixels in said corresponding line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter based on a comparison (S23) of said second filter decision value to a second threshold value.

20. A computer program product (73) comprising computer readable code means and a computer program (74) according to claim 18 stored on said computer readable means.

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U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
14/001,627	Andrey Norkin	1009-0641 / P33966 US2

102721
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INTERNATIONAL APPLICATION NO.	
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I.A. FILING DATE	PRIORITY DATE
12/16/2011	03/01/2011

CONFIRMATION NO. 2724
371 FORMALITIES LETTER



Date Mailed: 09/06/2013

Notification of Insufficient Fees (DO/EO/US)

The following items have been submitted by the applicant or the IB to the United States Patent and Trademark Office as a Designated Office (37 CFR 1.494):

- Priority Document
- Copy of the International Application filed on 08/26/2013
- Copy of the International Search Report filed on 08/26/2013
- Copy of IPE Report filed on 08/26/2013
- Copy of Annexes to the IPER filed on 08/26/2013
- Preliminary Amendments filed on 08/26/2013
- Information Disclosure Statements filed on 08/26/2013
- Oath or Declaration filed on 08/26/2013
- U.S. Basic National Fees filed on 08/26/2013
- Priority Documents filed on 08/26/2013

The following items **MUST** be furnished within the period set forth below in order to complete the requirements for acceptance under 35 U.S.C. 371:

- Additional claim fees of $**1020** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

SUMMARY OF FEES DUE:

Total additional fees required for this application is $**1020** for a Large Entity:

Additionally the following defects have been observed:

- Preliminary Amendments have not been entered because it is not consistent with the changes made via the IPER (claims 1-20).

Total additional claim fee(s) for this application is $**1020**
- $**240** for **3** total claims over 20.
- $**780** for multiple dependent claim surcharge.

ALL OF THE ITEMS SET FORTH ABOVE MUST BE SUBMITTED WITHIN TWO (2) MONTHS FROM THE DATE OF THIS NOTICE OR BY 32 MONTHS FROM THE PRIORITY DATE FOR THE APPLICATION, WHICHEVER IS LATER. FAILURE TO PROPERLY RESPOND WILL RESULT IN ABANDONMENT.

The time period set above may be extended by filing a petition and fee for extension of time under the provisions of 37 CFR 1.136(a).

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/001,627	08/26/2013		1480	1009-0641 / P33966 US2	20	3

CONFIRMATION NO. 2724

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FILING RECEIPT



Date Mailed: 09/06/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

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Assignment For Published Patent Application

TELEFONAKTIEBOLAGET L M ERICSSON (PUBL), Stockholm, SE

Power of Attorney: The patent practitioners associated with Customer Number 102721

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/SE2011/051526 12/16/2011
which claims benefit of 61/447,862 03/01/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 09/04/2013
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/001,627**
Projected Publication Date: 12/12/2013

Non-Publication Request: No

Early Publication Request: No
Title

Deblocking Filtering Control

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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NOT GRANTED

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/001,627

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	480
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3			OR	x 80 =	240
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							780
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2500

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
14001627	

Applicant(s) Andrey Norkin

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1					
2		1				
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Total Indep	3		0		0	
Total Depend	20	↵	0	↵	0	↵
Total Claims	23		0		0	

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby appoint the Practitioners associated with the following Customer Number:

102721

as attorneys or agents to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.72(b). This appointment will automatically lapse five years after the date of execution of this document unless earlier revoked.

Assignee Name and Address:

Telefonaktiebolaget LM Ericsson (publ)
S-164 83 Stockholm
Sweden

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the Assignee:

Name: John Han
Title: Vice President Patent Development

March 5, 2012

Name: Joakim Hasselgren
Title: PU Manager LTE & OFDM

March 5, 2012

Electronic Acknowledgement Receipt

EFS ID:	16799397
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	09-SEP-2013
Filing Date:	26-AUG-2013
Time Stamp:	15:36:52
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73.	ASO.pdf	118258 359558031afc8f9ae94e4fc5718ca87f153e8b18	no	3

Warnings:	
Information:	

2	Power of Attorney	EricssonPOA.pdf	471391 b745d0232aaf8066b3ee363c6cb8d50809ae5796	no	1

Warnings:	
Information:	
Total Files Size (in bytes):	589649

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Telefonaktiebolaget L M Ericsson (publ)

Application No./Patent No.: 14/001,627 Filed/Issue Date: 2013-08-26

Titled: Deblocking Filtering Control

Telefonaktiebolaget L M Ericsson (publ), a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 031083, Frame 0206, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by37 CFR3.73(b). The information is required toobtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentialityis governed by35 U.S.C. 122and 37 CFR1.11 and1.14. Thiscollection is estimated to take 12 minutes to complete, including gathering, preparing, and submittingthe completed application form to the USPTO.Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent tothe Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.**SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/ Daniel P. Homiller, Reg. # 55,275 /	2013-09-09
Signature	Date
Daniel P. Homiller	55,275
Printed or Typed Name	Title or Registration Number

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The **Privacy Act of 1974 (P.L. 93-579)** requires that yoube given certain informationin connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, pleasebe advised that: (1) the general authority forthe collection of thisinformation is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and(3) the principal purpose forwhich the information isused by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent applicationor patent. If you do not furnish the requested information,the U.S. Patent and Trademark Office may not be able to process and/or examineyour submission,which may result in termination of proceedings or abandonment of the applicationor expiration of the patent.

The informationprovided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the informationin order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an InternationalApplication filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, arecord may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from thissystem of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Norkin et al.	)	
	)	Examiner: TBD
Application No.: 14/001,627	)	
Filing Date: 2013-08-26	)	Confirmation No.: TBD
Title: Deblocking Filtering Control	)	
Attorney Ref.: 1009-0641 / P33966 US2	)	

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Please be advised that this is a **U.S. National Stage Filing of PCT Application PCT/SE2011/051526.**

Prior to examination, please amend the application as indicated below.

AMENDMENTS TO THE CLAIMS

1-20. (Canceled)

21. (New) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block based on $\left|p2_i - 2p1_i + p0_i\right|$,

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculating a second filter decision value for said block based on $\left|q2_i - 2q1_i + q0_i\right|$,

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

22. (New) The method of claim 21, wherein:

calculating said first filter decision value comprises calculating said first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$, wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block , said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$, wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block

boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

23. (New) The method of claim 21, wherein determining how many pixels in said line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

wherein determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

24. (New) The method of claim 21, wherein

determining how many pixels in said line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold

value; and

determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

25. (New) A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame based on $\left|p2_i - 2p1_i + p0_i\right|$, wherein

$p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for said block based on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

26. (New) The device of claim 25:

wherein said first decision value calculator is configured to calculate said first filter decision value as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$, wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

wherein said second decision value calculator is configured to calculate said second filter decision value as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$, wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of

said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

27. (New) The device of claim 25, wherein:

said first pixel determiner is configured to i) determine to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

28. (New) The device of claim 25, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value;

wherein:

said first pixel determiner is configured to i) determine to filter two pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter no pixels in said corresponding line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

29. (New) The device of claim 25, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

30. (New) The device of claim 25, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second

offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding line of pixels.

31. (New) The device of claim 25, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

32. (New) An encoder comprising the filtering control device of claim 25.

33. (New) A user equipment comprising:

the encoder of claim 32; and

a memory configured to store video frames;

wherein said encoder is configured to encode said video frames into encoded video frames, and wherein said memory is further configured to store said encoded video frames.

34. (New) A decoder comprising the filtering control device of claim 25.

35. (New) A user equipment comprising:

the decoder of claim 34;

a memory configured to store encoded video frames; and

a media player configured to render decoded video frames into video data displayable on a display;

wherein the decoder is configured to decode said encoded video frames into the decoded video frames.

36. (New) A non-transitory computer-readable medium comprising a computer program stored thereon for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program comprises computer program instructions that when run on a computer cause the computer to:

calculate a first filter decision value for said block based on $|p2_i - 2p1_i + p0_i|$,

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said block based on $|q2_i - 2q1_i + q0_i|$,

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next

closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a line of pixels in said block to filter relative to said block boundary, based on said first filter decision value, wherein said determining how many pixels in said line of pixels to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in a corresponding line of pixels in said neighboring block to filter relative to said block boundary, based on said second filter decision value, wherein determining how many pixels in said corresponding line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

REMARKS

Applicant submits the foregoing claim amendments prior to examination on the merits for consideration by the Examiner. The amendments cancel claims 1-20, and add new claims 21-36. The amendments are not made for reasons of patentability. Instead, the new claims 21-36 are substantially similar to the now canceled claims, but are written to eliminate multiple dependent claims and drawing reference numbers, and to ensure that the language of the claims better comports with U.S. practice. No new matter has been added.

Applicant respectfully requests that the Examiner enter the amendments prior to examination on the merits.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

/ Daniel P. Homiller, Reg. # 55,275 /

Dated: 30 October 2013

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Electronic Acknowledgement Receipt

EFS ID:	17271511
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	30-OCT-2013
Filing Date:	26-AUG-2013
Time Stamp:	16:56:09
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Response_to_Notice_of_Insufficient_Fees.pdf	22144 fc7b5bb1a00a345f8be0ba4e62168b0c876c6506	no	2

Warnings:	
Information:	

2	Preliminary Amendment	Preliminary_Amendment_CORRECTED.pdf	58671 dd5884fffacdf04352c871a248272b12e62dfe82	no	15

Warnings:	
Information:	
Total Files Size (in bytes):	80815

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of **Telefonaktiebolaget L M Ericsson (publ)**	)	
Serial No.: **14/001,627**	)	PATENT PENDING
Filed: **August 26, 2013**	)	Examiner: TBD
For: **Deblocking Filtering Control**	)	Group Art Unit: TBD
Docket No: **1009-0641 / P33966 US2**	)	Confirmation No.: 2724

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTIFICATION OF INSUFFICIENT FEES

This paper is being filed in response to the Notification of Insufficient Fees mailed September 6, 2013. In the Preliminary Amendment filed concurrently with this letter, PCT pending claims 1-20 are canceled, and new claims 21-36 are added;

- after entry of the Preliminary Amendment, the instant application should have a total of 16 claims;
- of the 16 claims pending after entry of the Preliminary Amendment, claims 21, 25 and 36 are independent, for a total of 3 independent claims;
- Applicant paid filing fees in the amount of $1480 at the time of filing ($280 basic national stage fee, $480 national stage search fee (search report prepared and provided to USPTO), and a $720 national state examination fee;
- Applicant should not owe any additional claims fees as total claims filed did not exceed 20, there are no more than 3 independent claims, and all multiple-dependent claims were canceled in the Preliminary Amendment.

For the reasons outlined above with the submission of a second Preliminary Amendment, Applicant believes that all required national stage filing fees have been paid and requests that the Notification of Insufficient Fees be withdrawn. If, however, additional fees are determined to be due, please deduct them from the Murphy, Bilak & Homiller, PLLC Deposit Account No. 50-5650.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

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Dated: 30 October 2013

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U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
14/001,627	Andrey Norkin	1009-0641 / P33966 US2

102721
Murphy, Bilak & Homiller/Ericsson
8000 Regency Parkway, Suite 415
Cary, NC 27518

INTERNATIONAL APPLICATION NO.	
PCT/SE2011/051526	
I.A. FILING DATE	PRIORITY DATE
12/16/2011	03/01/2011

CONFIRMATION NO. 2724
371 ACCEPTANCE LETTER

OC000000064926706

Date Mailed: 11/14/2013

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

08/26/2013	09/01/2013
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1) and (c)(2) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).*

The following items have been received:

- Copy of the International Application filed on 08/26/2013
- Copy of the International Search Report filed on 08/26/2013
- Copy of IPE Report filed on 08/26/2013
- Copy of Annexes to the IPER filed on 08/26/2013
- Preliminary Amendments filed on 10/30/2013
- Information Disclosure Statements filed on 08/26/2013
- Inventor's Oath or Declaration filed on 08/26/2013
- U.S. Basic National Fees filed on 08/26/2013
- Priority Documents filed on 08/26/2013
- Power of Attorney filed on 09/09/2013
- Application Data Sheet (37 CFR 1.76) filed on 08/26/2013

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

FRANCINE YOUNG

Telephone: (703) 756-1462

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/001,627

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	480
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	16 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1480

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/001,627	08/26/2013	2482	1480	1009-0641 / P33966 US2	16	3

CONFIRMATION NO. 2724

UPDATED FILING RECEIPT

102721
Murphy, Bilak & Homiller/Ericsson
8000 Regency Parkway, Suite 415
Cary, NC 27518



Date Mailed: 11/14/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Andrey Norkin, Solna, SWEDEN;
Kenneth Andersson, Gavle, SWEDEN;
Rickard Sjöberg, Stockholm, SWEDEN;

Applicant(s)

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Kenneth Andersson, Gavle, SWEDEN;
Rickard Sjöberg, Stockholm, SWEDEN;

Assignment For Published Patent Application

TELEFONAKTIEBOLAGET L M ERICSSON (PUBL), Stockholm, SE

Power of Attorney: The patent practitioners associated with Customer Number 102721

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/SE2011/051526 12/16/2011
which claims benefit of 61/447,862 03/01/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 09/04/2013
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/001,627**
Projected Publication Date: 12/12/2013

Non-Publication Request: No

Early Publication Request: No

Title

Deblocking Filtering Control

Preliminary Class

375

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2

CONFIRMATION NO. 2724

102721
Murphy, Bilak & Homiller/Ericsson
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Cary, NC 27518

PUBLICATION NOTICE

OC000000065495493

Title: Deblocking Filtering Control

Publication No.US-2013-0329814-A1
Publication Date:12/12/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: **Norkin**	)	
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Application No.: **14/001,627**	)	Examiner: KELLEY, CHRISTOPHER S
	)	
Filing Date: **Aug 26, 2013**	)	Confirmation No.: 2724
	)	
Title: **Deblocking Filtering Control**	)	
	)	
Attorney Ref.: **1009-0641 / P33966 US2**	)	
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PRELIMINARY AMENDMENT

Please be advised that this is a **U.S. National Stage Filing of PCT Application PCT/SE2011/051526.**

Prior to examination, please amend the application as indicated below.

AMENDMENTS TO THE CLAIMS

1-33. (Canceled)

34. (New) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculatinga second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said first line of pixels in said block to filter relative to

said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

35. (New) The method according to claim 34, wherein

calculating said first filter decision value comprises calculating said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to,

in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

36. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

37. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding first line of pixels in said

neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

38. (New) A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for a neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a first line of pixels

in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator, wherein

further comprising a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value.

39. (New) The device according to claim 38, wherein

said first decision value calculator is configured to calculate said first filter decision value as:

$$\left|p2_0 - 2p1_0 + p0_0\right| + \left|p2_3 - 2p1_3 + p0_3\right|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a

pixel second next closest to, in said second line of pixels, said block boundary; and

said second decision value calculator is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

40. (New) The device according to claim 38, further comprising:

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said first line of pixels in said

block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

41. (New) The device according to claim 38, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value, wherein

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value

as determined by said second comparator and ii) determine to filter no pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

42. (New) The device according to claim 38, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

43. (New) The device according to claim 38, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said first line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said first line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said first line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said first line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said first line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said

corresponding first line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding first line of pixels.

44. (New) The device according to claim 38, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

45. (New) An encoder comprising a filtering control device according to claim 38.

46. (New) A user equipment comprising:

a memory configured to store video frames; and

an encoder according to claim 45 configured to encode said video frames into encoded

video frames, wherein said memory is further configured to store said encoded video frames.

47. (New) A decoder comprising a filtering control device according to claim 38.

48. (New) A user equipment comprising:

a memory configured to store encoded video frames;

a decoder according to claim 47 configured to decode said encoded video frames into decoded video frames; and

a media player configured to render said decoded video frames into video data displayable on a display.

49. (New) A computer program for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program comprises code means which when run on a computer causes the computer to:

calculate a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said neighboring block, by only using pixels

$q2_i$, $q1_i$ and $q0_i$, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a first line of pixels in said block to filer relative to said block boundary based on said first filter decision value; and

determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value,

wherein determine how many pixels in said first line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

50. (New) A computer program product comprising computer readable code means and a computer program according to claim 49 stored on said computer readable means.

REMARKS

Applicant submits the foregoing claim amendments prior to examination on the merits for consideration by the Examiner. The amendments cancel claims 1-33, and add new claims 34-50. No new matter has been added.

Applicant respectfully requests that the Examiner enter the amendments prior to examination on the merits.

Respectfully submitted,
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	)	
Application No.: **14/001,627**	)	Examiner: KELLEY, CHRISTOPHER S
	)	
Filing Date: **Aug 26, 2013**	)	Confirmation No.: 2724
	)	
Title: **Deblocking Filtering Control**	)	
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Attorney Ref.: **1009-0641 / P33966 US2**	)	
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PRELIMINARY AMENDMENT

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Prior to examination, please amend the application as indicated below.

AMENDMENTS TO THE CLAIMS

1-33. (Canceled)

34. (New) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculatinga second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said first line of pixels in said block to filter relative to

said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

35. (New) The method according to claim 34, wherein

calculating said first filter decision value comprises calculating said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to,

in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

36. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

37. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding first line of pixels in said

neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

38. (New) A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for a neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a first line of pixels

in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator, wherein

further comprising a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value.

39. (New) The device according to claim 38, wherein

said first decision value calculator is configured to calculate said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a

pixel second next closest to, in said second line of pixels, said block boundary; and

said second decision value calculator is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

40. (New) The device according to claim 38, further comprising:

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said first line of pixels in said

block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

41. (New) The device according to claim 38, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value, wherein

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value

as determined by said second comparator and ii) determine to filter no pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

42. (New) The device according to claim 38, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

43. (New) The device according to claim 38, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said first line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said first line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said first line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said first line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said first line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said

corresponding first line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding first line of pixels.

44. (New) The device according to claim 38, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

45. (New) An encoder comprising a filtering control device according to claim 38.

46. (New) A user equipment comprising:

a memory configured to store video frames; and

an encoder according to claim 45 configured to encode said video frames into encoded

video frames, wherein said memory is further configured to store said encoded video frames.

47. (New) A decoder comprising a filtering control device according to claim 38.

48. (New) A user equipment comprising:

a memory configured to store encoded video frames;

a decoder according to claim 47 configured to decode said encoded video frames into decoded video frames; and

a media player configured to render said decoded video frames into video data displayable on a display.

49. (New) A computer program for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program comprises code means which when run on a computer causes the computer to:

calculate a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said neighboring block, by only using pixels

$q2_i$, $q1_i$ and $q0_i$, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a first line of pixels in said block to filer relative to said block boundary based on said first filter decision value; and

determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value,

wherein determine how many pixels in said first line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

50. (New) A computer program product comprising computer readable code means and a computer program according to claim 49 stored on said computer readable means.

REMARKS

Applicant submits the foregoing claim amendments prior to examination on the merits for consideration by the Examiner. The amendments cancel claims 1-33, and add new claims 34-50. No new matter has been added.

Applicant respectfully requests that the Examiner enter the amendments prior to examination on the merits.

Respectfully submitted,
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: **Norkin**	)	
	)	
Application No.: **14/001,627**	)	Examiner: KELLEY, CHRISTOPHER S
	)	
Filing Date: **Aug 26, 2013**	)	Confirmation No.: 2724
	)	
Title: **Deblocking Filtering Control**	)	
	)	
Attorney Ref.: **1009-0641 / P33966 US2**	)	
	)	
	)	

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Please be advised that this is a **U.S. National Stage Filing of PCT Application PCT/SE2011/051526.**

Prior to examination, please amend the application as indicated below.

AMENDMENTS TO THE CLAIMS

1-33. (Canceled)

34. (New) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculatinga second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said first line of pixels in said block to filter relative to

said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

35. (New) The method according to claim 34, wherein

calculating said first filter decision value comprises calculating said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to,

in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

36. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

37. (New) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding first line of pixels in said

neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

38. (New) A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for a neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a first line of pixels

in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator, wherein

further comprising a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value.

39. (New) The device according to claim 38, wherein

said first decision value calculator is configured to calculate said first filter decision value as:

$$\left|p2_0 - 2p1_0 + p0_0\right| + \left|p2_3 - 2p1_3 + p0_3\right|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a

pixel second next closest to, in said second line of pixels, said block boundary; and

said second decision value calculator is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

40. (New) The device according to claim 38, further comprising:

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said first line of pixels in said

block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

41. (New) The device according to claim 38, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value, wherein

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value

as determined by said second comparator and ii) determine to filter no pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

42. (New) The device according to claim 38, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

43. (New) The device according to claim 38, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said first line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said first line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said first line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said first line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said first line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said

corresponding first line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding first line of pixels.

44. (New) The device according to claim 38, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

45. (New) An encoder comprising a filtering control device according to claim 38.

46. (New) A user equipment comprising:

a memory configured to store video frames; and

an encoder according to claim 45 configured to encode said video frames into encoded

video frames, wherein said memory is further configured to store said encoded video frames.

47. (New) A decoder comprising a filtering control device according to claim 38.

48. (New) A user equipment comprising:

a memory configured to store encoded video frames;

a decoder according to claim 47 configured to decode said encoded video frames into decoded video frames; and

a media player configured to render said decoded video frames into video data displayable on a display.

49. (New) A computer program for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program comprises code means which when run on a computer causes the computer to:

calculate a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said neighboring block, by only using pixels

$q2_i$, $q1_i$ and $q0_i$, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a first line of pixels in said block to filer relative to said block boundary based on said first filter decision value; and

determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value,

wherein determine how many pixels in said first line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

50. (New) A computer program product comprising computer readable code means and a computer program according to claim 49 stored on said computer readable means.

REMARKS

Applicant submits the foregoing claim amendments prior to examination on the merits for consideration by the Examiner. The amendments cancel claims 1-33, and add new claims 34-50. No new matter has been added.

Applicant respectfully requests that the Examiner enter the amendments prior to examination on the merits.

Respectfully submitted,
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Electronic Acknowledgement Receipt

EFS ID:	20757278
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
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Time Stamp:	16:28:59
Application Type:	U.S. National Stage under 35 USC 371

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	Preliminary_Amendment.pdf	65432 19be1c6ffc8d295b82c243571a88d8c28ffb0df8	no	16

Warnings:	
Information:	

Total Files Size (in bytes):	65432

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/001,627	Filing Date 08/26/2013	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **11/20/2014**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 17	Minus	** 23	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/ERIC V. BURNS/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	14/001,627
Filing Date	Aug 26, 2013
First Named Inventor	Andrey Norkin
Art Unit	2482
Examiner Name	KELLEY, CHRISTOPHER S
Attorney Docket Number	1009-0641 / P33966 US2

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T [5]
		2005123732	JP	A	2005- 05-12	MATSUSHITA ELECTRIC IND CO LTD		
		2010141883	JP	A	2010-06-24	NVIDIA CORP		
		2012044074	WO	A2	2012-04-05	SAMSUNG ELECTRONICS CO LTD		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
		AN, JICHENG et al., "CE 8 subtest1: Improved deblocking filter", IEEE, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th Meeting: Daegu, Korea, January 2011, 1-8.	

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	Art Unit	2482
	Examiner Name	KELLEY, CHRISTOPHER S
	Attorney Docket Number	1009-0641 / P33966 US2

		AN, JICHENG, "TEIO Subtestl: Improved Deblocking Filter", Joint Collaborative Team on Video Coding, of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 3rd Meeting, Guangzhou, CN, 7-15 October 2010, 1-8.	
		LIST, PETER et al., "Adaptive Deblocking Filter", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 3, Issue 7, July 2003, 614-619.	
		UGUR, KEMAL et al., "Appendix to Description of video coding technology proposal by Tandberg Nokia Ericsson", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Dresden, DE, 15-23 April 2010, 1-55.	
		UGUR, KEMAL et al., "High Performance, Low Complexity Video Coding and the Emerging HEVC Standard", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 20, No. 12, December 2010, 1688-1697.	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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	Art Unit	2482
	Examiner Name	KELLEY, CHRISTOPHER S
	Attorney Docket Number	1009-0641 / P33966 US2

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☒ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2015-12-30
Name/Print	Daniel P. Homiller	Registration Number	55,275

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Bibliographic data: JP2005123732 (A) — 2005-05-12

APPARATUS AND METHOD FOR DEBLOCKING FILTER PROCESSING

Inventor(s): LEE MEN HUANG; SHEN SHENG MEI; HONDA YOSHIMASA ± (LEE MEN HUANG, ; SHEN SHENG MEI, ; HONDA YOSHIMASA)

Applicant(s): MATSUSHITA ELECTRIC IND CO LTD ± (MATSUSHITA ELECTRIC IND CO LTD)

Classification: **- international:** ***H03M7/30; H03M7/36; H04N19/117; H04N19/134; H04N19/136; H04N19/137; H04N19/157; H04N19/159; H04N19/167; H04N19/196; H04N19/33; H04N19/423; H04N19/50; H04N19/51; H04N19/513; H04N19/63; H04N19/80; H04N19/82; H04N19/86; H04N19/91; H04N7/12;*** (IPC1-7): H03M7/36; H04N7/32

- cooperative: **H04N19/117**; **H04N19/159**; **H04N19/176**; **H04N19/527**; **H04N19/61**; **H04N19/63**; **H04N19/82**

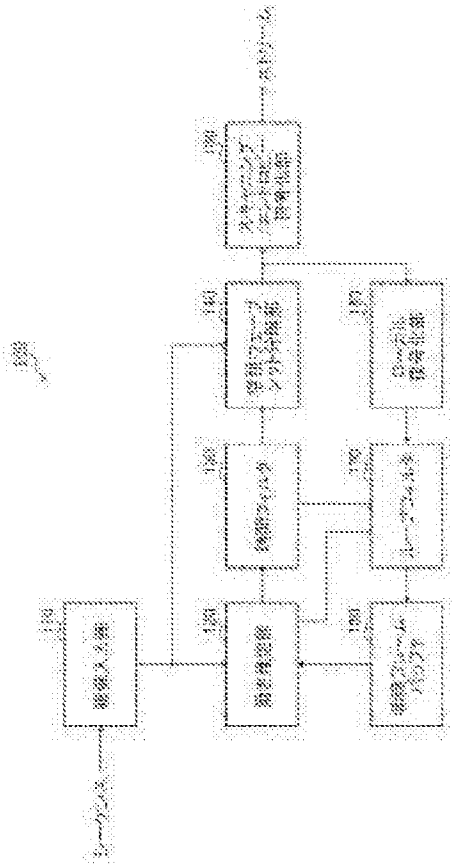
Application number: JP20030353989 20031014

Priority number(s): JP20030353989 20031014

Also published as: US2005078750 (A1) CN1607836 (A)

Abstract of JP2005123732 (A)

PROBLEM TO BE SOLVED: To attain high image quality without unnecessarily consuming power of a processing apparatus. ;SOLUTION: In a loop filter 170, first, a motion estimate block of variable size in a frame subjected to motion estimate processing is acquired. Then, deblocking filter processing is applied to the frame subjected to motion estimate processing. Also, the application of deblocking filter processing is conducted only on the boundary between some motion estimate block in the frame subjected to motion estimate processing and a motion estimate block adjacent to this motion estimate block. ;COPYRIGHT: (C)2005,JPO&NCIPI



(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2005-123732
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(43)公開日　平成17年5月12日(2005.5.12)

(51)Int.Cl.[7]		F I			テーマコード（参考）
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H03M	7/36	H03M	7/36		5J064

審査請求 未請求　請求項の数 10　OL　（全 16 頁）

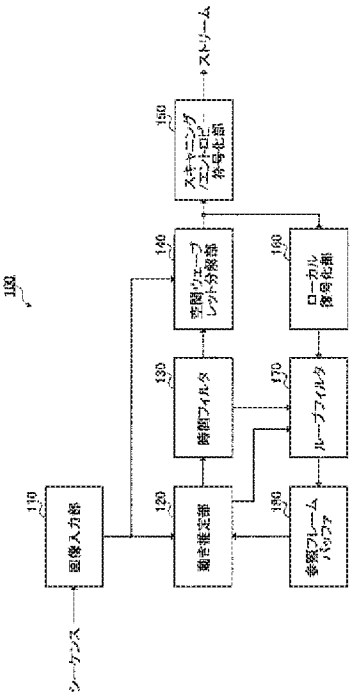
(21)出願番号　特願2003-353989(P2003-353989)
(22)出願日　平成15年10月14日(2003.10.14)

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最終頁に続く

(54)【発明の名称】デブロックフィルタ処理装置およびデブロックフィルタ処理方法

(57)【要約】
【課題】　処理装置の電力を不必要に消費することなく高画質化を実現すること。
【解決手段】　ループフィルタ１７０において、まず、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックを取得する。そして、取得された動き推定ブロックに従って、デブロックフィルタ処理を、動き推定処理が施されたフレームに対して適用する。また、デブロックフィルタ処理の適用は、動き推定処理が施されたフレームにおけるある動き推定ブロックとこの動き推定ブロックに隣接する動き推定ブロックとの境界のみで、実行される。
【選択図】　図１



【特許請求の範囲】
【請求項1】
動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックを取得する取得手段と、
取得された動き推定ブロックに従って前記フレームにデブロックフィルタ処理を適用する適用手段と、
を有することを特徴とするデブロックフィルタ処理装置。
【請求項2】
前記適用手段は、
前記フレーム内の一の動き推定ブロックと当該動き推定ブロックに隣接する他の動き推定ブロックとの境界のみで、デブロックフィルタ処理の適用を行うことを特徴とする請求項１記載のデブロックフィルタ処理装置。
【請求項3】
前記適用手段は、
前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理のタップ長を設定することを特徴とする請求項２記載のデブロックフィルタ処理装置。
【請求項4】
前記適用手段は、
前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理の強度を設定することを特徴とする請求項２記載のデブロックフィルタ処理装置。
【請求項5】
前記適用手段は、
前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理の適用画素数を設定することを特徴とする請求項２記載のデブロックフィルタ処理装置。
【請求項6】
請求項２記載のデブロックフィルタ処理装置を有することを特徴とする映像符号化装置。
【請求項7】
請求項２記載のデブロックフィルタ処理装置を有することを特徴とする映像復号化装置。
【請求項8】
対応する映像符号化装置から送信される信号に従って、前記フレームにおいてデブロックフィルタ処理を適用すべき時間分解レベルを変更することを特徴とする請求項７記載の映像復号化装置。
【請求項9】
前記フレームが再構築されたときにデブロックフィルタ処理の適用を行うことを特徴とする請求項７記載の映像復号化装置。
【請求項10】
動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックを取得する取得ステップと、
取得された動き推定ブロックに従って前記フレームにデブロックフィルタ処理を適用する適用ステップと、
を有することを特徴とするデブロックフィルタ処理方法。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、高度マルチメディアデータ符号化、特に、可変ブロックサイズベースでの動

き予測を用いる映像符号化に適用されるデブロックフィルタ処理装置およびデブロックフィルタ処理方法に関する。

【背景技術】

【0002】

一般に映像圧縮技術において、画質や圧縮率を向上するために様々なフィルタが用いられる。低ビットレートの圧縮映像を復号して得られた画像には、量子化ノイズや動き補償によりブロックアーティファクトが生じることが多い。デブロックフィルタ処理装置（以下「デブロックフィルタ」または単に「フィルタ」と言う）の主な役割の１つは、復号画像におけるブロック境界を平滑化し、ブロックアーティファクトを低減または除去することである。また、デブロックフィルタには、例えばデコーダ側で映像を再生する際にノイズを除去し画質を安定化させることで高画質化を図るポストフィルタと、例えばエンコーダ側で映像を圧縮する際にノイズを除去し圧縮効率を向上させることで高画質化を図るループフィルタとがある。

【0003】

従来、高画質化のためのデブロックフィルタとしては、特許文献１に記載されたものがある。この文献では、フィルタ強度を符号化モードに合わせて復号画像に適用するポストフィルタが開示されている。また、その他にも、復号画像の画質を向上させるために参照画像および非参照画像の両方に適用するループフィルタが提案されている。

【特許文献1】特開２００１－２２４０３１号公報

【発明の開示】

【発明が解決しようとする課題】

【0004】

しかしながら、上記従来のデブロックフィルタは、画像に対して固定ブロックサイズベースで適用されるものである。

【0005】

例えば、映像符号化に関する規格ＩＳＯ／ＩＥＣ１４４９６パート１０においては、ＤＣＴ（離散コサイン変換）が４ｘ４サイズのブロック（以下、ＮｘＮサイズを有するブロックを「ＮｘＮブロック」と略記する）に対して施されるため、従来のデブロックフィルタは、４ｘ４ブロックの境界に対して適用されるよう設計される。また、例えば、規格ＩＳＯ／ＩＥＣ１４４９６パート２においては、ＤＣＴが８ｘ８サイズで実行されるため、従来のデブロックフィルタは、８ｘ８ブロックの境界に対して適用されるよう設計される。このようなフィルタ設計は、ＤＣＴを考慮に入れたものとしては良好である。なぜなら、低ビットレートでのブロックノイズの多くは、ＤＣＴにより発生しているからである。

【0006】

ところが、次世代の映像符号化の規格となり得るものとして近年注目を集めているフレーム間ウェーブレット映像符号化方式には、上記のフィルタ設計が最適とは言えない。一般にこの方式では、時間方向においては、ブロックベースの動き推定／補償を伴うＭＣＴＦ（Motion Compensated Temporal Filtering）が用いられ、空間変換には、２Ｄ－ＤＷＴ（離散ウェーブレット変換）が用いられる。ＤＣＴと異なり、ＤＷＴは復号画像にブロックアーティファクトを生じないという特徴を持っている。したがって、この方式において、ブロックアーティファクトを生じさせる主因となる工程は動き推定／補償である。とりわけ低ビットレートのときやＧＯＰ（Group Of Picture）サイズが小さい低遅延モードのときに動き推定／補償を実行する場合、不正確な動き推定や量子化によってブロックアーティファクトが生じ得る。ＭＣＴＦの場合は時間分解レベルの各々でこれが実行されるため、全時間分解レベルにわたってブロックアーティファクトが蓄積されることもあり得る。

【0007】

以下、動き推定を用いたウェーブレット符号化（ＭＣウェーブレット符号化）の一般例について図９を参照しながら説明する。ここでは、ＧＯＰサイズ＝８の場合を例として説明する。

【0008】
図９に示すように、レベル０では８つの原フレームが存在する。動き推定および時間方向のウェーブレットフィルタ（この例ではＨａａｒフィルタが示されているがより長いフィルタも適用可能である）を用いた時間分解処理の後、レベル１では、低域のフレームＬ１、Ｌ２、Ｌ３、Ｌ４からなるグループと高域のフレームＨ１、Ｈ２、Ｈ３、Ｈ４からなるグループとが生成される。それから、低域のフレームＬ１、Ｌ２、Ｌ３、Ｌ４に対してさらに動き推定および時間フィルタ処理が施され、レベル２では、低域のフレームＬＬ１、ＬＬ２からなるグループと高域のフレームＬＨ１、ＬＨ２からなるグループとが生成される。そして、再び動き推定および時間フィルタ処理が施され、最終的に、レベル３では２つのフレームＬＬＬ１、ＬＬＨ１のみが存在している。
【0009】
そして、レベル３でのフレームＬＬＬ１、ＬＬＨ１、レベル２でのＬＨ１、ＬＨ２およびレベル１でのＨ１、Ｈ２、Ｈ３、Ｈ４に対しては空間ウェーブレット分解が施され、続いて、スキャニングが行われ、空間スケーラビリティ、時間スケーラビリティおよび画質スケーラビリティ等を考慮したエントロピー符号化（可変長符号化）が行われ、スケーラブルなストリームが生成されることとなる。
【0010】
一般に理解されているように、ＭＣウェーブレット符号化で用いられる動き推定は、ＩＳＯ／ＩＥＣ１３８１８パート２の１６ｘ１６やＩＳＯ／ＩＥＣ１４４９６パート２の最大１６ｘ１６のような固定ブロックサイズに常に基づいているわけではない。このサイズは、４ｘ４の小さいものから６４ｘ６４の大きなものまで、さらに映像の性質によってはさらに大きなものまで可変である。図１０は、参照フレームＡおよび現在フレームＢの間の動き推定／補償のためのブロックマッチングにおいて使用し得る可変ブロックサイズ（例えば、４ｘ４から６４ｘ６４まで）を例示したものである。
【0011】
また、図１１は、従来の固定ブロックサイズベースのデブロックフィルタ処理の適用例を示した図である。ここでは、図１１において実線で示されたブロックを有するフレームに対して破線で示されたデブロックフィルタ処理を適用した例について説明する。ブロックＳ１、Ｓ２、Ｓ３は動き推定のために選択されたサイズをそれぞれ有し、ブロックＳ１は６４ｘ６４ブロックであり、ブロックＳ２は３２ｘ３２ブロックであり、ブロックＳ３は１６ｘ１６ブロックである。
【0012】
動き推定のブロックサイズがブロックＳ１のように６４ｘ６４であるとすると、この６４ｘ６４ブロック内にブロックアーティファクトは存在していないはずである。このような場合に６４ｘ６４より小さいサイズの固定サイズのデブロックフィルタ処理を適用すると、処理装置（例えば、ＣＰＵ）の電力が不必要に消費されてしまう。また、それだけでなく、重要な情報がフィルタリングされ、その結果として画像の鮮鋭度が失われてぼやけてしまい、結局、高画質化を実現することができないという問題があった。
【0013】
本発明は、かかる点に鑑みてなされたものであり、処理装置の電力を不必要に消費することなく高画質化を実現することができるデブロックフィルタ処理装置およびデブロックフィルタ処理方法を提供することを目的とする。
【課題を解決するための手段】
【0014】
本発明のデブロックフィルタ処理装置は、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックを取得する取得手段と、取得された動き推定ブロックに従って前記フレームにデブロックフィルタ処理を適用する適用手段と、を有する構成を採る。
【0015】
この構成によれば、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックに従って、デブロックフィルタ処理を当該フレームに適用するため、例えばデブロ

ックフィルタ処理におけるブロックサイズを動き推定ブロックのサイズに合わせて適応的に変化させた場合に、デブロックフィルタ処理のブロックサイズと動き推定ブロックのサイズとを一致させることができ、デブロックフィルタ処理の量の増大を抑制することができるだけでなく画像の鮮鋭度が無駄に失われることを防止することができ、処理装置の電力を不必要に消費することなく高画質化を実現することができる。

【0016】

本発明のデブロックフィルタ処理装置は、上記構成において、前記適用手段は、前記フレーム内の一の動き推定ブロックと当該動き推定ブロックに隣接する他の動き推定ブロックとの境界のみで、デブロックフィルタ処理の適用を行う構成を採る。

【0017】

この構成によれば、デブロックフィルタ処理の適用位置を２つの動き推定ブロック間の境界のみに限定することができ、デブロックフィルタ処理のブロックサイズと動き推定ブロックのサイズとを一致させることができ、デブロックフィルタ処理の量の増大を抑制することができるだけでなく画像の鮮鋭度が無駄に失われることを防止することができ、処理装置の電力を不必要に消費することなく高画質化を実現することができる。

【0018】

本発明のデブロックフィルタ処理装置は、上記構成において、前記適用手段は、前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理のタップ長を設定する構成を採る。

【0019】

この構成によれば、動き推定処理が施されたフレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて当該フレームに対するデブロックフィルタ処理のタップ長の設定を行うため、デブロックフィルタ処理を適用する際のタップ長の設定を効率的に行うことができる。

【0020】

本発明のデブロックフィルタ処理装置は、上記構成において、前記適用手段は、前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理の強度を設定する構成を採る。

【0021】

この構成によれば、動き推定処理が施されたフレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて当該フレームに対するデブロックフィルタ処理の強度の設定を行うため、デブロックフィルタ処理を適用する際の強度の設定を効率的に行うことができる。

【0022】

本発明のデブロックフィルタ処理装置は、上記構成において、前記適用手段は、前記フレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて、前記フレームに対するデブロックフィルタ処理の適用画素数を設定する構成を採る。

【0023】

この構成によれば、動き推定処理が施されたフレームに対応する符号化情報および送信情報の少なくともいずれか一方に基づいて当該フレームに対するデブロックフィルタ処理の適用画素数の設定を行うため、デブロックフィルタ処理を適用する際の適用画素数を効率的に行うことができる。

【0024】

本発明の映像符号化装置は、上記のデブロックフィルタ処理装置を有する構成を採る。

【0025】

この構成によれば、上記のデブロックフィルタ処理装置と同様の作用効果を、映像符号化装置において実現することができる。

【0026】

本発明の映像復号化装置は、上記のデブロックフィルタ処理装置を有する構成を採る。

【0027】

この構成によれば、上記のデブロックフィルタ処理装置と同様の作用効果を、映像復号化装置において実現することができる。

【0028】

本発明の映像復号化装置は、上記構成において、対応する映像符号化装置から送信される信号に従って、前記フレームにおいてデブロックフィルタ処理を適用すべき時間分解レベルを変更する構成を採る。

【0029】

この構成によれば、対応する映像符号化装置から例えば所定の指示が送信された場合にデブロックフィルタ処理を適用すべき時間分解レベルやその数を変更することができ、映像復号化装置におけるデブロックフィルク処理の効率を向上させたり負荷を低減したりすることができる。

【0030】

本発明の映像復号化装置は、上記構成において、前記フレームが再構築されたときにデブロックフィルタ処理の適用を行う構成を採る。

【0031】

この構成によれば、再構築されたフレームに対してデブロックフィルタ処理の適用を行うことができる。

【0032】

本発明のデブロックフィルタ処理方法は、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックを取得する取得ステップと、取得された動き推定ブロックに従って前記フレームにデブロックフィルタ処理を適用する適用ステップと、を有するようにした。

【0033】

この方法によれば、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックに従って、デブロックフィルタ処理を当該フレームに適用するため、例えばデブロックフィルタ処理におけるブロックサイズを動き推定ブロックのサイズに合わせて適応的に変化させた場合に、デブロックフィルタ処理のブロックサイズと動き推定ブロックのサイズとを一致させることができ、デブロックフィルタ処理の量の増大を抑制することができるだけでなく画像の鮮鋭度が無駄に失われることを防止することができ、処理装置の電力を不必要に消費することなく高画質化を実現することができる。

【発明の効果】

【0034】

以上説明したように、本発明によれば、処理装置の電力を不必要に消費することなく高画質化を実現することができる。

【発明を実施するための最良の形態】

【0035】

本発明の骨子は、動き推定処理が施されたフレームにおける可変サイズの動き推定ブロックに従って、デブロックフィルタ処理を当該フレームに適用することである。

【0036】

以下、本発明の実施の形態について、図面を用いて詳細に説明する。

【0037】

（実施の形態１）

図１は、本発明の実施の形態１に係るループフィルタを有する映像符号化装置の構成を示すブロック図である。

【0038】

図１に示す映像符号化装置１００は、画像入力部１１０、動き推定部１２０、時間フィルタ１３０、空間ウェーブレット分解部１４０、スキャニング／エントロピー符号化部１５０、ローカル復号化部１６０、ループフィルタ１７０および参照フレームバッファ１８０を有する。

【0039】

画像入力部１１０は、入力される映像のシーケンスにおける所定数（固定数または可変数）の隣接フレームを１ＧＯＰとしてグループ化した上で、フレームを動き推定部１２０に出力する。また、画像入力部１１０は、例えばランダムアクセスやエラーリカバリーの目的で他のフレームから独立した符号化フレームを得るために、フレームを空間ウェーブレット分解部１４０に直接出力しても良い。

【0040】

動き推定部１２０は、参照フレームバッファ１８０に一時的に記憶された参照フレームを参照し、１ＧＯＰ内で、または複数のＧＯＰ間で、画像入力部１１０からのフレームに対して動き推定および動き補償を行う。

【0041】

時間フィルタ１３０は、動き補償されたフレームに対して時間ウェーブレット分解を施し、複数の時間分解レベルでの低域および高域の時間フレームを生成する。

【0042】

空間ウェーブレット分解部１４０は、時間フィルタ１３０からの時間フレームまたは画像入力部１１０からのフレームに対して空間ウェーブレット分解を施す。

【0043】

スキャニング／エントロピー符号化部１５０は、空間ウェーブレット分解部１４０からのフレームに対してスキャニングおよびエントロピー符号化を施す。これらの処理が施されたフレームは、符号化されたスケーラブルなストリームとして出力される。

【0044】

ローカル復号化部１６０は、空間ウェーブレット分解部１４０からのフレームをローカル復号化する。

【0045】

本願発明の特徴部分であるループフィルタ１７０は、独立した符号化フレームを除いて、ローカル復号化されたフレームに対して後述のデブロックフィルタ処理を施す。デブロックフィルタ処理は、複数の時間分解レベルの各々に対応して実行される。デブロックフィルタ処理を実行する際、ループフィルタ１７０は、デブロックフィルタ処理を適応的に実行するために、符号化／送信情報を取得する。取得される符号化／送信情報としては、動き推定部１２０による動き推定に関する動き推定情報、時間フィルタ１３０による時間ウェーブレット分解に関する時間分解情報、その他には、量子化パラメータ、ビットレート関連情報、色成分、要求される空間解像度、要求される時間解像度等の情報が挙げられる。動き推定情報は、例えば、ＭＥ（動き推定）ブロックサイズ、動き予測モード（イントラ（フレーム内予測符号化）モード、順方向予測符号化モード、逆方向予測符号化モードまたは双方向予測符号化モード）、動きベクトル、シーン変更等の情報を含む。時間分解情報は、例えば、使用する分解フィルタ、処理対象の時間分解レベル、ＧＯＰサイズ等の情報を含む。

【0046】

参照フレームバッファ１８０は、ループフィルタ１７０によってデブロックフィルタ処理が施されたフレームを、動き推定部１２０による動き推定で用いられる参照フレームとして一時的に記憶する。

【0047】

次いで、上記構成を有する映像符号化装置１００のループフィルタ１７０にて実行されるデブロックフィルタ処理について説明する。図２は、ループフィルタにて実行されるデブロックフィルタ処理の動作を説明するためのフロー図であり、ここで説明するデブロックフィルタ処理は、処理対象のフレームに対して時間分解レベル毎に（例えば第１の時間分解レベルから最終時間分解レベルまでの順で）実行される。例えば、時間分解レベル毎の低域のフレームに対して実行される。

【0048】

デブロックフィルタ処理は、ステップＳ１０００での、ＭＥブロックの取得から開始される。ここでは、１つの時間フレームを構成するＭＥブロックの中の１つを選択して取得

する。

【0049】

すなわち、このステップでは、動き推定／補償に用いられたＭＥブロックを１つずつ取得する。このようにすることで、デブロックフィルタ処理のためのフィルタサイズ（後述のタップ長）を、ＭＥブロックの可変ブロックサイズに適応させることができる。図３は、可変ブロックサイズベースのデブロックフィルタ処理の適用例を示した図である。図３において実線で示された可変ブロックサイズのＭＥブロックに、破線で示されたデブロックフィルタ処理のフィルタサイズが合わせられていることが分かる。

【0050】

そして、ステップＳ１１００では、ＭＥブロックの上端および左端の少なくともいずれか一方に他のブロックが隣接しているか否か、すなわち、上端の水平境界および左端の垂直境界の少なくともいずれか一方があるか否かを判定する。この判定において、上記の境界がある場合（Ｓ１１００：ＹＥＳ）ステップＳ１２００に進み、上記の境界がない場合（Ｓ１１００：ＮＯ）ステップＳ２２００に進む。

【0051】

ステップＳ１２００では、取得したＭＥブロックの境界の中の１つを選択して取得する。そして、ステップＳ１３００で、上記の符号化／送信情報を取得する。

【0052】

そして、ステップＳ１４００で、ノイズ除去のためにＭＥブロックと隣接ブロックとの境界に適用するデブロックフィルタ処理のタップ長を設定する。タップ長は、隣り合う２つのブロックのサイズのうち小さい方を採用することにより決定される。また、水平境界に対して適用されるデブロックフィルタ処理（垂直フィルタ処理）の場合、そのタップ長はブロックの高さに依存して決定され、垂直境界に対して適用されるデブロックフィルタ処理（水平フィルタ処理）の場合、そのタップ長はブロックの幅に依存して決定される。

【0053】

図４および図５は、デブロックフィルタ処理におけるタップ長の設定例をそれぞれ説明するための図である。

【0054】

図４に示す例では、処理対象のブロックＰ、ブロックＰの上側に隣り合うブロックＲおよびブロックＰの左側に隣り合うブロックＱは、いずれも同じサイズを有している。この場合、ブロックＰに対して適用される水平フィルタ処理のタップ長は、ブロックＰ、Ｑの高さに基づいて決定され、ブロックＰに対して適用される垂直フィルタ処理のタップ長は、ブロックＰ、Ｒの幅に基づいて決定される。

【0055】

一方、図５に示す例では、処理対象のブロックＰのサイズが、ブロックＰの左側に隣り合うブロックＱよりも小さく、ブロックＰの上側に隣り合うブロックＲ、Ｓ、Ｔの各々よりも大きい。この場合、ブロックＰに対して適用される水平フィルタ処理のタップ長は、ブロックＰの高さに基づいて決定される。また、ブロックＰに対して適用される垂直フィルタ処理のうちブロックＲとの境界に対応するもののタップ長は、ブロックＲの幅に基づいて決定される。また、ブロックＰに対して適用される垂直フィルタ処理のうちブロックＳとの境界に対応するもののタップ長は、ブロックＳの幅に基づいて決定され、ブロックＰに対して適用される垂直フィルタ処理のうちブロックＴとの境界に対応するもののタップ長は、ブロックＴの幅に基づいて決定される。

【0056】

このようにして、ノイズが発生する領域が大きいほど、無駄なく大きなタップ長の設定が可能となる。

【0057】

そして、ステップＳ１５００で、デブロックフィルタ処理を適用する際のフィルタ強度を設定する。ノイズの強度がより大きいブロックにより強いフィルタ強度のデブロックフィルタ処理が適用されるように、フィルタ強度は、隣り合う２つのブロックの動き予測モ

ードに応じて設定される。例えば４段階のフィルタ強度が設定可能である場合、次のようにフィルタ強度の設定を行う。両ブロックまたはいずれかのブロックの動き予測モードがイントラのとき、フィルタ強度を最強に（Ｂｓ＝３）する。両ブロックが異なる参照フレームを参照したものであるとき、両ブロックが異なる数の参照フレームを参照したものであるとき、または、両ブロックが同一の参照フレームを参照したものでありながら動きベクトルが類似していないときは、２番目に大きなフィルタ強度（Ｂｓ＝２）を採用する。両ブロックが同一の参照フレームを参照したもので動きベクトルが類似しているときは、３番目に大きな（２番目に小さな）フィルタ強度（Ｂｓ＝１）を採用する。その他のときは、フィルタ強度の設定をオフ（Ｂｓ＝０）とし、対応する境界にフィルタリングを適用しないようにする。

【0058】

そして、ステップＳ１６００で、デブロックフィルタ処理を適用する画素数を設定する。より具体的には、垂直境界に対して適用される水平フィルタ処理における適用画素数は、その垂直境界から左右それぞれ何画素まで水平フィルタ処理を適用するかを決定することで設定される。また、水平方向に対して適用される垂直フィルタ処理における適用画素数は、その水平境界から上下それぞれ何画素まで垂直フィルタ処理を適用するかを決定することで設定される。

【0059】

なお、垂直境界の場合は境界の左側および右側の適用画素数を異なる値に設定したり、水平境界の場合は境界の上側および下側の適用画素数を異なる値に設定したりしても良い。ただし、処理効率や処理速度の向上の観点では、左右それぞれの適用画素数または上下それぞれの適用画素数を同じ値に設定すると、より効果的である。

【0060】

どの画素に対してフィルタリングを適用するか、および、いくつの画素に対してフィルタリングを適用するかを決定するために、閾値が用いられる。この閾値は、符号化処理や送信処理の間にスケーラビリティのための階層化データ欠落により混入されるブロックノイズの補正に必要なフィルタ量に対応している。また、閾値は、使用した符号化方式によって経験的に設定しても良い。

【0061】

また、閾値の設定は、量子化パラメータや、フィルタに掛けられる時間フレームの時間分解レベルに基づいて行われる。異なる量子化パラメータは異なる特性や大きさのブロックノイズを発生させる。量子化パラメータが使用した符号化方式に明示されていない場合は、要求されるビットレート、またはビットストリームから除去されたビットプレーン数から閾値を導出しても良い。例えば、低ビットレート、または除去されたビットプレーン数が多い場合、量子化パラメータは大きくなる。ＭＣＴＦ期間における画素の正規化のために、画素値のダイナミックレンジは時間分解レベル毎に変化するが、このダイナミックレンジによって閾値を決定しても良い。

【0062】

そして、ステップＳ１７００、Ｓ１８００、Ｓ１９００では、設定したタップ長、フィルタ強度および適用画素数に基づいて、取得した境界での全ライン上の画素に対してフィルタリングを施す。より具体的には、まずステップＳ１７００で、１ライン分の画素をフィルタリングし、ステップＳ１８００で、最終ラインに対するフィルタリングが完了したか否か（取得した境界に残りのラインが存在するか否か）を判定する。この判定において、最終ラインに対するフィルタリングが完了していない場合（Ｓ１８００：ＮＯ）、ステップＳ１９００で次のラインに進み、ステップＳ１７００に戻る。一方、最終ラインに対するフィルタリングが完了した場合（Ｓ１８００：ＹＥＳ）、ステップＳ２０００に進む。

【0063】

ステップＳ２０００では、取得されたＭＥブロックにおいて先に取得された境界の他にまだフィルタリングされていない境界があるか否かを判定する。この判定において、他の

境界が残っている場合（Ｓ２０００：ＹＥＳ）、ステップＳ２１００で次の境界に進み、ステップＳ１２００に戻る。一方、他の境界が残っていない場合（Ｓ２０００：ＮＯ）、ステップＳ２２００に進む。このような判定を行うことで、動き推定／補償処理における全てのブロックに対してフィルタリングを掛けることができる。よって、このデブロックフィルタ処理は、各時間分解レベルでの時間フレームをはじめとする様々な再構築フレームに対して適用することができる。

【0064】

ステップＳ２２００では、現在処理対象となっている時間フレームにおいて先に取得されたＭＥブロックの他にまだフィルタリングされていないＭＥブロックがあるか否か、換言すれば、全てのＭＥブロックがフィルク済みであるか否かを判定する。この判定において、他のＭＥブロックが残っている場合（Ｓ２２００：ＮＯ）、ステップＳ２３００で次のＭＥブロックに進み、ステップＳ１０００に戻る。一方、他のＭＥブロックが残っていない場合（Ｓ２２００：ＹＥＳ）、現在の時間分解レベルにおけるデブロックフィルタ処理を終了する。

【0065】

上述のデブロックフィルタ処理を行うことによって、よりきれいな参照フレームを用いて、後続のフレームや次の時間分解レベルにおける動き推定を行うことが可能となる。

【0066】

なお、デブロックフィルタ処理において、上記の工程以外に、取得した色成分の情報に応じて、デブロックフィルタ処理実行のオンオフを自動的に切り替えても良い。

【0067】

既に述べたとおり、ループフィルタ１７０にて実行されるデブロックフィルタ処理は、各時間分解レベルに対応している。つまり、図６に示すように、レベル０での８つの原フレームがレベル１からレベル３までの各時間フレームに時間分解される場合、レベル１、レベル２およびレベル３の各々で、上記のデブロックフィルタ処理が実行される。

【0068】

このように、本実施の形態によれば、可変サイズの動き推定ブロックに従って、動き推定処理が施されたフレーム内のある動き推定ブロックとこの動き推定ブロックに隣接する他の動き推定ブロックとの境界のみで、デブロックフィルタ処理の適用を行うため、デブロックフィルタ処理のフィルタサイズと動き推定ブロックサイズとを一致させることができ、デブロックフィルタ処理の量の増大を抑制することができるだけでなく画像の鮮鋭度が無駄に失われることを防止することができ、処理装置の電力を不必要に消費することなく高画質化を実現することができる。

【0069】

（実施の形態２）

図７は、本発明の実施の形態２に係るループフィルタを有する映像復号化装置の構成を示すブロック図である。

【0070】

本実施の形態では、本発明に係るデブロックフィルタ処理を実行するフィルタをエンコーダ側およびデコーダ側の両方で用いられる一般的なケースについて説明する。なお、エンコーダ側のフィルタについては、実施の形態１で説明したループフィルタ１７０と同様のものであるため、その説明を省略する。

【0071】

図７に示す映像復号化装置２００は、対応する映像符号化装置から入力されるストリームに対して逆スキャニングおよび逆エントロピー符号化を施しフレームを生成する逆スキャニング／逆エントロピー符号化部２１０と、生成されたフレームに対して空間ウェーブレット合成を施す空間ウェーブレット合成部２２０と、独立した符号化フレーム以外のフレームに対して時間フィルタ処理を施す時間フィルタ２３０と、時間フィルタ処理（時間ウェーブレット合成）されたフレームに対して動き補償を施す動き補償部２４０と、動き補償されたフレームを加算して再構築フレームを生成し、または独立した符号化フレーム

から再構築フレームを生成し、生成された再構築フレームを出力する画像加算部２５０と、実施の形態１で説明したループフィルク１７０にて実行されるデブロックフィルタ処理と同様の処理を実行するループフィルタ２６０と、ループフィルタ２６０によってデブロックフィルタ処理が施されたフレームを、動き補償部２４０による動き補償で用いられる参照フレームとして一時的に記憶する参照フレームバッファ２７０とを有する。

【0072】

なお、図７における破線の矢印Ｂは、複数の時間分解レベルに応じた処理が映像復号化装置２００内で行われることを示唆している。

【0073】

ループフィルタ２６０は、デブロックフィルタ処理を適応的に実行するための符号化／送信情報をストリームから分離して取得することで、実施の形態１で詳述したデブロックフィルタ処理と同様の処理を実行することが可能となり、よって、よりきれいな参照フレームを時間フィルタ２３０による時間ウェーブレット合成および動き補償部２４０による動き補償に用いることができるようになる。

【0074】

また、ループフィルタ２６０は、対応する映像符号化装置からのシグナリングをストリームから分離して受信することで、当該シグナリングに応じて、デブロックフィルタ処理を適用する時間分解レベルを単一の時間分解レベルから複数の時間分解レベルまで適応的に変更することができる。よって、対応する映像符号化装置から所定の指示が送信された場合に、デブロックフィルタ処理を適用する時間分解レベルやその数を削減することができ、映像復号化装置２００の処理効率を向上させたり処理負荷を低減したりすることができる。

【0075】

このように、本実施の形態によれば、実施の形態１で説明した映像符号化装置におけるループフィルタと同様の作用効果を、映像復号化装置におけるループフィルタで実現することができる。また、対応する映像符号化装置からのストリームから符号化／送信情報を分離して取得するため、映像符号化装置および映像復号化装置の各々で実行されるデブロックフィルタ処理を同様のものとすることができ、各装置内のループフィルタを一対の組み合わせとして動作させることができる。

【0076】

なお、本実施の形態では、符号化／送信情報が映像符号化装置からのストリームから取得されるものとして説明しているが、映像復号化装置２００が符号化／送信情報を自ら導出することが可能な場合はこの限りではない。

【0077】

（実施の形態３）

図８は、本発明の実施の形態３に係るポストフィルタを有する映像復号化装置の構成を示すブロック図である。なお、本実施の形態の映像復号化装置は、実施の形態２で説明した映像復号化装置２００と同様の基本的構成を有しており、同一の構成要素には同一の参照符号を付し、その詳細な説明を省略する。

【0078】

本実施の形態では、本発明に係るデブロックフィルタ処理を実行するフィルタがデコーダ側のみで用いられる一般的なケースについて説明する。

【0079】

図８に示す映像復号化装置３００は、図７に示す映像復号化装置２００におけるループフィルタ２６０の代わりにポストフィルタ３１０を備えた構成を採っている。

【0080】

ポストフィルタ３１０は、実施の形態１で詳述したデブロックフィルタ処理と同様の処理を、画像加算部２５０からの再構築フレームに対して適用し、デブロックフィルタ処理が施されたよりきれいなフレームを再構築フレームとして出力する。

【0081】

また、ポストフィルタ３１０は、デブロックフィルタ処理を適応的に実行するための符号化／送信情報を入力されるストリームから分離して取得することで、実施の形態１で詳述したデブロックフィルタ処理と同様の処理を実行することが可能となる。ただし、映像復号化装置３００が符号化／送信情報を自ら導出することが可能な場合は、必ずしもストリームからの取得を行わなくても良い。

【0082】

また、ポストフィルタ３１０にて実行されるデブロックフィルタ処理は、実施の形態２で説明したループフィルタ２６０にて実行されるデブロックフィルタ処理を、再構築フレームが生成されたときに最終レベルで実行することにより実現される。

【0083】

このように、本実施の形態によれば、実施の形態１で説明した映像符号化装置におけるループフィルタと同様の作用効果を、映像復号化装置におけるポストフィルタで実現することができる。

【産業上の利用可能性】

【0084】

本発明のデブロックフィルタ処理装置およびデブロックフィルタ処理方法は、処理装置の電力を不必要に消費することなく高画質化を実現する効果を有し、高度マルチメディアデータ符号化、特に、可変ブロックサイズベースでの動き推定を用いる映像符号化にて有用である。

【図面の簡単な説明】

【0085】

【図1】本発明の実施の形態１に係るループフィルタを有する映像符号化装置の構成を示すブロック図

【図2】本発明の実施の形態１に係るループフィルタにて実行されるデブロックフィルタ処理の動作を説明するためのフロー図

【図3】本発明の実施の形態１に係る可変ブロックサイズベースのデブロックフィルタ処理の適用例を示した図

【図4】本発明の実施の形態１に係るデブロックフィルタ処理におけるタップ長設定の一例を説明するための図

【図5】本発明の実施の形態１に係るデブロックフィルタ処理におけるタップ長設定の他の例を説明するための図

【図6】本発明の実施の形態１に係るデブロックフィルタ処理と時間分解レベルとの関係を示す図

【図7】本発明の実施の形態２に係るループフィルタを有する映像復号化装置の構成を示すブロック図

【図8】本発明の実施の形態３に係るポストフィルタを有する映像復号化装置の構成を示すブロック図

【図9】従来のＭＣウェーブレット符号化の一般例を示す図

【図10】従来の動き推定／補償のための可変ブロックサイズを例示した図

【図11】従来の固定ブロックサイズベースのデブロックフィルタ処理の適用例を示した図

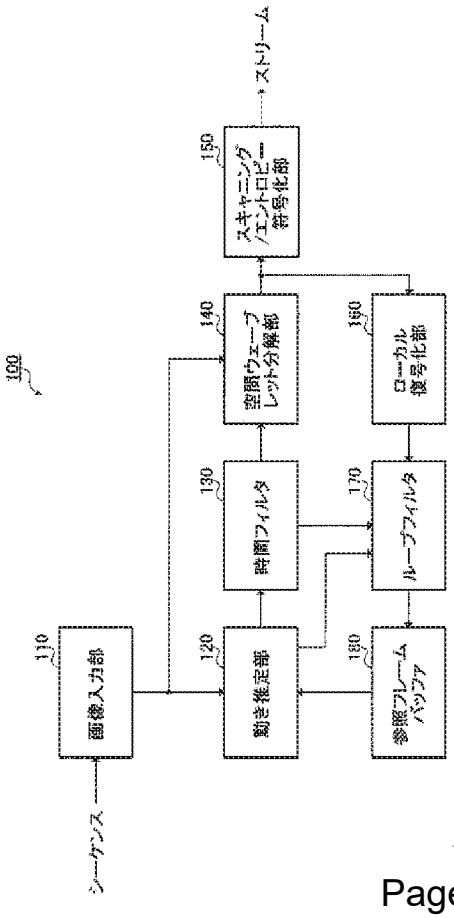
【符号の説明】

【0086】

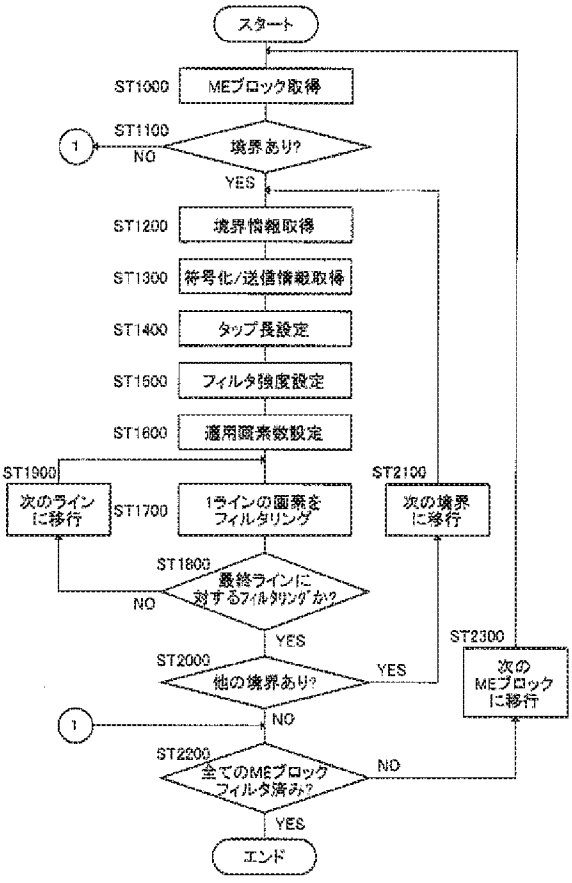
１００　映像符号化装置
１１０　画像入力部
１２０　動き推定部
１３０、２３０　時間フィルタ
１４０　空間ウェーブレット分解部
１５０　スキャニング／エントロピー符号化部
１６０　ローカル復号化部
１７０、２６０　ループフィルタ

１８０、２７０　参照フレームバッファ
２００、３００　映像復号化装置
２１０　逆スキャニング／逆エントロピー符号化部
２２０　空間ウェーブレット合成部
２４０　動き補償部
２５０　画像加算部
３１０　ポストフィルタ

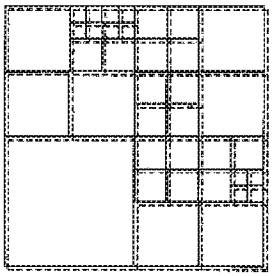
【図1】



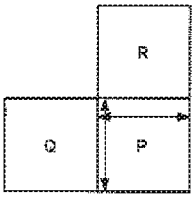
【図2】



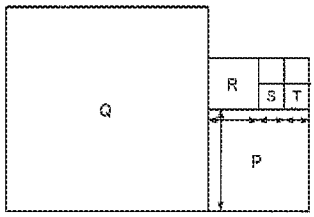
【図3】



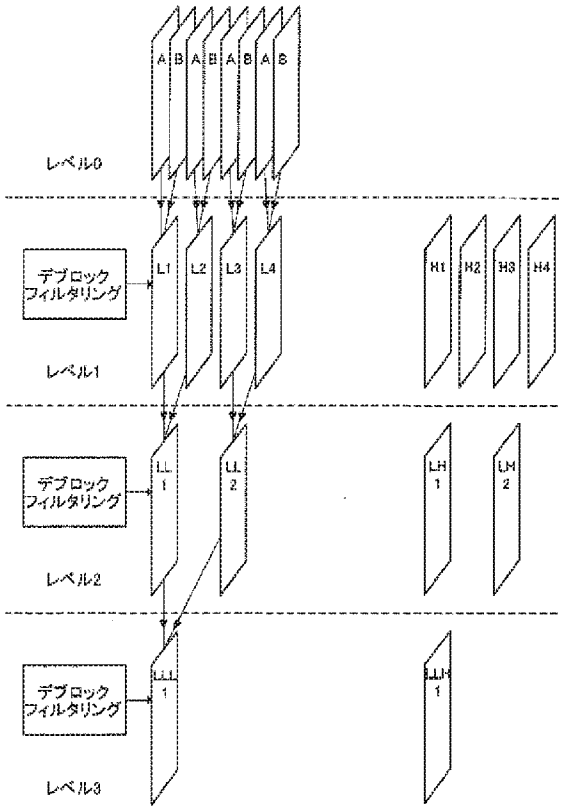
【図4】


R
Q
P

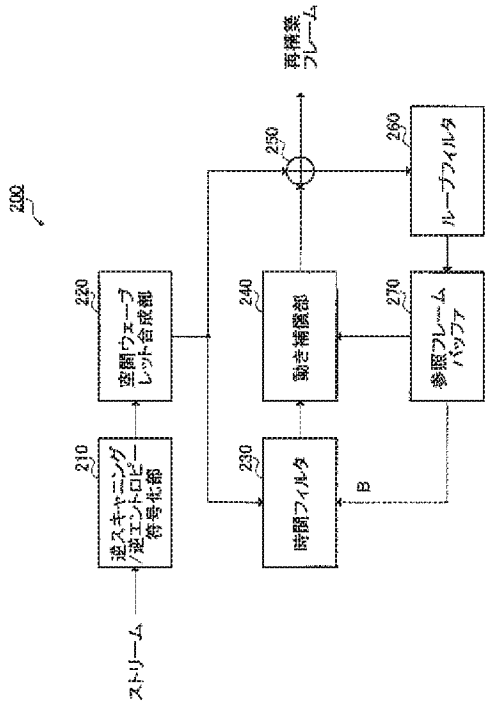
【図5】


Q
R
S
T
P

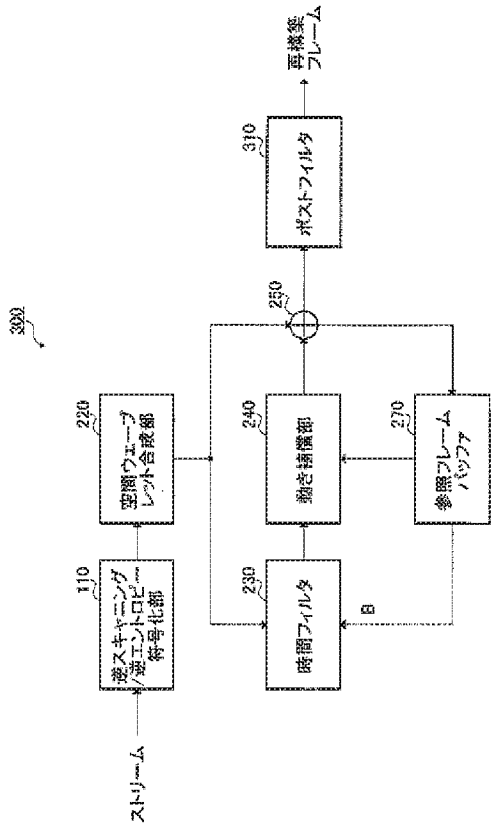
【図6】


A
B
レベル0
デブロック
フィルタリング
L1
L2
L3
L4
H1
H2
H3
H4
レベル1
LL 1
LL 2
LH 1
LH 2
レベル2
LLL 1
LLH 1
レベル3

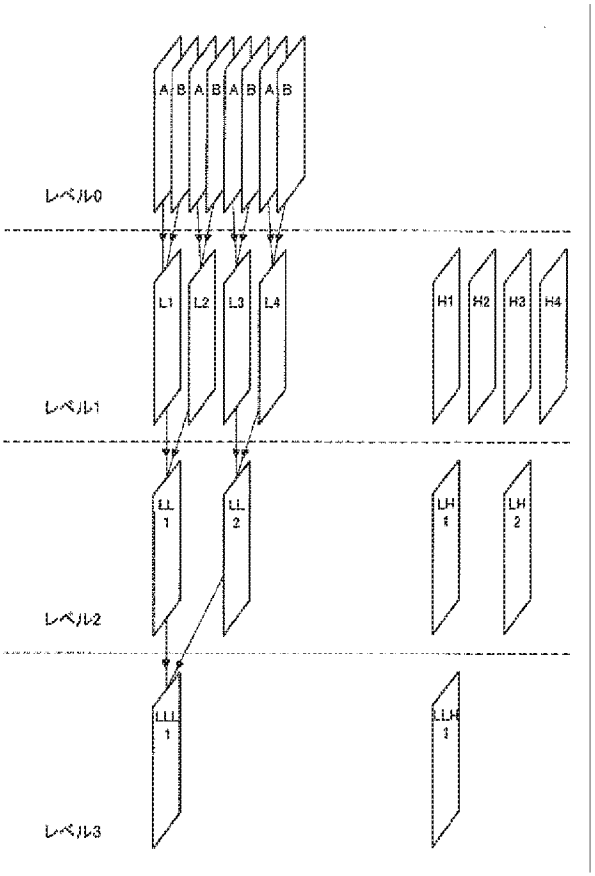
【図7】


200
再構築フレーム
250
260
ループフィルタ
220
空間ウェーブレット合成部
240
動き補償部
270
参照フレームバッファ
210
逆スキャニング/逆エントロピー符号化部
230
時間フィルタ
B
ストリーム

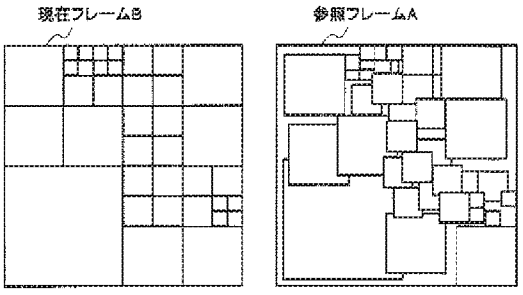
【図8】


再構築フレーム
310
ポストフィルタ
250
300
220
空間ウェーブレット合成部
240
動き補償部
270
参照フレームバッファ
110
逆スキャニング/逆エントロピー符号化部
230
時間フィルタ
B
ストリーム

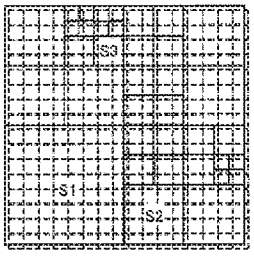
【図9】


A B A B A B A B
レベル0
L1 L2 L3 L4
H1 H2 H3 H4
レベル1
LL 1
LL 2
LH 1
LH 2
レベル2
LL 1
LH 1
レベル3

【図10】


現在フレームB
参照フレームA

【図11】


S3
S1
S2

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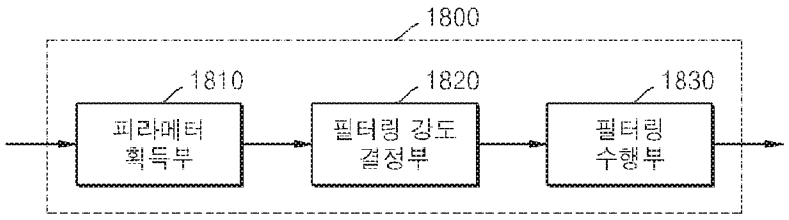
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[다음 쪽 계속]

(54) Title: ADAPTIVE FILTERING METHOD AND APPARATUS

(54) 발명의 명칭 : 적응적 필터링 방법 및 장치

[Fig. 18]



1810 ... Parameter acquiring unit
1820 ... Filtering strength determining unit
1830 ... Filtering unit

(57) Abstract: Disclosed are a filtering method and apparatus which adaptively perform deblocking filtering. According to one embodiment of the present invention, the adaptive filtering method involves: acquiring parameters which indicate the degree of proximity of values of pixels located around a block boundary to a predetermined line; determining a filtering strength at the block boundary on the basis of the acquired parameter; and performing filtering in accordance with the determined filtering strength.

(57) 요약서: 디블록킹 필터링을 적응적으로 수행하는 필터링 방법 및 장치가 개시된다. 본 발명의 실시예에 따른 적응적 필터링 방법은 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인에 가까운 정도를 나타내는 파라메타를 획득하고, 획득된 파라메타에 기초하여 블록 경계에서의 필터링 강도를 결정하며, 결정된 필터링 강도에 기초하여 필터링을 수행한다.

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공개:

— 국제조사보고서 없이 공개하며 보고서 접수 후 이를 별도 공개함 (규칙 48.2(g))

명세서

발명의 명칭: 적응적 필터링 방법 및 장치

기술분야

[1] 본 발명은 비디오의 부호화 및 복호화에 관한 것으로, 특히 비디오 부호화 및 복호화시에 발생하는 블록킹 효과(blocking artifact)를 효과적으로 제거하기 위한 적응적 필터링 방법 및 장치에 관한 것이다.

배경기술

[2] 고해상도 또는 고화질 비디오 컨텐트를 재생, 저장할 수 있는 하드웨어의 개발 및 보급에 따라, 고해상도 또는 고화질 비디오 컨텐트를 효과적으로 부호화하거나 복호화하는 비디오 코덱의 필요성이 증대하고 있다. 기존의 비디오 코덱에 따르면, 비디오는 소정 크기의 매크로블록에 기반하여 제한된 부호화 방식에 따라 부호화되고 있다.

[3] 매크로 블록에 기초한 예측 부호화 방식은 블록들간 경계에서 픽셀값의 불연속으로 인해 블록킹 효과(blocking effect)를 유발할 수 있다. 따라서, 비디오 코덱에서는 비디오 압축률을 향상시키고 복원 영상의 화질을 향상시키기 위해 디블록킹 필터링을 수행한다.

발명의 상세한 설명

기술적 과제

[4] 본 발명이 해결하고자 하는 기술적 과제는 블록의 경계 영역에서 발생하는 블록킹 효과를 감소시키는 디블록킹 필터링을 수행하는 방법 및 장치를 제공하는 것이다.

과제 해결 수단

[5] 본 발명의 일 실시예에 따른 적응적 필터링 방법은 블록 경계 주변에 위치한 픽셀들의 픽셀값에 기초하여 획득된 파라메터에 기초하여 필터링 강도를 결정하여 필터링을 수행한다.

발명의 효과

[6] 본 발명의 실시예들에 따르면 압축된 후 복원되는 비디오로부터 블록킹 효과를 제거함으로써 비디오의 품질을 크게 개선할 수 있다.

도면의 간단한 설명

[7] 도 1은 본 발명의 디블록킹 필터링을 수행하는 비디오 부호화 장치의 블록도를 도시한다.

[8] 도 2은 본 발명의 일 실시예에 따른 디블록킹 필터링을 수행하는 비디오 복호화 장치의 블록도를 도시한다.

[9] 도 3은 본 발명의 일 실시예에 따른 부호화 단위의 개념을 도시한다.

[10] 도 4는 본 발명의 일 실시예에 따른 부호화 단위에 기초한 영상 부호화부의 블록도를 도시한다.

[11] 도 5는 본 발명의 일 실시예에 따른 부호화 단위에 기초한 영상 복호화부의 블록도를 도시한다.

[12] 도 6는 본 발명의 일 실시예에 따른 심도별 부호화 단위 및 예측 단위를 도시한다.

[13] 도 7은 본 발명의 일 실시예에 따른, 부호화 단위 및 변환 단위의 관계를 도시한다.

[14] 도 8은 본 발명의 일 실시예에 따라, 심도별 부호화 정보들을 도시한다.

[15] 도 9는 본 발명의 일 실시예에 따른 심도별 부호화 단위를 도시한다.

[16] 도 10, 11 및 12는 본 발명의 일 실시예에 따른, 부호화 단위, 예측 단위 및 주파수 변환 단위의 관계를 도시한다.

[17] 도 13은 표 1의 부호화 모드 정보에 따른 부호화 단위, 예측 단위 및 변환 단위의 관계를 도시한다.

[18] 도 14는 본 발명의 일 실시예에 따라, 최대 부호화 단위들, 각 최대 부호화 단위를 세분한 트리 구조에 따른 부호화 단위들, 각 부호화 단위를 세분한 예측 단위 및 변환 단위를 포함하는 데이터 단위들을 도시한다.

[19] 도 15 내지 도 17은, 각각 도 14의 데이터 단위들에 대해서 소정 크기 이상의 데이터 단위가 갖는 경계를 기초로 결정된 필터링 경계를 도시한다.

[20] 도 18은 본 발명의 일 실시예에 따른 적응적 필터링 장치의 구성을 나타낸 블록도이다.

[21] 도 19a 및 도 19b는 본 발명의 일 실시예에 따른 디블록킹 필터링을 설명하기 위한 필터링 경계에 위치한 픽셀들을 도시한 것이다.

[22] 도 20a 및 도 20b는 본 발명의 일 실시예에 따라서 블록 경계 주변의 픽셀들의 픽셀값들을 이용한 파라메터 획득 과정을 설명하기 위한 참조도이다.

[23] 도 21은 본 발명의 일 실시예에 따른 적응적 필터링 방법을 나타낸 플로우 차트이다.

[24] 도 22a 및 도 22b는 본 발명의 다른 실시예에 따른 적응적 필터링 방법을 설명하기 위한 참조도이다.

발명의 실시를 위한 최선의 형태

[25] 본 발명의 일 실시예에 따른 적응적 필터링 방법은 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득하는 단계; 상기 획득된 파라메타에 기초하여 상기 블록 경계에서의 필터링 강도를 결정하는 단계; 및 상기 결정된 필터링 강도에 기초하여 필터링을 수행하는 단계를 포함한다.

[26] 본 발명의 일 실시예에 따른 적응적 필터링 장치는 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득하는 파라메타 획득부; 상기 획득된 파라메타에 기초하여 상기 블록 경계에서의 필터링 강도를 결정하는 필터링 강도 결정부; 및

상기 결정된 필터링 강도에 기초하여 필터링을 수행하는 필터링 수행부를 포함한다.

[27] 본 발명의 일 실시예에 따른 적응적 필터링 방법은 수신된 비트스트림을 파싱하여, 현재 픽처가 분할된 최대 부호화 단위들 중 각각의 최대 부호화 단위에 포함되는 트리 구조에 따른 부호화 단위들에 따라, 부호화 단위별로 부호화된 영상 데이터, 상기 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보 및 상기 최대 부호화 단위의 디블록킹 필터링에 대한 정보를 추출하는 단계; 상기 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보에 기초하여, 상기 부호화 단위별로 예측 및 변환을 위한 예측 단위들 및 변환 단위들을 결정하고 부호화된 영상 데이터를 복호화하는 단계; 상기 디블록킹 필터링에 대한 정보를 이용하여, 상기 트리 구조에 따른 부호화 단위들, 상기 예측 단위들 및 변환 단위들 중 적어도 하나의 데이터 단위의 경계들 중 디블록킹 필터링을 수행할 필터링 경계를 결정하는 단계; 상기 결정된 필터링 경계를 기준으로 상기 필터링 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득하는 단계; 상기 획득된 파라메타에 기초하여 상기 블록 경계에서의 필터링 강도를 결정하는 단계; 및 상기 결정된 필터링 강도에 기초하여 필터링을 수행하는 단계를 포함한다.

발명의 실시를 위한 형태

[28] 도 1은 본 발명의 일 실시예에 따른 디블록킹 필터링을 수행하는 비디오 부호화 장치의 블록도를 도시한다.

[29] 일 실시예에 따른 디블록킹을 수행하는 비디오 부호화 장치(100)(이하, '비디오 부호화 장치(100)'이라 한다.)는, 부호화 단위 결정부(110), 디블록킹 필터링부(130) 및 전송부(120)를 포함한다.

[30] 일 실시예에 따른 부호화 단위 결정부(110)는, 비디오의 하나의 픽처의 영상 데이터를 입력받아, 최대 크기의 데이터 단위인 최대 부호화 단위로 분할한다. 일 실시예에 따른 최대 부호화 단위는 크기 32x32, 64x64, 128x128, 256x256 등의 데이터 단위로, 가로 및 세로 크기가 8보다 큰 2의 자승인 정사각형의 데이터 단위일 수 있다.

[31] 일 실시예에 따른 부호화 단위 결정부(110)는, 각각의 최대 부호화 단위마다, 공간적으로 분할된 영역별로 계층적 구조의 부호화 단위들을 결정한다. 최대 부호화 단위의 계층적 구조의 부호화 단위들은, 최대 부호화 단위의 공간적 분할 횟수를 나타내는 심도에 기초하여 표현된다. 바람직하게는, 트리 구조에 따른 부호화 단위들은, 최대 부호화 단위에 포함되는 모든 심도별 부호화 단위들 중, 부호화 심도로 결정된 심도의 부호화 단위들을 포함한다. 부호화 심도의 부호화 단위는, 최대 부호화 단위 내에서 동일 영역에서는 심도에 따라 계층적으로 결정되고, 다른 영역들에 대해서는 독립적으로 결정될 수 있다.

[32] 일 실시예에 따른 부호화 단위 결정부(110)는, 현재 최대 부호화 단위에 포함되는 심도별 부호화 단위들을 각각 부호화하고, 영역별로 상위 심도 및 하위 심도의 부호화 단위에 대한 부호화 결과를 비교하여 최적의 부호화 결과를 출력하는 부호화 단위 및 해당 심도인 부호화 심도를 결정할 수 있다. 또한, 현재 영역에 대한 부호화 심도는, 다른 영역에 대한 부호화 심도와 독립적으로 결정될 수 있다.

[33] 따라서 일 실시예에 따른 부호화 단위 결정부(110)는, 최대 부호화 단위마다, 영역별로 독립적으로 결정된 부호화 심도의 부호화 단위들로 구성된 트리 구조에 따른 부호화 단위들을 결정할 수 있다. 또한 일 실시예에 따른 부호화 단위 결정부(110)는, 부호화 심도의 부호화 단위를 결정하는 과정에서 예측 부호화를 수행한다. 일 실시예에 따른 부호화 단위 결정부(110)는, 부호화 심도의 부호화 단위가 최적의 부호화 결과를 출력하기 위한 예측 부호화가 수행되는 데이터 단위인 예측 단위 또는 파티션을 결정할 수 있다. 예를 들어 크기 2N x 2N의 부호화 단위에 대한 파티션 타입은, 크기 2N x 2N, 2N x N, N x 2N 및 N x N의 파티션들을 포함할 수 있다. 일 실시예에 따른 파티션 타입은 부호화 단위의 높이 또는 너비가 대칭적 비율로 분할된 대칭적 파티션들뿐만 아니라, 1:n 또는 n:1과 같이 비대칭적 비율로 분할된 파티션들, 기하학적인 형태로 분할된 파티션들, 임의적 형태의 파티션들 등을 선택적으로 포함할 수도 있다. 또한 파티션 타입의 예측 모드는, 인터 모드, 인트라 모드, 스킵 모드 등을 포함할 수 있다.

[34] 일 실시예에 따른 부호화 단위는 최대 크기 및 심도로 특징지어질 수 있다. 심도란 부호화 단위가 최대 부호화 단위로부터 계층적으로 분할되는 횟수에 따르는 지표이며, 심도가 깊어질수록 심도별 부호화 단위는 최대 부호화 단위로부터 최소 부호화 단위까지 분할될 수 있다. 최대 부호화 단위의 심도가 최상위 심도이며 최소 부호화 단위가 최하위 부호화 단위로 정의될 수 있다. 최대 부호화 단위는 심도가 깊어짐에 따라 심도별 부호화 단위의 크기는 감소하므로, 상위 심도의 부호화 단위는 복수 개의 하위 심도의 부호화 단위를 포함할 수 있다.

[35] 일 실시예에 따른 최대 심도는 최대 부호화 단위로부터 최소 부호화 단위까지의 분할 횟수와 관련된 지표이다. 일 실시예에 따른 제 1 최대 심도는, 최대 부호화 단위로부터 최소 부호화 단위까지의 총 분할 횟수를 나타낼 수 있다. 일 실시예에 따른 제 2 최대 심도는 최대 부호화 단위로부터 최소 부호화 단위까지의 심도 레벨의 총 개수를 나타낼 수 있다. 예를 들어, 최대 부호화 단위의 심도가 0이라고 할 때, 최대 부호화 단위가 1회 분할된 부호화 단위의 심도는 1로 설정되고, 2회 분할된 부호화 단위의 심도가 2로 설정될 수 있다. 이 경우, 최대 부호화 단위로부터 4회 분할된 부호화 단위가 최소 부호화 단위라면, 심도 0, 1, 2, 3 및 4의 심도 레벨이 존재하므로 제 1 최대 심도는 4, 제 2 최대 심도는 5로 설정될 수 있다.

[36] 일 실시예에 따른 최대 부호화 단위의 트리 구조에 따른 부호화 단위 및 파티션의 결정 방식에 대해서는, 도 3 내지 13을 참조하여 상세히 후술한다.

[37] 일 실시예에 따른 디블록킹 필터링부(130)는 부호화 단위들, 예측 단위들 및 변환 단위들 중 적어도 하나의 데이터 단위에 기초하여 디블록킹 필터링을 수행할 필터링 경계를 결정하고, 결정된 필터링 경계에 인접한 픽셀들의 픽셀값들에 기초하여 필터링 경계에서의 필터링 강도를 결정하며, 결정된 필터링 강도에 기초하여 디블록킹 필터링을 수행한다. 예를 들어, 디블록킹 필터링부(130)는 후술되는 바와 같이 부호화 단위, 예측 단위 및 변환 단위가 결정되면, 이들 부호화 단위, 예측 단위 및 변환 단위의 크기 등을 기준으로 소정 크기 이상을 갖는 데이터 단위의 경계를 디블록킹 필터링을 수행할 필터링 경계로 결정하고, 필터링 경계에 인접한 픽셀값들에 대한 디블록킹 필터링을 수행할 수 있다..

[38] 일 실시예에 따른 전송부(120)는, 디블록킹 필터링부(130)에 의해 결정된 디블록킹 필터링에 대한 정보를 부호화하여, 픽처의 부호화된 데이터 및 최대 부호화 단위의 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보와 함께 전송할 수 있다. 디블록킹 필터링에 대한 정보는, 트리 구조에 따른 부호화 단위, 예측 단위 및 변환 단위 등의 데이터 단위가 갖는 경계들 중 디블록킹 필터링이 수행되는 데이터 단위를 결정하기 위한 데이터 단위 크기와 같은 필터링 경계 결정 정보를 포함할 수 있다.

[39] 일 실시예에 따른 전송부(120)는, 디블록킹 필터링에 대한 정보를 픽처의 SPS(Sequence Parameter Set) 또는 PPS(Picture Parameter Set)에 삽입하여 전송할 수 있다.

[40] 일 실시예에 따른 디블록킹 필터링을 위한 필터링 경계의 결정 및 디블록킹 필터링 과정에 대해서는, 도 14 내지 도 22를 참조하여 후술한다.

[41] 일 실시예에 따른 부호화 단위 결정부(110)는 현재 픽처의 특성을 고려하여 결정된 최대 부호화 단위의 크기 및 최대 심도를 기반으로, 각각의 최대 부호화 단위마다 최적의 형태 및 크기의 부호화 단위를 결정할 수 있다. 또한, 각각의 최대 부호화 단위마다 다양한 예측 모드, 주파수 변환 방식을 적용하여 부호화를 수행할 수 있으므로, 다양한 영상 크기의 부호화 단위의 영상 특성을 고려한 최적의 부호화 모드가 결정될 수 있다.

[42] 영상의 해상도가 매우 높거나 데이터량이 매우 큰 영상을 크기가 16x16 또는 8x8로 고정되어 있는 기존 매크로블록 단위로 부호화한다면, 픽처당 매크로블록의 수가 과도하게 많아진다. 이에 따라, 매크로블록마다 생성되는 압축 정보도 많아지므로 압축 정보의 전송 부담이 커지고 데이터 압축 효율이 감소하는 경향이 있다. 따라서, 일 실시예에 따른 부호화 단위 결정부(110)는, 영상의 크기를 고려하여 부호화 단위의 최대 크기를 증가시키면서, 영상 특성을 고려하여 부호화 단위를 조절할 수 있으므로, 비디오에 대한 최종적인 압축 효율이 증대될 수 있다.

[43] 또한, 일 실시예에 따른 트리 구조에 따른 부호화 단위에 기반한 디블록킹 필터링을 통해, 디블록킹 필터링이 수행된 참조 픽처를 이용함으로써 원본 픽처와의 오차를 감소시키는 예측 부호화가 수행될 수 있다.

[44] 도 2는 일 실시예에 따른 트리 구조에 따른 부호화 단위에 기반한 디블록킹 필터링을 수행하는 비디오 복호화 장치의 블록도를 도시한다.

[45] 일 실시예에 따른 트리 구조에 따른 부호화 단위에 기반한 디블록킹 필터링을 수행하는 비디오 복호화 장치(200)(이하, '비디오 복호화 장치(200)'이라 한다)는, 수신 및 추출부(210), 복호화부(220) 및 디블록킹 필터링부(230)를 포함한다.

[46] 일 실시예에 따른 수신 및 추출부(210)는, 비디오에 대한 비트스트림을 수신하고 파싱하여, 최대 부호화 단위별로, 트리 구조에 따른 부호화 단위들에 따라 부호화 단위별로 부호화된 영상 데이터, 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보 및 디블록킹 필터링에 대한 정보를 추출한다. 일 실시예에 따른 수신 및 추출부(210)는, 디블록킹 필터링에 대한 정보를 픽처의 SPS 또는 PPS로부터 추출할 수도 있다.

[47] 일 실시예에 따른 복호화부(220)는, 수신 및 추출부(210)에 의해 추출된 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보에 기초하여, 부호화 단위별로 부호화된 영상 데이터를 복호화한다.

[48] 일 실시예에 따른 복호화부(220)는, 최대 부호화 단위별 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보에 기초하여, 최대 부호화 단위 내에 포함되는 부호화 심도의 부호화 단위 및 해당 부호화 단위의 파티션 타입, 예측 모드, 변환 단위 등을 결정할 수 있다.

[49] 일 실시예에 따른 복호화부(220)는, 최대 부호화 단위에 포함되는 트리 구조에 따른 부호화 단위들 가운데 각각의 부호화 단위마다, 결정된 파티션 타입, 예측 모드, 변환 단위에 기초하여 부호화된 영상 데이터를 복호화함으로써, 최대 부호화 단위의 부호화된 영상 데이터를 복호화할 수 있다.

[50] 복호화부(220)에 의해 복호화된 영상 데이터 및, 수신 및 추출부(210)에 의해 추출된 디블록킹 필터링에 대한 정보가 일 실시예에 따른 디블록킹 필터링부(230)에 입력된다.

[51] 일 실시예에 따른 디블록킹 필터링부(230)는 디블록킹 필터링에 대한 정보를 이용하여, 트리 구조에 따른 부호화 단위들, 예측 단위들 및 변환 단위들 중 적어도 하나의 데이터 단위의 경계들 중 디블록킹 필터링을 수행할 필터링 경계를 결정하고, 결정된 필터링 경계를 기준으로 필터링 경계에 인접한 픽셀들의 픽셀값들에 기초하여 필터링 경계에서의 필터링 강도를 결정하며, 결정된 필터링 강도에 기초하여 복호화된 영상 데이터에 대해 디블록킹 필터링을 수행한다.

[52] 일 실시예에 따른 디블록킹 필터링부(230)를 통해 디블록킹필터링이 수행된 참조 픽처를 참조하여, 다음 픽처에 대한 예측 복호화가 수행되므로, 복원 영상과 원본 영상 간의 오차가 감소될 수 있다.

[53] 도 3은 본 발명의 일 실시예에 따른 부호화 단위의 개념을 도시한다.

[54] 부호화 단위의 예는, 부호화 단위의 크기는 너비x높이로 표현되며, 크기 64x64인 부호화 단위부터, 32x32, 16x16, 8x8를 포함할 수 있다. 크기 64x64의 부호화 단위는 크기 64x64, 64x32, 32x64, 32x32의 예측 단위들로 분할될 수 있고, 크기 32x32의 부호화 단위는 크기 32x32, 32x16, 16x32, 16x16의 예측 단위들로, 크기 16x16의 부호화 단위는 크기 16x16, 16x8, 8x16, 8x8의 예측 단위들로, 크기 8x8의 부호화 단위는 크기 8x8, 8x4, 4x8, 4x4의 예측 단위들로 분할될 수 있다.

[55] 비디오 데이터(310)에 대해서는, 해상도는 1920x1080, 부호화 단위의 최대 크기는 64, 최대 심도가 2로 설정되어 있다. 비디오 데이터(320)에 대해서는, 해상도는 1920x1080, 부호화 단위의 최대 크기는 64, 최대 심도가 3로 설정되어 있다. 비디오 데이터(330)에 대해서는, 해상도는 352x288, 부호화 단위의 최대 크기는 16, 최대 심도가 1로 설정되어 있다. 도 3에 도시된 최대 심도는, 최대 부호화 단위로부터 최소 부호화 단위까지의 총 분할 횟수를 나타낸다.

[56] 해상도가 높거나 데이터량이 많은 경우 부호화 효율의 향상 뿐만 아니라 영상 특성을 정확히 반영하기 위해 부호화 사이즈의 최대 크기가 상대적으로 큰 것이 바람직하다. 따라서, 비디오 데이터(330)에 비해, 해상도가 높은 비디오 데이터(310, 320)는 부호화 사이즈의 최대 크기가 64로 선택될 수 있다.

[57] 비디오 데이터(310)의 최대 심도는 2이므로, 비디오 데이터(310)의 부호화 단위(315)는 장축 크기가 64인 최대 부호화 단위로부터, 2회 분할되어 심도가 두 계층 깊어져서 장축 크기가 32, 16인 부호화 단위들까지 포함할 수 있다. 또한, 비디오 데이터(330)의 최대 심도는 1이므로, 비디오 데이터(330)의 부호화 단위(335)는 장축 크기가 16인 부호화 단위들로부터, 1회 분할되어 심도가 한 계층 깊어져서 장축 크기가 8인 부호화 단위들까지 포함할 수 있다.

[58] 비디오 데이터(320)의 최대 심도는 3이므로, 비디오 데이터(320)의 부호화 단위(325)는 장축 크기가 64인 최대 부호화 단위로부터, 3회 분할되어 심도가 세 계층 깊어져서 장축 크기가 32, 16, 8인 부호화 단위들까지 포함할 수 있다. 심도가 깊어질수록 세부 정보의 표현능력이 향상될 수 있다.

[59] 도 4는 본 발명의 일 실시예에 따른 부호화 단위에 기초한 영상 부호화부의 블록도를 도시한다.

[60] 일 실시예에 따른 영상 부호화부(400)는, 일 실시예에 따른 비디오 부호화 장치(100)에 대응될 수 있다. 인트라 예측부(410)는 현재 프레임(405) 중 인트라 모드의 부호화 단위에 대해 인트라 예측을 수행하고, 움직임 추정부(420) 및 움직임 보상부(425)는 인터 모드의 현재 프레임(405) 및 참조 프레임(495)를 이용하여 인터 추정 및 움직임 보상을 수행한다.

[61] 인트라 예측부(410), 움직임 추정부(420) 및 움직임 보상부(425)로부터 출력된 데이터는 주파수변환부(430) 및 양자화부(440)를 거쳐 양자화된 변환 계수로 출력된다. 양자화된 변환 계수는 역양자화부(460), 역주파수변환부(470)을 통해 공간 영역의 데이터로 복원되고, 복원된 공간 영역의 데이터는 디블록킹부(480)

및 루프 필터링부(490)를 거쳐 후처리되어 참조 프레임(495)으로 출력된다. 양자화된 변환 계수는 엔트로피 부호화부(450)를 거쳐 비트스트림(455)으로 출력될 수 있다.

[62] 일 실시예에 따른 영상 부호화부(400)의 인트라 예측부(410), 움직임 추정부(420), 움직임 보상부(425), 주파수변환부(430) 및 양자화부(440), 역양자화부(460), 역주파수변환부(470), 디블록킹부(480) 및 루프 필터링부(490)는 최대 부호화 단위별로 트리 구조에 따른 부호화 단위들을 고려하여 동작할 수 있다.

[63] 특히, 디블록킹 필터링부(480)는 부호화 단위의 최대 크기 및 트리 구조에 따른 부호화 단위들에 기초하여 디블록킹 필터링을 수행할 필터링 경계를 결정하고, 결정된 필터링 경계를 기준으로 인접한 픽셀들의 픽셀값들에 기초하여 필터링 경계에서의 필터링 강도를 결정하며, 결정된 필터링 강도에 기초하여 디블록킹 필터링을 수행한다.

[64] 도 5는 본 발명의 일 실시예에 따른 부호화 단위에 기초한 영상 복호화부의 블록도를 도시한다.

[65] 비트스트림(505)이 파싱부(510)를 거쳐 복호화 대상인 부호화된 비디오 데이터 및 복호화를 위해 필요한 부호화에 관한 정보가 파싱된다. 부호화된 비디오 데이터는 엔트로피 복호화부(520) 및 역양자화부(530)를 거쳐 역양자화된 데이터로 출력되고, 역주파수변환부(540)를 거쳐 공간 영역의 영상 데이터가 복원된다.

[66] 공간 영역의 영상 데이터에 대해서, 인트라 예측부(550)는 인트라 모드의 부호화 단위에 대해 인트라 예측을 수행하고, 움직임 보상부(560)는 참조 프레임(585)를 함께 이용하여 인터 모드의 부호화 단위에 대해 움직임 보상을 수행한다.

[67] 인트라 예측부(550) 및 움직임 보상부(560)를 거친 공간 영역의 데이터는 디블록킹부(570) 및 루프 필터링부(580)를 거쳐 후처리되어 복원 프레임(595)으로 출력될 수 있다. 또한, 디블록킹부(570) 및 루프 필터링부(580)를 거쳐 후처리된 데이터는 참조 프레임(585)으로서 출력될 수 있다.

[68] 일 실시예에 따른 비디오 복호화 장치(200)의 복호화부(220)에서 영상 데이터를 복호화하기 위해, 일 실시예에 따른 영상 복호화부(500)의 파싱부(510) 이후의 단계별 동작들이 수행될 수 있다.

[69] 일 실시예에 따른 영상 복호화부(500)는 일 실시예에 따른 비디오 복호화 장치(200)에 상응하므로, 영상 복호화부(500)의 파싱부(510), 엔트로피 복호화부(520), 역양자화부(530), 역주파수변환부(540), 인트라 예측부(550), 움직임 보상부(560), 디블록킹부(570) 및 루프 필터링부(580)가, 최대 부호화 단위마다 트리 구조에 따른 부호화 단위들에 기반하여 작업을 수행하여야 한다.

[70] 특히, 디블록킹부(570)는 파싱된 디블록킹 필터링에 대한 정보를 이용하여,

트리 구조에 따른 부호화 단위들, 예측 단위들 및 변환 단위들 중 적어도 하나의 데이터 단위의 경계들 중 디블록킹 필터링을 수행할 필터링 경계를 결정하고, 결정된 필터링 경계를 기준으로 인접한 픽셀들의 픽셀값들에 기초하여 필터링 경계에서의 필터링 강도를 결정하며, 결정된 필터링 강도에 기초하여 복호화된 영상 데이터에 대해 디블록킹 필터링을 수행한다. 디블록킹 필터링에 관한 구체적인 동작은 도 14 이하에서 후술한다.

[71] 도 6은 본 발명의 일 실시예에 따른 심도별 부호화 단위 및 예측 단위를 도시한다.

[72] 일 실시예에 따른 비디오 부호화 장치(100) 및 일 실시예에 따른 비디오 복호화 장치(100)는 영상 특성을 고려하기 위해 영역별로 독립적으로 결정된 트리 구조에 따른 부호화 단위를 사용한다. 부호화 단위의 최대 높이 및 너비, 최대 심도는 영상의 특성에 따라 적응적으로 결정될 수도 있으며, 사용자의 요구에 따라 다양하게 설정될 수도 있다. 미리 설정된 부호화 단위의 최대 크기에 따라, 심도별 부호화 단위의 크기가 결정될 수 있다.

[73] 일 실시예에 따른 부호화 단위의 계층 구조(600)는 부호화 단위의 최대 높이 및 너비가 64이며, 최대 심도가 5인 경우를 도시하고 있다. 도 6에 도시된 최대 심도는, 최대 부호화 단위로부터 최소 부호화 단위까지의 심도 레벨의 총 개수를 나타낸다.

[74] 일 실시예에 따른 부호화 단위의 계층 구조(600)의 세로축을 따라서 심도가 깊어지므로 심도별 부호화 단위의 높이 및 너비가 각각 분할한다. 또한, 부호화 단위의 계층 구조(600)의 가로축을 따라, 각각의 심도별 부호화 단위의 예측 부호화의 기반이 되는 부분적 데이터 단위인 예측 단위(또는 파티션)가 도시되어 있다.

[75] 즉, 부호화 단위(610)는 부호화 단위의 계층 구조(600) 중 최대 부호화 단위로서 심도가 0이며, 부호화 단위의 크기, 즉 높이 및 너비가 64x64이다. 세로축을 따라 심도가 깊어지며, 크기 32x32인 심도 1의 부호화 단위(620), 크기 16x16인 심도 2의 부호화 단위(630), 크기 8x8인 심도 3의 부호화 단위(640), 크기 4x4인 심도 4의 부호화 단위(650)가 존재한다. 크기 4x4인 심도 4의 부호화 단위(650)는 최소 부호화 단위이다.

[76] 각각의 심도별로 가로축을 따라, 부호화 단위의 예측 단위로서, 파티션들이 배열된다. 즉, 심도 0의 크기 64x64의 부호화 단위(610)의 예측 단위는, 크기 64x64의 부호화 단위(610)에 포함되는 크기 64x64의 파티션(610), 크기 64x32의 파티션들(612), 크기 32x64의 파티션들(614), 크기 32x32의 파티션들(616)일 수 있다. 반대로 보면, 부호화 단위는 예측 단위들(610, 612, 614, 616)을 포함하는 최소 크기의 정사각형의 데이터 단위일 수 있다.

[77] 마찬가지로, 심도 1의 크기 32x32의 부호화 단위(620)의 예측 단위는, 크기 32x32의 부호화 단위(620)에 포함되는 크기 32x32의 파티션(620), 크기 32x16의 파티션들(622), 크기 16x32의 파티션들(624), 크기 16x16의 파티션들(626)일 수

있다.

[78] 마찬가지로, 심도 2의 크기 16x16의 부호화 단위(630)의 예측 단위는, 크기 16x16의 부호화 단위(630)에 포함되는 크기 16x16의 파티션(630), 크기 16x8의 파티션들(632), 크기 8x16의 파티션들(634), 크기 8x8의 파티션들(636)일 수 있다.

[79] 마찬가지로, 심도 3의 크기 8x8의 부호화 단위(640)의 예측 단위는, 크기 8x8의 부호화 단위(640)에 포함되는 크기 8x8의 파티션(640), 크기 8x4의 파티션들(642), 크기 4x8의 파티션들(644), 크기 4x4의 파티션들(646)일 수 있다.

[80] 마지막으로, 심도 4의 크기 4x4의 부호화 단위(650)는 최소 부호화 단위이며 최하위 심도의 부호화 단위이고, 크기 4x4의 부호화 단위(650)의 예측 단위는, 크기 4x4의 파티션(650), 크기 4x2의 파티션들(652), 크기 2x4의 파티션들(654), 크기 2x2의 파티션들(656)일 수 있다.

[81] 일 실시예에 따른 비디오 부호화 장치(100)의 부호화 단위 결정부(110)는, 최대 부호화 단위(610)의 부호화 심도를 결정하기 위해, 최대 부호화 단위(610)에 포함되는 각각의 심도의 부호화 단위마다 부호화를 수행하여야 한다.

[82] 동일한 범위 및 크기의 데이터를 포함하기 위한 심도별 부호화 단위의 개수는, 심도가 깊어질수록 증가한다. 예를 들어, 심도 1의 부호화 단위 한 개가 포함하는 데이터에, 심도 2의 부호화 단위는 네 개가 포함된다. 따라서, 동일한 데이터의 부호화 결과를 심도별로 비교하기 위해서, 한 개의 심도 1의 부호화 단위 및 네 개의 심도 2의 부호화 단위를 이용하여 각각 부호화되어야 한다.

[83] 각각의 심도별 부호화를 위해서는, 부호화 단위의 계층 구조(600)의 가로축을 따라, 심도별 부호화 단위의 예측 단위들마다 부호화를 수행하여, 해당 심도에서 가장 작은 부호화 오차인 대표 부호화 오차가 선택될 수 있다. 또한, 부호화 단위의 계층 구조(600)의 세로축을 따라 심도가 깊어지며, 각각의 심도마다 부호화를 수행하여, 심도별 대표 부호화 오차를 비교하여 최소 부호화 오차가 검색될 수 있다. 최대 부호화 단위(610) 중 최소 부호화 오차가 발생하는 심도 및 예측 단위가 최대 부호화 단위(610)의 부호화 심도 및 파티션 타입으로 선택될 수 있다.

[84] 도 7은 본 발명의 일 실시예에 따른, 부호화 단위 및 변환 단위의 관계를 도시한다.

[85] 일 실시예에 따른 비디오 부호화 장치(100) 또는 일 실시예에 따른 비디오 복호화 장치(200)는, 최대 부호화 단위마다 최대 부호화 단위보다 작거나 같은 크기의 부호화 단위로 영상을 부호화하거나 복호화한다. 부호화 과정 중 주파수변환을 위한 변환 단위의 크기는 각각의 부호화 단위보다 크지 않은 데이터 단위를 기반으로 선택될 수 있다.

[86] 예를 들어, 일 실시예에 따른 비디오 부호화 장치(100) 또는 일 실시예에 따른 비디오 복호화 장치(200)에서, 현재 부호화 단위(710)가 64x64 크기일 때, 32x32 크기의 변환 단위(720)를 이용하여 주파수변환이 수행될 수 있다.

[87] 또한, 64x64 크기의 부호화 단위(710)의 데이터를 64x64 크기 이하의 32x32,

16x16, 8x8, 4x4 크기의 변환 단위들로 각각 주파수변환을 수행하여 부호화한 후, 원본과의 오차가 가장 적은 변환 단위가 선택될 수 있다.

[88] 도 8은 본 발명의 일 실시예에 따라, 심도별 부호화 모드 정보들을 도시한다.

[89] 일 실시예에 따른 비디오 부호화 장치(100)는 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보로서, 각각의 부호화 심도의 부호화 단위마다 파티션 타입에 관한 정보(800), 예측 모드에 관한 정보(810), 변환 단위 크기에 대한 정보(820)를 부호화하여 전송할 수 있다.

[90] 파티션 타입에 대한 정보(800)는, 현재 부호화 단위의 예측 부호화를 위해 예측 단위(파티션)로서, 현재 부호화 단위가 분할된 타입에 대한 정보를 나타낸다. 예를 들어, 심도 0 및 크기 2Nx2N의 현재 부호화 단위 CU_0는, 크기 2Nx2N의 예측 단위(802), 크기 2NxN의 예측 단위(804), 크기 Nx2N의 예측 단위(806), 크기 NxN의 예측 단위(808) 중 어느 하나의 타입으로 분할되어 예측 단위로 이용될 수 있다. 이 경우 현재 부호화 단위의 파티션 타입에 관한 정보(800)는 크기 2Nx2N의 예측 단위(802), 크기 2NxN의 예측 단위(804), 크기 Nx2N의 예측 단위(806) 및 크기 NxN의 예측 단위(808) 중 하나를 나타내도록 설정된다.

[91] 예측 모드에 관한 정보(810)는, 각각의 예측 단위의 예측 모드를 나타낸다. 예를 들어 예측 모드에 관한 정보(810)를 통해, 파티션 타입에 관한 정보(800)가 가리키는 예측 단위가 인트라 모드(812), 인터 모드(814) 및 스킵 모드(816) 중 하나로 예측 부호화가 수행되는지 여부가 설정될 수 있다.

[92] 또한, 변환 단위 크기에 관한 정보(820)는 현재 부호화 단위를 어떠한 변환 단위를 기반으로 주파수변환을 수행할지 여부를 나타낸다. 예를 들어, 변환 단위는 인트라 모드의 제 1 크기(822) 및 제 2 크기(824), 인터 모드의 제 1 크기(826) 및 제 2 크기(828) 중 하나일 수 있다.

[93] 일 실시예에 따른 비디오 복호화 장치(200)의 수신 및 추출부(210)는, 각각의 심도별 부호화 단위마다 파티션 타입에 관한 정보(800), 예측 모드에 관한 정보(810), 변환 단위 크기에 대한 정보(820)를 추출하고, 복호화부(220)가 이 정보(800, 810, 820)를 복호화에 이용할 수 있다.

[94] 도 9는 본 발명의 일 실시예에 따른 심도별 부호화 단위를 도시한다.

[95] 심도의 변화를 나타내기 위해 분할 정보가 이용될 수 있다. 분할 정보는 현재 심도의 부호화 단위가 하위 심도의 부호화 단위로 분할될지 여부를 나타낸다.

[96] 심도 0 및 2N_0x2N_0 크기의 부호화 단위(900)의 예측 부호화를 위한 예측 단위(910)는 2N_0x2N_0 크기의 파티션 타입(912), 2N_0xN_0 크기의 파티션 타입(914), N_0x2N_0 크기의 파티션 타입(916), N_0xN_0 크기의 파티션 타입(918)을 포함할 수 있다. 부호화 단위가 대칭적 비율로 분할된 파티션들(912, 914, 916, 918)만이 예시되어 있지만, 전술한 바와 같이 파티션 타입은 이에 한정되는 것은 아니다.

[97] 파티션 타입마다, 한 개의 2N_0x2N_0 크기의 예측 단위, 두 개의 2N_0xN_0 크기의 예측 단위, 두 개의 N_0x2N_0 크기의 예측 단위, 네 개의 N_0xN_0 크기의

예측 단위마다 반복적으로 예측 부호화가 수행되어야 한다. 크기 2N_0x2N_0, 크기 N_0x2N_0 및 크기 2N_0xN_0 및 크기 N_0xN_0의 예측 단위에 대해서는, 인트라 모드 및 인터 모드로 예측 부호화가 수행될 수 있다. 스킵 모드는 크기 2N_0x2N_0의 예측 단위에 예측 부호화가 대해서만 수행될 수 있다.

[98] 크기 2N_0x2N_0, 2N_0xN_0 및 N_0x2N_0의 파티션 타입(912, 914, 916) 중 하나에 의한 부호화 오차가 가장 작다면, 더 이상 하위 심도로 분할할 필요 없다.

[99] 크기 N_0xN_0의 파티션 타입(918)에 의한 부호화 오차가 가장 작다면, 심도 0를 1로 변경하며 분할하고(920), 심도 2 및 크기 N_0xN_0의 파티션 타입의 부호화 단위들(930)에 대해 반복적으로 부호화를 수행하여 최소 부호화 오차를 검색해 나갈 수 있다.

[100] 심도 1 및 크기 2N_1x2N_1 (=N_0xN_0)의 부호화 단위(930)의 예측 부호화를 위한 예측 단위(940)는, 크기 2N_1x2N_1의 파티션 타입(942), 크기 2N_1xN_1의 파티션 타입(944), 크기 N_1x2N_1의 파티션 타입(946), 크기 N_1xN_1의 파티션 타입(948)을 포함할 수 있다. 또한, 크기 N_1xN_1 크기의 파티션 타입(948)에 의한 부호화 오차가 가장 작다면, 심도 1을 심도 2로 변경하며 분할하고(950), 심도 2 및 크기 N_2xN_2의 부호화 단위들(960)에 대해 반복적으로 부호화를 수행하여 최소 부호화 오차를 검색해 나갈 수 있다.

[101] 최대 심도가 d인 경우, 심도별 부호화 단위는 심도 d-1일 때까지 설정되고, 분할 정보는 심도 d-2까지 설정될 수 있다. 즉, 심도 d-2로부터 분할(970)되어 심도 d-1까지 부호화가 수행될 경우, 심도 d-1 및 크기 2N_(d-1)x2N_(d-1)의 부호화 단위(980)의 예측 부호화를 위한 예측 단위(990)는, 크기 2N_(d-1)x2N_(d-1)의 파티션 타입(992), 크기 2N_(d-1)xN_(d-1)의 파티션 타입(994), 크기 N_(d-1)x2N_(d-1)의 파티션 타입(996), 크기 N_(d-1)xN_(d-1)의 파티션 타입(998)을 포함할 수 있다.

[102] 파티션 타입 중, 한 개의 크기 2N_(d-1)x2N_(d-1)의 예측 단위, 두 개의 크기 2N_(d-1)xN_(d-1)의 예측 단위, 두 개의 크기 N_(d-1)x2N_(d-1)의 예측 단위, 네 개의 크기 N_(d-1)xN_(d-1)의 예측 단위마다 반복적으로 예측 부호화를 통한 부호화가 수행되어, 최소 부호화 오차가 발생하는 파티션 타입이 검색될 수 있다.

[103] 크기 N_(d-1)xN_(d-1)의 파티션 타입(998)에 의한 부호화 오차가 가장 작더라도, 최대 심도가 d이므로, 심도 d-1의 부호화 단위 CU_(d-1)는 더 이상 하위 심도로의 분할 과정을 거치지 않으며, 현재 최대 부호화 단위(900)에 대한 부호화 심도가 심도 d-1로 결정되고, 파티션 타입은 N_(d-1)xN_(d-1)로 결정될 수 있다. 또한 최대 심도가 d이므로, 심도 d-1의 부호화 단위(952)에 대해 분할 정보는 설정되지 않는다.

[104] 데이터 단위(999)은, 현재 최대 부호화 단위에 대한 '최소 단위'라 지칭될 수 있다. 일 실시예에 따른 최소 단위는, 최하위 부호화 심도인 최소 부호화 단위가 4분할된 크기의 정사각형의 데이터 단위이며, 최대 부호화 단위에 포함되는

모든 부호화 심도의 부호화 단위, 예측 단위 및 변환 단위에 포함될 수 있는 최대 크기의 정사각 데이터 단위일 수 있다. 이러한 반복적 부호화 과정을 통해, 일 실시예에 따른 비디오 부호화 장치(100)는 부호화 단위(900)의 심도별 부호화 오차를 비교하여 가장 작은 부호화 오차가 발생하는 심도를 선택하여, 부호화 심도를 결정하고, 해당 파티션 타입 및 예측 모드가 부호화 심도의 부호화 모드로 설정될 수 있다.

[105] 이런 식으로 심도 0, 1, ..., d-1, d의 모든 심도별 최소 부호화 오차를 비교하여 오차가 가장 작은 심도가 선택되어 부호화 심도로 결정될 수 있다. 부호화 심도 및 해당 심도의 예측 단위는 부호화 모드에 관한 정보로써 부호화되어 전송될 수 있다. 또한, 심도 0으로부터 부호화 심도에 이르기까지 부호화 단위가 분할되어야 하므로, 부호화 심도의 분할 정보만이 '0'으로 설정되고, 부호화 심도를 제외한 심도별 분할 정보는 '1'로 설정되어야 한다.

[106] 일 실시예에 따른 비디오 복호화 장치(200)의 수신 및 추출부(210)는 부호화 단위(900)에 대한 부호화 심도 및 예측 단위에 관한 정보를 추출하여 부호화 단위(900)를 복호화하는데 이용할 수 있다. 일 실시예에 따른 비디오 복호화 장치(200)는 심도별 분할 정보를 이용하여 분할 정보가 '0'인 심도를 부호화 심도로 파악하고, 해당 심도에 대한 부호화 모드에 관한 정보를 이용하여 해당 부호화 단위의 부호화된 데이터를 복호화할 수 있다.

[107] 도 10, 11 및 12는 본 발명의 일 실시예에 따른, 부호화 단위, 예측 단위 및 주파수 변환 단위의 관계를 도시한다.

[108] 부호화 단위 그룹(1010)은, 현재 최대 부호화 단위에 대해 일 실시예에 따른 비디오 부호화 장치(100)가 결정한 트리 구조에 따른 부호화 단위들이다. 예측 단위 그룹(1060)은 부호화 단위 그룹(1010) 중 각각의 부호화 심도의 부호화 단위의 예측 단위들이며, 변환 단위 그룹(1070)은 각각의 부호화 심도별 부호화 단위의 변환 단위들이다.

[109] 부호화 단위 그룹(1010)은 최대 부호화 단위의 심도가 0이라고 하면, 심도 1의 부호화 단위들(1012, 1054), 심도 2의 부호화 단위들(1014, 1016, 1018, 1028, 1050, 1052), 심도 3의 부호화 단위들(1020, 1022, 1024, 1026, 1030, 1032, 1048), 심도 4의 부호화 단위들(1040, 1042, 1044, 1046)를 포함한다.

[110] 예측 단위들(1060) 중 일부(1014, 1016, 1022, 1032, 1048, 1050, 1052, 1054)는 각각의 부호화 단위가 분할된 타입이다. 즉, 예측 단위(1014, 1022, 1050, 1054)는 2NxN의 파티션 타입이며, 예측 단위(1016, 1048, 1052)는 Nx2N의 파티션 타입, 예측 단위(1032)는 NxN의 파티션 타입이다. 즉, 예측 단위는 각각의 부호화 단위보다 작거나 같다.

[111] 변환 단위들(1070) 중 일부(1052)의 영상 데이터에 대해서는 부호화 단위에 비해 작은 크기의 데이터 단위로 주파수변환 또는 역주파수변환이 수행된다. 또한, 변환 단위(1014, 1016, 1022, 1032, 1048, 1050, 1052, 1054)는 해당 부호화 단위의 예측 단위와 서로 다른 크기 또는 형태의 데이터 단위이다. 즉, 하나의

부호화 단위의 변환 단위 및 예측 단위는 각각 독립적으로 결정된다. 따라서, 일 실시예에 따른 비디오 부호화 장치(100) 및 일 실시예에 따른 비디오 복호화 장치(200)는 동일한 부호화 단위에 대한 인트라 예측/움직임 추정/움직임 보상 작업, 및 주파수변환/역변환 작업이라 할지라도, 각각 별개의 데이터 단위를 기반으로 수행할 수 있다.

[112] 이에 따라, 최대 부호화 단위마다, 영역별로 계층적인 구조의 부호화 단위들마다 재귀적으로 부호화가 수행되어 최적 부호화 단위가 결정됨으로써, 재귀적 트리 구조에 따른 부호화 단위들이 구성될 수 있다.

[113] 부호화 정보는 부호화 단위에 대한 분할 정보, 파티션 타입 정보, 예측 모드 정보, 변환 단위 크기 정보를 포함할 수 있다. 이하 표 1은 일 실시예에 따른 비디오 부호화 장치(100) 및 일 실시예에 따른 비디오 복호화 장치(200)에서 이용될 수 있는 부호화 모드 정보의 일례를 도시한다.

[114] 표 1

[Table 1]

<table>
<tr><td colspan="5">분할 정보 0 (현재 심도 d의 크기 2Nx2N의 부호화 단위에 대한 부호화)</td><td>분할 정보 1</td></tr>
<tr><td>예측 모드</td><td colspan="2">파티션 타입</td><td colspan="2">변환 단위 크기</td><td rowspan="3">하위 심도 d+1의 부호화 단위들마다 반복적 부호화</td></tr>
<tr><td>인트라 인터스킵 (2Nx2N만)</td><td>대칭형 파티션 타입</td><td>비대칭형 파티션 타입</td><td>변환 단위 분할 정보 0</td><td>변환 단위 분할 정보 1</td></tr>
<tr><td>2Nx2N2NxNNx2NNxN</td><td>2NxnU2NxnDnLx2NnRx2N</td><td>2Nx2N</td><td>NxN (대칭형 파티션 타입) N/2xN/2 (비대칭형 파티션 타입)</td></tr>
</table>

[115] 일 실시예에 따른 비디오 부호화 장치(100)의 전송부(130)는 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보를 출력하고, 일 실시예에 따른 비디오 복호화 장치(200)의 수신 및 추출부(210)는 수신된 비트스트림으로부터 트리 구조에 따른 부호화 단위들에 대한 부호화 모드 정보를 추출할 수 있다.

[116] 분할 정보는 현재 부호화 단위가 하위 심도의 부호화 단위들로 분할되는지 여부를 나타낸다. 현재 심도 d의 분할 정보가 0이라면, 현재 부호화 단위가 더 이상 분할되지 않는 부호화 심도이므로, 부호화 심도에 대해서 파티션 타입 정보, 예측 모드, 변환 단위 크기 정보가 정의될 수 있다. 분할 정보가 1이라면 하위 심도로 한 단계 더 분할되므로, 분할된 4개의 하위 심도의 부호화 단위마다 독립적으로 부호화가 수행되어야 한다.

[117] 예측 모드 정보는, 인트라 모드, 인터 모드 및 스킵 모드 중 하나로 나타낼 수

있다. 인트라 모드 및 인터 모드는 모든 파티션 타입 정보에서 정의될 수 있으며, 스킵 모드는 파티션 타입 2Nx2N에서만 정의될 수 있다.

[118] 파티션 타입 정보는, 대칭적 파티션 타입 2Nx2N, 2NxN, Nx2N 및 NxN과, 부호화 단위의 높이 또는 너비가 높이 또는 너비가 비대칭적 비율로 분할된 비대칭적 파티션 타입 2NxnU, 2NxnD, nLx2N, nRx2N를 나타낼 수 있다. 비대칭적 파티션 타입 2NxnU 및 2NxnD는 각각 높이가 1:3 및 3:1로 분할된 형태이며, 비대칭적 파티션 타입 nLx2N 및 nRx2N은 각각 너비가 1:3 및 3:1로 분할된 형태를 나타낸다.

[119] 변환 단위 크기 정보는, 변환 단위 분할 정보에 따라 두 종류의 크기로 설정될 수 있다. 즉, 변환 단위 분할 정보가 0 이라면, 변환 단위의 크기 2Nx2N이 현재 부호화 단위의 크기로 설정된다. 변환 단위 분할 정보가 1이라면, 현재 부호화 단위가 분할된 크기의 변환 단위가 설정될 수 있다. 또한 현재 부호화 단위에 대한 파티션 타입이 대칭형 파티션 타입이라면 변환 단위의 크기는 NxN, 비대칭형 파티션 타입이라면 N/2xN/2로 설정될 수 있다.

[120] 일 실시예에 따른 트리 구조에 따른 부호화 단위들의 부호화 모드 정보는, 부호화 심도의 부호화 단위, 예측 단위 및 최소 단위 단위 중 적어도 하나에 대해 할당될 수 있다. 부호화 심도의 부호화 단위는 동일한 부호화 정보를 보유하고 있는 예측 단위 및 최소 단위를 하나 이상 포함할 수 있다. 따라서, 인접한 데이터 단위들끼리 각각 할당된 부호화 정보들을 확인하면, 동일한 부호화 심도의 부호화 단위에 포함되는지 여부가 확인될 수 있다. 또한, 데이터 단위에 할당된 부호화 정보를 이용하면 해당 부호화 심도의 부호화 단위를 확인할 수 있으므로, 최대 부호화 단위 내의 부호화 심도들의 분포가 유추될 수 있다.

[121] 따라서 이 경우 현재 부호화 단위가 주변 데이터 단위를 참조하여 예측 부호화하기 위해, 현재 부호화 단위에 인접하는 심도별 부호화 단위 내의 데이터 단위의 부호화 정보가 직접 참조되어 이용될 수 있다.

[122] 또 다른 실시예로, 현재 부호화 단위가 주변 부호화 단위를 참조하여 예측 부호화가 수행되는 경우, 인접하는 심도별 부호화 단위의 부호화 정보를 이용하여 심도별 부호화 단위 내에서 현재 부호화 단위에 인접하는 데이터를 검색함으로써, 주변 부호화 단위가 참조될 수도 있다.

[123] 도 13은 표 1의 부호화 모드 정보에 따른 부호화 단위, 예측 단위 및 변환 단위의 관계를 도시한다.

[124] 최대 부호화 단위(1300)는 부호화 심도의 부호화 단위들(1302, 1304, 1306, 1312, 1314, 1316, 1318)을 포함한다. 이 중 하나의 부호화 단위(1318)는 부호화 심도의 부호화 단위이므로 분할 정보가 0으로 설정될 수 있다. 크기 2Nx2N의 부호화 단위(1318)의 예측 단위의 파티션 타입 정보는, 파티션 타입 2Nx2N(1322), 2NxN(1324), Nx2N(1326), NxN(1328), 2NxnU(1332), 2NxnD(1334), nLx2N(1336) 및 nRx2N(1338) 중 하나로 설정될 수 있다.

[125] 파티션 타입 정보가 대칭형 파티션 타입 2Nx2N(1322), 2NxN(1324),

Nx2N(1326) 및 NxN(1328) 중 하나로 설정되어 있는 경우, 변환 단위 분할 정보(TU size flag)가 0이면 크기 2Nx2N의 변환 단위(1342)가 설정되고, 변환 단위 분할 정보가 1이면 크기 NxN의 변환 단위(1344)가 설정될 수 있다.

[126] 파티션 타입 정보가 비대칭형 파티션 타입 2NxnU(1332), 2NxnD(1334), nLx2N(1336) 및 nRx2N(1338) 중 하나로 설정된 경우, 변환 단위 분할 정보(TU size flag)가 0이면 크기 2Nx2N의 변환 단위(1352)가 설정되고, 변환 단위 분할 정보가 1이면 크기 N/2xN/2의 변환 단위(1354)가 설정될 수 있다.

[127] 도 14는 본 발명의 일 실시예에 따라, 최대 부호화 단위들, 각 최대 부호화 단위를 세분한 트리 구조에 따른 부호화 단위들, 각 부호화 단위를 세분한 예측 단위 및 변환 단위를 포함하는 데이터 단위들을 도시한다. 즉, 도 14는 전술한 도 10 내지 도 12에 도시된 바와 같은 부호화 단위, 예측 단위 및 변환 단위를 전부 포함하는 데이터 단위들을 오버레핑하여 하나로 표시한 것이다. 도 14에서, 최대 부호화 단위의 크기는 32x32으로 가정하며, 부호화 심도의 부호화 단위들은 실선으로 도시되며, 부호화 심도의 부호화 단위가 분할된 형태의 예측 단위 및 변환 단위는 부호화 단위 내에 점선으로 도시된다. 또한, 트리 구조의 부호화 단위의 부호화 심도는 0, 1, 2이며, 최대 심도는 3으로 설정된 것으로 가정한다.

[128] 도 14를 참조하면, 데이터 단위 그룹(1400)은, 크기 32x32의 9개의 최대 부호화 단위들의 부호화 심도의 부호화 단위들을 포함하고 있다. 전술한 바와 같이 최대 부호화 단위마다, 심도에 따라 구별되는 계층적인 구조의 부호화 단위들을 이용하여 재귀적으로 부호화가 수행되어 최적 부호화 단위가 결정되는 한편, 각 부호화 단위의 예측 및 변환을 위한 최적의 예측 단위 및 변환 단위가 결정될 수 있다. 일 실시예에 따른 디블록킹 필터링부(120)는 도 14에 도시된 바와 같은 부호화 단위들, 예측 단위들 및 변환 단위들 중 적어도 하나의 데이터 단위에 기초하여 디블록킹 필터링을 수행할 필터링 경계를 결정한다.

[129] 구체적으로, 디블록킹 필터링부(120)는 부호화 단위들, 예측 단위들 및 변환 단위들 중 소정 크기 이상의 데이터 단위가 갖는 경계에 기초하여 필터링 경계를 결정할 수 있다. 다시 말해서, 도 14를 참조하면, 현재 픽처가 32x32 크기의 최대 부호화 단위로 분할되고, 각 최대 부호화 단위는 다시 심도에 따라 구별되는 계층적인 구조의 부호화 단위들로 분할되며, 각 부호화 단위는 다시 예측 및 변환을 위해 심도별 부호화 단위보다 더 작은 크기의 예측 단위 및 변환 단위로 분할된다고 하였을 때, 이러한 부호화 단위들, 예측 단위들 및 변환 단위들 각각이 갖는 경계들 중 소정 크기 이상의 데이터 단위가 갖는 경계만을 디블록킹 필터링이 수행될 필터링 경계로 결정할 수 있다.

[130] 도 15 내지 도 17은, 각각 도 14의 데이터 단위들에 대해서 소정 크기 이상의 데이터 단위가 갖는 경계를 기초로 결정된 필터링 경계를 도시한다.

[131] 도 14 및 도 15를 참조하면, 도 14의 부호화 단위들, 예측 단위들 및 변환 단위들이 결정되면, 디블록킹 필터링부(120)는 부호화 단위들, 예측 단위들 및 변환 단위들 각각의 경계들 중 소정 크기 이상의 데이터 단위가 갖는 경계만을

디블록킹 필터링이 수행될 필터링 경계로 결정할 수 있다. 예를 들어, 디블록킹 필터링부(120)는 도 15에 도시된 바와 같이 32x32 이상의 크기를 갖는 부호화 단위들, 예측 단위들 및 변환 단위들의 경계만을 디블록킹 필터링이 수행될 필터링 경계로 결정하거나, 도 16에 도시된 바와 같이 16x16 이상의 크기를 갖는 부호화 단위들, 예측 단위들 및 변환 단위들의 경계만을 디블록킹 필터링이 수행될 필터링 경계로 결정하거나, 도 17에 도시된 바와 같이 8x8 이상의 크기를 갖는 부호화 단위들, 예측 단위들 및 변환 단위들의 경계만을 디블록킹 필터링이 수행될 필터링 경계로 결정할 수 있다. 이와 같이, 소정 크기 이상의 데이터 단위가 갖는 경계만을 디블록킹 필터링이 수행되는 필터링 경계로 결정하면, 동일한 분할 형태에 대해서도 필터링이 수행되는 필터링 경계는 변화된다. 예를 들어, 도 15에 도시된 바와 같이 32x32 이상의 크기를 갖는 데이터 단위의 경계에 대해서만 디블록킹 필터링이 수행된다고 가정하였을 때, 32x32 크기의 최대 부호화 단위(1510)를 분할한 부호화 단위, 변환 단위 및 분할 단위의 경계들 중 32x32 크기의 최대 부호화 단위(1510)와 중복되는 경계 부분은 제외하고 내부 경계는 필터링 경계로 고려되지 않는다. 이에 반하여, 도 16에 도시된 바와 같이 16x16 이상의 크기를 갖는 데이터 단위의 경계에 대해서만 디블록킹 필터링이 수행되는 경우에는, 도 15의 최대 부호화 단위(1510)에 대응되는 최대 부호화 단위(1610)를 분할한 부호화 단위들(1611 내지 1614)이 갖는 내부 경계 역시 필터링 경계로 결정된다.

[132] 한편, 디블록킹 필터링부(120)는 소정 크기 이상의 데이터 단위가 갖는 경계라도 프레임 경계에 해당하는 경우에는 해당 경계를 필터링 경계로 결정하지 않는다. 즉, 픽처의 가장자리에 해당하는 최외곽의 경계에 대해서는 본 발명의 실시예에 따른 디블록킹 필터링이 수행되지 않는다.

[133] 디블록킹 필터링부(120)는 전술한 바와 같이 소정 크기 이상의 데이터 단위가 갖는 경계를 기준으로 필터링 경계를 결정하는 것뿐이 아니라, 부호화 단위별, 픽처 단위별 또는 슬라이스 단위별로 임의의 크기의 데이터 단위가 갖는 경계에서 필터링을 수행할 지 여부를 나타내는 소정의 신택스에 기초하여 디블록킹 필터링을 수행할 필터링 경계를 결정할 수도 있다. 또한, 도 2의 디블록킹 필터링부(230) 역시 도 1의 디블록킹 필터링부(130)과 유사하게 소정 크기 이상의 데이터 단위가 갖는 경계에 기초하여 필터링 경계를 결정하거나, 또는 수신된 비트스트림에 포함된 부호화 단위별, 픽처 단위별 또는 슬라이스 단위별로 설정된 디블록킹에 관한 신택스 정보에 기초하여 디블록킹 필터링을 수행할 필터링 경계를 결정할 수 있다.

[134] 부호화 단위(이하 "블록"이라 한다)에 기초한 부호화 방식에서는 블록 경계에서 발생한 왜곡이 포함된 영상이 다른 영상의 부호화시에 참조되어 화질 열화가 그대로 전파되는 문제점이 있을 수 있다. 따라서, 전술한 바와 같이 디블록킹 필터링부(130, 230)에서는 블록 결함(block artifact)을 감소시키기 위한 디블록킹 필터링을 수행한다. 하지만, 이러한 디블록킹 필터링 과정은 연산

과정이 방대하므로 부호화기나 복호화기의 자원을 많이 소모하는 문제점이 있다. 따라서, 일반적으로 디블록킹 필터링은 소정의 판단 기준에 따라서 선택된 블록 경계에 대해서만 수행된다. 일 예로, 종래 H.264 등의 부호화 방식에서는 블록 경계 주변의 픽셀들이 속한 블록의 예측 모드 및 경계 주변의 픽셀이 속한 블록 내의 변환 계수값에 기초하여 경계 강도(boundary strength)를 결정하고, 이러한 경계 강도에 기초하여 디블록킹 필터링의 on/off를 결정한다.

[135] 본 발명의 일 실시예에 따르면 디블록킹 필터링의 수행 여부 또는 필터링 강도는 필터링 경계 주변의 픽셀들이 갖는 픽셀값에 기초하여 결정된다. 구체적으로, 본 발명의 일 실시예에 따르면 디블록킹 필터링 수행 여부 또는 필터링 강도는 필터링 경계 주변의 픽셀들의 픽셀값들이 소정의 라인(line)에 얼마나 가까운지 여부를 나타내는 파라메타를 이용하여 결정된다. 이하, 도 18 내지 도 21을 참조하여 본 발명의 일 실시예에 따른 적응적 필터링 방식에 대하여 구체적으로 설명한다.

[136] 도 18은 본 발명의 일 실시예에 따른 적응적 필터링 장치의 구성을 나타낸 블록도이다. 도 18의 적응적 필터링 장치(1800)는 도 1의 비디오 부호화 장치(100)의 디블록킹 필터링부(130) 및 도 2의 비디오 복호화 장치(200)의 디블록킹 필터링부(230)에 대응된다.

[137] 도 18을 참조하면, 본 발명의 일 실시예에 따른 적응적 필터링 장치(1800)는 파라메터 획득부(1810), 필터링 강도 결정부(1820) 및 필터링 수행부(1830)를 포함한다.

[138] 파라메터 획득부(1810)는 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 커브 라인(linecurve)에 가까운 정도를 나타내는 파라메타(parameter)를 획득한다. 이러한 커브는 다항식(polynomial)와 같은 임의의 함수로 표현될 수 있으며, 가장 간단한 예로서 이러한 커브는 라인(line)이 될 수 있다. 이하의 설명에서는 커브로써 라인을 가정하여 설명하지만 본 발명에 따른 사상은 라인에 한정되지 않고 임의의 커브에 모두 적용가능할 것이다. 일 예로, 블록 경계 주변에 위치한 픽셀들의 픽셀값이 단조 증가하거나 단조 감소하는 경우, 블록 경계 주변에 위치한 픽셀들의 픽셀값은 직선 상에 위치한 것으로 가정할 수 있다. 이와 같이 파라메터 획득부(1810)는 블록 경계 주변에 위치한 픽셀들의 픽셀값의 변화를 고려하여 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인에 가까운지 여부를 나타내는 파라메타를 획득한다. 구체적으로, 파라메터 획득부(1810)는 블록 경계를 중심으로 소정 개수의 대칭되는 위치의 픽셀들 사이의 픽셀값 차이와 대칭되는 위치의 픽셀들 사이의 거리에 따라 결정되는 기울기의 차이값에 기초하여 파라메타를 획득할 수 있다. 파라메터 획득부(1810)의 동작 및 파라메터에 대해서는 도 19 및 도 20을 참조하여 구체적으로 후술한다.

[139] 필터링 강도 결정부(1820)는 파라메터 획득부(1810)에서 획득된 파라메타에 기초하여 블록 경계에서의 필터링 강도를 결정한다. 필터링 강도 결정부(1820)는 파라메터와 소정의 임계값을 비교한 결과에 기초하여, 블록 경계 주변에 위치한

픽셀들의 픽셀값이 소정의 라인에 가까운 경우에는 약한 강도의 디블록킹 필터링을 적용하거나 디블록킹 필터링 동작이 off, 즉 스킵되도록 필터링 강도를 결정한다.

[140] 필터링 수행부(1830)는 필터링 강도 결정부(1820)에서 결정된 필터링 강도에 기초하여 블록 경계에 인접한 픽셀들에 대한 디블록킹 필터링을 수행한다.

[141] 도 19a 및 도 19b는 본 발명의 일 실시예에 따른 디블록킹 필터링을 설명하기 위한 필터링 경계에 위치한 픽셀들을 도시한 것이다.

[142] 도 19a를 참조하면, 수평 방향 필터링 경계를 기준으로 디블록킹 필터링을 적용하기 전의 수평 방향 필터링 경계의 상측 및 하측으로 인접한 픽셀들의 픽셀값을 p0 내지 p4 및 q0 내지 q4(1910)로 정의한다. 또한, 디블록킹 필터링을 적용한 후 수평 방향 필터링 경계의 상측 및 하측으로 인접한 픽셀들의 픽셀값을 p0' 내지 p4' 및 q0' 내지 q4'(1920)로 정의한다. 유사하게 도 19b를 참조하면 수직 방향 필터링 경계를 기준으로 디블록킹 필터링을 적용하기 전의 수직 방향 필터링 경계의 좌측 및 우측으로 인접한 픽셀들의 픽셀값을 p0 내지 p4 및 q0 내지 q4(1930)로 정의한다. 또한, 디블록킹 필터링을 적용한 후 수직 방향 필터링 경계의 좌측 및 우측으로 인접한 픽셀들의 픽셀값을 p0' 내지 p4' 및 q0' 내지 q4'(1940)로 정의한다. 수평 방향 및 수직 방향 필터링 경계를 기준으로 한 디블록킹 필터링 동작은 방향의 차이만 있을 뿐 동일하게 동작한다. 이하, 도 19a 및 도 19b에 도시된 바와 같은 블록 경계 주변의 픽셀들의 픽셀값들이 소정의 라인에 얼마나 가까운지 여부를 나타내는 파라메터를 획득하는 과정에 대하여 구체적으로 설명한다.

[143] 도 20a 및 도 20b는 본 발명의 일 실시예에 따라서 블록 경계 주변의 픽셀들의 픽셀값들을 이용한 파라메터 획득 과정을 설명하기 위한 참조도이다.

[144] 도 19a 및 19b에 도시된 바와 같은 필터링 경계 주변의 픽셀들을 도 20a 및 도 20b에 도시된 바와 같이 픽셀값을 기준으로 배열하는 경우, 픽셀값의 차이값에 따라서 필터링 경계 주변의 픽셀들이 소정의 라인(2010)에 얼마나 가까운지가 결정될 수 있다. 예를 들어 도 20b에 도시된 바와 같이 소정의 라인을 직선(2020)이라고 가정한다. 또한, 픽셀 사이의 거리를 d(d는 양의 정수)라고 가정하면, 필터링 경계에 최근접으로 인접한 픽셀들의 픽셀값 p0 및 q0 사이의 기울기는 (q0-p0)/d이며, 다음 인접 픽셀들의 픽셀값 p1 및 q1 사이의 기울기는 (q1-p1)/3d이다. 필터링 경계에 인접한 픽셀들의 픽셀값이 도 20b에 도시된 바와 같은 가상의 직선(2020) 상에 가까운지 여부는 이러한 p0 및 q0 사이의 기울기와 p1 및 q1 사이의 기울기가 서로 얼마나 유사한지 여부를 결정함으로써 판단될 수 있다. 따라서, 파라메터 획득부(1810)는 필터링 경계를 중심으로 대칭되는 위치의 픽셀들 사이의 픽셀값 차이와 대칭되는 위치의 픽셀들 사이의 거리에 따라 결정되는 기울기의 차이값에 기초하여 필터링 경계 주변의 픽셀들의 픽셀값이 소정의 직선(2020)에 얼마나 가까운지를 나타내는 파라메타를 획득할 수 있다.

[145] 구체적으로, 파라메터 획득부(1810)는 p0 및 q0 사이의 기울기 (q0-p0)/d와 p1 및 q1 사이의 기울기 (q1-p1)/3d 사이의 차이값을 획득한다. d=1이라고 가정하면 기울기 사이의 차이값은 {(q0-p0)-(q1-p1)/3}이 된다. 파라메터 획득부(1810)는 이러한 차이값에 소정의 상수값, 예를 들어 9/16을 곱한 {9*(q0-p0)-3*(q1-p1)}/16을 전술한 필터링 경계 주변의 픽셀들이 소정의 라인에 가까운지 여부를 나타내는 파라메터(△)로 결정한다. 파라메터(△)의 절대값이 작다는 것은 p0 및 q0 사이의 직선의 기울기와 p1 및 q1 사이의 직선의 기울기가 상호 유사하다는 것으로, 다시 말해서 p0, p1, q0 및 q1이 소정의 직선(2020)에 가깝다는 것을 의미한다. 따라서, 파라메터(△)의 절대값 크기에 기초하여 필터링 경계 주변의 픽셀들의 픽셀값이 얼마나 소정의 직선에 가까운지 여부가 결정될 수 있다.

[146] 이와 같이 파라메터 획득부(1810)에서 파라메터(△)가 획득되면, 필터링 강도 결정부(1820)는 파라메터(△)의 절대값과 소정의 임계치(thr1)를 비교한 결과에 따라서 필터링 강도를 결정한다. 여기서, 소정의 임계치(thr1)은 p0 및 q0가 속하는 블록의 양자화시에 이용된 양자화 파라메터 QP(Quantization Parameter)에 기초하여 미리 정해진 값일 수 있다. 필터링 강도 결정부(1820)는 파라메터(△)의 절대값이 소정의 임계치(thr1)보다 작은 경우 약한 강도의 디블록킹 필터링이 수행되도록 필터링 강도를 결정하거나, 디블록킹 필터링이 수행되지 않도록 결정할 수 있다. 또한, 필터링 강도 결정부(1820)는 파라메터(△)의 절대값이 소정의 임계치(thr1)보다 작은 경우 약한 강도의 디블록킹 필터링이 수행되도록 결정하고, 파라메터(△)의 절대값이 소정의 임계치(thr1)보다 큰 경우에는 디블록킹 필터링을 수행하지 않는 것으로 결정할 수 있다. 파라메터(△)의 절대값과 소정의 임계치(thr1)를 비교한 결과에 따라서, 어떤 경우에 약한 강도의 필터링을 적용할지, 아니면 디블록킹 필터링 자체를 스킵할지 여부는 필요에 따라 설정할 수 있는 사항이다. 본 발명의 일 실시예에 따른 사상은 전술한 소정의 라인 및 파라메터(△)를 디블록킹의 필터링 강도 및 스킵 여부를 판단하기 위한 지표로써 이용할 수 있다는 것에 있다.

[147] 필터링 수행부(1830)는 필터링 강도 결정부(1820)에서 결정된 필터링 강도에 기초하여 디블록킹 필터링을 수행한다. 예를 들어, 블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0 및 p1, 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0 및 q1, p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이라고 가정할 때, 파라메타(△)가 소정 임계치(thr1)보다 작은 경우, 필터링 수행부(1830)는 다음과 같은 알고리즘에 따라서 디블록킹 필터링을 수행할 수 있다.

[148] {

[149] p0'=p0+△;

[150] q0'=q0-△;

[151] △p1=(p0-2*p1+p2+2*△)/4;

[152] p1'=p1+Δp1;

[153] Δq1=(q0-2*q1+q2-2*Δ)/4;

[154] q1'=q1+Δq1

[155] }

[156] 도 21은 본 발명의 일 실시예에 따른 적응적 필터링 방법을 나타낸 플로우 차트이다.

[157] 도 21을 참조하면, 단계 2110에서 파라메터 획득부(1810)는 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득한다. 전술한 바와 같이, 소정의 라인으로써 직선을 이용할 수 있다. 또한, 소정의 라인으로써 직선을 이용하는 경우, 파라메터 획득부(1810)는 블록 경계를 중심으로 대칭되는 위치의 픽셀들 사이의 기울기의 차이값에 기초하여 파라메타를 획득한다. 전술한 바와 같이, 블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0 및 p1, 상기 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0 및 q1, 상기 p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이며, 파라메타를 Δ라고 가정할 때 파라메터 획득부(1810)는 다음의 수학식; Δ=(9*(q0-p0)-3*(q1-p1))/16 을 통해 파라메타(Δ)를 획득할 수 있다.

[158] 단계 2120에서, 필터링 강도 결정부(1820)는 획득된 파라메타에 기초하여 블록 경계에서의 필터링 강도를 결정한다. 전술한 바와 같이, 필터링 강도 결정부(1820)는 파라메터의 절대값과 소정의 임계값을 비교하여, 파라메터의 절대값이 소정 임계값보다 작은 경우 약한 강도의 디블록킹 필터링을 수행하거나 디블록킹 필터링이 off되도록 결정할 수 있다.

[159] 단계 2130에서, 필터링 수행부(1830)는 결정된 필터링 강도에 기초하여 필터링을 수행한다.

[160] 한편, 전술한 본 발명의 일 실시예에 따른 적응적 필터링 방식에서는 블록 경계에 인접한 4개의 픽셀들의 픽셀값을 이용하여 파라메터를 결정하였으나, 파라메터 결정에 이용되는 픽셀의 개수는 필요에 따라 변경될 수 있다.

[161] 이와 같이, 본 발명의 일 실시예에 따른 적응적 필터링 장치 및 방법에 따르면, 블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인에 가까운 경우에는 불필요한 필터링 처리로 인해 화질이 열화되는 것을 방지하기 위해서 약한 강도의 디블록킹 필터링을 적용하거나 디블록킹 필터링 자체를 수행하지 않는다.

[162] 도 22a 및 도 22b는 본 발명의 다른 실시예에 따른 적응적 필터링 방법을 설명하기 위한 참조도이다.

[163] 전술한 본 발명의 일 실시예에 따른 적응적 필터링 방식에서는 블록 경계 주변의 픽셀들의 픽셀값이 소정의 라인에 얼마나 가까운지 여부를 나타내는 파라메터에 기초하여 디블록킹 필터링의 강도 또는 디블록킹 필터링의 스킵 여부를 판단하였다. 본 발명의 다른 실시예에 따른 적응적 필터링 방식에서는

블록 경계를 중심으로 양측면에 위치한 인접 픽셀들의 최대값과 최소값을 비교하여 강한 강도의 디블록킹 필터링 수행 여부를 결정한다.

[164] 도 22a 및 22b를 참조하면, 디블록킹 필터링부(130,230)는 블록 경계를 중심으로 양측면에 위치한 소정 개수의 주변 픽셀들의 픽셀값의 최대값과 최소값을 계산한다. 도 22a 및 22b에 도시된 바와 같이, 블록 경계를 중심으로 좌우로 4개씩, 총 8개의 주변 픽셀을 이용하는 경우 좌측의 주변 픽셀들의 픽셀값들 p0 내지 p3 중 최대값을 pMax, 최소값을 pMin으로 정의하며, 우측의 주변 픽셀들의 픽셀값들 q0 내지 q3 중 최대값을 qMax, 최소값을 qMin으로 정의한다. 이 때, 디블록킹 필터링부(130, 230)는 pMax와 qMin, qMax와 pMin을 비교하여, 도 22a에 도시된 바와 같이 pMax<qMin을 만족하거나 또는 도 22b에 도시된 바와 같이 qMax<pMin을 만족하는 경우, 즉 블록 경계를 중심으로 어느 한 쪽의 픽셀값들 모두가 다른 한 쪽의 모든 픽셀값보다 작은 경우에는 강한 강도의 디블록킹 필터링을 수행하는 것으로 결정할 수 있다.

[165] 디블록킹 필터링부(130,230)은 강한 강도의 디블록킹 필터링 적용 조건이 만족되지 않는 경우에는, 전술한 본 발명의 일 실시예에 따른 파라메터(Δ)를 결정하여 약한 강도의 디블록킹을 적용할 것인지 또는 디블록킹 필터링을 스킵할 것인지 여부를 결정할 수 있다.

[166] 한편, 상술한 본 발명의 실시예들은 컴퓨터에서 실행될 수 있는 프로그램으로 작성가능하고, 컴퓨터로 읽을 수 있는 기록매체를 이용하여 상기 프로그램을 동작시키는 범용 디지털 컴퓨터에서 구현될 수 있다. 상기 컴퓨터로 읽을 수 있는 기록매체는 마그네틱 저장매체(예를 들면, 롬, 플로피 디스크, 하드디스크 등) 및 광학적 판독 매체(예를 들면, 시디롬, 디브이디 등)와 같은 저장매체를 포함한다.

[167] 이제까지 본 발명에 대하여 그 바람직한 실시예들을 중심으로 살펴보았다. 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자는 본 발명이 본 발명의 본질적인 특성에서 벗어나지 않는 범위에서 변형된 형태로 구현될 수 있음을 이해할 수 있을 것이다. 그러므로 개시된 실시예들은 한정적인 관점이 아니라 설명적인 관점에서 고려되어야 한다. 본 발명의 범위는 전술한 설명이 아니라 특허청구범위에 나타나 있으며, 그와 동등한 범위 내에 있는 모든 차이점은 본 발명에 포함된 것으로 해석되어야 할 것이다.

청구범위

[청구항 1] 적응적 필터링 방법에 있어서,
블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득하는 단계;
상기 획득된 파라메타에 기초하여 상기 블록 경계에서의 필터링 강도를 결정하는 단계; 및
상기 결정된 필터링 강도에 기초하여 필터링을 수행하는 단계를 포함하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 2] 제 1항에 있어서,
상기 라인은 상기 픽셀값에 기초한 다항식(polynomial), 임의의 커브, 함수 및 직선(straight line) 중 하나인 것을 특징으로 하는 적응적 필터링 방법.

[청구항 3] 제 1항에 있어서,
상기 파라메타를 획득하는 단계는
상기 블록 경계를 중심으로 대칭되는 위치의 픽셀들의 픽셀값 차이에 기초하여 상기 파라메타를 획득하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 4] 제 1항에 있어서,
상기 파라메타를 획득하는 단계는
상기 블록 경계를 중심으로 소정 개수의 대칭되는 위치의 픽셀들 사이의 픽셀값 차이와 상기 대칭되는 위치의 픽셀들 사이의 거리에 따라 결정되는 기울기의 차이값에 기초하여 상기 파라메타를 획득하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 5] 제 1항에 있어서,
상기 파라메타를 획득하는 단계는
블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0 및 p1, 상기 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0 및 q1, 상기 p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이며, 상기 파라메타를 △라고 가정할 때,
다음의 수학식; △=(9*(q0-p0)-3*(q1-p1))/16 을 통해 상기 파라메타(△)를 획득하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 6] 제 1항에 있어서,
상기 필터링 강도를 결정하는 단계는
상기 획득된 파라메타의 절대값과 소정의 임계값을 비교한 결과에 기초하여 상기 필터링 강도를 결정하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 7] 제 6항에 있어서,

상기 임계값은 상기 블록 경계 주변의 블록들을 양자화할 때 이용되는 양자화 파라메타에 기초하여 결정되는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 8] 제 6항에 있어서,
상기 획득된 파라메타의 절대값이 상기 임계값보다 큰 경우 상기 필터링을 수행하지 않는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 9] 제 1항에 있어서,
상기 필터링을 수행하는 단계는
블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0, p1 및 p2, 상기 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0, q1 및 q2, 상기 p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이며, 상기 파라메타를 △라고 가정할 때, 다음의 수학식; △=(9*(q0-p0)-3*(q1-p1))/16 을 통해 획득된 상기 파라메타(△)가 소정 임계값보다 작은 경우, 다음의 알고리즘;
{
p0'=p0+△;
q0'=q0-△;
△p1=(p0-2*p1+p2+2*△)/4;
p1'=p1+△p1;
△q1=(q0-2*q1+q2-2*△)/4;
q1'=q1+△q1
}
에 따라 상기 픽셀값 p0, p1, q0 및 q1을 각각 p0', p1', q0' 및 q1'로 대체하는 필터링을 수행하는 것을 특징으로 하는 적응적 필터링 방법.

[청구항 10] 적응적 필터링 장치에 있어서,
블록 경계 주변에 위치한 픽셀들의 픽셀값이 소정의 라인(line)에 가까운 정도를 나타내는 파라메타(parameter)를 획득하는 파라메타 획득부;
상기 획득된 파라메타에 기초하여 상기 블록 경계에서의 필터링 강도를 결정하는 필터링 강도 결정부; 및
상기 결정된 필터링 강도에 기초하여 필터링을 수행하는 필터링 수행부를 포함하는 것을 특징으로 하는 적응적 필터링 장치.

[청구항 11] 제 10항에 있어서,
상기 라인은 상기 픽셀값에 기초한 다항식(polynomial), 임의의 커브, 함수 및 직선(straight line) 중 하나인 것을 특징으로 하는 적응적 필터링 장치.

[청구항 12] 제 10항에 있어서,
상기 파라메타 획득부는
상기 블록 경계를 중심으로 대칭되는 위치의 픽셀들의 픽셀값 차이에 기초하여 상기 파라메타를 획득하는 것을 특징으로 하는 적응적 필터링 장치.

[청구항 13] 제 10항에 있어서,
상기 파라메타 획득부는
상기 블록 경계를 중심으로 소정 개수의 대칭되는 위치의 픽셀들 사이의 픽셀값 차이와 상기 대칭되는 위치의 픽셀들 사이의 거리에 따라 결정되는 기울기의 차이값에 기초하여 상기 파라메타를 획득하는 것을 특징으로 하는 적응적 필터링 장치.

[청구항 14] 제 10항에 있어서,
상기 파라메타 획득부는
블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0 및 p1, 상기 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0 및 q1, 상기 p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이며, 상기 파라메타를 △라고 가정할 때, 다음의 수학식; △=(9*(q0-p0)-3*(q1-p1))/16 을 통해 상기 파라메타(△)를 획득하는 것을 특징으로 하는 적응적 필터링 장치.

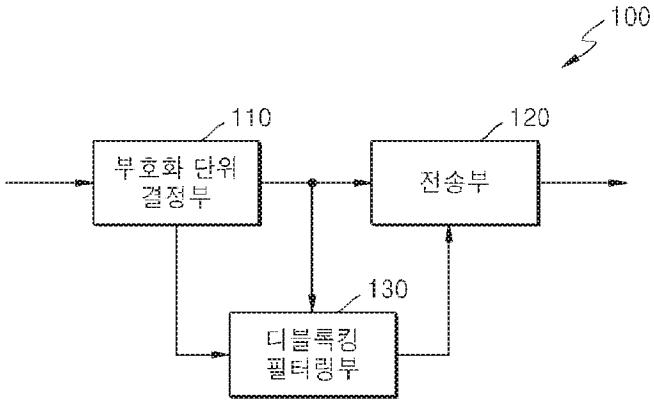
[청구항 15] 제 10항에 있어서,
상기 필터링 수행부는
블록 경계를 중심으로 제 1 측면에 위치하는 픽셀들의 픽셀값을 p0, p1 및 p2, 상기 블록 경계를 중심으로 제 2 측면에 위치하는 픽셀들의 픽셀값을 q0, q1 및 q2, 상기 p0 및 q0의 픽셀값을 갖는 픽셀이 블록 경계에 인접한 픽셀이며, 상기 파라메타를 △라고 가정할 때, 다음의 수학식; △=(9*(q0-p0)-3*(q1-p1))/16 을 통해 획득된 상기 파라메타(△)가 소정 임계값보다 작은 경우, 다음의 알고리즘;

{
p0'=p0+△;
q0'=q0-△;
△p1=(p0-2*p1+p2+2*△)/4;
p1'=p1+△p1;
△q1=(q0-2*q1+q2-2*△)/4;
q1'=q1+△q1
}

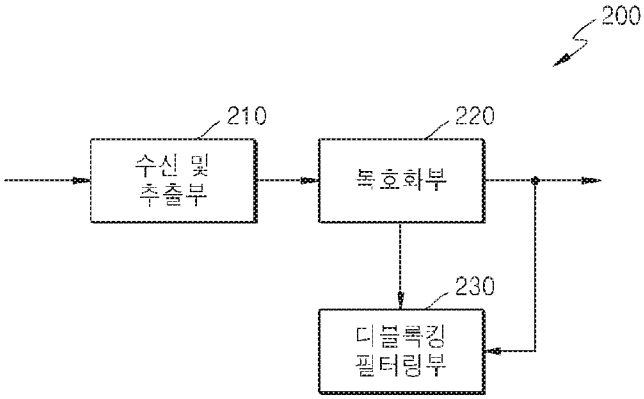
에 따라 상기 픽셀값 p0, p1, q0 및 q1을 각각 p0', p1', q0' 및 q1'로 대체하는 필터링을 수행하는 것을 특징으로 하는 적응적 필터링

장치.

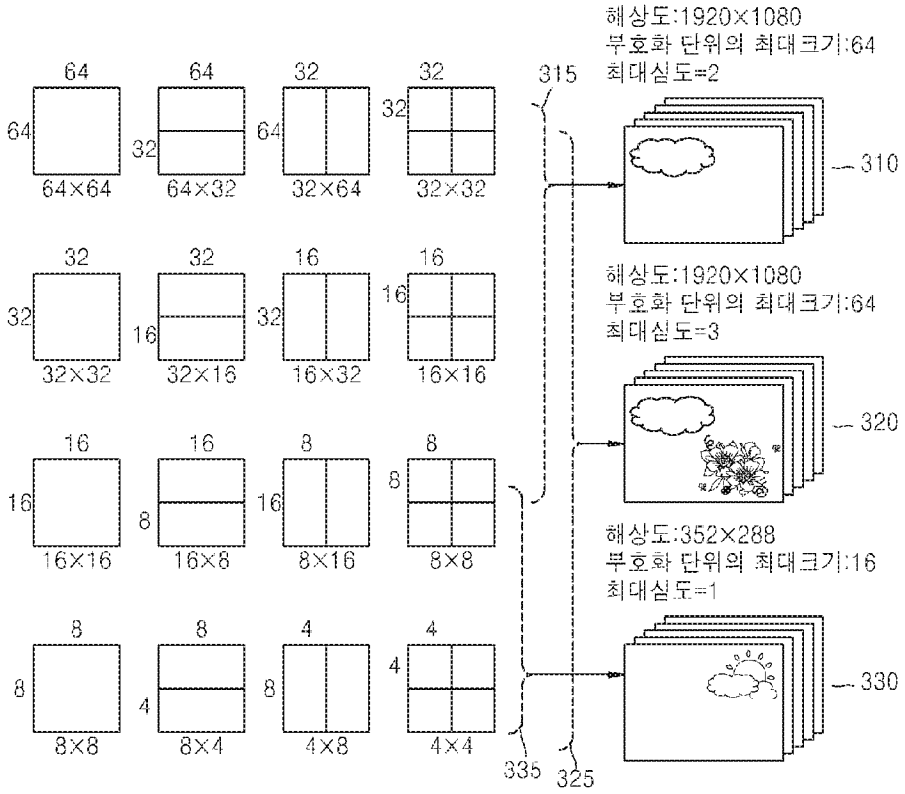
[Fig. 1]



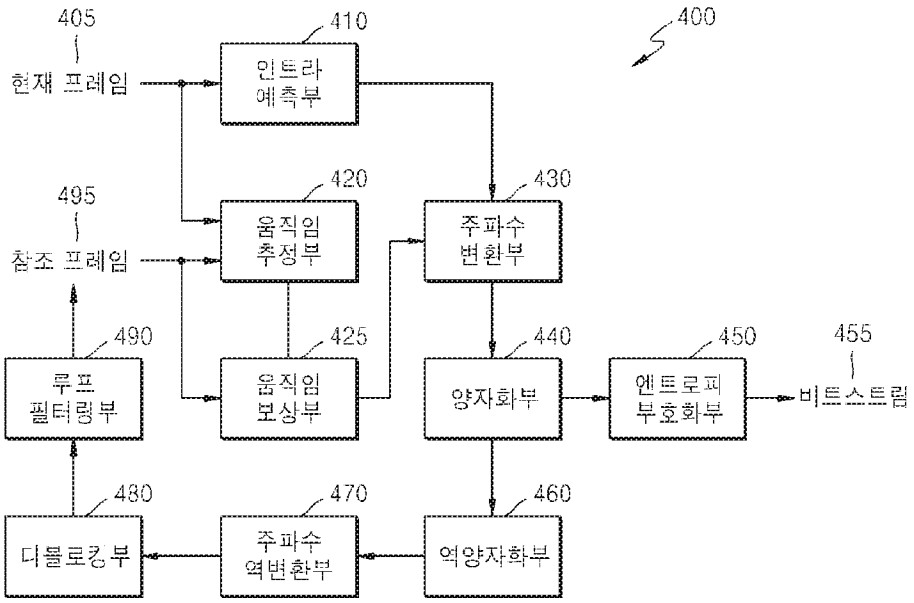
[Fig. 2]



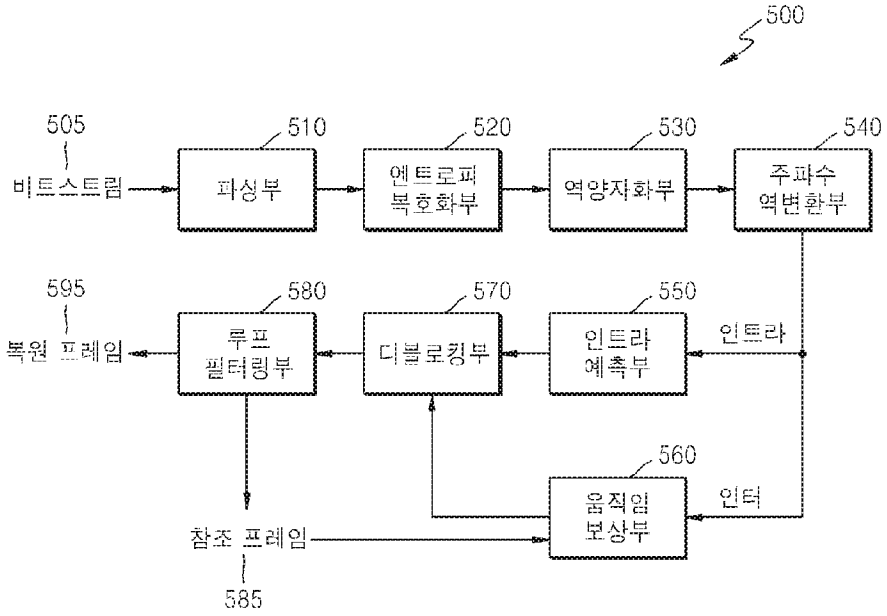
[Fig. 3]



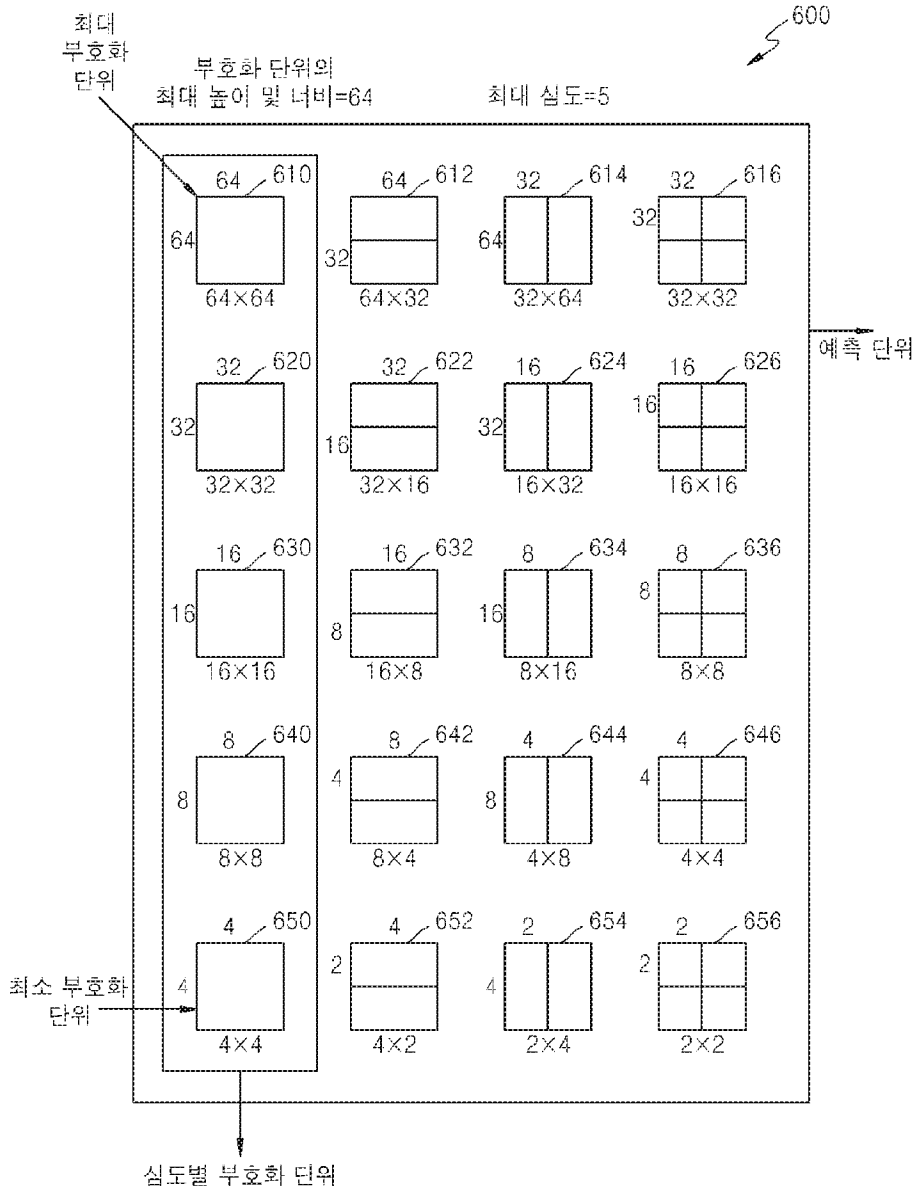
[Fig. 4]


405
현재 프레임
410
인트라 예측부
400
420
움직임 추정부
430
주파수 변환부
495
참조 프레임
490
루프 필터링부
425
움직임 보상부
440
양자화부
450
엔트로피 부호화부
455
비트스트림
480
디블로킹부
470
주파수 역변환부
460
역양자화부

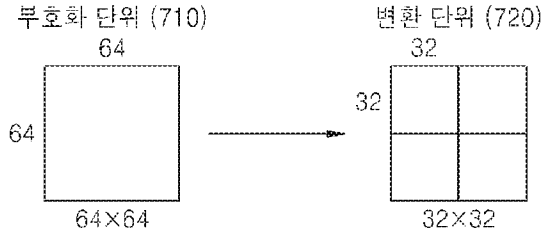
[Fig. 5]


500
505
비트스트림
510
파싱부
520
엔트로피 복호화부
530
역양자화부
540
주파수 역변환부
595
복원 프레임
580
루프 필터링부
570
디블로킹부
550
인트라 예측부
인트라
560
움직임 보상부
인터
참조 프레임
585

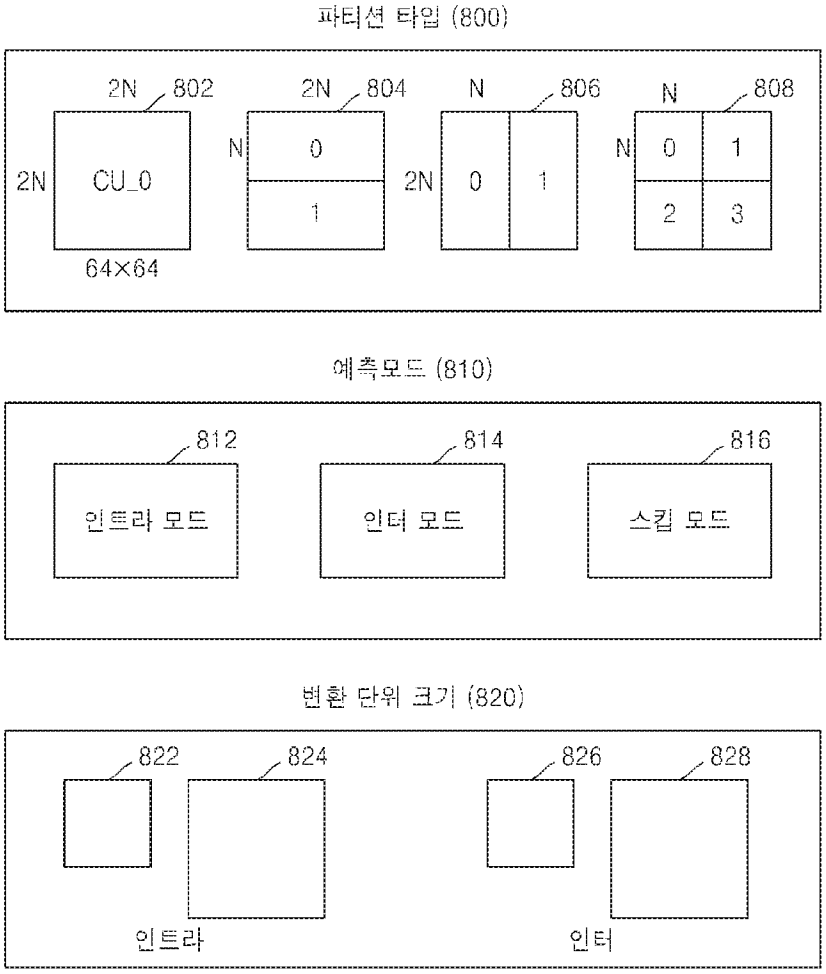
[Fig. 6]


600
최대 부호화 단위
부호화 단위의 최대 높이 및 너비=64
최대 심도=5
64 610
64×64
64 612
64×32
32 614
32×64
32 616
32×32
32 620
32×32
32 622
32×16
16 624
16×32
16 626
16×16
16 630
16×16
16 632
16×8
8 634
8×16
8 636
8×8
8 640
8×8
8 642
8×4
4 644
4×8
4 646
4×4
4 650
4×4
4 652
4×2
2 654
2×4
2 656
2×2
예측 단위
최소 부호화 단위
심도별 부호화 단위

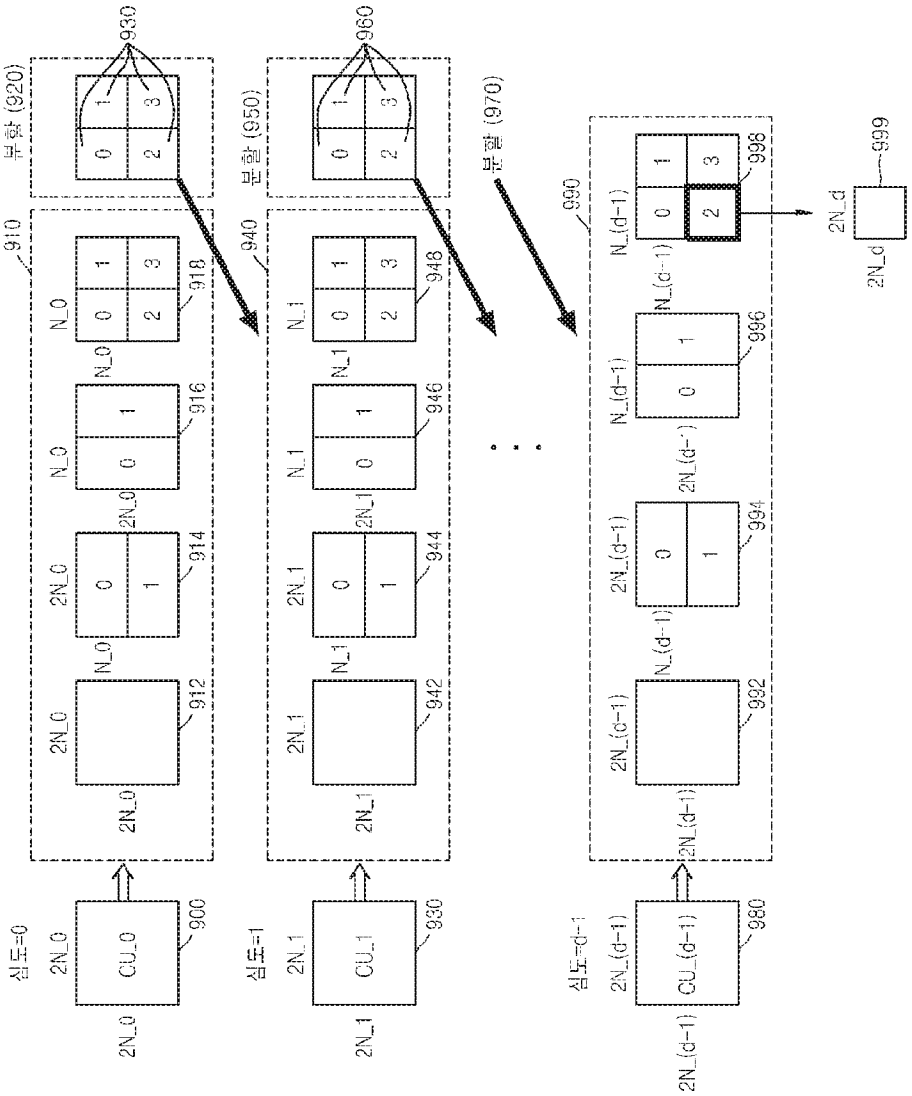
[Fig. 7]


부호화 단위 (710)
64
64
64×64
변환 단위 (720)
32
32
32×32

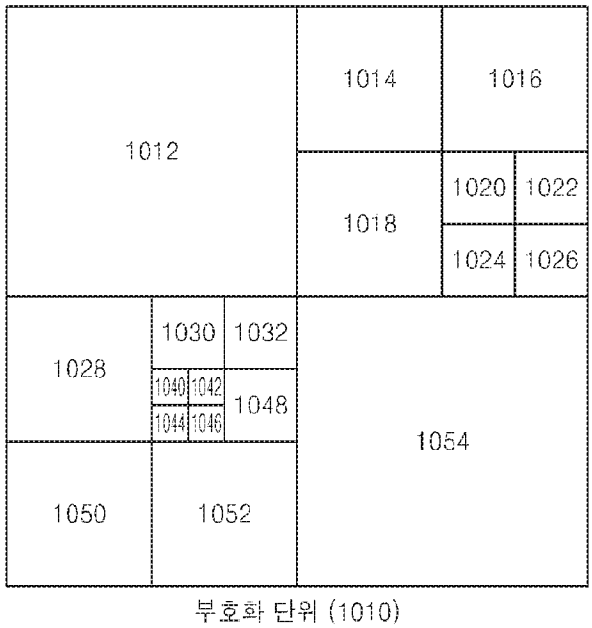
[Fig. 8]


파티션 타입 (800)
2N
802
2N
804
N
806
N
808
2N
CU_0
64×64
N
0
1
2N
0
1
N
0
1
2
3
예측모드 (810)
812
814
816
인트라 모드
인터 모드
스킵 모드
변환 단위 크기 (820)
822
824
826
828
인트라
인터

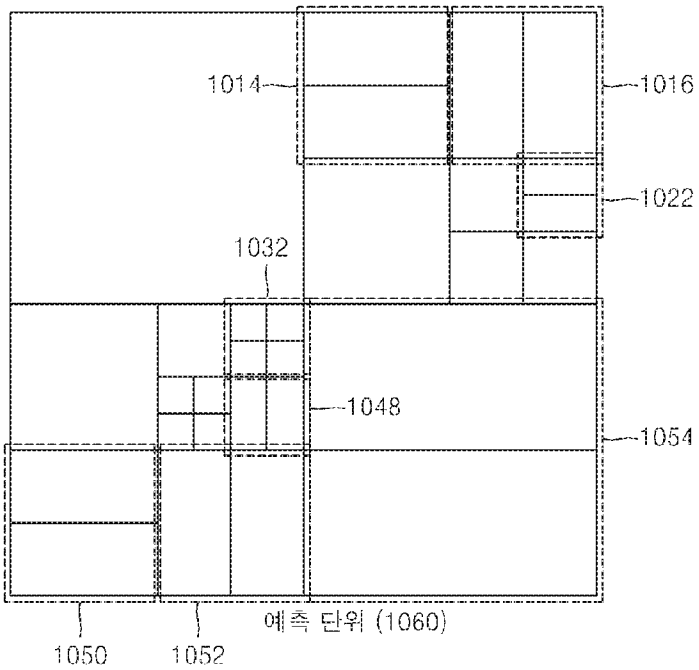
[Fig. 9]


분할 (920)
분할 (950)
분할 (970)
910
940
990
930
960
900
980
912
914
916
918
932
942
944
946
948
992
994
996
998
999
심도=0
심도=1
심도=d-1
CU_0
CU_1
CU_(d-1)
N_0
N_1
N_(d-1)
2N_0
2N_1
2N_(d-1)
2N_d

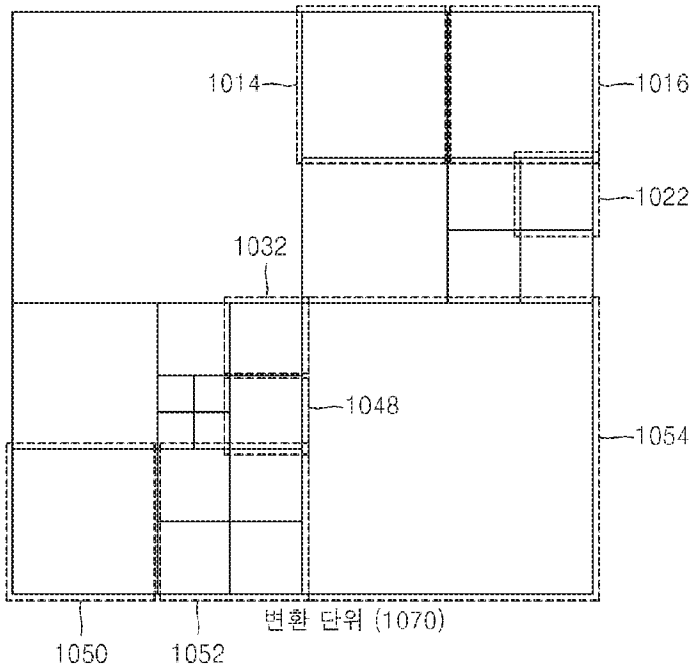
[Fig. 10]


1012
1014
1016
1018
1020
1022
1024
1026
1028
1030
1032
1040
1042
1044
1046
1048
1050
1052
1054
부호화 단위 (1010)

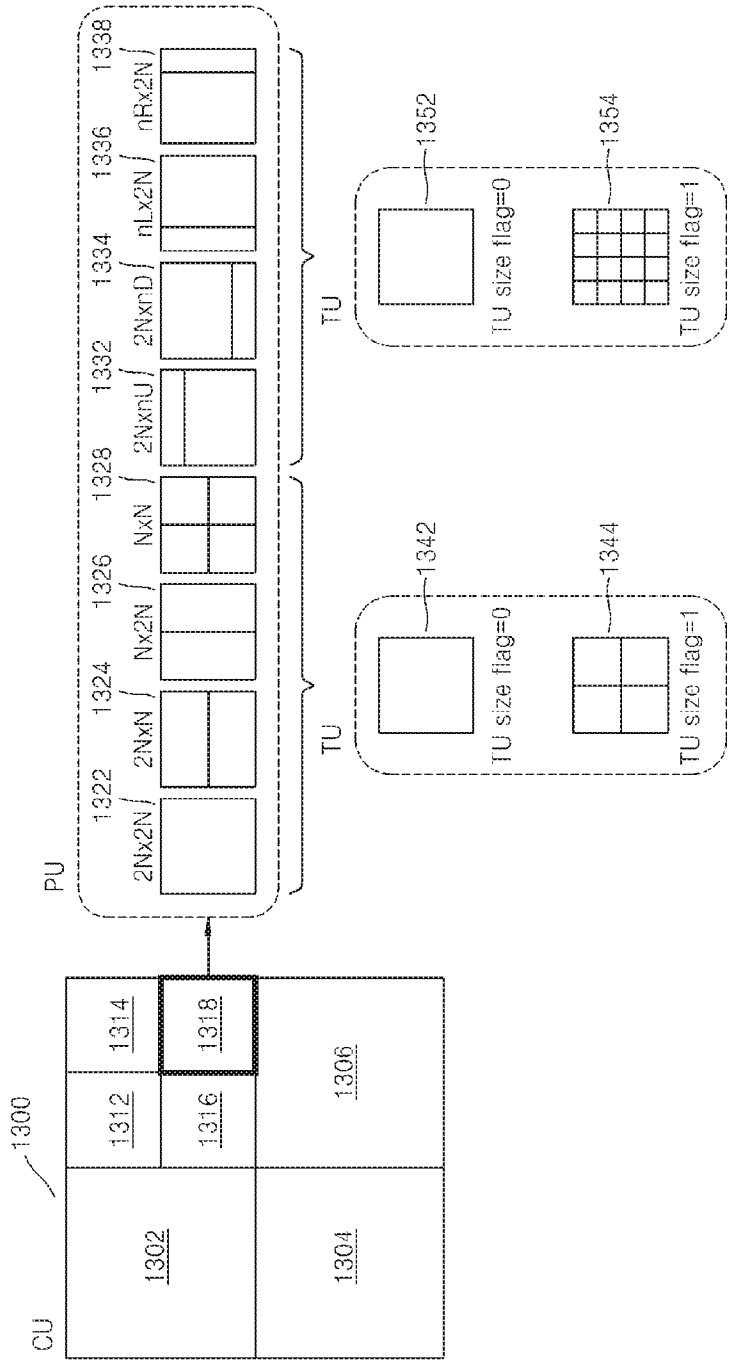
[Fig. 11]


1014
1016
1022
1032
1048
1054
예측 단위 (1060)
1050
1052

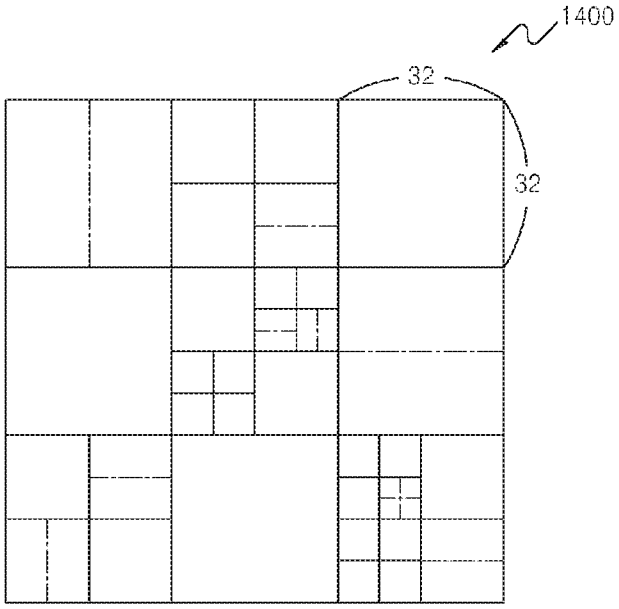
[Fig. 12]


1014
1016
1022
1032
1048
1054
변환 단위 (1070)
1050
1052

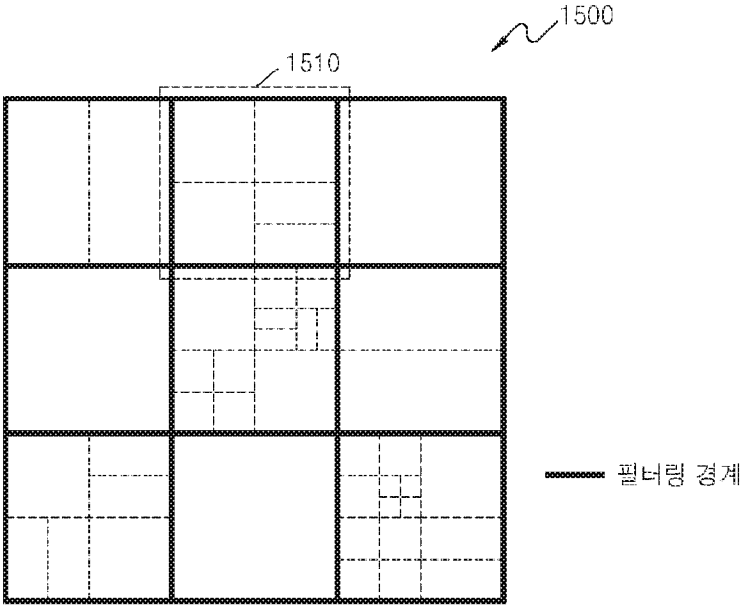
[Fig. 13]


CU
1300
1302
1304
1306
1312
1314
1316
1318
PU
2Nx2N
1322
2NxN
1324
Nx2N
1326
NxN
1328
2NxnU
1332
2NxnD
1334
nLx2N
1336
nRx2N
1338
TU
TU
1342
TU size flag=0
1344
TU size flag=1
1352
TU size flag=0
1354
TU size flag=1

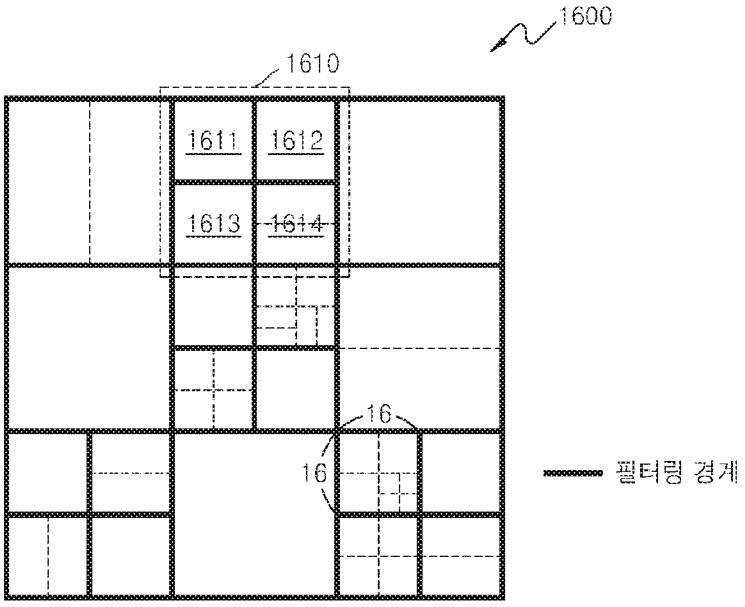
[Fig. 14]



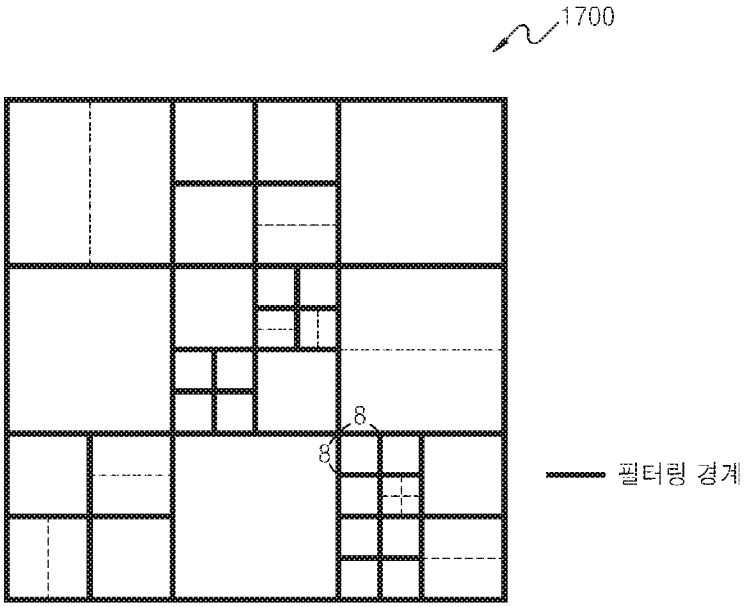
[Fig. 15]



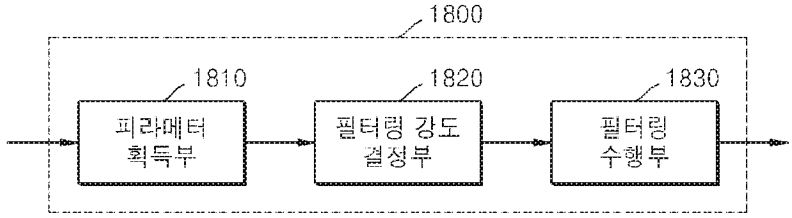
[Fig. 16]



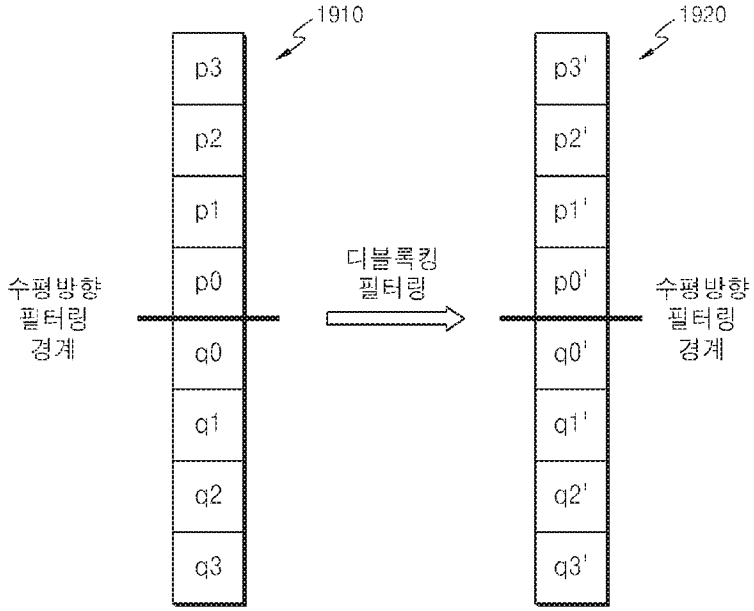
[Fig. 17]



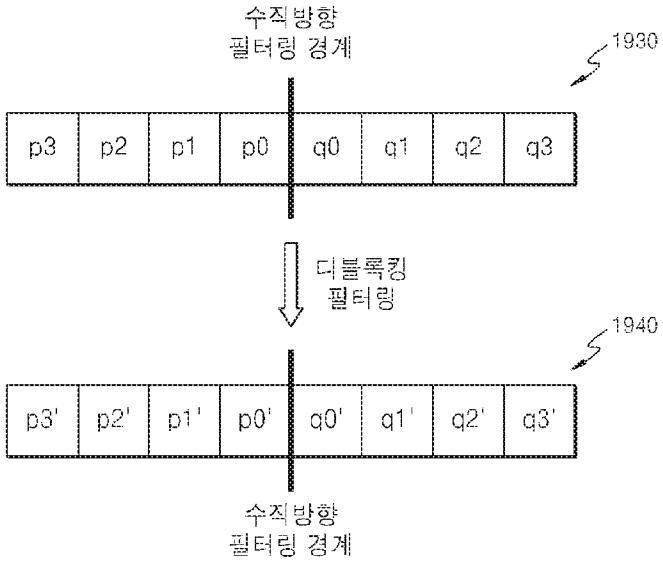
[Fig. 18]



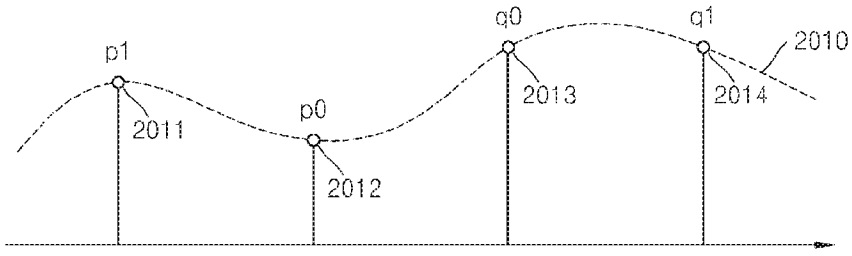
[Fig. 19a]



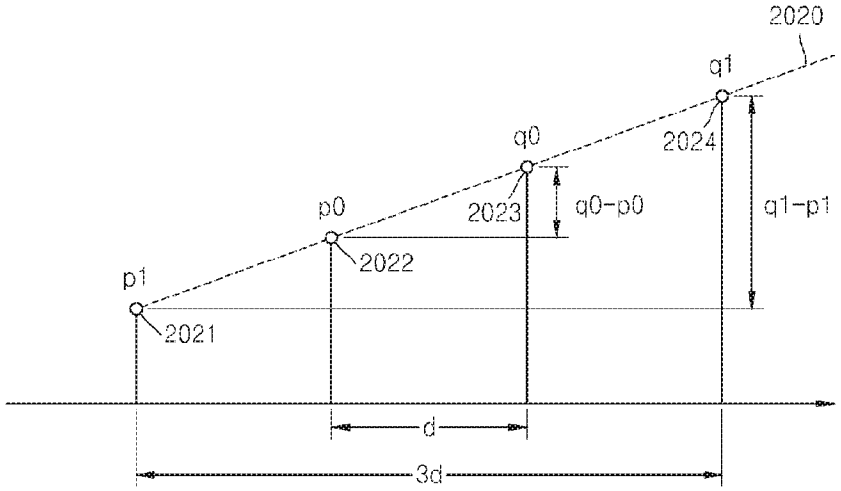
[Fig. 19b]



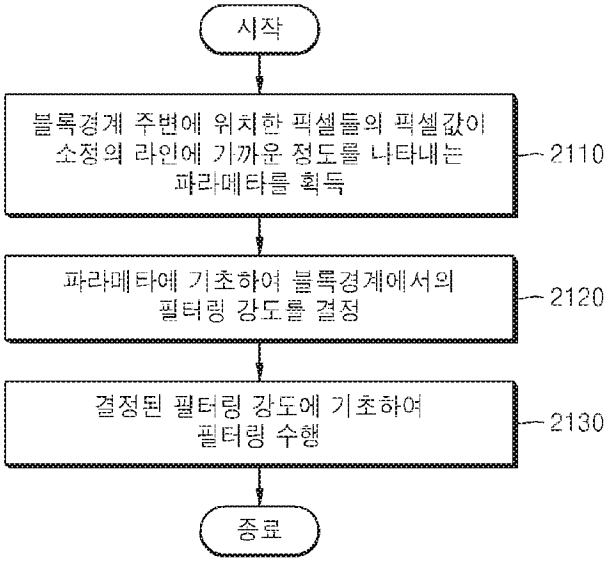
[Fig. 20a]



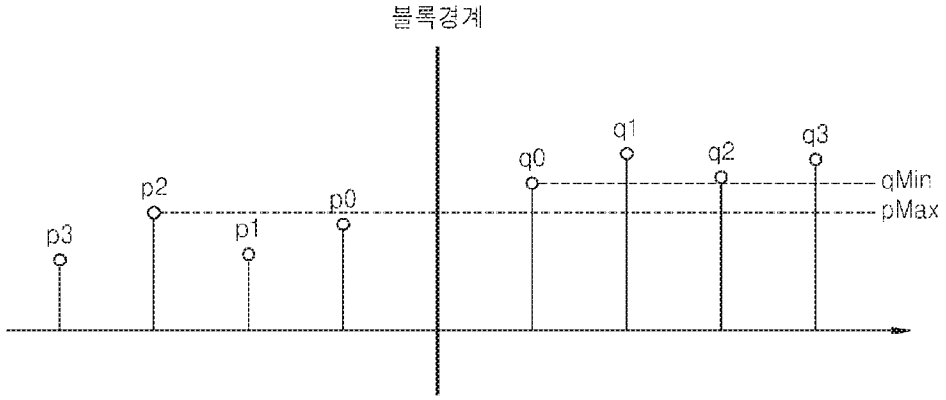
[Fig. 20b]



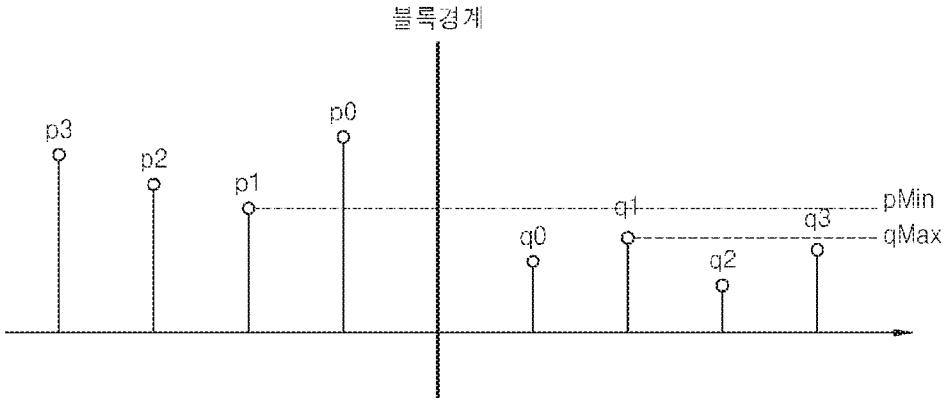
[Fig. 21]



[Fig. 22a]



[Fig. 22b]



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MEASUREMENT-BASED AND SCALABLE DEBLOCK FILTERING OF IMAGE DATA

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Applicant(s): NVIDIA CORP ± (NVIDIA CORP)

Classification: **- international:** ***H04N19/00***
- cooperative: **G06T5/002**; **G06T5/20**; **H04N19/117**; **H04N19/14**; **H04N19/17**; **H04N19/176**; **H04N19/182**; **H04N19/61**; **H04N19/86**; G06T2207/10016; G06T2207/20021

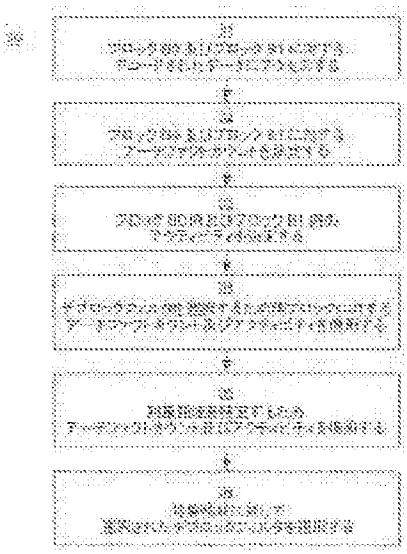
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Abstract of JP2010141883 (A)

PROBLEM TO BE SOLVED: To determine permissible balance between the need for removing blocking artifact and the need for keeping detail at a satisfactory level in deblocking of image data. ;SOLUTION: In a deblocking operation, pixel values in a first block of pixels are compared with each other and the pixel values in the first block are compared with pixel values in a second block of pixels adjacent to the first block. Based on the comparison results, a digital deblocking filter and a target region are selected. The target region is selected for identifying the number of pixels in the first block and the number of pixels in the second block to which the selected filter is to be applied. ;COPYRIGHT: (C)2010,JPO&INPIT



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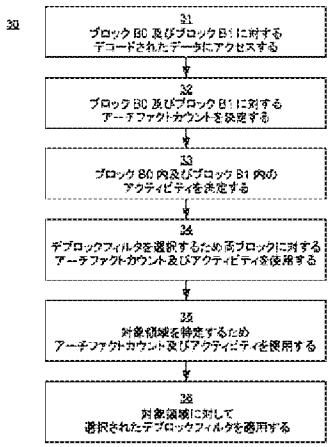
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最終頁に続く

(54)【発明の名称】画像データの測定ベースのスケーラブルデブロックフィルタリング

(57)【要約】
【課題】　画像データのデブロッキングにおいて、ブロッキングアーチファクトを排除する必要性と、ディテールを満足なレベルに維持する必要性との間の許容できるバランスを取り決めること。
【解決手段】　デブロッキング動作において、ピクセルの第１のブロック内のピクセル値が比較され、また、前記第１のブロックにおけるピクセル値が前記第１のブロックに隣接するピクセルの第２のブロックにおけるピクセル値と比較される。前記比較の結果に基づいて、デジタルデブロッキングフィルタ及び対象領域が選択され、前記対象領域は、前記選択されたフィルタが適用されるべき、前記第１のブロックにおけるピクセルの数及び第２のブロックにおけるピクセルの数を識別するものである。
【選択図】　図３



【特許請求の範囲】
【請求項１】
画像データをデブロッキングする方法を行うためのコンピュータ実施可能な命令を有するコンピュータ読み取り可能な媒体において、
前記方法は、
ピクセルの第１のブロック内のピクセル値の比較を行い、前記第１のブロックにおけるピクセル値を、前記第１のブロックに隣接するピクセルの第２のブロックにおけるピクセル値と比較するステップと、
前記比較の結果に基づいて、複数のフィルタからデジタルデブロッキングフィルタを選択し、前記デブロッキングフィルタが適用されるべき対象領域を選択するステップであって、前記対象領域は、前記第１のブロックにおける第１の数のピクセル及び前記第２のブロックにおける第２の数のピクセルを含む、ステップと、
前記デブロックフィルタを前記対象領域に適用して前記第１のブロック及び第２のブロックに対する新しいピクセル値を生成するようにするステップと、
を含む、コンピュータ読み取り可能な媒体。
【請求項２】
前記方法は、更に、
前記ピクセルの第１のブロックに対する第１の値及び前記ピクセルの第２のブロックに対する第２の値を計算するステップであって、前記第１の値は、前記第１のブロックに対する選択されたピクセル値と、前記第１のブロックに隣接し且つ前記第２のブロックを含む第１の複数のブロックに対する選択されたピクセル値との間の差の尺度に基づいており、前記第１の値は、前記第１のブロックに対する第１の複数のピクセル値における偏差の尺度にも基づいており、前記第２の値は、前記第２のブロックに対する選択されたピクセル値と、前記第２のブロックに隣接し且つ前記第１のブロックを含む第２の複数のブロックに対する選択されたピクセル値との間の差の尺度に基づいており、前記第２の値は、前記第２のブロックに対する第２の複数のピクセル値における偏差の尺度にも基づいている、ステップと、
前記複数のフィルタから前記デブロックフィルタを選択するためのインデックスとして前記第１の値及び第２の値のうちの１つを使用するステップと、
を含む、請求項１に記載のコンピュータ読み取り可能な媒体。
【請求項３】
前記方法は、更に、
隣接するピクセルの第１の対についてピクセル値の減算を行うことにより、前記第１のブロックに対する前記選択されたピクセル値と前記第１の複数のブロックに対する前記選択されたピクセル値との間の差を計算するステップであって、前記第１の対の各々は、前記第１のブロックにおけるピクセル及び前記第１の複数のブロックにおけるピクセルに関連付けられている、ステップと、
隣接するピクセルの第２の対についてピクセル値の減算を行うことにより、前記第２のブロックにおける前記選択されたピクセル値と前記第２の複数のブロックにおける前記選択されたピクセル値との間の差を計算するステップであって、前記第２の対の各々は、前記第２のブロックにおけるピクセル及び前記第２の複数のブロックにおけるピクセルに関連付けられている、ステップと、
を含む、請求項２に記載のコンピュータ読み取り可能な媒体。
【請求項４】
前記方法は、更に、
前記第１のブロックに対する前記選択されたピクセル値と前記第１の複数のブロックに対する前記選択されたピクセル値との間の差の各々が第１のしきい値を越える毎に、第１のカウンタ値を増分し、且つ、前記第１のブロックに対する前記選択されたピクセル値と前記第１の複数のブロックに対する前記選択されたピクセル値との間の差の各々が前記第１のしきい値及び第２のしきい値の両方を越える毎に、前記第１のカウンタ値を再び増分

するステップであって、前記第１の値は、前記第１のカウンタ値に基づいている、ステップと、
前記第２のブロックに対する前記選択されたピクセル値と前記第２の複数のブロックに対する前記選択されたピクセル値との間の差の各々が前記第１のしきい値を越える毎に、第２のカウンタ値を増分し、且つ、前記第２のブロックに対する前記選択されたピクセル値と前記第２の複数のブロックに対する前記選択されたピクセル値との間の差の各々が前記第１のしきい値及び前記第２のしきい値の両方を越える毎に、前記第２のカウンタ値を再び増分するステップであって、前記第２の値は、前記第２のカウンタ値に基づいている、ステップと、
を含む、請求項２に記載のコンピュータ読み取り可能な媒体。

【請求項５】
前記方法は、更に、
前記第１の複数のピクセル値についての第１の重み付け平均を計算するステップと、
前記第２の複数のピクセル値について第２の重み付け平均を計算するステップと、
前記第１の複数のピクセル値と前記第１の重み付け平均との間の差を加算して、前記第１の複数のピクセル値における偏差を決定するステップと、
前記第２の複数のピクセル値と前記第２の重み付け平均との間の差を加算して、前記第２の複数のピクセル値における偏差を決定するステップと、
を含む、請求項２に記載のコンピュータ読み取り可能な媒体。

【請求項６】
前記第１の値は、前記第１のブロックに対する前記選択されたピクセル値と前記第１の複数のブロックに対する前記選択されたピクセル値との間の差に比例しており且つ前記第１の複数のピクセル値における偏差に逆比例しており、更に、前記第２の値は、前記第２のブロックに対する前記選択されたピクセル値と前記第２の複数のブロックに対する前記選択されたピクセル値との間の差に比例しており且つ前記第２の複数のピクセル値における偏差に逆比例している、請求項２に記載のコンピュータ読み取り可能な媒体。

【請求項７】
前記第１の値及び前記第２の値のうち最小のものが、前記デブロックフィルタを選択するためのインデックスとして使用される、請求項２に記載のコンピュータ読み取り可能な媒体。

【請求項８】
画像データをデブロッキングするコンピュータ実施方法において、
画像データの第１のブロックにおける第１の複数のピクセルに対するピクセル値と画像データの他のブロックの第１のセットにおける第２の複数のピクセルに対するピクセル値との間の差に基づいて第１のメトリックを算出するステップであって、前記第１のブロック及び前記他のブロックの第１のセットは、共通のエッジを有しており、更に、前記第１の複数のピクセル及び前記第２の複数のピクセルは、前記エッジに隣接している、ステップと、
前記第１のブロックにおける第３の複数のピクセルに対するピクセル値と前記第３の複数のピクセルに対する前記ピクセル値から導出される中間値との間の差に基づいて第２のメトリックを算出するステップと、
前記第１のブロックに対する第１の値を計算するステップであって、前記第１の値は、前記第１のメトリック及び前記第２のメトリックの関数である、ステップと、
前記第３の複数のピクセルについて第１の数のピクセル値にデブロックフィルタを適用して、新しいピクセル値を生成するステップであって、前記第１の数は、前記第１の値に基づく、ステップと、
を含む、コンピュータ実施方法。

【請求項９】
第２のブロックにおける第４の複数のピクセルに対するピクセル値と他のブロックの第２のセットにおける第５の複数のピクセルに対するピクセル値との間の差に基づいて第３

のメトリックを算出するステップであって、前記第２のブロック及び前記他のブロックの第２のセットは、共通のエッジを有しており、更に、前記第４の複数のピクセル及び前記第５の複数のピクセルは、前記エッジに隣接している、ステップと、
前記第２のブロックにおける第６の複数のピクセルに対するピクセル値と前記第６の複数のピクセルに対するピクセル値から導出される中間値との間の差に基づいて第４のメトリックを算出するステップと、
前記第２のブロックに対する第２の値を計算するステップであって、前記第２の値は、前記第３のメトリック及び前記第４のメトリックの関数である、ステップと、
複数のフィルタから、前記第１の値及び前記第２の値のうちの１つでもって前記複数のフィルタを割り出すことにより、前記デブロックフィルタを選択するステップと、
前記第６の複数のピクセルにおける第２の数のピクセル値に前記デブロックフィルタを適用して、新しいピクセル値を生成するステップであって、前記第２の数は、前記第２の値に基づいている、ステップと、
を更に含む、請求項８に記載のコンピュータ実施方法。
【請求項１０】
前記第１の複数のピクセルに対するピクセル値と前記第２の複数のピクセルに対するピクセル値との間の差の各々を２つのしきい値と比較するステップと、
１つのしきい値を越える場合にカウンタ値を１回増分し、両方のしきい値を越える場合にカウンタ値を２回増分するステップであって、前記第１のメトリックは、前記カウンタ値に対応している、ステップと、
を更に含む、請求項８に記載のコンピュータ実施方法。
【請求項１１】
前記第２のメトリックを算出するステップは、
前記第３の複数のピクセルに対するピクセル値についての重み付け平均を計算する工程と、
前記第３の複数のピクセルに対するピクセル値と前記重み付け平均との間の偏差を計算する工程と、
前記第３の複数のピクセルと前記第１のブロックのエッジとの間の距離に基づいて前記偏差を重み付けして、重み付けされた偏差を生成する工程と、
前記重み付けされた偏差を加算する工程であって、前記第２のメトリックは、前記重み付けされた偏差の和に対応する、工程と、
を含む、請求項８に記載のコンピュータ実施方法。
【請求項１２】
前記第１の値は、前記第１のメトリックに比例しており、且つ前記第２のメトリックに逆比例している、請求項８に記載のコンピュータ実施方法。
【請求項１３】
画像データをデコーディングしデブロッキングするためのシステムにおいて、
第１のピクセル値を有するピクセルを含む第１のブロックと、前記第１のブロックに隣接し且つ第２のピクセル値を有するピクセルを含む第２のブロックとを含むデコードされた画像データを記憶するよう動作するコンピュータ読み取り可能なメモリと、
前記メモリに接続され、且つ複数のデブロックフィルタからデジタルデブロックフィルタを選択し、前記第１のピクセル値のうちの第１の数及び前記第２のピクセル値のうちの第２の数に対して前記デブロックフィルタを適用するよう動作するデブロッカーであって、前記第１の数は、前記第１のブロックに対する選択されたピクセル値と前記第２のブロックを含む第１の複数のブロックに対する選択されたピクセル値との間の差に基づいており、前記第１の数は、前記第１のピクセル値の間の偏差にも基づいており、更に、前記第２の数は、前記第２のブロックに対する選択されたピクセル値と前記第１のブロックを含む第２の複数のブロックに対する選択されたピクセル値との間の差に基づいており、前記第２の数は、前記第２のピクセル値の間の偏差にも基づいており、前記デブロックフィルタは、前記第１の数及び前記第２の数のうちの１つでもって前記複数のフィルタを割り出

すことにより選択される、デブロッカーと、
を備えるシステム。
【請求項１４】
前記デブロッカーは、更に、前記第１のブロックに対する選択されたピクセル値と前記第１の複数のブロックに対する選択されたピクセル値との間の差の各々を第１のしきい値及び第２のしきい値と比較し且つそれに応じて第１のカウンタ値を増分するように動作するものであり、前記第１の数は、前記第１のカウンタ値の関数であり、更に、前記デブロッカーは、前記第２のブロックに対する選択されたピクセル値と前記第２の複数のブロックに対する選択されたピクセル値との間の差の各々を前記第１のしきい値及び前記第２のしきい値と比較し且つそれに応じて第２のカウンタ値を増分するように動作し、前記第２の数は、前記第２のカウンタ値の関数である、請求項１３に記載のシステム。
【請求項１５】
前記デブロッカーは、更に、前記第１のピクセル値について第１の重み付け平均を計算し、それから、前記第１のピクセル値と前記第１の重み付け平均との間の差を加算して、前記第１のピクセル値の間の偏差を決定するように動作し、更に、前記デブロッカーは、前記第２のピクセル値について第２の重み付け平均を計算し、次いで前記第２のピクセル値と前記第２の重み付け平均との間の差を加算して、前記第２のピクセル値の間の偏差を決定するように動作する、請求項１３に記載のシステム。
【発明の詳細な説明】
【技術分野】
【０００１】
[0001]本発明による実施形態は、一般的に、データ処理に関し、より詳細には、ビデオデコーディング及びデブロッキングに関する。
【背景技術】
【０００２】
[0002]ビデオは、各々がピクセルの２次元アレイより成る一連のピクチャー（又はフレーム）を含む。これらピクセルは、ブロックに分割される（例えば、ピクセルの８ｘ８アレイ）。ビデオは、総ビットレートを減少させるようにエンコード（圧縮）され、このビデオが別の装置へとより効率的に送信されるようにし、その別の装置において、デコード（解凍）され、再構成され、表示されるようにすることができる。
【０００３】
[0003]現在のビデオ及び画像圧縮技法は、ブロック変換係数の知覚量子化の如き非可逆処理を含む。ビデオフレーム内の独立ブロックを非可逆エンコーディングすると、デコードされ再構成された画像のブロックエッジにブロッキングアーチファクトとして知られる急な移行が生じてしまうことがあり、レンダリングされた画像が比較的に塊状の外観を呈してしまうことがある。
【０００４】
[0004]ブロッキングアーチファクトの出現を排除又は減少させるため、デコーディング装置は、デブロッキング動作を行う。デブロッキングにおいては、隣接ブロックの間の移行を滑らかなものとし、表示されるビデオの知覚品質を改善するため、デブロックフィルタ（例えば、ローパスデジタルフィルタ）がブロック境界に亘って適用される。
【０００５】
[0005]しかしながら、適切な強度のデブロックフィルタを選択するのに問題がある。もし、選択されたフィルタが弱過ぎる場合には、ブロッキングアーチファクトの出現を効果的に減少させることができない。他方では、もし、選択されたフィルタが強すぎる場合には、多くのディテールが除去され過ぎてしまうことがある。
【０００６】
[0006]デブロックフィルタを適用するピクセルの数を選択するのにも問題がある。一方の極端な場合として、もし、ブロック境界に直ぐ隣接するピクセルのみにフィルタを適用する場合には、ブロッキングアーチファクトは、効果的に減少又は排除されないことがあ

る。他方の極端な場合として、もし、フィルタがブロックにおけるピクセルの全てに亘って適用される場合には、幾つかのピクセル値が不必要に変更されてしまい、そのブロック内のディテールが失われてしまうことがある。

【発明の概要】

【発明が解決しようとする課題】

【０００７】

[0007]従って、ブロッキングアーチファクトを減少又は排除する必要性と、ディテールを満足なレベルに維持する必要性との間の許容できるバランスを取り決めるできるデブロックフィルタを選択できることが重要である。また、画像データのオーバーフィルタリング及び画像ディテールの付随的ロスを避けるために、選択されたデブロックフィルタが適用されるべきピクセルの数を決定できることも重要である。

【課題を解決するための手段】

【０００８】

[0008]本発明の実施形態によれば、デブロッキングするため、ピクセルの第１のブロック内のピクセル値が比較され、また、前記第１のブロックにおけるピクセル値が前記第１のブロックに隣接するピクセルの第２のブロックにおけるピクセル値と比較される。前記比較の結果に基づいて、デジタルデブロッキングフィルタ及び「対象領域」が選択され、前記対象領域は、前記選択されたフィルタが適用されるべき、前記第１のブロックにおけるピクセルの数及び第２のブロックにおけるピクセルの数を識別するものである。

【０００９】

[0009]より特定すると、１つの実施形態では、ピクセルの第１のブロックに対して第１の値が計算され、ピクセルの第２のブロックに対して第２の値が計算され、前記第２のブロックは、前記第１のブロックに隣接するものである。１つの実施形態では、前記第１の値は、前記第１のブロックに対する「アーチファクトカウント」及び前記第１のブロック内の「アクティビティ」に基づいている。前記アーチファクトカウントは、前記第１のブロックに関連するブロッキングアーチファクトの数の尺度を与える。前記アクティビティは、前記第１のブロックでの変動量の尺度を与えており、より特定すると、アクティビティは、選択されたピクセル値の平均又は重み付け平均の如き中間値からの前記選択されたピクセル値の偏差量の尺度を与える。同様の形式において、前記第２の値は、前記第２のブロックに対するアーチファクトカウント及び前記第２のブロック内のアクティビティに基づいている。このような実施形態では、前記第１の値及び前記第２の値は、各々前記アーチファクトカウントに比例しており且つ前記第１のブロック及び前記第２のブロック内の前記アクティビティにそれぞれ反比例している。

【００１０】

[0010]１つの実施形態では、前記アーチファクトカウントは、前記第１のブロックと前記第２のブロックとの間の境界に亘るピクセル値の差を計算し、それらの差を２つのしきい値と比較することにより、決定される。２つのしきい値の使用により、前記アーチファクトの視覚感度をより正確に評価することができ、適切な強度のデブロックフィルタを選択することが容易となる。このような実施形態では、ユーザー（例えば、視聴者）は、個々の好みに基づいて、前記しきい値のうちの少なくとも１つを選択する。

【００１１】

[0011]１つの実施形態では、前述の第１の値及び第２の値のうちの１つが、フィルタのバンクの中からデジタルデブロックフィルタを選択するためのインデックスとして使用され、前記バンクのフィルタは、前記インデックスの値が増大するにつれて、次第に強度が増大していくものである。このような実施形態では、前記第１の値及び前記第２の値のうちの最小のものが、デブロックフィルタを選択するのに使用される。異なる強度のフィルタを有するフィルタバンクの使用により、固定フィルタリング及びフィルタリング判断の間のハードスイッチングに伴う欠点を排除することができる。更にまた、前記フィルタバンクにおけるフィルタの数は、本発明を実施するのに使用されるグラフィック処理装置（ＧＰＵ）のタイプに従って特定することができる。例えば、ロアーエンド又はベースライ

ンＧＰＵに使用する場合には、より少ないタップを有するより少ない数のフィルタを選択することができる。一般的には、計算処理能力の異なるレベルを有する異なる実施を支援するため、フィルタリングの全体の複雑さを縮小又は拡張することができる。

【００１２】

[0012]それから、前記選択されたデブロックフィルタが、前記第１のブロックと前記第２のブロックとの間の境界に亘って、前記境界の一方の側における特定の数のピクセル及び前記境界の他方の側における特定の数のピクセルに対して適用され、前記ブロック境界に亘る移行を滑らかなものとする前記第１のブロック及び前記第２のブロックに対する新しいピクセル値を生成することができる。より特定すると、前記選択されたデブロックフィルタは、前記第１のブロックにおける第１の数のピクセル値及び前記第２のブロックにおける第２の数のピクセル値に対して適用される。１つの実施形態では、前記ピクセル値の第１の数は、前述した第１の値に対応し、前記ピクセル値の第２の数は、前述の第２の値に対応する。従って、前記第１の値及び前記第２の値は、デブロックフィルタを選択すること及び対象領域を定めることの両者のために使用される。

【００１３】

[0013]要するに、本発明の実施形態によれば、デブロックフィルタリングは、適応性（例えば、ブロック当たりのアーチファクトカウント及びアクティビティによって測定されるようなピクセル値の品質に対して）があり、スケーラブル（例えば、グラフィックスカードの能力に対して）であり、且つユーザーにより制御できるものとなる。本発明による実施形態は、広範囲の処理能力に対して十分に適合できるばかりでなく、広範囲のビデオ品質及び低ビットレートビデオ（例えば、インターネットビデオ）の増強の如きアプリケーションに対しても十分に適合できるものである。

【００１４】

[0014]本発明の種々な実施形態のこれらの目的及び他の目的及び効果については、当業者であれば、種々な図面に例示されている実施形態の以下の詳細な説明を読んだ後、認識できよう。

【００１５】

[0015]本発明は、添付図面の各図に、これに限定するものとしてではなく、単なる例示として示されており、これら図において、同様の参照符号は、同様の要素を指している。

【図面の簡単な説明】

【００１６】

【図１】本発明の実施形態によるデコーダを実施することができるシステムの一例のブロック図である。

【図２】本発明の１つの実施形態によるデコーディング及び後処理パイプラインの一例の要素を示すブロック図である。

【図３】本発明の一実施形態による画像データをデブロッキングするためのコンピュータ実施方法のフローチャートである。

【図４】本発明の一実施形態による画像フレームにおけるブロックのアレイの一例を示している。

【図５】本発明の一実施形態によるブロッキングアーチファクトを計数するのに使用されるしきい値を例示している。

【図６】（Ａ）は、本発明の一実施形態によるブロックにおけるピクセルの行の一例を示している。（Ｂ）は、本発明の一実施形態によるピクセル値の分布の一例を示している。

【図７】本発明の一実施形態による対象領域の一例を示している。

【図８】本発明の一実施形態による画像データを処理するためのコンピュータ実施方法の一例のフローチャートである。

【発明を実施するための形態】

【００１７】

[0025]幾つかの実施形態が添付図面に例示されている、本発明による実施形態について、以下詳細に説明する。これら実施形態に関連して本発明を説明するのであるが、これら

説明は、本発明をこれらの実施形態に限定しようとしているものではないことは、理解されよう。反対に、本発明は、特許請求の範囲により定められるような本発明の精神及び範囲内に含まれる代替物、変形物及び均等物を包含しようとしているものである。更にまた、本発明の実施形態の以下の詳細な説明においては、本発明を完全に理解できるようにするため、多くの特定の細部について説明している。しかしながら、本発明は、これらの特定の細部を伴わずとも実施できるものであることは、当業者には認識されよう。一方では、よく知られた方法、手順、構成部分及び回路については、本発明の実施形態の態様を不必要に不明瞭なものとしてしまわないように、詳述していない。

【００１８】

[0026]以下の詳細な説明の幾つかの部分は、コンピュータメモリ内のデータビットに関するオペレーションの手順、ステップ、ロジックブロック、処理及びその他の記号表現の形にてなされている。これらの説明及び表現は、自分の業績の実体を他の当業者に対して最も効果的に伝えるため当業者により使用される手段である。手順、コンピュータ実行ステップ、ロジックブロック、プロセス等は、ここで、且つ一般的に、希望の結果に至る自己矛盾のない一連のステップ又は命令であると考えられている。これらステップは、物理量の物理的操作を必要とするものである。通常、必ずしもそうではないが、これらの量は、コンピュータシステムにおいて記憶されたり、転送されたり、結合されたり、比較されたり、その他の形にて操作されることのできる電気的又は磁気的信号の形を取っている。これらの信号を、ビット、値、要素、記号、文字、用語、数字等として記載するのが、時には、また、主として慣用されているという理由で、便宜的であることが分かっている。

【００１９】

[0027]しかしながら、これらの及び同様の用語の全ては、適当な物理量に関連付けられるものであり、これらの量に適用される単なる便宜的なラベルに過ぎないことを、念頭におかれたい。前述したことから明らかなように、特に断らない限り、本発明を通じて、「エンコーディング」、「デコーディング」、「デブロッキング」、「受け取る」、「送る」、「使用する」、「適用する」、「計算する」、「増分する」、「比較する」、「選択する」、「加算する」、「重み付けする」、「コンピューティング又は算出する」、「アクセスする」等の如き用語を使用する説明は、コンピュータシステムのレジスタ及びメモリ内の物理（電子的）量として表されているデータを操作して、コンピュータシステムのメモリ又はレジスタ又は他の同様の情報記憶、送信又はディスプレイ装置内の物理量として同様に表される他のデータへと変換するコンピュータシステム又は同様の電子的コンピューティング装置の動作及び処理を指していることを、理解されたい。

【００２０】

[0028]図３及び図８は、本発明の実施形態によるデータを処理するためのコンピュータ実施方法の一例のフローチャートである。これらフローチャートでは、特定のステップが示されているが、このようなステップは、典型的な例示である。即ち、本発明の実施形態は、種々な他のステップ又はこれらフローチャートに示されているステップの変形を行うため十分に適合されるものである。

【００２１】

[0029]図３及び図８のフローチャートは、１つ以上のコンピュータ又は他の装置により実行される、プログラムモジュールの如きある形式のコンピュータ使用可能な媒体に存在するコンピュータ実行可能な命令として実施することができる。一般的に、プログラムモジュールは、特定のタスクを行い又は特定の抽象データタイプを実施するルーチン、プログラム、オブジェクト、コンポーネント、データ構造等を含む。プログラムモジュールの機能は、種々な実施形態において望まれるように組み合わされ又は分散させることができる。

【００２２】

[0030]一例として、これに限定するものではないが、コンピュータ使用可能な媒体は、コンピュータ記憶媒体及び通信媒体を含むことができる。コンピュータ記憶媒体は、コンピュータ読み取り可能な命令、データ構造、プログラムモジュール又は他のデータの如き

情報を記憶するための任意の方法又は技法において実施される揮発性及び不揮発性、リムーバブル及びノンリムーバブル媒体を含む。コンピュータ記憶媒体は、これらに限定されないが、ランダムアクセスメモリ（ＲＡＭ）、リードオンリメモリ（ＲＯＭ）、電気的に消去可能なプログラマブルＲＯＭ（ＥＥＰＲＯＭ）、フラッシュメモリ又は他のメモリ技法、コンパクトディスクＲＯＭ（ＣＤ-ＲＯＭ）、デジタルバーサタイルディスク（ＤＶＤ）又は他の光記憶装置、磁気カセット、磁気テープ、磁気ディスク記憶装置又は他の磁気記憶装置、又は希望の情報を記憶するのに使用される任意の他の媒体を含む。

【００２３】

[0031]通信媒体は、搬送波又は他のトランスポート機構の如き変調データ信号におけるコンピュータ読み取り可能な命令、データ構造、プログラムモジュール又は他のデータを実施することができ、任意の情報配信媒体を含む。用語「変調データ信号」は、信号のもつ諸特性のうちの１つ以上のものが、その信号における情報をエンコードするような仕方にて設定され又は変更されているような信号を意味している。一例として、これに限定するものではないが、通信媒体は、ワイヤードネットワーク又はダイレクトワイヤード接続の如きワイヤード媒体、及び音響、無線周波数（ＲＦ）、赤外線及び他のワイヤレス媒体の如きワイヤード媒体を含む。前述したものの任意のものの組合せも、コンピュータ読み取り可能な媒体の範囲内に含まれるものである。

【００２４】

[0032]以下の説明において、そうではないと言わない限り、「デコーダ」は、デコーディング及びデブロッキングの両方を行う要素（例えば、スタンドアロン又は周辺装置又は統合システム）を指している。「デコーディング」は、そうではないと言わない限り、基本デコーディング動作（例えば、可変長デコーディング、逆量子化、逆変換及びモーション補償）を指しており、一方、「デブロッキング」は、デコーディング結果に対してデブロックフィルタを適用することを指している。「ブロック」は、ピクセルのアレイ（例えば、ＮｘＮアレイ）を指している。用語「ピクセル」は、２次元スクリーンスペースにおける位置を指しており、一方、用語「ピクセル値」は、ピクセルに関連したデータ（例えば、ルマ値、クロマ値等）を指している。

【００２５】

[0033]図１は、本発明によるデコーダを実施することができるシステム１０の一例のブロック図である。図１の実施形態では、このシステムは、バス１５を介してグラフィック処理装置（ＧＰＵ）１２に結合されたホスト中央処理装置（ＣＰＵ）１１を含む。このＧＰＵは、媒体処理装置（ＭＰＵ）とも称される。

【００２６】

[0034]これらＣＰＵ及びＧＰＵは、共に、メモリ１４に結合されている。図１の実施形態では、そのメモリは、共有メモリであり、このメモリは、ＣＰＵ及びＧＰＵの両方のための命令及びデータを記憶する。別の仕方として、ＣＰＵ及びＧＰＵのそれぞれに専用の別々のメモリを設けることができる。このメモリは、結合されるディスプレイ（スクリーン）１３を駆動するピクセルデータを記憶するためのビデオバッファを含むこともできる。

【００２７】

[0035]このシステム１０は、１つの実施では、オンスクリーンカーソル制御装置を含むユーザーインターフェース１６をも含む。このユーザーインターフェースは、キーボード、マウス及び／又はタッチスクリーン装置（タッチパッド）を含むことができる。

【００２８】

[0036]一般的に言うと、このシステム１０は、本発明の実施形態による機能を実施するコンピュータシステムプラットフォームの基本構成部分を含む。このシステム１０は、例えば、多数の異なるタイプのコンピュータシステム（例えば、サーバー、ラップトップ、デスクトップ及びノートブック）のうちの任意のもの、並びに、セットトップボックス又はデジタルテレビジョンの如き家庭用娯楽システム（例えば、ＤＶＤプレーヤー）、又は携帯用又は手持ち型電子装置（例えば、携帯電話、携帯情報端末又は手持ち型ゲーム装置

）として実施される。

【００２９】

[0037]図２は、本発明の１つの実施形態によるデコーダ２０の要素を示すブロック図である。一般に、このデコーダは、エンコードされたビットストリーム２１を受け取り、そのビットストリームにおけるデータをデコードし、表示可能な画像データ２４を生成する。

【００３０】

[0038]１つの実施形態では、生の画像データ（例えば、ビデオデータ）は、エムペグフォー（ＭＰＥＧ－４）パート１０又はＭＰＥＧ－４アドバンスドビデオコーディング（ＡＶＣ）としても知られている、Ｈ.２６４の如き圧縮スキームを使用して圧縮（エンコード）される。従って、これらに限定されないが、フレームタイプ（例えば、イントラコードＩ－フレーム、予測Ｐ－フレーム又は双予測Ｂ－フレーム）、マクロブロック予測モード（例えば、インターブロック対イントラブロック）、変換（例えば、離散コサイン変換）係数、テクスチャ係数及びモーションベクトル情報の如きエンコーディングパラメータのセットが生成される。それから、これらエンコーディングパラメータは、例えば、ハフマンコーディングを使用して、可変長コード（ＶＬＣ）へと変換される。そのエンコードされたビットストリームは、そのＶＬＣを含む直列化ビットストリームである。

【００３１】

[0039]デコーダは、本質的には、画像データを再構成するように、エンコーディング処理の逆を行うものである。図２の実施形態では、デコーダは、デコーディングステージ２２及びデブロッキングステージ２３を含むデコーディングパイプライン２６を含む。

【００３２】

[0040]デコーディングステージは、可変長デコーディング、逆量子化、逆変換及びモーション補償の如き基本デコーディング（解凍）動作を行う。一般的に、デコーディングステージは、ＶＬＣを抽出するためエンコーダされたビットストリームを構文解析し、それから、前述したエンコーディングパラメータを再生するようにそのＶＬＣを変換する。次いで、それらエンコーディングパラメータは、元のビデオデータを再構成するのに使用される（より特定すると、元のビデオデータのある変形が構成される）。

【００３３】

[0041]デブロッキングステージにおいては、再構成された画像がレンダリングされる（表示される）ときに、隣接ブロックの間の境界を滑らかなものとするため、デジタルデブロックフィルタが、デコードされるブロックに適用される。図２の実施形態では、デブロッキングステージは、デコーディングステージにおいて行われるデコーディングのタイプとは無関係であり、従って、ループ外デブロッカーとして類別することができる。

【００３４】

[0042]図３は、本発明の一実施形態によるコンピュータ実施デブロッキング方法の概観を与えるフローチャート３０である。ステップ３１において、図４も参照するに、第１のブロックＢ０及び第２のブロックＢ１に対するデコードされるデータ（ピクセル値）にアクセスする。１つの実施形態では、ここで説明しようとしているデブロッキング方法に対しては、計算の数及び複雑さを減少させるために、ルマ平面のみが使用される。主観テストによれば、ブロッキングアーチファクトの知覚に関しては、クロマ値は、ルマ値程には重要ではなく、従って、デブロックフィルタリングの強度を確立するのに、ルマ値のみを使用することができることが示されている。しかしながら、本発明は、ルマ値のみを使用することに限定されない。

【００３５】

[0043]図３のステップ３２において、ブロックＢ０及びＢ１の各々について、「アーチファクトカウント」が決定される。一般的に言って、アーチファクトカウントは、各ブロックに関連したブロッキングアーチファクトの数の尺度である。更なる情報については、図４の説明に関連して与えられる。

【００３６】

[0044]図３のステップ３３において、ブロックＢ０及びＢ１の各々について、「アクティビティ」が決定される。一般的に言って、アクティビティは、ブロック内のピクセル値の偏差の尺度である。更なる情報については、図６の（Ａ）及び（Ｂ）の説明に関連して与えられる。

【００３７】

[0045]図３のステップ３４において、フィルタバンクからデブロックフィルタを選択するのに、両ブロックについてのアーチファクトカウント及びアクティビティが一緒に使用される。より特定すると、１つの実施形態では、第１のブロックについての第１の値Ｎ０が、第１のブロックについてのアーチファクトカウント及びアーチファクトに基づいて計算され、同様にして、第２のブロックについての第２の値Ｎ１が計算される。これら値Ｎ０及びＮ１は、インデックス値Ｎを設定するのに使用され、そのインデックス値は、次いで、フィルタバンクからデブロックフィルタを選択するのに使用される。更なる情報については、図７の説明に関連して与えられる。

【００３８】

[0046]図３のステップ３５において、アーチファクトカウント及びアクティビティは、選択されたデブロックフィルタが適用されるべきブロックＢ０及びＢ１におけるピクセル値の数を選択するための基礎としても使用される。より特定すると、１つの実施形態では、値Ｎ０及びＮ１は、ブロックＢ０及びＢ１の境界に亘って延長し且つ選択されたデブロックフィルタが適用されるべきピクセルの数を定める「対象領域」を特定するのに使用される。更なる情報については、図７の説明に関連して与えられる。

【００３９】

[0047]図３のステップ３６において、選択されたデブロックフィルタは、対象領域に対してブロックＢ０及びＢ１の間の境界に亘って適用される。即ち、選択されたデブロックフィルタは、それらブロックの各々における対応する数の新しい（変更された）ピクセル値を生成するように、ブロックＢ０における特定された数のピクセル値及びブロックＢ１における特定された数のピクセル値に対して適用される。更なる情報については、図７の説明に関連して与えられる。

【００４０】

[0048]１つの実施形態では、前述したような方法が２つのパス、即ち、垂直境界が処理される水平パス及び水平境界が処理される垂直パスにおいて、画像フレームにおけるブロックの全ての水平境界及び垂直境界に対して適用される。これら２つのパスは、順次行われ、この場合には、第１のパスの結果（変更されたピクセル値）は、記憶されて、第２のパスのための入力として使用される。

【００４１】

アーチファクトカウント

[0049]ここで図４を参照するに、画像フレーム４０は、ブロックＢ０及びＢ１を含むブロックのアレイを含む。このフレーム４０は、あるビデオにおけるように、このようなフレームのシーケンスにおける１つのフレームであってよい。

【００４２】

[0050]図４においては、８つ（８）のブロックのみが表されているが、実際には、画像フレームは、このような多数のブロックを含むものである。ブロックＢ０及びＢ１は、互いに隣接しており、即ち、ブロックＢ０及びＢ１は、エッジ又は境界４１を共有している。ブロックＢ１に加えて、ブロックＢ０に隣接する多数の他のブロックがあり、同様に、ブロックＢ０に加えて、ブロックＢ１に隣接する多数の他のブロックがある。

【００４３】

[0051]図４の実施形態例では、各ブロックは、８ｘ８のピクセルのアレイを含む。しかしながら、本発明は、これに限定されるものでなく、他のブロックサイズでも使用できるものである。ここでの説明のため、ブロック境界は、ピクセルの間に入るものとして定義されていることに注意されたい。ピクセルの全てが図４に例示されているのではなく、ブロックＢ０及びＢ１の境界に隣接するピクセルのみが示されている。

【００４４】
[0052]前述したように、本発明の一実施形態によれば、画像フレームにおけるブロックの各々に対して、アーチファクトカウントが決定される。一般的に言って、１つのブロックに対するアーチファクトカウントは、そのブロックと隣接ブロック（その対象ブロックとエッジを共有する４つのブロック）との間の境界に亘る選択されたピクセル値（例えば、ルマ値）の間の差をしきい値処理することにより、決定される。各ブロックに対する測定は、そのブロックの境界の４つ全てに亘って行われる。ブロック当たりのアーチファクトカウントは、記憶され、その後、デブロックフィルタを選択し且つそのフィルタが適用されるピクセルの数を選択するのに、アクティビティ尺度と共に使用される。
【００４５】
[0053]より特定すると、１つの実施形態では、隣接ピクセルの各対について、ピクセル値の減算がなされ、ここで、各対は、ブロック境界の一方の側の１つのピクセルと、そのブロック境界の他方の側の直ぐ隣接するピクセルとからなるものである。ブロックＢ０及びＢ１を例として使用すると、ピクセルｐ０に対するピクセル値とピクセルｑ０に対するピクセル値との間の減算がなされる。同様に、ピクセルｐ１に対するピクセル値とピクセルｑ１に対するピクセル値との間の減算がなされ、そして、ブロックＢ０の４つのエッジの各々の周りについて全てそのような減算がなされる。即ち、ブロックＢ０に対するアーチファクトカウントは、ブロックＢ０とブロックＢ１との間の境界、ブロックＢ０とブロックＢ２との間の境界、ブロックＢ０とブロックＢ３との間の境界及びブロックＢ０とブロックＢ４との間の境界に亘るピクセル値の差に基づいている。
【００４６】
[0054]このような処理は、ブロックＢ１の４つのエッジの各々に沿う各ピクセルに対して繰り返され、最終的には、そのフレームにおける各ブロックに対して繰り返される。２つのピクセル値の間の差の絶対値は、その差が常に正の数であるように、使用される。
【００４７】
[0055]従って、任意のブロックＢＮに対して、

$$diff(BN,i) = |[p(i)\text{に対するピクセル値}] - [q(i)\text{に対するピクセル値}]| \quad (1)$$

ここで、ピクセルｐ（ｉ）は、ブロックＢＮのエッジに位置しており、ｑ（ｉ）は、ピクセルｐ（ｉ）からのブロック境界に亘る、直ぐそれに隣接したピクセルである。隅部のピクセルに対するピクセル値は、水平パスにおいて１回、垂直パスにおいて１回の合計２回使用される。従って、図４の実施形態では、ｉ＝１，２，……，３２である。
【００４８】
[0056]１つの実施形態では、図５を参照するに、差diff（ＢＮ，ｉ）の各々は、それから、第１のしきい値thr１及び第２のしきい値thr２の両者と比較され、ここでは、第２のしきい値は、第１のしきい値より大きい。このような実施形態では、第２のしきい値は、第１のしきい値の定数倍であり、即ち、thr２＝ｎ＊thr１であり、ここで、ｎ＞１である。従って、もし、第１のしきい値が増大される場合には、第２のしきい値も増大される。第１のしきい値と第２のしきい値との間のこのような関係のため、第１のしきい値と第２のしきい値との間の範囲は、第１のしきい値が増大される場合には、増大される。
【００４９】
[0057]これらブロックの各々に、カウンタが関連付けられており、例えば、第１のカウンタがブロックＢ０に関連付けられており、第２のカウンタがブロックＢ１に関連付けられている。図５の実施形態では、「ｉ」の各値に対して、もし、diff（ＢＮ，ｉ）の値が第１のしきい値thr１以上である場合には、ブロックＢＮに関連付けられたカウンタは増分される（例えば、１の値だけ増大される）。もし、diff（ＢＮ，ｉ）の値が第１のしきい値thr１より小さい場合には、ブロックＢＮに関連付けられたカウンタは、diff（ＢＮ，ｉ）とthr１との比だけ増大される。もし、diff（ＢＮ，ｉ）の値が第２のしきい値thr２以上である場合には、ブロックＢＮに関連付けられたカウンタは再び増分される（例えば、更に１の値だけ増大される）。もし、diff（ＢＮ，ｉ）の値が第２のしきい値thr２より

小さいが第１のしきい値thr１より大きい場合には、ブロックＢＮに関連付けられたカウンタは、diff（ＢＮ，ｉ）とthr２との比だけ増大される。この実施形態では、カウンタ値は、第２のしきい値thr２が越えられるとしても、２より多い増分だけ増大されることはないことに注意されたい。

【００５０】

[0058]従って、例えば、ブロックＢ０に対して、

Artifactcount（Ｂ０，ｉ）＝

min（１，[diff（Ｂ０，ｉ）/thr１]）＋min[１，diff（Ｂ０，ｉ）/thr２]）　（２）

Artifactcount_Ｂ０＝Σ（Artifact_count（Ｂ０，ｉ））　（３）

ここで、Artifact_count（Ｂ０，ｉ）は、ブロックＢ０に対するカウンタ値がdiff（Ｂ０，ｉ）の各値に対して増大される量であり、Artifact_count_Ｂ０は、ブロックＢ０に対するカウンタの最終値である。このようにして、ブロックＢ０に対するアーチファクトカウントが累積され、同様にして、ブロックＢ１及びフレームにおける各ブロックに対してアーチファクトカウントが累積される。

【００５１】

[0059]ブロッキングアーチファクトに対する可視感度をより良く評価するため、２つの別々のしきい値が使用される。もし、例えば、あるブロック境界に亘るピクセル値の差が相当に大きく、且つ、もし、そのブロック境界を取り巻く区域が比較的に低い周波数のコンテンツ（低アクティビティ）を有する場合には、そのアーチファクトは、より可視的に気になるものとなろう。このような情況においては、その境界でのブロックエッジは、そのアーチファクトを許容できる程度まで減少させるため、増大長さ（より多くのタップ）を有する強いローパスフィルタを使用すると、より良好に処理されるであろう。こうするために、両しきい値を越えるに十分に大きな各差は、そのカウンタ値に加えられる増分量を２倍とする。もし、アクティビティが低い場合には、増大したローパスフィルタリング能力を有する強いフィルタを選択することで、その代わりとすることができる。

【００５２】

[0060]１つの実施形態では、しきい値は、ユーザーにより制御される。即ち、ユーザーは、例えば、第１のしきい値thr１を特定することができる。何故ならば、第２のしきい値thr２は、第１のしきい値の倍数であり、第２のしきい値もまた、ある意味では、ユーザーにより制御される値であるからである。フィルタの強度は、しきい値thr１を減少することにより増大され、また、その逆とすることもできる。従って、ユーザーは、例えば、自分の個人的好み又はユーザーの装置の表示能力に基づいて、デブロックフィルタリングの強度を確立することができる。ループ外デブロッキングはデコーディングとは無関係であるので、デコードされたコンテンツの同じインスタンスを、一方では、より大きなスクリーンサイズ又はより高い解像度のディスプレイのためにフィルタリングすることができ、また、他方では、より小さなスクリーンサイズ又はより低い解像度のディスプレイのためにフィルタリングすることができる。

【００５３】

[0061]１つの実施においては、ユーザーには、そのユーザーが任意の値の範囲内（例えば、０から１００まで）に位置させることのできるスライダーの如きグラフィックユーザーインターフェース（ＧＵＩ）が与えられる。従って、ユーザーは、必ずしも特定のデブロックフィルタを選択する必要がなく、その代わりに、ユーザーにとって満足な画像品質に対応するセッティングを選択することができ、そして、そのセッティングは、希望の画像品質を生じさせるようなデブロックフィルタにマッピングされているものである。従って、そのＧＵＩは、フィルタバンクにおけるフィルタの数とは無関係であり、異なるタイプのＣＰＵに対する本発明のスケーラビリティを容易なものとしている。

【００５４】

アクティビティの計算

[0062]図６の（Ａ）は、２つの隣接するブロックＢ０及びＢ１及びブロックＢ０におけるピクセルｐ０、ｐ１、……、ｐ７の行を例示しており、一方、図６の（Ｂ）は、これ

らのピクセルの相対値の一例を例示している。これらの例は、行当たり８つのピクセルを示しているが、本発明は、これに限定されるものではない。

【００５５】

[0063]前述したように、本発明の一実施形態によれば、アクティビティの尺度は、これらブロックの各々に対して決定される。より特定すると、１つの実施形態では、アクティビティの尺度は、各ブロックの各行及び各ブロックの各列に対して決定される。

【００５６】

[0064]一般に、アクティビティは、選択されたピクセル値から導出された中間値からのそれら選択されたピクセル値の偏差の関数として決定される。特に、１つの実施形態では、その中間値は、選択されたピクセル値の重み付け平均である。このような１つの実施形態では、選択されたピクセル値の各々とその重み付け平均との間の差もまた重み付けされる。従って、１つの実施形態では、アクティビティは、選択されたピクセル値の重み付け平均からのそれら選択されたピクセル値の偏差の重み付け関数として決定される。

【００５７】

[0065]前述したように、デブロックフィルタリングは、２つのパス、即ち、水平パスと垂直パスとを使用して達成される。水平パス中では、ピクセルの各行が処理され、即ち、前述した選択されたピクセル値は、ピクセルの行に対応している。垂直パス中では、ピクセルの各列が処理され、即ち、前述した選択されたピクセル値は、ピクセルの列に対応している。

【００５８】

[0066]１つの実施形態では、ピクセルｐ０、ｐ１、……、ｐ７の重み付け平均（ＷＭ）は、次のように決定される。

ＷＭ＝（ｗ０＊ｐ０＋ｗ１＊ｐ１＋……＋ｗ７＊ｐ７）＞＞５　　（４）

ここで、ｗ０、ｗ１、……ｗ７は、ｗ０＞ｗ１＞……＞ｗ７及びｗ０＋ｗ１＋……＋ｗ７＝３２であるように選択された重みであり、また、表現を簡単化するため、ｐ０、ｐ１、……、ｐ７は、ピクセル値を表している。一般に、重み付けファクタは、ピクセルが対象境界に近い程より大きくなる。従って、図６の（Ａ）の例では、ピクセルｐ０がブロックＢ０及びブロックＢ１の間の境界により近いので、そのピクセルは、他のピクセルより大きく重み付けされ、以下同様とされる。

【００５９】

[0067]１つの実施形態では、ピクセルｐ０、ｐ１、……、ｐ７に関連するアクティビティは、次のように決定される。

アクティビティ＝ａ＊（ｐ０－ＷＭ）＋ｂ＊（ｐ１－ＷＭ）＋ｃ＊（ｐ２－ＷＭ）
＋ｄ＊（ｐ３－ＷＭ）＋ｅ＊（ｐ４－ＷＭ）＋ｆ＊（ｐ５－ＷＭ）
＋ｇ＊（ｐ６－ＷＭ）＋ｈ＊（ｐ７－ＷＭ）　　（５）

ここで、ａ、ｂ、……、ｈは、ａ＞ｂ＞……＞ｈである固定重みである。前述したのと同様に、これら重み付けファクタは、ピクセルが対象境界に近い程より大きくなる。この実施形態では、それら重みは、ブロック境界からのピクセルのマンハッタン距離が増大するにつれて減少する、重み付け平均からの偏差の関連性を示唆するのに使用される。

【００６０】

フィルタ及び対象領域の選択

[0068]この点を要約するに、前述した実施形態によれば、アーチファクトカウントは、各ブロックに対して決定され、アクティビティは、各ブロックの各行及び各列に対して決定される。この情報は、メモリに記憶されたフィルタバンクからデブロックフィルタを選択するのに、且つその選択されたフィルタが適用されるべきピクセルの数（対象領域）を識別するのに使用することができる。

【００６１】

[0069]１つの実施形態では、ブロック当たりのアーチファクトカウント及び行又は列当たりのアクティビティは、第１のブロック（例えば、ブロックＢ０）の各行及び各列に対する第１の値Ｎ０及び第２のブロック（例えば、ブロックＢ１）の各行及び各列に対する

第２の値Ｎ１を決定するのに使用される。説明を簡単とするため、ブロックＢ０の単一行及びブロックＢ１の対応する行について、以下説明する。

【００６２】

[0070]図７は、ブロックＢ０の行Ｒ０及びブロックＢ１の対応する行Ｒ１を例示しており、即ち、行Ｒ０及び行Ｒ１は、同じ水平ラインに沿って存在しているものである。

【００６３】

[0071]行Ｒ０に対する第１の値Ｎ０は、次のように決定される。

Ｎ０＝exp（-[Activity_Ｒ０]/[Artifact_count_Ｂ０））　（６）

ここで、Activity_Ｒ０は、行Ｒ０に関連したアクティビティを表しており、Artifact_count_Ｂ０は、ブロックＢ０に対するアーチファクトカウントを表している。同様に、第２の値Ｎ１は、次のように決定される。

Ｎ１＝exp（-[Activity_Ｒ１]/[Artifact_count_Ｂ１））　（７）

【００６４】

[0072]値Ｎ０及びＮ１は、アーチファクトカウントに比例していることに注意されたい。他方、値Ｎ０及びＮ１は、ブロック境界に亘るアクティビティに逆比例している。

【００６５】

[0073]本発明の実施形態によれば、値Ｎ０及びＮ１のうちの１つが、予め選択されたフィルタのバンクからデブロックフィルタを選択するのに使用される。１つの実施形態では、値Ｎ０及びＮ１のうちの最小のものが、フィルタバンクからデブロックフィルタを選択するのに使用される。Ｎ０及びＮ１のうちの最小のものを使用することにより、画像ディテールの連続性を保証することができる。即ち、Ｎ０及びＮ１のうちの最小のものを使用することにより、選択されたフィルタは、最大値の方を使用したとした場合に選択されたであろうフィルタよりも弱いものとなる。従って、この実施形態では、ブロッキングアーチファクトの除去よりも、画像ディテールの方が重んじられることとなる。しかしながら、もし、アーチファクトの除去をより重要であると考える場合には、それに代えて、Ｎ０及びＮ１のうちの最大のものを使用することができる。

【００６６】

[0074]１つの実施形態では、フィルタバンクは、異なる強度の７つ（７）のフィルタを含む。異なる強度のフィルタを有するフィルタバンクを使用することにより、固定フィルタリング及びフィルタリング判断の間のハードスイッチングに伴う欠点を排除することができる。

【００６７】

[0075]１つの実施では、フィルタバンクは、次のようなフィルタ（Ｈ）を含み、ここで、インデックスＮ＝０，１，……，６である。

表１－典型的なフィルタバンク

Ｈ[Ｎ]＝	{０	０	０	０	１２８	０	０	０	０}
	{０	０	０	２６	７６	２６	０	０	０}
	{０	０	－５	４２	５４	４２	－５	０	０}
	{０	１	７	３３	４６	３３	７	１	０}
	{－２	２	１５	３０	３８	３０	１５	２	－２}
	{８	８	１６	１６	３２	１６	１６	８	８}
	{８	１６	１６	１６	１６	１６	１６	１６	８}

【００６８】

[0076]前述の例では、フィルタバンクにおけるフィルタは、インデックスＮの値が（より高いアーチファクトカウントに対するように）増大するにつれて、そのフィルタの強度が増大するような順序に配列されている。表１におけるフィルタ係数は例である。異なる仕様を有する異なるフィルタを設計し使用することもできる。

【００６９】

[0077]前述したように、値ＮＯ及びＮ１は、アーチファクトカウントに比例している。前述したように２つのしきい値thr１及びthr２を使用する場合には、アーチファクトカウントは、ブロック境界に亘るピクセル値の間の差が比較的に大きいときには、２倍増分される。従って、もしアーチファクトカウントのみを考慮する（即ち、アクティビティを無視する）場合には、アーチファクトカウントが高い程、ＮＯ及びＮ１の値がより高くなり、それにより、ローパスフィルタリングがより強くなり、ブロッキングアーチファクトをより効果的に排除又は減少させることになる。他方では、値ＮＯ及びＮ１は、ブロック境界に亘るアクティビティに逆比例している。従って、もしアクティビティのみを考慮する（即ち、アーチファクトカウントを無視する）場合には、アクティビティが高い程、ＮＯ及びＮ１の値がより低くなり、それにより、ローパスフィルタリングがより弱くなり、ブロック境界に隣接する区域におけるディテールが失われないようにすることができる。

【００７０】

[0078]１つの実施形態では、ＮＯ及びＮ１のうちの選択された値（例えば、最小のもの）は、最も近い整数へと丸められ、フィルタの１つを選択するためのインデックスＮとして使用される。即ち、Ｎ＝min（ＮＯ，Ｎ１）である。　例えば、もし、ＮＯ及びＮ１が、それぞれ３及び４であることが見出される場合には、Ｎは、３であり、次のフィルタが対象領域に対して適用される。

Ｈ[３]＝{０　１　７　３３　４６　３３　７　１　０}

【００７１】

[0079]ＮＯ及びＮ１の値は、対象領域（選択されたフィルタが適用されるピクセルの数）を定めるのにも使用される。一般に、選択されたフィルタは、ブロックＢＯにおけるＮＯ個のピクセル及びブロックＢ１におけるＮ１個のピクセルに対して適用される。従って、前述の例では、図７に示されるように、フィルタＨ[３]は、ブロックＢＯにおける３つのピクセル及びブロックＢ１における４つのピクセルに対して適用される。対象領域は、ブロック境界の各側において異なる数のピクセルを含むことができ、従って、対象領域に対して相当程度の融通性が与えられることに注意されたい。

【００７２】

[0080]本発明による実施形態は、フィルタバンクに７個のフィルタを含むことに限定されない。計算の複雑さを減少させるため、フィルタバンクのフィルタの個数をより少なくすることができる。前述の表で示したような典型的なフィルタよりもより少ないタップを使用しているようなフィルタを使用することもできる。例えば、ロアーエンド又はベースラインＧＰＵに使用するため、多分より少ないタップを有するより少ない数のフィルタを選択することができる。このようにして、ＧＰＵの処理能力に従って異なるＧＰＵ実施を支援するため、フィルタリングの全体の複雑さをスケーラブルなものとすることができる。

【００７３】

[0081]フィルタバンクは、８個以上のフィルタを含むこともできる。フィルタバンクにおけるフィルタの数は、フィルタ及び対象領域の両方を選択するため同じ数Ｎを使用しない実施において増大することができる。例えば、ここで前述したように、ＮＯ及びＮ１の値は、対象領域を定める目的で最も近い整数へと丸めることができるのであるが、それらの実際の値を使用して、８個以上のエントリを含むフィルタバンクを割り出すようにすることもできる。

【００７４】

[0082]ＮＯ及びＮ１の計算される値を、行又は列におけるピクセルの数より大きく、また、Ｎの値及びフィルタバンクにおけるフィルタの数を、行又は列におけるピクセルの数より大きくすることもできることに注意されたい。このような実施においては、対象領域のサイズを決定するため、ＮＯ及びＮ１の値を、行又は列におけるピクセルの数に対応する値へ規制する（例えば、縮小又は拡張する）ことができ、また、フィルタバンクからフィルタを選択するため、スケーラブルでない値を使用することができ、また、必要であるならば、対象領域のサイズを決定するのに使用されるものと同じ又は異なるスケーリング

ファクタを使用して、それら値をスケーラブルとすることもできる。

【００７５】

[0083]図８は、本発明の一実施形態によるデータを処理するためのコンピュータ実施方法の一例のフローチャート８０である。ステップ８１において、ピクセルの第１のブロック（ブロックＢ０）に対する第１の値（Ｎ０）及びピクセルの第２のブロック（ブロックＢ１）に対する第２の値（Ｎ１）が計算される。第１の値Ｎ０は、ブロックＢ０に対する選択されたピクセル値とブロックＢ１を含むブロックＢ０に隣接するブロックに対する選択されたピクセル値との間の差の尺度に基づく。１つの実施形態では、これらの差は、各々がブロックＢ０におけるピクセル及び隣接ブロックにおける隣接ピクセルに関連した対である隣接ピクセル対に対するピクセル値の減算により得られる（前述の式（１）におけるように）。このような１つの実施形態では、ブロックＢ０に関連したカウンタ値は、これらの差の各々が第１のしきい値（例えば、しきい値thr１）を越える毎に増分され、また、これらの差の各々が第２のしきい値（例えば、しきい値thr２）を越える毎に再び増分される。カウンタ値は、もし、これらの差が第１のしきい値より小さいく又は第１のしきい値と第２のしきい値との間に入る場合には、ある同等量だけ増大されもすることができる（前述の式（２）におけるように）。一般的に言って、第１の値Ｎ０は、ブロックＢ０に対するアーチファクトカウントに基づく。

【００７６】

[0084]第１の値Ｎ０は、ブロックＢ０に対するピクセル値のサブセット（例えば、行Ｒ０）における偏差の尺度にも基づく。１つの実施形態では、このピクセル値のサブセット（行Ｒ０）に対して重み付け平均が計算され、それから、このサブセットにおける各ピクセル値とその重み付け平均との間の差が決定される。このような１つの実施形態では、これらピクセル値と重み付け平均との間の差も重み付けされる（前述の式（５）におけるように）。一般的に言って、第１の値Ｎ０は、ブロックＢ０内のアクティビティにも基づく。

【００７７】

[0085]第２の値Ｎ１は、同様に、ブロックＢ１に対するアーチファクトカウント及びブロックＢ１内のアクティビティに基づく。

【００７８】

[0086]ステップ８２において、第１の値Ｎ０及び第２の値Ｎ１のうちの１つ（Ｎ０又はＮ１）が、フィルタバンク（例えば、表１）からデジタルデブロックフィルタ（Ｈ）を選択するためのインデックス（Ｎ）として使用される。

【００７９】

[0087]ステップ８３において、第１の値Ｎ０及び第２の値Ｎ１が、選択されたデブロックフィルタを適用すべきピクセル値の数（例えば、ブロックＢ０の行Ｒ０及びブロックＢ１の対応する行におけるピクセルの数）を特定するのに使用される。即ち、第１の値Ｎ０及び第２の値Ｎ１は、対象領域（前述の図７の例におけるように）を定めるのに使用される。

【００８０】

[0088]図８のステップ８４において、選択されたデブロックフィルタが、ブロックＢ０におけるピクセル値及びブロックＢ１におけるピクセル値に適用され、新しいピクセル値が生成される。即ち、選択されたデブロックフィルタは、ブロッキングアーチファクトを排除又は減少させるため、対象領域に適用される。

【００８１】

[0089]要するに、本発明の実施形態によれば、ブロッキングアーチファクトの処理と、満足なレベルのディテールの維持との間の許容できるバランスを取り決めるデブロックフィルタが選択される。更に、選択されたデブロックフィルタが適用されるべきピクセルの数を、画像ディテールのオーバーフィルタリングを避けるため、適当に決定することができる。その上、本発明によるデブロックフィルタリングは、適応性があり（例えば、ブロック当たりのアーチファクトカウント及びアクティビティにより測定されるようなピクセ

ル値の品質に対して）、スケーラブルであり（例えば、グラフィックカードの能力に対して）、ユーザーが制御できるものであり、且つ広範囲に亘るビデオ品質及び低ビットレートビデオ（例えば、インターネットビデオ）の増強の如きアプリケーションに対して十分に適合できるものである。

【００８２】

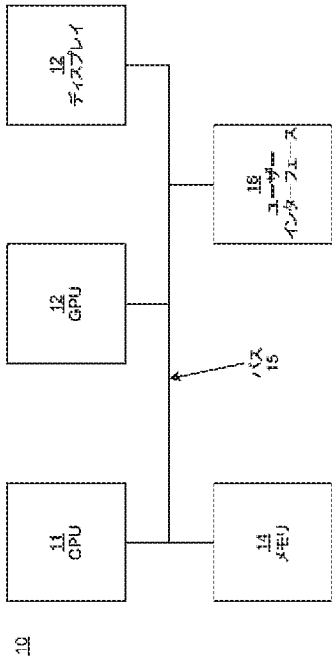
[0090]本発明の特定の実施形態の前述の説明は、例示のための説明として提示されたものである。これら説明は、これが全てであるというものでなく、また、本発明を、ここで開示した形そのものに限定しようとするものでなく、前述したことを考慮するならば、多くの変更及び変形が可能であるものである。これら実施形態は、本発明の原理及びその実際の応用について最良な説明をなし、それにより、他の当業者が、本発明及び種々な実施形態を、意図するような特定の用途に適合するように種々な変更を加えて最良に利用できるようにするために、選択され説明されているのである。本発明の範囲は、特許請求の範囲及びそれらの均等物により定められるものとせんとするものである。

【符号の説明】

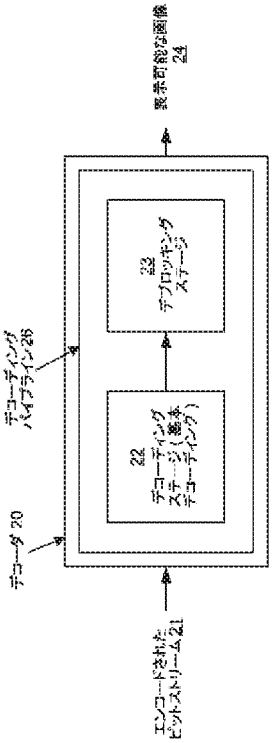
【００８３】

１０・・・システム、１１・・・ホスト中央処理装置（ＣＰＵ）、１２・・・グラフィック処理装置（ＧＰＵ）、１３・・・ディスプレイ（スクリーン）、１４・・・メモリ、１５・・・バス、１６・・・ユーザーインターフェース、２０・・・デコーダ、２１・・・エンコードされたビットストリーム、２２・・・デコーディングステージ、２３・・・デブロッキングステージ、２４・・・表示可能な画像データ、２６・・・デコーディングパイプライン、３０・・・フローチャート、４０・・・画像フレーム、４１・・・エッジ又は境界、８０・・・フローチャート、Ｂ０～Ｂ４、ＢＮ・・・ブロック、ｐ０～ｐ７・・・ピクセル、ｑ０～ｑ７・・・ピクセル、Ｒ０、Ｒ１・・・行、Ｎ０・・・第１の値、Ｎ１・・・第２の値、Ｎ・・・インデックス、ＷＭ・・・重み付け平均、ｗ０～ｗ７・・・重み

【図１】



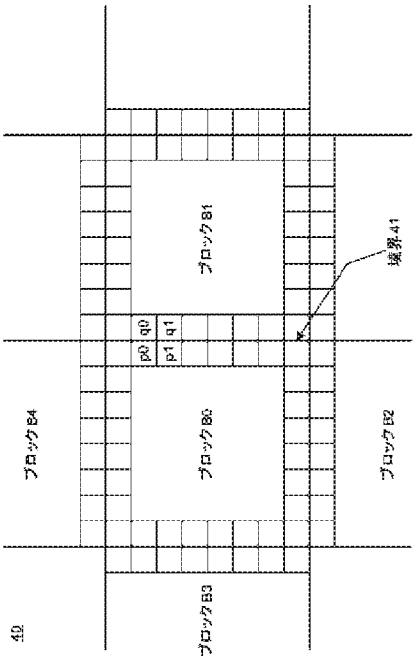
【図２】



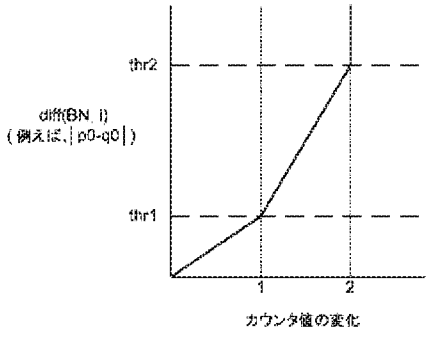
【図３】


39
31
ブロックB0及びブロックB1に対する
デコードされたデータにアクセスする
32
ブロックB0及びブロックB1に対する
アーチファクトカウントを決定する
33
ブロックB0内及びブロックB1内の
アクティビティを決定する
34
デブロックフィルタを選択するため両ブロックに対する
アーチファクトカウント及びアクティビティを使用する
35
対象領域を特定するため
アーチファクトカウント及びアクティビティを使用する
36
対象領域に対して
選択されたデブロックフィルタを適用する

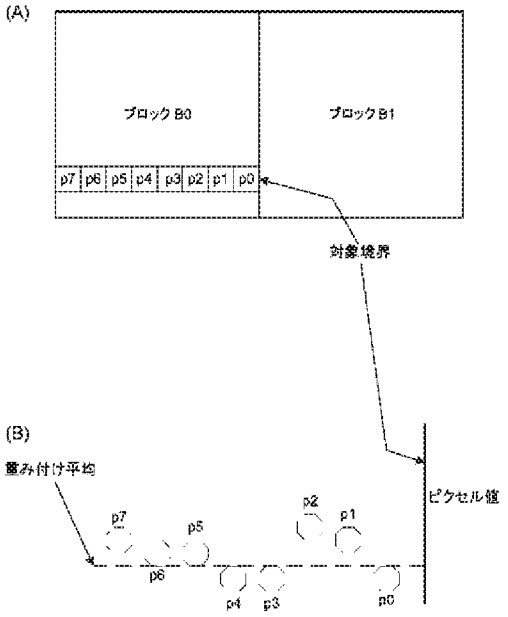
【図４】


ブロックB1
境界41
q0
q1
p0
p1
ブロックB4
ブロックB5
ブロックB2
ブロックB3
49

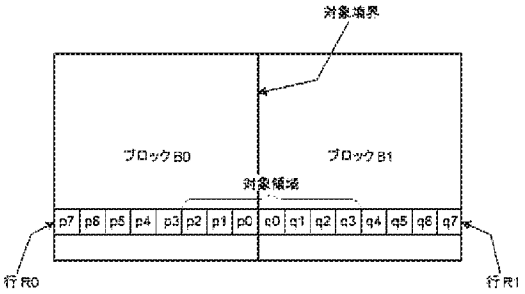
【図５】


thr2
thr1
diff(BN_I)
(例えば、|p0-q0|)
1
2
カウンタ値の変化

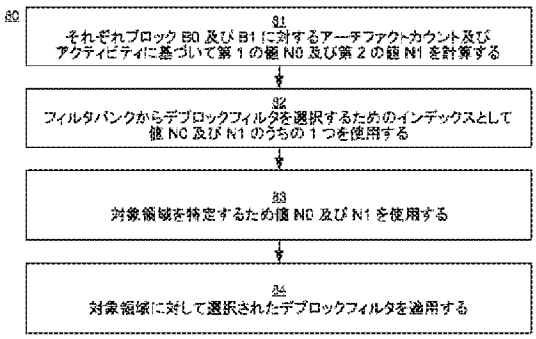
【図６】


(A)
ブロックB0
ブロックB1
p7
p6
p5
p4
p3
p2
p1
p0
対象境界
(B)
重み付け平均
ピクセル値
p7
p5
p2
p1
p6
p4
p3
p0

【図７】


対象境界
ブロックB0
ブロックB1
対象領域
p7 p6 p5 p4 p3 p2 p1 p0 q0 q1 q2 q3 q4 q5 q6 q7
行R0
行R1

【図８】


80
81
それぞれブロックB0及びB1に対するアーチファクトカウント及び
アクティビティに基づいて第１の値N0及び第２の値N1を計算する
82
フィルタバンクからデブロックフィルタを選択するためのインデックスとして
値N0及びN1のうちの１つを使用する
83
対象領域を特定するため値N0及びN1を使用する
84
対象領域に対して選択されたデブロックフィルタを適用する

フロントページの続き

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Ｆターム(参考) 5C159 KK03 SS02 SS08 SS10 SS13 SS20 TA69 TC02 TC10 TC33
TC47 TD03 TD04 TD07 UA05

【外国語明細書】
2010141883000001.pdf

Electronic Acknowledgement Receipt

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Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
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Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
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Application Type:	U.S. National Stage under 35 USC 371

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Transmittal.pdf	20428 42cce9a06e4e46e6db8b32d5af4bcc01764bda1f	no	1

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	40382 71995ce690eff5fd6a0e5d874f0eb2952fc54141	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	JP2005123732A.pdf	1371844 5f116f36a440f1fb675e467b4011f57acb408cd3	no	18
Warnings:					
Information:					
4	Foreign Reference	WO2012044074A2.pdf	4615748 559f9df876d93c0974b655ba6dd2c37a7cee76df	no	40
Warnings:					
Information:					
5	Foreign Reference	JP2010141883A.pdf	2221811 7894393fb35319182d6260446765cd3cf3995845	no	24
Warnings:					
Information:					
6	Non Patent Literature	Ugur.pdf	1722676 d90fcd8975827cc9c908b24b9f43809443efaba8	no	10
Warnings:					
Information:					
7	Non Patent Literature	Ugur-Appendix.pdf	387541 6ed1e1e28ff18a35708191b4505760ead0b3649b	no	5
Warnings:					
Information:					
8	Non Patent Literature	An.pdf	964548 b46384970184f5f9581b8b4afe6a7e5ffc8bd383	no	8
Warnings:					
Information:					
9	Non Patent Literature	List.pdf	995545 ec3a78b97d5ac6df56ea72958c6af56be5d0e364	no	6
Warnings:					
Information:					
10	Non Patent Literature	An1.pdf	593538 f4ed6fd622787e0c253d6689a218dc0fcddb6067	no	8

Warnings:	
Information:	
Total Files Size (in bytes):	12934061

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: **Norkin**	)	
Serial No.: **14/001,627**	)	PATENT PENDING
Filed: **Aug 26, 2013**	)	Examiner: KELLEY, CHRISTOPHER S
For: **Deblocking Filtering Control**	)	Group Art Unit: 2482
Attorney's Docket No: **1009-0641 / P33966 US2**	)	Confirmation No.: 2724

MS AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

INFORMATION DISCLOSURE STATEMENT

In accordance with 37 C.F.R. 1.56, counsel wishes to make of record the attached items of information for the Examiner's consideration in connection with this application. Also enclosed is Form PTO/SB/08a for the Examiner's convenience in making such consideration of record. Inclusion herein of any particular item of information is not to be construed as an admission that same is prior art.

The Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account 50-5650.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

/ Daniel P. Homiller, Reg. # 55,275 /

Dated: 2015-12-30

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2	2724

102721 7590 01/21/2016

Murphy, Bilak & Homiller/Ericsson
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EXAMINER	
HESS, MICHAEL J	

ART UNIT	PAPER NUMBER
2481	

NOTIFICATION DATE	DELIVERY MODE
01/21/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

official@mbhiplaw.com

Office Action Summary	Application No. 14/001,627	Applicant(s) NORKIN ET AL.	
	Examiner Michael J. Hess, Esq.	Art Unit 2481	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/20/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *34-42 and 44-50* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *34-42 and 44-50* is/are rejected.

8)☒ Claim(s) *43* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 101

1. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

2. **Claims 49** and **50** are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. Said claims are drawn to computer programs, per se, which is non-statutory subject matter. In addition, under a broadest reasonable interpretation, such claims are considered to read on transitory propagating signals. See Subject Matter Eligibility of Computer Readable Media memo dated February 23, 2010 (1351 OG 212). Examiner recommends redrafting claims 49 and 50 to cover "non-transitory computer-readable" media.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. **Claims 34–42** and **44–50** are rejected under 35 U.S.C. 103(a) as being unpatentable over Bjontegaard (US 2006/0078048 A1), in view of List ("Adaptive Deblocking Filter," IEEE Transactions on Circuits and Systems for Video Technology, Vol. 13, No. 7, July 2003) (herein "List").

5. Regarding **claim 34**, the combination of Bjontegaard and List teaches **a method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising: calculating a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on: $|p2_i-2p1_i+p0_i|$ wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary** (Bjontegaard, ¶ 0042: disclosing in the equation that the inner gradient conditions (linearity) of the samples in each of the two neighboring blocks are calculated and compared against a threshold where the coefficients [1, -2, 1] exhibit symmetry; Examiner notes that the equation should be understood in light of Bjontegaard's Figure 3; see also Applicant's dependent claim 35 for context)**; calculating a second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on: $|q2_i-2q1_i+q0_i|$ wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary** (Bjontegaard, ¶ 0042: disclosing in the equation that the inner gradient

conditions (linearity) of the samples in each of the two neighboring blocks are calculated and compared against a threshold where the coefficients [1, -2, 1] exhibit symmetry; Examiner notes that the equation should be understood in light of Bjontegaard's Figure 3; see also Applicant's dependent claim 35 for context)**; determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value** (Bjontegaard, ¶¶ 0045 and 0046: teach determining whether no pixels or certain pixels within a line of pixels should be filtered according to the threshold condition).

6. One of ordinary skill in the art, at the time of Applicant's invention, would have been motivated to combine the elements taught by Bjontegaard with those of List because both publications are drawn to the same field of endeavor and because such a combination of teachings is helpful for a skilled artisan to understand a full implementation of the H.264 deblocking algorithm. This rationale applies to all combinations of Bjontegaard and List in this Office Action.

7. Regarding **claim 35**, the combination of Bjontegaard and List teaches **the method according to claim 34, wherein calculating said first filter decision value comprises calculating said first filter decision value as: $|p2_0-2p1_0+p0_0|+|p2_3-2p1_3+p0_3|$ wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next**

closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and calculating said second filter decision value comprises calculating said second filter decision value as: $|q2_0-2q1_0+q0_0|+|q2_3-2q1_3+q0_3|$ wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary (Bjontegaard, Claim 3, Equation: teaches testing the inner gradient (linearity) of pixel lines 2 and 5; Examiner finds Applicant's design choice

of choosing lines 0 and 3 is obvious in view of the teachings of Bjontegaard, absent an unexpected result).

8. Regarding **claim 36**, the combination of Bjontegaard and List teaches **the method according to claim 34, wherein determining how many pixels in said first line of pixels in said block to filter comprises: comparing said first filter decision value to a first threshold value; determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and determining to filter one pixel in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises: comparing said second filter decision value to a second threshold value; determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and determining to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value** (Bjontegaard, ¶¶ 0034–0037: teach filter decisions for one pixel, c, for a block and an optional second filter decision for pixel, b, for the same block, otherwise no filtering is performed).

9. Regarding **claim 37**, the combination of Bjontegaard and List teaches **the method according to claim 34, wherein determining how many pixels in said first**

line of pixels in said block to filter comprises: comparing said first filter decision value to a first threshold value; determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and determining to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises: comparing said second filter decision value to a second threshold value; determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and determining to filter no pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value (Bjontegaard, ¶¶ 0034–0037: teach filter decisions for one pixel, c, for a block and an optional second filter decision for pixel, b, for the same block, otherwise no filtering is performed).

10. **Claim 38** lists the same elements as claim 34, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 34 applies to the instant claim.

11. **Claim 39** lists the same elements as claim 35, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 35 applies to the instant claim.

12. **Claim 40** lists the same elements as claim 36, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 36 applies to the instant claim.

13. **Claim 41** lists the same elements as claim 37, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 37 applies to the instant claim.

14. Regarding **claim 42**, the combination of Bjontegaard and List teaches **the device according to claim 38, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block** (Bjontegaard, ¶ 0029: teaches the thresholds are based on quantization parameter, QP, said quantization parameters being assigned to each block).

15. Regarding **claim 44**, the combination of Bjontegaard and List teaches **the device according to claim 38, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and said second pixel determiner is**

configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator (Bjontegaard, ¶¶ 0034–0037: teach filter decisions for one pixel, c, for a block and an optional second filter decision for pixel, b, for the same block, otherwise no filtering is performed).

16. Regarding **claim 45**, the combination of Bjontegaard and List teaches **an encoder comprising a filtering control device according to claim 38** (Bjontegaard, ¶ 0006).

17. Regarding **claim 46**, the combination of Bjontegaard and List teaches **a user equipment comprising: a memory configured to store video frames; and an encoder according to claim 45 configured to encode said video frames into encoded video frames, wherein said memory is further configured to store said encoded video frames** (Bjontegaard, ¶ 0006).

18. Regarding **claim 47**, the combination of Bjontegaard and List teaches **a decoder comprising a filtering control device according to claim 38** (Bjontegaard, ¶ 0006).

19. Regarding **claim 48**, the combination of Bjontegaard and List teaches **a user equipment comprising: a memory configured to store encoded video frames; a decoder according to claim 47 configured to decode said encoded video frames into decoded video frames; and a media player configured to render said**

decoded video frames into video data displayable on a display (Bjontegaard, ¶ 0006).

20. **Claim 49** lists the same elements as claim 34, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 34 applies to the instant claim.

21. **Claim 50** lists the same elements as claim 34, but in apparatus form rather than method form. Therefore, the rationale for the rejection of claim 34 applies to the instant claim.

Allowable Subject Matter

22. **Claim 43** would be allowable if a terminal disclaimer is filed (see Double Patenting Rejection below) and if rewritten to include all of the limitations of the base claim and any intervening claims.

Double Patenting

23. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the claims at issue are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir.

1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); In re Vogel, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the reference application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/forms/. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

24. Claim 43 is provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claim 62 of copending Application No. 13/979,006

(reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because they cover substantially similar subject matter.

25. This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Conclusion

26. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Panchapakesan et al. (U.S. Patent Application Publication No. 2009/0285308 A1) discloses the comparing of pixel gradients to thresholds to determine proper edge filtering strength and multiplying at least one threshold by a tuning factor (see e.g. ¶ 0053).

b. Cho et al. (U.S. Patent Application Publication No. 2005/0013363 A1) discloses deblocking filtering, clipping, gradients, and thresholds to determine filter strength (see e.g. ¶ 0116).

c. Raveendran (U.S. Patent Application Publication No. 2005/0276505 A1) discloses deblocking filtering, clipping, gradients, and thresholds to determine filter strength (see e.g. ¶ 0030).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL HESS whose telephone number is (571) 270-7933. The examiner can normally be reached Monday - Friday 8:30am-6:00pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William Vaughn can be reached on (571) 272-3922. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8933.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Michael J Hess, Esq./
Examiner, Art Unit 2481

Notice of References Cited	Application/Control No. 14/001,627	Applicant(s)/Patent Under Reexamination NORKIN ET AL.	
	Examiner Michael J. Hess, Esq.	Art Unit 2481	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2004/0101059 A1	05-2004	Joch, Anthony	H04N19/159	375/240.29
*	B	US-2005/0013363 A1	01-2005	Cho, Dae-sung	H04N19/105	375/240.12
*	C	US-2005/0276505 A1	12-2005	Raveendran, Vijayalakshmi R.	H04N19/176	382/268
*	D	US-2006/0078048 A1	04-2006	Bjontegaard; Gisle	H04N19/139	375/240.03
*	E	US-2009/0285308 A1	11-2009	Panchapakesan; Kannan	H04N19/61	375/240.24
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SEARCH NOTES		
Search Notes	Date	Examiner

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US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Field

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	14/001,627
	Filing Date	Aug 26, 2013
	First Named Inventor	Andrey Norkin
	Art Unit	2482
	Examiner Name	KELLEY, CHRISTOPHER S
	Attorney Docket Number	1009-0641 / P33966 US2

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

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		2005123732	JP	A	2005- 05-12	MATSUSHITA ELECTRIC IND CO LTD		
		2010141883	JP	A	2010-06-24	NVIDIA CORP		
		2012044074	WO	A2	2012-04-05	SAMSUNG ELECTRONICS CO LTD		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
		AN, JICHENG et al., "CE 8 subtest1: Improved deblocking filter", IEEE, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th Meeting: Daegu, Korea, January 2011, 1-8.	

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Doc description: Information Disclosure Statement (IDS) Field

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	Attorney Docket Number	1009-0641 / P33966 US2

		AN, JICHENG, "TEIO Subtestl: Improved Deblocking Filter", Joint Collaborative Team on Video Coding, of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 3rd Meeting, Guangzhou, CN, 7-15 October 2010, 1-8.	
		LIST, PETER et al., "Adaptive Deblocking Filter", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 3, Issue 7, July 2003, 614-619.	
		UGUR, KEMAL et al., "Appendix to Description of video coding technology proposal by Tandberg Nokia Ericsson", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Dresden, DE, 15-23 April 2010, 1-55.	
		UGUR, KEMAL et al., "High Performance, Low Complexity Video Coding and the Emerging HEVC Standard", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 20, No. 12, December 2010, 1688-1697.	

EXAMINER SIGNATURE

Examiner Signature	/Michael Hess/	Date Considered	01/12/2016

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Attorney Docket Number	1009-0641 / P33966 US2

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☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2015-12-30
Name/Print	Daniel P. Homiller	Registration Number	55,275

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EAST Search History

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Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	24	((Andrey) near2 (Norkin)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/01/12 14:57
L2	63	((Kenneth) near2 (Andersson)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/01/12 14:57
S1	1	(14/001627).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/07 23:43
S2	13	(("20060078048") or ("20040101059") or ("20090285308") or ("20050013363") or ("20050276505")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/07 23:49
S3	3	((13/695402) or (13/979006) or (13/021012)).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 13:48
S4	2	(11/250187).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 18:48
S6	3	("20040081368").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 20:16

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Application Number	
Filing Date	
First Named Inventor	Norkin
Art Unit	
Examiner Name	
Attorney Docket Number	1009-0641 / P33966 US2

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Receipt date: 08/26/2013	Application Number	14001627 - GAU: 2481
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	First Named Inventor	Norkin
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1009-0641 / P33966 US2

	1	IKEDA, Masaru et al. "Parallel Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTCJ/SC29/WG, Document to JCT-VC, 11 4th Meeting. January 2011. pp 1-7	☐
	2	NARROSCHKE, Matthias. "Reduction of Operations in the Critical Path of the Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting. 20-28 January, 2011. pp 1-15.	☐
	3	NORKIN, Andrey et al. "CE12.1: Ericsson Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/I EC JTC1/SC29/WG, Document to JCT-VC, 11 5th Meeting: Geneva, 16-23 March 2011. pp. 1-17.	☐
	4	NORKIN, Andrey et al. "Development of HEVC Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting: Daegu, KR. 20-28 January 2011. pp. 1-4.	☐

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	Art Unit	
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☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2013-08-26
Name/Print	Daniel P. Homiller	Registration Number	55275

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	Examiner	Art Unit

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	14/001,627
Filing Date	Aug 26, 2013
First Named Inventor	Andrey Norkin
Art Unit	2481
Examiner Name	HESS, MICHAEL J
Attorney Docket Number	1009-0641 / P33966 US2

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		20100142844	A1	2010-06-10	Pereira, Rochelle et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number [3]	Country Code [2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T [5]
		2681913	EP	B1	2015-11-25	Telefonaktiebolaget L M Ericsson (publ)		

NON-PATENT LITERATURE DOCUMENTS

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CERTIFICATION STATEMENT

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(54) DEBLOCKING FILTERING CONTROL

STEUERUNG EINES ENTBLOCKIERUNGSFILTERS

COMMANDE DE FILTRAGE ANTIBLOCS

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(56) References cited:
US-A1- 2010 142 844

- **MATTHIAS NARROSCHKE ET AL: "Reduction of operations in the critical path of the deblocking filter", 95. MPEG MEETING; 24-1-2011 - 28-1-2011; DAEGU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m18974, 22 January 2011 (2011-01-22), XP030047543,**
- **NORKIN A ET AL: "Development of HEVC deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D377, 16 January 2011 (2011-01-16), XP030008416, ISSN: 0000-0013**
- **ANDREY NORKIN ET AL: "CE12.1: Ericsson deblocking filter", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19803, 19 March 2011 (2011-03-19), XP030048370,**
- **MASARU IKEDA ET AL: "Parallel deblocking filter", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JC TVC-SITE/,, no. JCTVC-D263, 15 January 2011 (2011-01-15), XP030008303, ISSN: 0000-0013**

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EP 2 681 913 B1

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Description

TECHNICAL FIELD

[0001] The present embodiments generally relate to filtering control and in particular to controlling deblocking filtering over block boundaries in a video frame.

BACKGROUND

[0002] Deblocking filters are used in the video coding standards in order to combat blocking artifacts. The blocking artifacts arise because the original video frames are split into blocks which are processed relatively independently. The blocking artifacts can, for instance, arise due to different intra predictions of the blocks, quantization effects and motion compensation. Two particular variants of deblocking are described below.

[0003] In state of the art video coding, such as H.264, there is a deblocking filter, also denoted loop filter, after prediction and residual reconstruction, but before storage of the reconstruction for later reference when encoding or decoding the subsequent frames. The deblocking filtering consists of several steps such as filter decisions, filtering operations, a clipping function and changes of pixel values. The decision to filter the border or not is made based on evaluation of several conditions. Filter decisions depend on macroblock (MB) type, motion vector (MV) difference between neighboring blocks, whether neighboring blocks have coded residuals and on the local structure of the current and/or neighboring blocks.

[0004] Then the amount of filtering for a pixel depends, among others, on the position of that pixel relative to the block border or boundary and on the quantization parameter (QP) value used for residual coding.

[0005] The filter decision is based on comparing three pixel differences with thresholds. The thresholds are adapted to the quantization parameter (QP). For instance, assume a vertical block boundary of

a b c d | e f g h

where a, b c and d denote the pixel values of the pixels of a row of pixels in the current block and e, f, g and h denote the corresponding pixel values of the pixels of a corresponding row of pixels in the neighboring block. If the following conditions are fulfilled the filter decision is positive, e.g. abs(d-e)<thr1, abs(c-d)<thr2, and abs(e-f)<thr2, where thr1 and thr2 are adapted based on QP.

[0006] There are two filtering modes in H.264. In the first filtering mode, referred to as normal filtering, filtering can be described with a delta value with which filtering changes the current value. The filtering for the pixels closest to the block boundary is d' = d + delta and e' = e - delta, where delta has been clipped off to a threshold $\pm$thr3 to a value that is constrained by the QP. More filtering is thereby allowed for high QP than for low QP. Clipping can be described as delta_clipped = max(-thr3, min(thr3, delta)), where thr3 is controlling the filter strength. A larger value of thr3 means that the filtering is stronger which means that a stronger low-pass filtering effect will happen.

[0007] The filter strength can be increased if any of the following two conditions also holds, e.g. abs(b-d)<thr2 and abs(e-g)<thr2. The filter strength is adapted by clipping the delta less, e.g. allow for more variation.

[0008] The second filtering mode, referred to as strong filtering, is applied for intra macroblock boundaries only, when the following condition is fulfilled abs(d-e)< thr1/4.

[0009] For more information of deblocking filtering in H.264 reference is made to List et al., Adaptive Deblocking Filter, IEEE Transactions on Circuits and Systems for Video Technology, vol. 13, no. 7, July 2003.

[0010] In the draft HEVC (High Efficiency Video Coding) specification "Test Model under Consideration", ITU-T SG16 WP3 document, JCTVC-B205, Chapter 6.5 In-loop filter process, the deblocking filter works differently from H.264. The filtering is performed if at least one of the blocks on the side of the boundary is intra, or has non-zero coefficients, or the difference between the motion vector components of the blocks is greater or equal to one integer pixel. For example, when filtering the border between the blocks with a vertical block boundary of

$$p3_i\ p2_i\ p1_i\ p0_i\ |\ q0_i\ q1_i\ q2_i\ q3_i$$

with p_{j_i} denoting the pixel value of pixel number *j* of row number *i* in the current block and q_{j_i} denoting the pixel value of pixel number *j* of row number *i* in the neighboring block, i=0...7, j=0...3, then the following condition should also be satisfied:

$$d = |p2_2 - 2\times p1_2 + p0_2| + |q2_2 - 2\times q1_2 + q0_2| + |p2_5 - 2\times p1_5 + p0_5| + |q2_5 - 2\times q1_5 + q0_5| < \beta$$

[0011] where β depends on QP. In the above mentioned HEVC specification, there is a table of β, where β increases with QP.

[0012] If the conditions are fulfilled and filtering is done between the current block and the neighboring block, one of two types of filtering is performed, referred to as weak and strong filtering, respectively. The choice between the strong and the weak filtering is done separately for each line depending on the following conditions. For each line i=0...7, the strong filtering is performed if all the following conditions are true, otherwise, weak filtering is performed:

$$d < (\beta >> 2)$$

$$(|p3_i - p0_i| + |q0_i - q3_i|) < (\beta >> 3)$$

$$|p0_i - q0_i| < ((5 \times t_C + 1) >> 1)$$

where tc and β depend on QP and >> denotes a right shift operator.

[0013] Weak filtering is performed based on the above conditions. The actual filtering works by computing an offset (Δ), adding it to the original pixel value and clip the sum to a filtered output pixel value in the range of 0-255:

$$\Delta = Clip(-t_C, t_C, (13 \times (q0_i - p0_i) + 4 \times (q1_i - p1_i) - 5 \times (q2_i - p2_i) + 16) >> 5))$$

$$p0_i = Clip_{0\text{-}255}(p0_i + \Delta)$$

$$q0_i = Clip_{0\text{-}255}(q0_i - \Delta)$$

$$p1_i = Clip_{0\text{-}255}(p1_i + \Delta/2)$$

$$q1_i = Clip_{0\text{-}255}(q1_i - \Delta/2)$$

where the clip function Clip(A, B, x) is defined as Clip(A, B, x)=A if x<A, Clip(A, B, x)=B if x>B and Clip(A, B, x)=x if A≤x≤B and $Clip_{0\text{-}255}(X)$ is defined as Clip(0, 255, x).

[0014] Strong filtering mode is performed by the following set of operations:

$$p0_i = Clip_{0\text{-}255}((p2_i + 2 \times p1_i + 2 \times p0_i + 2 \times q0_i + q1_i + 4) >> 3)$$

$$q0_i = Clip_{0\text{-}255}((p1_i + 2 \times p0_i + 2 \times q0_i + 2 \times q1_i + q2_i + 4) >> 3)$$

$$p1_i = Clip_{0\text{-}255}((p2_i + p1_i + p0_i + q0_i + 2) >> 2)$$

$$q1_i = Clip_{0\text{-}255}((p0_i + q0_i + q1_i + q2_i + 2) >> 2)$$

$$p2_i = Clip_{0\text{-}255}((2 \times p3_i + 3 \times p2_i + p1_i + p0_i + q0_i + 4) >> 3)$$

$$q2_i = Clip_{0\text{-}255}((p0_i + q0_i + q1_i + 3 \times q2_i + 2 \times q3_i + 4) >> 3)$$

[0015] Deblocking filtering decisions according to HEVC can lead to inaccurate deblocking filtering over block boundaries for certain blocks. In particular neighboring blocks having different levels of local structures could be handled incorrectly in HEVC by filtering one of the blocks too much to thereby represses and filter away local structures in the block.

[0016] Matthias Narroschke et al: Reduction of operations in the critical path of the deblocking filter", 95, MPEG meeting 24-1-2011-28-1-2011; Dagu; no. m18974, 22 January 2011 relates to a method for determining filter decisions. Pixels on both sides of the block boundary are used for determining one filtering decision, i.e. how many pixels that should be considered for deblocking, but the same filter decision is used for both sides of the block boundary.

[0017] US 2010/142844 A1 relates to a deblocking operation wherein a region of interest is determined which determines the number of pixels that should be filtered. The number of pixels can be different on either side of the block boundary. The region of interest is determined based on N0 (for block B0) and N1 (for block B1) which are calculated based on an activity metric and an artifact count. The artifact count is determined for each block and an activity is determined for each row and for each column of each block. When determining the artifact count for N0 pixels on both side of the block boundary are used, and also when determining the artifact count for N1 pixels on both side of the block boundary are used.

SUMMARY

[0018] Hence, there is a need for an efficient deblocking filtering control that can be used to reduce blocking artifacts at block boundaries and that does not have the above mentioned drawbacks. It is a general objective to provide an efficient deblocking filtering control. It is a particular objective to provide asymmetric filtering decisions over a block boundary.

[0019] According to a first aspect a method for filtering control applicable to a block of multiple pixels in a video frame is provided where each pixel has a respective pixel value. In the method, a first filter decision value for said block is calculated, by only using pixels of said block, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block, a line of pixels being a row or a column of pixels, wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame. $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary. A second filter decision value for said neighboring block is calculated, by only using pixels of said neighboring block based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said neighboring block, a line of pixels being a row or a column of pixels, wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary. $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary. The first line of pixels and the corresponding first line in the neighboring block are opposing lines with regard to the block boundary and perpendicular to the block boundary. It is determined how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value and how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

[0020] According to a second aspect a filtering control device is provided. The filtering control device comprises a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame, by only using pixels of said block, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block and a line of pixels being a row or a column of pixels. $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring

block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary. The filtering control device further comprises a second decision value calculator configured to calculate a second filter decision value for a neighboring block, by only using pixels of said neighboring block, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein i=0---N-1 and N is the number of lines of pixels of said neighboring block (20), a line of pixels being a row or a column of pixels. $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, and said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary. The first line of pixels and the corresponding first line in the neighboring block are opposing lines with regard to the block boundary and perpendicular to the block boundary. The filtering control device further comprises a first pixel determiner configured to determine how many pixels in a first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator and a second pixel determiner configured to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator. The filtering control device further comprises a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value and a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value.

[0021] According to a further aspect an encoder comprising a filtering control device according to the aspect above is provided.

[0022] According to a yet further aspect a user equipment is provided. The user equipment comprises a memory configured to store video frames, and an encoder according to the aspect above configured to encode said video frames into encoded video frames, wherein said memory is further configured to store said encoded video frames.

[0023] According to a yet further aspect a decoder is provided which comprises a filtering control device according to the aspect above.

[0024] According to a yet further aspect a user equipment is provided which comprises a memory configured to store encoded video frames, a decoder according to an aspect above configured to decode said encoded video frames into decoded video frames, and a media player configured to render said decoded video frames into video data displayable on a display.

[0025] According to a yet further aspect a computer program for filtering control of a block of multiple pixels in a video frame is provided where each pixel having a respective pixel value. Said computer program comprises code means which when run on a computer causes the computer to calculate a first filter decision value for said block, by only using pixels of said block, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block (10), a line of pixels being a row or a column of pixels. $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary. The computer is further caused to calculate a second filter decision value for said neighboring block, by only using pixels of said neighboring block, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein i=0---N-1 and N is the number of lines of pixels of said neighboring block, a line of pixels being a row or a column of pixels. $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary. The first line of pixels and the corresponding first line in the neighboring block are opposing lines with regard to the block boundary and perpendicular

to the block boundary. The computer is further caused to determine how many pixels in a first line of pixels in said block to filer relative to said block boundary based on said first filter decision value and to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value,

wherein determine how many pixels in said first line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value and to determine how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

[0026] The embodiments achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig. 1 is a flow diagram of a method for filtering control according to an embodiment;

Figs. 2A and 2B illustrate two embodiments of neighboring blocks and a block boundary over which deblocking filtering can be applied;

Fig. 3 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to an embodiment;

Fig. 4 is a flow diagram illustrating an embodiment of the determining steps in Fig. 1;

Fig. 5 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 according to another embodiment;

Fig. 6 is a flow diagram illustrating additional, optional steps of the method in Fig. 1 and an embodiment of the determining steps in Fig. 1;

Fig. 7 is a flow diagram illustrating an additional, optional step of the method in Fig. 1 according to an embodiment;

Fig. 8 is a schematic block diagram of an embodiment of a filtering control device;

Fig. 9 is a schematic block diagram of another embodiment of a filtering control device;

Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device;

Fig. 11 is a schematic block diagram of yet another embodiment of a filtering control device;

Fig. 12 is a schematic block diagram of a software implementation of a filtering control device in a computer according to an embodiment;

Fig. 13 is a schematic block diagram of an encoder according to an embodiment;

Fig. 14 is a schematic block diagram of a decoder according to an embodiment;

Fig. 15 is a schematic block diagram of a user equipment according to an embodiment;

Fig. 16 is a schematic block diagram of a user equipment according to another embodiment; and

Fig. 17 is a schematic overview of a portion of a communication network comprising a network device according to an embodiment.

DETAILED DESCRIPTION

[0028] Throughout the drawings, the same reference numbers are used for similar or corresponding elements.

[0029] The embodiments generally relate to filtering control and controlling deblocking filtering over block boundaries in a video frame. The filtering control of the embodiments provides asymmetric deblocking decisions with regard to block boundaries by making independent filtering decisions for the blocks of pixels separated by a block boundary. This means that the deblocking filtering can handle neighboring blocks having different levels of local structures to thereby adapt the particular deblocking filtering at each block based on its local structures.

[0030] As is well-known in the art, a video frame is divided into non-overlapping blocks of pixels that are encoded and decoded according to the various available intra and inter coding modes. Generally, a video frame is divided into non-overlapping macroblocks of 16x16 pixels. Such a macroblock can in turn be divided into smaller blocks of different sizes, such as 4x4 or 8x8 pixels. However, also rectangular blocks are possible according to the embodiments, such as, 4x8, 8x4, 8x16 or 16x8. The embodiments can be applied to any such block of pixels, including macroblocks or even larger blocks of pixels.

[0031] In the emerging High Efficiency Video Coding (HEVC) standard, coding units (CU), prediction units (PU) and transform units (TU) are used. The prediction units are defined inside a coding unit and contain the intra or inter prediction modes. Transform units are defined inside a coding unit and the largest transform size is 32×32 pixels and the smallest size is 4×4 pixels. The CU size is currently varying from 64×64 pixels (largest) to 8×8 pixels (smallest). In this way, the largest CU can be split into smaller CUs with the "level of granularity" depending on the local characteristics of the frame. That means that the largest CU may be split into smaller CUs of different sizes. The embodiments can also be used in connection with such coding units, which are regarded as being encompassed by the expression "block of pixels" as used herein.

[0032] Each pixel in the block has a respective pixel value. Video frames generally have color values assigned to the pixels, where the color values are represented in a defined color formats. One of the common color formats uses one luminance component and two chrominance components for each pixel, although other formats exist, such as using red, green and blue components for each pixel.

[0033] Traditionally, luminance component filtering and chrominance component filtering are done separately, possibly employing different filtering decisions and different deblocking filters. It is, though, possible that the luminance filtering decisions are used in chroma filtering, like in H.264. The embodiments can be applied to filtering control for the luminance component, the chrominance component or both the luminance component and the chrominance component. In a particular embodiment, the embodiments are applied to control luminance or luma filtering. Filtering decisions, or parts of filtering decisions for one component, such as luma, can be then used when making the filtering decisions for other components, such as chroma.

[0034] Deblocking filtering is conducted over a boundary, edge or border between neighboring blocks. As a consequence, such boundaries can be vertical boundaries 1, see Fig. 2A, between two neighboring blocks 10, 20 present side by side in the video frame. Alternatively, the boundaries are horizontal boundaries 1, see Fig. 2B, between two neighboring block 10, 20, where one block 10 is positioned above the other block 20 in the video frame. In a particular embodiment, vertical boundaries are filtered first starting from the left-most boundary and proceeding through the boundaries towards the right-hand side in their geometrical order. Then, horizontal boundaries are filtered starting with the boundary on the top and proceeding through the boundaries towards the bottom in their geometrical order. The embodiments are, however, not limited to this particular filtering order and can actually be applied to any predefined filtering order. In a particular embodiment, the boundaries at the edge of the video frame are preferably not filtered and thereby excluded from the deblocking filtering.

[0035] Fig. 1 is a flow diagram of a method for filtering control applicable to a block of multiple pixels in a video frame according to an embodiment. The method of Fig. 1 generally starts in step S1 where a first filter decision value is calculated for the block based at least on $|p2_i - 2p1_i + p0_i|$ wherein $p0_i$ denotes a pixel value of a pixel 11 closest to, in a first line of pixels 11, 13, 15, 17 in the block 10, a block boundary 1 to a neighboring block 20 of multiple pixels 21, 23, 25, 27 in the video frame. $p1_i$ denotes a pixel value of a pixel 13 next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 1 and $p2_i$ denotes a pixel value of a pixel 15 second next closest to, in the first line 12 of pixels 11, 13, 15, 17, the block boundary 10.

[0036] Step S2 correspondingly calculates a second filter decision value for the block based at least on $|q2_i - 2q1_i + q0_i|$, wherein $q0_i$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in a corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20, the block boundary 1, $q1_i$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1 and $q2_i$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding first line 22 of pixels 21, 23, 25, 27, the block boundary 1.

[0037] The first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 belong to the same horizontal line of pixels, i.e. row of pixels, extending over a vertical

boundary 1, see Fig. 2A, or belong to the same vertical line of pixels, i.e. column of pixels, extending over a horizontal boundary 1, see Fig. 2B. Hence, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 are perpendicular to the block boundary 1 between the block 10 and the neighboring block 20. Furthermore, the first line 12 of pixels 11, 13, 15, 17 in the block 10 and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 have the same line number. For instance, if the block 10 and the neighboring block 20 each comprises *N*, such as eight, rows or columns of pixels, having row or column numbers i=0...N-1 then the first line 10 of pixels 11, 13, 15, 17 has line number i in the block 10 and the corresponding first line 20 of pixels 21, 23, 25, 27 also has line number i but in the neighboring block 20. Thus, first line 12 of pixels 11, 13, 15, 17 in the block and the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 are opposing lines with regard to the block boundary 1.

[0038] According to the embodiments, "line of pixels" and "corresponding line of pixels" are employed to denote a "row of pixels" and a "corresponding row of pixels" in the case of a vertical block boundary as in Fig. 2A and denote a "column of pixels" and a "corresponding column of pixels" in the case of a horizontal block boundary as in Fig. 2B.

[0039] The first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could be predefined lines in the block 10 and the neighboring block 20, respectively. Thus, the first line 12 of pixels 11, 13, 15, 17 and the corresponding line 22 of pixels 21, 23, 25, 27 have a predefined and fixed line number i with regard to each block boundary 1 for which a filtering control is applied. Alternatively, the first line 12 of pixels 11, 13, 15, 17 and the corresponding first line 22 of pixels 21, 23, 25, 27 could represent a current line and a current corresponding line, respectively, which is further discussed herein.

[0040] The calculation of the first filter decision value in step S1 and the calculation of the second filter decision value in step S2 can be performed serially in any order, i.e. step S1 preceding step S2 or step S2 preceding step S1, or at least partly in parallel. The results of these two steps S1, S2 is, thus, a first filter decision value that is calculated based on pixel values in the block 10 and a second filter decision value that is calculated based on pixel values in the neighboring block 20 on the other side of the block boundary 1 relative to the block 10. More preferably, the calculation of the first decision value is performed only based on pixel values in the block 10 and therefore not based on any pixel values in the neighboring block 20. Correspondingly, the second filter decision value is preferably calculated based only on pixel values in the neighboring block 20 and not based on any pixel values in the block 10.

[0041] The first filter decision value calculated in step S1 is then used in step S3 to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1. The second filter decision value is correspondingly used in step S4 to determine how many pixels in a corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1. Thus, separate filter decision values are calculated for each side or part of a row or column of pixels extending over the block boundary 1 and a respective filter decision is taken for each side or part based on the particular filter decision value calculated for that side or part.

[0042] This should be compared to the prior art where a single or a set of filter decision values is calculated for a line of pixels and the corresponding line of pixels and where this filter decision value or set of filter decision values is used to decide how many pixels to filter on both sides of the block boundary. Thus, in the prior art the same number of pixels is always filtered for the corresponding line of pixels in the neighboring block as is done for the matching line of pixels in the block.

[0043] The present embodiments instead enable an asymmetric filtering control and deblocking filtering by making a separate filter decision for the line 12 of pixels 11, 13, 15, 17 in the block 10 and another, different filter decision for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. This means that based on the particular first and second filter decision values different or the same number of pixels in the line 12 of pixels 11, 13, 15, 17 could be selected for deblocking filtering and modification as the number of pixels in the corresponding line 22 of pixels 21, 23, 25, 27 that are selected for deblocking filtering and modification.

[0044] Generally, herein pX_y denotes the pixel value of pixel number X relative to the block boundary 1 in a line of pixels having line number y in the block 10. Correspondingly, qX_y denotes the pixel value of pixel number X relative to block boundary 1 in a corresponding line of pixels having line number y in the neighboring block 20.

[0045] Steps S3 and S4 can be performed serially in any order or indeed at least partly in parallel.

[0046] In a first embodiment, steps S1 and S2 could be performed once for a given block boundary 1 between the block 10 and the neighboring block 20 to thereby calculate a first filter decision value and a second filter decision value that applies to all lines 12 of pixels 11, 13, 15, 17 in the block 10 and to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20, respectively. In such approach the same first number of pixels are preferably filtered and modified in each line 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the block boundary 1, where this first number is determined based on the first filter decision value calculated in step S1. Correspondingly, the same second number of pixels are preferably filtered and modified in each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the block boundary 1, where this second number is determined based on the second filter decision value calculated in step S2.

[0047] Alternatively, in a second embodiment the first filter decision value and the second filter decision value applies

to a subset of the lines 12 of pixels 11, 13, 15, 17 in the block 10 and to a corresponding subset of the corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20. For instance, a pair of filter decision values could be used for the first four lines 12 of pixels 11, 13, 15, 17 in the block and the first four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and with another pair of filter decision values used for the remaining four lines 12 of pixels 11, 13, 15, 17 in the block and the remaining four corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

[0048] In a third embodiment the calculation in step S1 is performed for each line 12 of pixels 11, 13, 15, 17 in the block 10 and a separate determination in step S3 is then performed for each such line 12 of pixels 11, 13, 15, 17. In such a case, the calculation in step S2 is correspondingly performed for each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 and a separate determination in step S4 is performed for each such corresponding line 22 of pixels 21, 23, 25, 27.

[0049] Thus, in the third embodiment step S3 comprises determining how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated in step S1. Step S4 comprises determining how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated in step S2.

[0050] The following part describes how the third embodiment is applied separately for each line (row or column) crossing the block boundary 1. In this example the first filter decision value is defined as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and the second filter decision value is defined as $d_{qi} = |q2_i - 2q1_i + q0_i|$. The method then comprises:

- Calculate d_{pi}, calculate d_{qi} for each line i crossing the block boundary.
- if $d_{pi} < thr1$
  - do normal filtering of line i of current block 10, e.g. filter and modify two pixels from the block border or boundary;
- else, i.e. if $d_{pi} \geq thr1$
  - do not filter the second pixel from the block border or boundary of line i of the current block 10 or do not filter any pixels at all on line i of the current block 10;
- if $d_{qi} < thr2$
  - do normal filtering of line i of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_{qi} \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 of line i of the neighboring block 20 or do not filter any pixels at all on line i of the neighboring block 20.

[0051] As is illustrated by the example above, the third embodiment of the method in Fig. 1 can calculate separate first and second filter decision values and therefore make separate determinations of how many pixels to filter for each row or column in the block 10 and the neighboring block 20 relative to the block boundary 1. Thus, in this third embodiment the first and second filter decision values are line-specific filter decision values, i.e. calculated for each line 12 of pixels 11, 13, 15, 17 in the block 10 and for each corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20.

[0052] In the first embodiment, block-specific filter decision values are used. Thus, in such a case a single first filter decision value could be calculated for the block 10 relative to the block boundary 1 and apply to all lines 12 of pixels 11, 13, 15, 17 in the block 10 with regard to the particular block boundary 1. Correspondingly a single second filter decision value is calculated for the neighboring block 20 relative to the block boundary 1 and applies to all corresponding lines 22 of pixels 21, 23, 25, 27 in the neighboring block 20 with regard to the particular block boundary 1.

[0053] A first example of this first embodiment involves calculating a first filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1.

[0054] The second filter decision value is then preferably calculated as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

[0055] The first filter decision value is then used for all lines 12 of pixels 11, 13, 15, 17 in the block 10 when determining how many pixels to filter and the second filter decision value is used for all corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 when determining how many pixels to filter.

[0056] In this first example of the first embodiment, the first line of pixels corresponds to line i=2 and the corresponding first line corresponds to corresponding line i=2 and the second line of pixels corresponds to line i=5 and the second corresponding line corresponds to corresponding line i=5. In this case the block 10 preferably comprises eight lines and the neighboring block 20 preferably also comprises eight lines, i.e. i=0-7.

[0057] The following part illustrates an implementation example of the first embodiment. In this implementation example the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is defined as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q05|$.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
  - do normal filtering of current block 10, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_p \geq thr1$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr2$
  - do normal filtering of neighboring block 20, e.g. filter and modify two pixels from the block border or boundary 1;
- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

[0058] In a second example of the first embodiment the first filter decision value is calculated as a block-specific filter decision value based on pixel values in line i=3 and line i=4 instead of line i=2 and line i=5. The corresponding lines i=3 and i=4 in the neighboring block 20 are preferably then used for calculating the second filter decision value. The first filter decision value could then be calculated as $|p2_3 - 2p1_3 + P0_3| + |p2_4 - 2p1_4 + p0_4|$ and the second filter decision value is calculated as $|q2_3 - 2q1_3 + q0_3| + |q2_4 - 2q1_4 + q0_4|$, wherein $p0_3$ denotes the pixel value of the pixel closest to, in the first line of pixels, the block boundary 1, $p1_3$ denotes the pixel value of the pixel next closest to, in the first line of pixels, the block boundary 1, $p2_3$ denotes the pixel value of the pixel second next closest to, in the first line of pixels, the block boundary 1, $p0_4$ denotes a pixel value of a pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_4$ denotes a pixel value of a pixel next closest to, in the second line of pixels, the block boundary 1 and $p2_4$ denotes a pixel value of a pixel second next closest to, in the second line of pixels, the block boundary 1 and $q0_3$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in the corresponding first line of pixels, the block boundary 1, $q1_3$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding first line of pixels, the block boundary 1, $q2_3$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding first line of pixels, the block boundary 1, $q0_4$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_4$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1 and $q2_4$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1.

[0059] In the second embodiment a first filter decision value and a second filter decision value are calculated for a group of four lines of pixels and four corresponding lines of pixels. This second embodiment can be suitable if the block

and the neighboring block each have a size of 4x4 pixels. In addition, the second embodiment could also be used for larger blocks of pixels, such as 8x8 pixels. In the latter case, a pair of filter decisions is calculated for the first four lines pixels and first four corresponding lines of pixels and another pair of filter decisions is calculated for the remaining four lines of pixels and the remaining four corresponding lines of pixels.

[0060] A first example of the second embodiment calculates the first filter decision value as $|p2_0 - 2p1_0 + p0_0|+|p2_3 - 2p1_3 + p0_3|$ and the second filter decision value as $|q2_0 - 2q1_0 + q0_0 + q2_3 - 2q1_3 + q0_3|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision value is calculated as $|p2_0 - 2p1_0 + p0_0|+|p2_3 - 2p1_3 + p0_3|$ and $|q2_0 - 2q1_0 + q0_0| +|q2_3 - 2q1_3 + q0_3|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_4 - 2p1_4 + p0_4|+| p2_7 - 2p1_7 + p0_7|$ and $|q2_4 - 2q1_4 + q0_4|+|q2_7-2q1_7 + q0_7|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

[0061] A second example of the second embodiment calculates the first filter decision value as $|p2_1 - 2p1_1 + p0_1|+|p2_2 - 2p1_2 + p0_2|$ and the second filter decision value as $|q2_1 - 2q1_1 + q0_1|+|q2_2 - 2_q1_2 + q0_2|$. In such a case, the line of pixels and the corresponding line of pixels could run from line number i=0 to line number i=3. For larger blocks of pixels, such as i=0-7 as shown in Figs. 2A and 2B, the first pair of a first filter decision value and a second filter decision value is calculated as $|p2_1 - 2p1_1 + p0_1|+| p2_2 - 2p1_2 + p0_2|$ and $|q2_1 - 2q1_1 + q0_1 + q2_2 - 2q1_2 + q0_2|$. This first pair of filter decision values is applicable to the first four lines of pixels and first four corresponding line of pixels, i.e. i=0-3. The second pair of a first filter decision value and a second filter decision value is then calculated as $|p2_5 - 2p1_5 + p0_5| + |p2_6 - 2p1_6 + p0_6|$ and $|q2_5 - 2q1_5 + q0_5| + |q2_6 - 2q1_6 + q0_6|$. The second pair of filter decision values is then applicable to the four last line of pixels and the four last corresponding line of pixels, i.e. i=4-7.

[0062] This concept of the second embodiment can be extended to the case where the first filter decision value is calculated based on the pixel values of pixels present in a subset of the lines of pixels in the block and the second filter decision value is calculated based on the pixel values of pixels present in a subset of the corresponding lines of pixels in the neighboring block. Thus, in this general concept of the second embodiment the first filter decision value could be calculated as $|p2_i - 2p1_i + p0_i| + |p2_j - 2p1_j + p0_j|$, wherein i, j represent different line numbers in the interval 0 to N-1, with N denoting the total number of lines of pixels in the block and the neighboring block and i≠j. The second filter decision value is then preferably calculated as $|q2_i - 2q1_i + q0_i|+|q2_j - 2q1_j + q0_j|$. This concept can of course be extended with the subset containing more than two of the lines of pixels or the corresponding lines of pixels.

[0063] In a related example of the first or third embodiment, the first filter decision value is calculated as $\overline{\omega}_i|p2_i - 2p1_i + p0_i| + \overline{\omega}_j |p2_j - 2p1_j + p0_j|$ and the second filter decision value is calculated as $\overline{\omega}_i|q2_i - 2q1_i + q0_i| + \overline{\omega}_j|q2_j - 2q1j + q0j|$. $\overline{\omega}_i$, $\overline{\omega}j$ represent different line-specific weights. This concept can also be extended to the case with more than two lines of pixels and two corresponding lines of pixels. In a particular example, a line of pixels or corresponding line of pixels that is closer to the middle of the block or the neighboring block could then be assigned a comparatively higher weight as compared to a line or pixels or corresponding line of pixels that is closer to one of the edges of the block or the neighboring block.

[0064] In a fourth embodiment, a combination of block-specific and line-specific filter decision values is used to determine how many pixels to filter for the lines of pixels in the block and the corresponding lines of pixels in the neighboring block. Fig. 3 schematically illustrates such an embodiment. The method starts in step S10 where a third filter decision value is calculated as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$, wherein $p0_2$ denotes the pixel value of the pixel closest to, in a second line of pixels in the block 10, the block boundary 1, $p1_2$ denotes the pixel value of the pixel next closest to, in the second line of pixels, the block boundary 1, $p2_2$ denotes the pixel value of the pixel second next closest to, in the second line of pixels, the block boundary 1, $p0_5$ denotes a pixel value of a pixel closest to, in a third line of pixels in the block 10, the block boundary 1, $p1_5$ denotes a pixel value of a pixel next closest to, in the third line of pixels, the block boundary 1 and $p2_5$ denotes a pixel value of a pixel second next closest to, in the third line of pixels, the block boundary 1. The second line of pixels preferably corresponds to line number 2 in the block 10 and the third line of pixel preferably corresponds to line number 5 in the block 10, see Figs. 2A and 2B.

[0065] The next step S11 calculates a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, wherein $q0_2$ denotes the pixel value of the pixel in the neighboring block 20 closest to, in a corresponding second line of pixels in the neighboring block 20, the block boundary 1, $q1_2$ denotes the pixel value of the pixel of the neighboring block 20 next closest to, in the corresponding second line of pixels, the block boundary 1, $q2_2$ denotes the pixel value of the pixel in the neighboring block 20 second next closest to, in the corresponding second line of pixels, the block boundary 1, $q0_5$ denotes a pixel value of a pixel in the neighboring block 20 closest to, in a corresponding third line of pixels in the neighboring block 20, the block boundary 1, $q1_5$ denotes a pixel value of a pixel of the neighboring block 20 next closest to, in the corresponding third line of pixels, the block boundary 20 and $q2_5$ denotes a pixel value of a pixel in the neighboring block 20 second next closest to, in the corresponding third line of pixels, the block boundary 1. The second

corresponding line of pixels preferably corresponds to line number 2 in the neighboring block 20 and the third corresponding line of pixel preferably corresponds to line number 5 in the neighboring block 20, see Figs. 2A and 2B.

[0066] Steps S10 and S11 can be performed serially in any order or at least partly in parallel.

[0067] The next step S12 compares the third filter decision value calculated in step S10 with a third threshold value (T_3). If the third filter decision value is below the third threshold value the method continues to steps S1 and then S3 of Fig. 1. Thus, in such a case a respective line-specific or first filter decision value is calculated for each line i in the block 10, where i preferably is from 0 to 7. This first filter decision value is then calculated as $|p2_i - 2p1_i + p0_i|$ in step S1 of Fig. 1. Step S3 of Fig. 1 determines how many pixels in the line i of pixels in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated for the line i of pixels in step S1. This procedure is performed for each line of pixels in the block 10. Thus, with a block 10 as illustrated in Figs. 2A or 2B steps S1 and S3 will be performed eight times. The method then continues to step S13 of Fig. 3. Correspondingly, if the third filter decision value is not below the first threshold value in step S12 the method continues to step S13.

[0068] Step S13 compares the fourth filter decision value calculated in step S11 with a fourth threshold value (T_4). If the fourth filter decision value is below the fourth threshold the method continues to steps S2 and S4 of Fig. 1. A respective line-specific or second filter decision value is calculated for each corresponding line i in the neighboring block 20 as $|q2_i - 2q1_i + q0_i|$ in step S2 of Fig. 1. Step S4 of Fig. 3 determines how many pixels in the corresponding line i of pixels in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i of pixels in step S2. This procedure is performed for each corresponding line of pixels in the neighboring block 20. The method then ends. Correspondingly, if the fourth filter decision value is not below the second threshold value in step S13 the method ends.

[0069] The loop formed by steps S12, S1 and S3 can be performed sequentially in any order relative to the loop formed by steps S13, S2 and S4 or at least partly in parallel.

[0070] In an example of this fourth embodiment a combination of block-based and line-based asymmetric filter decisions is used. In this example the third filter decision value is calculated as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the fourth filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$. The line-specific filter decision values, i.e. the first and second filter decision values, are calculated as $d_{pi} = |p2_i - 2p1_i + p0_i|$ and $d_{qi} = |q2_i - 2q1_i + q0_i|$ for line and corresponding line number i, respectively.

- Calculate d_p, calculate d_q;
- if $d_p < thr1$
    - for each line i
        - calculate d_{pi} for line i
        - if $d_{pi} < thr1$
            - do normal filtering of line i in current block 10, e.g. two pixels from the block border or boundary 1;
        - else, i.e. if $d_{pi} \geq thr1$
            - do not filter the second pixel from the block border or boundary 1 of line i of current block 10 or do not filter any pixels at all on line i of current block 10;
- else, i.e. if $d_p \geq thr1$
    - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all;
- if $d_q < thr1$
    - for each line i
        - calculate d_{qi} for line i
        - if $d_{qi} < thr2$
            - do normal filtering of line i in neighboring block 20, e.g. two pixels from the block border or boundary 1;
        - else, i.e. if $d_{qi} \geq thr2$

- do not filter the second pixel from the block border or boundary 1 of line i of neighboring block 20 or do not filter any pixels at all on line i of neighboring block 20;

- else, i.e. if $d_q \geq thr2$
  - do not filter the second pixel from the block border or boundary 1 or do not filter any pixels at all.

[0071] In the above disclosed example the same threshold value has been used when comparing the third filter decision value and the first filter decision values, i.e. thr1, and the same threshold value has been used when comparing the fourth filter decision value and the second filter decision values, i.e. thr2. In an alternative approach, a third threshold value is used for the third filter decision value, a first threshold value is used for the first filter decision values, a fourth threshold value is used for the fourth filter decision value and a second threshold value is used for the second threshold values. In a particular embodiment, the third and fourth threshold values are equal and the first and second threshold values are equal.

[0072] Fig. 4 is a flow diagram illustrating a particular embodiment of the determining steps S3 and S4 of Fig. 1. The method continues from step S2 in Fig. 1. A next step S20 compares the first filter decision value (d_p) calculated in step S1 in Fig. 1 to a first threshold value (T_1). If the first filter decision value is below the first threshold value the method continues from step S20 to step S21. Step S21 determines to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. These two pixels are preferably the pixel 11 closest to the block boundary 1 and the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. However, if the first filter decision value is not below the first threshold in step S20 the method instead continues to step S22. A first embodiment of step S22 determines to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. This pixel 11 is preferably the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17. A second embodiment of step S22 determines to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

[0073] Steps S23 to S25 perform the corresponding determination for the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20. Thus, step S23 compares the second filter decision value (dq) calculated in step S2 in Fig. 1 with a second threshold value (T_2). If the second filter decision value is below the second threshold value the method continues to step S24. Step S24 determines to filter two pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. These two pixels 21, 23 are preferably the pixel 21 closest to the block boundary 1 and the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. If the second filter decision value is not below the second threshold the method instead continues to step S25 from step S23. A first embodiment of step S25 determines to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. This pixel 21 is preferably the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27. A second embodiment of step S25 determines to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block relative to the block boundary 1.

[0074] Steps S20, S21 and S22 can be performed prior to, following or at least in parallel to steps S23, S24 and S25.

[0075] This concept can be extended by using more than one threshold value per filter decision value. For instance, if $d_p<T_1$ two pixels are filtered in the line 12 of pixels 11, 13, 15, 17, if $T_1\leq d_p<T_1'$ one pixel is filtered in the line 12 of pixels 11, 13, 15, 17 and if $d_p\geq T_1'$ no pixels are filtered in the line 12 of pixels 11, 13,15,17. In this case $T_1<T_1'$. Correspondingly, if $d_q<T_2$ two pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27, if $T_2\leq d_q<T_2'$ one pixel is filtered in the corresponding line 22 of pixels 21, 23, 25, 27 and if $d_q\geq T_2'$ no pixels are filtered in the corresponding line 22 of pixels 21, 23, 25, 27. In this case $T_2<T_2'$.

[0076] Thus, in a general aspect the closer the first or second filter decision value is to zero the more filtering is to be applied to the particular line or corresponding line of pixels by filtering and possibly modifying more pixels in the line or corresponding line of pixels as compared to a larger first or second filter decision value. This means that a zero or low first or second filter decision value implies no or few structures but rather a fairly uniform area in the video frame. Correspondingly, a high first or second filter decision value generally reflects local structures in the area in the video frame, which local structures should not be repressed or filtered away.

[0077] This embodiment decreases the computational complexity in connection with deblocking filtering since the filtering of the second pixel from the block border may happen less frequently as compared to the prior art HEVC solution.

[0078] The threshold values discussed in the foregoing and used to compare the different filter decision values are preferably dependent on the quantization parameter (QP) assigned to the block or to the neighboring block. Fig. 5 schematically illustrates such an approach. The method starts in step S30 where the first threshold value, to which the first filter decision value is compared (see step S20 in Fig. 4), is determined based on a quantization parameter associated with the block 10. Correspondingly, step S31 determines the second threshold value, to which the second threshold value is compared (see step S23 in Fig. 4), based on a quantization parameter associated with the neighboring block

20 and/or a quantization parameter associated with the block 10.

[0079] For instance, T_1 and T_2 are determined based on the parameter β, which is determined from the QP value of the block 10 or the neighboring block 20. In a particular embodiment, the parameter β is read from a table based on the QP value, see Table 1 below.

Table 1 - β and QP values

QP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
QP	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
QP	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
β	38	40	42	44	46	48	50	52	54	56	58	60	62	64	64	64	64	64	

[0080] In particular embodiments $T_1=T_2=\beta/6$ or $T_1=T_2=(\beta + \beta>>1)>>3$. As another variant of the embodiment, the thresholds can be read from separate tables, i.e. T_1=function(QP), T_2=function(QP). Also the above mentioned third and fourth threshold values are preferably determined based on the quantization parameter associated with the block and the neighboring block, respectively.

[0081] Fig. 6 is a flow diagram illustrating how the filtering control of the embodiments can be used in connection with a filtering process. The method starts in step S40 where a first offset or delta value Δ is calculated based on $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel 11 closest to, in a line 12 of pixels 11, 13, 15, 17, the block boundary 1, $p1_j$ denotes a pixel value of a pixel 13 next closest to, in the line 12 of pixels 11, 13, 15, 1), the block boundary 1, $q0_j$ denotes a pixel value of a pixel 21 in the neighboring block 20 closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1 and $q1_j$ denotes a pixel value of a pixel 23 of the neighboring block 20 next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1.

[0082] This first offset is used in step S41 to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value, i.e. $p0'_j = p0_j + \Delta$. Step S41 also modifies the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value, i.e. $q0'_j = q0_j - \Delta$. The method then continues to steps S1 and S2 of Fig. 1 where the first (d_p) and second (d_q) filter decision values are calculated. A next step S42 compares the first filter decision value to a first threshold value (T_1). This step S42 corresponds to step S20 in Fig. 4. If the first filter decision value is below the threshold the method continues to step S43.

[0083] Step S43 calculates a second offset or delta value Δ_p based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel 15 second next closest to, in the line 12 of pixels 11, 13, 15, 17, the block boundary 1. The second offset is then used in step S44 to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value, i.e. $p1'_j = p1_j + \Delta_p$.

[0084] The method then continues to step S45. The method also continues in Fig. 6 from step S42 to step S45 if the first threshold value is not below the first threshold.

[0085] Step S45 compares the second filter decision value with a second threshold (T_2). This step S45 corresponds to step S23 of Fig. 4. If the second filter decision value is below the second threshold the method continues to step S46.

Step S46 calculates a third offset Δq based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel 25 in the neighboring block 20 second next closest to, in the corresponding line 22 of pixels 21, 23, 25, 27, the block boundary 1. The third offset is used in step S47 to modify the pixel value of the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value, i.e. $q1'_j = q1_j + \Delta q$.

[0086] Steps S42, S43 and S44 can be performed serially in any order or at least partly in parallel with steps S45, S46 and S47.

[0087] In above, the first, second and third offsets are calculated based on particular equations of pixel values. This

means that the first offset is calculated as a function of $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, the second offset is calculated as a function of $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$ and the third offset is calculated as a function of $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$. Different such functions are possible and can be used in steps S40, S43 and S46. Such functions could then be defined so that the calculations of the offsets are efficiently performed in hardware. In such a case, it is generally preferred not to have any divisions and/or define the functions so that the offsets will be an integer value. In an embodiment, (X+8)»4 is used as an integer-expression of X/16, where » denotes a right shift operation. Thus, in a particular embodiment step S40 calculates the first offset to be based on and preferably equal to $(9 \times (q0_j - p0_j) - 3 \times (q1_j - p1_j) + 8) >> 4$. Corresponding integer representations of the second and third offsets could be $(((p0_j + p2_j + 1) >> 1) - p1_j + \Delta) >> 1$ and $(((q0_j + q2_j + 1) >> 1) - q1_j - \Delta) >> 1$.

[0088] In an example the modified pixel values as a result of deblocking are calculated like in the following. In this example, the first filter decision value is defined as $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ and the second filter decision value is calculated as $d_q = |q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

- $$\Delta = \frac{9\times(q0 - p0) - 3\times(q1 - p1)}{16}$$
- $$p_0' = p_0 + \Delta$$
- $$q_0' = q_0 - \Delta$$
- if $d\,p < thrP$
  - $$\Delta_p = \frac{p0 + p2 - 2p1_j + 2\Delta}{4}$$
  - $$p_1' = p_1 + \Delta_p$$
- if $d_q < thrQ$
  - $$\Delta_q = \frac{q0 + q2 - 2q1 - 2\Delta}{4}$$
  - $$q_1' = q_1 + \Delta_q$$

[0089] Exact formulas for computation of the example above in the programming language can look like in the text below. Here, the Clip3 function is clipping of the output values to the range between the two first function arguments.

```
Int xCalcDP(Pel* piSrc, Int iOffset)
{
 return abs (piSrc [-iOffset*3]-2*piSrc[-iOffset*2]+piSrc[-
iOffset]);
}

Int xCalcDQ(Pel* piSrc, Int iOffset)
{
 return abs(piSrc[0]-2*piSrc[iOffset]+piSrc[iOffset*2]);
}

Int iDP=xCalcDP(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDP(piTmpSrc+iSrcStep*
(iIdx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iDQ=xCalcDQ(piTmpSrc+iSrcStep*(iIdx*uiPelsInPart+iBlkIdx*
DEBLOCK_SMALLEST_BLOCK+2),iOffset)+xCalcDQ(piTmpSrc+iSrcStep*(
Idx*uiPelsInPart+iBlkIdx*DEBLOCK_SMALLEST_BLOCK+5),iOffset);

Int iSideThreshold=iBeta/6;

Bool bFilterP=(iDP<iSideThreshold);
Bool bFilterQ=(iDQ<iSideThreshold);
delta=(9*(m4-m3)-3*(m5-m2)+8)>>4;

if (abs(delta)<iThrCut)
{
 Int tc2=tc>>1;

 delta=Clip3(-tc, tc, delta);
 piSrc[-iOffset]=Clip((m3+delta));
 piSrc[0]=Clip((m4-delta));

 if(bFilterP)
 {
  Int delta1=Clip3(-tc2,tc2,((((m1+m3+1)>>1)-m2+delta)>>1));
  piSrc[-iOffset*2]=Clip((m2+delta1));
 }
if(bFilterQ)
 {
  Int delta2=Clip3(-tc2,tc2,((((m6+m4+1)>>1)-m5-delta)>>1));
  piSrc[iOffset]=Clip((m5+delta2));
 }
}
```

[0090] Fig. 7 is a flow diagram illustrating additional optional steps of the method in Fig. 1. The method continues from step S2 in Fig. 1. A next step S50 compares a sum of the first decision value and the second decision value with a threshold value (T). If the sum is not below the threshold value, the method ends. Thus, in such a case no filtering at all is applied to block 10 and neighboring block 20 with regard to the particular block boundary 1. The block 10 and the neighboring block 20 then comprises at lot of local structures, which should not be filtered away. However, if the sum is below the threshold value the method continues to steps S3 and S4 in Fig. 1, where the determination of how many pixels to filter is performed based on the first filter decision value (step S3) or the second filter decision value (step S4).

[0091] This embodiment has an advantage that it does not require many additional computations as the values for the first and second filter decisions are also used for deciding whether to filter the block boundary at all.

[0092] The embodiments disclosed herein achieve asymmetric deblocking decisions that control deblocking filtering to be adaptive to the structure on each side of a block boundary. The asymmetric decisions means that the amount of filtering applied to one side of the block boundary can differ from the amount of filtering applied to the other side of the block boundary, thus providing additional adaptation to the local structure. This improves the objective and subjective video quality.

[0093] Fig. 8 is a schematic block diagram of an embodiment of a filtering control device 100. The filtering control device 100 comprises a first decision value calculator 110 configured to calculate a first filter decision value for a block

10 in a video frame based at least on $|p2_i - 2p1_i + p0_i|$. The filtering control device 100 also comprises a second decision value calculator 120 configured to calculate a second, different filter decision value for the block 10 based on $|q2_i - 2q1_i + q0_i|$.

[0094] A first pixel determiner 130 or first pixel determining unit or processor is configured to determine how many pixels in a line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to a block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110. A second pixel determiner 140 or second pixel determining unit or processor is provided in the filtering control device 100 to determine how many pixels in a corresponding line 22 of pixel 21, 23, 25, 27 in a neighboring block 20 of the video frame to filter relative to the block boundary based on the second filter decision value calculated by the second decision value calculator 120.

[0095] In an embodiment, the first pixel determiner 130 is configured to determine how many pixels in the first line 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the first line 12 of pixels 11, 13, 15, 17. The second pixel determiner 140 correspondingly determines in this embodiment how many pixels in the corresponding first line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated by the second decision value calculator 120 for the corresponding first line 22 of pixels 21, 23, 25, 27.

[0096] In another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value as $|p2_2 - 2p1_2 + p0_2| + p2_5 - 2p1_5 + p0_5|$ and the second decision value calculator 120 is configured to calculate the second filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

[0097] In yet another embodiment, the first decision value calculator 110 is configured to calculate the first filter decision value of a first pair as $|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$ and the second decision value calculator 120 is configured to calculate the second filter decision value of the first pair as $|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$. The first filter decision value calculator 110 is also configured to calculate the first filter decision value of a second pair as $|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ and the second filter decision value calculator 120 is also configured to calculate the second filter decision value of a the second pair as $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$.

[0098] Fig. 9 is a schematic block diagram of another embodiment of a filtering control device 100. The filtering control device 100 comprises, in this embodiment and in addition to the first decision value calculator 110, the second decision value calculator 120, the first pixel determiner 130 and the second pixel determiner 140, a third decision value calculator 150. The third decision value calculator 150 is then configured to calculate a third filter decision value as $|p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$. A fourth decision value calculator 160 is also implemented in the filtering control device 100 and configured to calculate a fourth filter decision value as $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$.

[0099] In this embodiment, the first filter decision value calculator 110 is configured to calculate the first filter decision value if the third filter decision value calculated by the third decision value calculator 150 is below a third threshold value. If the third decision value is below the third threshold, the first decision value calculator 110 calculates a first threshold value for each line i 12 of pixels 11, 13, 15, 17 in the block 10 as $|p2_i - 2p1_i + p0_i|$. The first pixel determiner 130 then determines, if the third filter decision value is below the third threshold value and for each line i 12 of pixels 11, 13, 15, 17 in the block 10, how many pixels in the line i 12 of pixels 11, 13, 15, 17 in the block 10 to filter relative to the block boundary 1 based on the first filter decision value calculated by the first decision value calculator 110 for the line i 12 of pixels 11, 13, 15, 17.

[0100] The second decision value calculator 120 is preferably responsive to a comparison between the fourth filter decision value and a fourth threshold value. Thus, if the fourth filter decision value calculated by the fourth decision value calculator 160 is below the fourth threshold the second decision value calculator 120 calculates a second filter decision value as $|q2_i - 2q1_i + q0_i|$ for each corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20. The second pixel determiner 240 is configured to determine, if the fourth filter decision value is below the fourth threshold value and for each corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20, how many pixels in the corresponding line i 22 of pixels 21, 23, 25, 27 in the neighboring block 20 to filter relative to the block boundary 1 based on the second filter decision value calculated for the corresponding line i 22 of pixels 21, 23, 25, 27.

[0101] Fig. 10 is a schematic block diagram of a further embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises a first comparator 180 configured to compare the first filter decision value calculated by the first decision value calculator 110 to a first threshold value. A second comparator 182 is correspondingly configured to compare the second filter decision value calculated by the second decision value calculator 120 to a second threshold value.

[0102] In this embodiment, the first pixel determiner 130 is configured to determine to filter two pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1 if the first filter decision value is below the first threshold value as determined by the first comparator 180. However, if the first filter decision value is not below the first threshold value the first pixel determiner 130 is instead configured to determine to filter one pixel in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1. Alternatively, the first pixel determiner 130 is instead configured to determine to filter no pixels in the line 12 of pixels 11, 13, 15, 17 in the block 10 relative to the block boundary 1.

[0103] The second pixel determiner 140 is configured to determine to filter two pixels in the corresponding line 22 of

pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1 if the second filter decision value is below the second threshold value as determined by the second comparator 182. However, if the second filter decision value is not below the second threshold the second pixel determiner 140 is instead configured to determine to filter one pixel in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1. Alternatively, the second pixel determiner 140 is instead configured to determine to filter no pixels in the corresponding line 22 of pixels 21, 23, 25, 27 in the neighboring block 20 relative to the block boundary 1.

[0104] In an embodiment the filtering control device 100 of Fig. 10 comprises a first offset calculator 181 configured to calculate a first offset based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$. A first pixel modifier 190 of the filtering control device 100 is configured to modify the pixel value of the pixel 11 closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the first offset to the pixel value of this pixel 11. A second pixel value modifier 192 is configured to modify the pixel value of the pixel 21 closest to the block boundary 1 in the corresponding line 12 of pixels 21, 23, 25, 27 by subtracting the first offset from the pixel value of this pixel 21.

[0105] A second offset calculator 183 is preferably implemented in the filtering control device 100 to calculate a second offset if the first filter decision value is below the first threshold value as determined by the first comparator 180. The second offset is then calculated based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$. A third pixel modifier 194 is operated if the first filter decision value is below the first threshold value. In such a case, the third pixel modifier 194 is configured to modify the pixel value of the pixel 13 next closest to the block boundary 1 in the line 12 of pixels 11, 13, 15, 17 by adding the second offset to the pixel value of this pixel 13.

[0106] A third offset calculator 185 is configured to calculate a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$ if the second filter decision value is below the second threshold value as determined by the second comparator 182. If the second filter decision value is below the second threshold value a fourth pixel modifier 196 of the filtering control device 100 is configured to modify the pixel value of the pixel 23 next closest to the block boundary 1 in the corresponding line 22 of pixels 21, 23, 25, 27 by adding the third offset to the pixel value of this pixel 23.

[0107] The embodiments of the filtering control device 100 discussed in the foregoing in connection with Figs. 9 and 10 compares filter decision values to respective threshold values. In an embodiment, such threshold values are calculated by the filtering control device 100 for the particular block boundary 1. The filtering control device 100 then preferably comprises a threshold determiner 170 or threshold determining processor or unit configured to determine the first threshold value used by the first comparator 180 in Fig. 10 and the third threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the block 10. Correspondingly, the threshold determiner 170 correspondingly preferably determines the second threshold value used by the second comparator 182 in Fig. 10 and the fourth threshold value used by the filtering control device 100 in Fig. 9 based on a quantization parameter associated with the neighboring block 20.

[0108] Fig. 11 is schematic block diagram of yet another embodiment of a filtering control device 100. In addition to the units 110-140 of the embodiment illustrated in Fig. 8, the filtering control device 100 comprises in this embodiment a third comparator 184 configured to compare a sum of the first filter decision value and the second filter decision value to a threshold value. If the sum is equal to or exceeds the threshold value the first and second pixel determiners 130, 140 will not determine any number of pixels to filter since no filtering is to be applied to the block 10 and the neighboring block 20 with regard to the particular block boundary 1. However, if the sum is below the threshold, the first and second pixel determiners 130, 140 are operated to determine the number of pixels to filter based on the first or second filter decision values, respectively.

[0109] The embodiments of the filtering control device 100 discussed in the foregoing and disclosed in Figs. 8-11 can be combined. For instance, the third value calculator 150 and fourth value calculator 160 of Fig. 9 can be implemented in any of the embodiments disclosed in Figs. 10 or 11. Correspondingly, the third comparator 184 of Fig. 11 can be implemented in any of the embodiments disclosed in Figs. 9 or 10.

[0110] Although the respective units 110-196 disclosed in conjunction with Figs. 8-11 have been disclosed as physically separate units 110-196 in the filtering control device 100, and all may be special purpose circuits, such as ASICs (Application Specific Integrated Circuits), alternative embodiments of the filtering control device 100 are possible where some or all of the units 110-196 are implemented as computer program modules running on a general purpose processor. Such an embodiment is disclosed in Fig. 12.

[0111] Fig. 12 schematically illustrates an embodiment of a computer 70 having a processing unit 72, such as a DSP (Digital Signal Processor) or CPU (Central Processing Unit). The processing unit 72 can be a single unit or a plurality

of units for performing different steps of the method described herein. The computer 70 also comprises an input/output (I/O) unit 71 for receiving recorded or generated video frames or encoded video frames and outputting encoded video frame or decoded video data. The I/O unit 71 has been illustrated as a single unit in Fig. 12 but can likewise be in the form of a separate input unit and a separate output unit.

[0112] Furthermore, the computer 70 comprises at least one computer program product 73 in the form of a non-volatile memory, for instance an EEPROM (Electrically Erasable Programmable Read-Only Memory), a flash memory or a disk drive. The computer program product 73 comprises a computer program 74, which comprises code means which when run on or executed by the computer 70, such as by the processing unit 72, causes the computer 70 to perform the steps of the method described in the foregoing in connection with Fig. 1. Hence, in an embodiment the code means in the computer program 74 comprises a first decision value calculating (DVC) module 310 for calculating the first filter decision value for a block, a second pixel value calculating module 320 for calculating the second filter decision value for the block, a first pixel determining (PD) module 330 for determining how many pixels in the line 12 of pixels 11, 13, 15, 17 to filter and a second pixel determining module 340 for determining how many pixels in the corresponding line 22 of pixels 21, 23, 25, 27 to filter. These modules 310-340 essentially perform the steps of the flow diagram in Fig. 1 when run on the processing unit 72. Thus, when the different modules 310-340 are run on the processing unit 72 they correspond to the corresponding units 110-140 of Figs. 8-11.

[0113] The computer program 74 may additionally comprise a third decision value calculating module, a fourth decision value calculating module, a threshold determining module, a first comparing module, second comparing module, a third comparing module, a first offset calculating module, a second offset calculating module, a third offset calculating module, a first pixel modifying module, a second pixel modifying module, a third pixel modifying module and/or a fourth pixel modifying module to perform the operation of the corresponding units 150-196 in Figs. 9-11.

[0114] The computer 70 of Fig. 12 can be a user equipment or be present in a user equipment. In such a case, the user equipment may additionally comprise or be connected to a display to display video data.

[0115] The filtering control device of Figs. 8-11 is preferably used in video coding. It functions and is therefore preferably implemented both in a video encoder and in a video decoder. The video decoder can be implemented preferably in hardware but also in software. The same holds for the video encoder.

[0116] Fig. 13 is a schematic block diagram of an encoder 40 for encoding a block of pixels in a video frame of a video sequence according to an embodiment.

[0117] A current block of pixels is predicted by performing a motion estimation by a motion estimator 50 from an already provided block of pixels in the same frame or in a previous frame. The result of the motion estimation is a motion or displacement vector associated with the reference block, in the case of inter prediction. The motion vector is utilized by a motion compensator 50 for outputting an inter prediction of the block of pixels.

[0118] An intra predictor 49 computes an intra prediction of the current block of pixels. The outputs from the motion estimator/compensator 50 and the intra predictor 49 are input in a selector 51 that either selects intra prediction or inter prediction for the current block of pixels. The output from the selector 51 is input to an error calculator in the form of an adder 41 that also receives the pixel values of the current block of pixels. The adder 41 calculates and outputs a residual error as the difference in pixel values between the block of pixels and its prediction.

[0119] The error is transformed in a transformer 42, such as by a discrete cosine transform, and quantized by a quantizer 43 followed by coding in an encoder 44, such as by entropy encoder. In inter coding, also the estimated motion vector is brought to the encoder 44 for generating the coded representation of the current block of pixels.

[0120] The transformed and quantized residual error for the current block of pixels is also provided to a inverse quantizer 45 and inverse transformer 46 to retrieve the original residual error. This error is added by an adder 47 to the block prediction output from the motion compensator 50 or the intra predictor 49 to create a reference block of pixels that can be used in the prediction and coding of a next block of pixels. This new reference block is first processed by a filtering control device 100 according to the embodiments in order to control any deblocking filtering that is applied to the reference block to combat any blocking artifact. The processed new reference block is then temporarily stored in a frame buffer 48, where it is available to the intra predictor 49 and the motion estimator/compensator 50.

[0121] Fig. 14 is a corresponding schematic block diagram of a decoder 60 comprising a filtering control device 100 according to the embodiments. The decoder 60 comprises a decoder 61, such as entropy decoder, for decoding an encoded representation of a block of pixels to get a set of quantized and transformed residual errors. These residual errors are dequantized in an inverse quantizer 62 and inverse transformed by an inverse transformer 63 to get a set of residual errors.

[0122] These residual errors are added in an adder 64 to the pixel values of a reference block of pixels. The reference block is determined by a motion estimator/compensator 67 or intra predictor 66, depending on whether inter or intra prediction is performed. A selector 68 is thereby interconnected to the adder 64 and the motion estimator/compensator 67 and the intra predictor 66. The resulting decoded block of pixels output form the adder 64 is input to a filtering control device 100 according to the embodiments in order to control any deblocking filter that is applied to combat any blocking artifacts. The filtered block of pixels is output form the decoder 60 and is furthermore preferably temporarily provided to

a frame buffer 65 and can be used as a reference block of pixels for a subsequent block of pixels to be decoded. The frame buffer 65 is thereby connected to the motion estimator/compensator 67 to make the stored blocks of pixels available to the motion estimator/compensator 67.

[0123] The output from the adder 64 is preferably also input to the intra predictor 66 to be used as an unfiltered reference block of pixels.

[0124] In the embodiments disclosed in Figs. 13 and 14 the filtering control device 100 controls deblocking filtering in the form of so called in-loop filtering. In an alternative implementation at the decoder 60 the filtering control device 100 is arranged to perform so called post-processing filtering. In such a case, the filtering control device 100 operates on the output frames outside of the loop formed by the adder 64, the frame buffer 65, the intra predictor 66, the motion estimator/compensator 67 and the selector 68. No deblocking filtering and filtering control is then typically done at the encoder.

[0125] Fig. 15 is a schematic block diagram of a user equipment or media terminal 80 housing a decoder 60 with a filtering control device. The user equipment 80 can be any device having media decoding functions that operates on an encoded video stream of encoded video frames to thereby decode the video frames and make the video data available. Non-limiting examples of such devices include mobile telephones and other portable media players, tablets, desktops, notebooks, personal video recorders, multimedia players, video streaming servers, set-top boxes, TVs, computers, decoders, game consoles, etc. The user equipment 80 comprises a memory 84 configured to store encoded video frames. These encoded video frames can have been generated by the user equipment 80 itself. Alternatively, the encoded video frames are generated by some other device and wirelessly transmitted or transmitted by wire to the user equipment 80. The user equipment 80 then comprises a transceiver (transmitter and receiver) or input and output port 82 to achieve the data transfer.

[0126] The encoded video frames are brought from the memory 84 to a decoder 60, such as the decoder illustrated in Fig. 14. The decoder 60 comprises a filtering control device 100 according to embodiments. The decoder 60 then decodes the encoded video frames into decoded video frames. The decoded video frames are provided to a media player 86 that is configured to render the decoded video frames into video data that is displayable on a display or screen 88 of or connected to the user equipment 80.

[0127] In Fig. 15, the user equipment 80 has been illustrated as comprising both the decoder 60 and the media player 86, with the decoder 60 implemented as a part of the media player 86. This should, however, merely be seen as an illustrative but non-limiting example of an implementation embodiment for the user equipment 80. Also distributed implementations are possible where the decoder 60 and the media player 86 are provided in two physically separated devices are possible and within the scope of user equipment 80 as used herein. The display 88 could also be provided as a separate device connected to the user equipment 80, where the actual data processing is taking place.

[0128] Fig. 16 illustrates another embodiment of a user equipment 80 that comprises en encoder, such as the encoder of Fig. 13, comprising a filtering control device according to the embodiments. The encoder 40 is then configured to encode video frames received by the I/O unit 82 and/or generated by the user equipment 80 itself. In the latter case, the user equipment 80 preferably comprises a media engine or recorder, such as in the form of or connected to a (video) camera. The user equipment 80 may optionally also comprise a media player 86, such as a media player 86 with a decoder and filtering control device according to the embodiments, and a display 88.

[0129] As illustrated in Fig. 17, the encoder 40 and/or decoder 60, such as illustrated in Figs. 13 and 14, may be implemented in a network device 30 being or belonging to a network node in a communication network 32 between a sending unit 34 and a receiving user equipment 36. Such a network device 30 may be a device for converting video according to one video coding standard to another video coding standard, for example, if it has been established that the receiving user equipment 36 is only capable of or prefers another video coding standard than the one sent from the sending unit 34. The network device 30 can be in the form of or comprised in a radio base station, a Node-B or any other network node in a communication network 32, such as a radio-based network.

[0130] The embodiments described above are to be understood as a few illustrative examples of the present invention. It will be understood by those skilled in the art that various modifications, combinations and changes may be made to the embodiments without departing from the scope of the present invention. In particular, different part solutions in the different embodiments can be combined in other configurations, where technically possible. The scope of the present invention is, however, defined by the appended claims.

Claims

1. A method for filtering control applicable to a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11,13,15,17) having a respective pixel value, said method comprising:

   calculating (S1) a first filter decision value for said block (10), by only using pixels of said block (10), based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block (10), a line of pixels being a row or a column of pixels, wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25,27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1);

calculating (S2) a second filter decision value for said neighboring block (20), by only using pixels of said neighboring block (20) based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein i=0---N-1 and N is the number of lines of pixels of said neighboring block (20), a line of pixels being a row or a column of pixels, wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1); wherein the first line (12) of pixels and the corresponding first line (22) in the neighboring block (20) are opposing lines with regard to the block boundary (1) and perpendicular to the block boundary (1),

determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on a comparison (S20) of said first filter decision value to a first threshold value; and

determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on a comparison (S23) of said second filter decision value to a second threshold value.

2. The method according to claim 1, wherein

calculating (S1) said first filter decision value comprises calculating (S1) said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in a first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and

calculating (S2) said second filter decision value comprises calculating (S2) said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20), said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

3. The method according to any of the claims 1 to 2, wherein
determining (S3) how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;
determining (S21) to filter two pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and
determining (S22) to filter one pixel in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;
determining (S24) to filter two pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and
determining (S25) to filter one pixel in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

4. The method according to any of the claims 1 to 2, wherein
determining (S3) how many pixels in said first line (12) of pixels (11,13,15,17) in said block (10) to filter comprises:

comparing (S20) said first filter decision value to a first threshold value;
determining (S21) to filter two pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value; and
determining (S22) to filter no pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value; and

determining (S4) how many pixels in said corresponding first line (22) of pixels (21,23,25,27) in said neighboring block (20) to filter comprises:

comparing (S23) said second filter decision value to a second threshold value;
determining (S24) to filter two pixels in said corresponding first line (22) of pixels (21, 23 ,25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value; and
determining (S25) to filter no pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value.

5. A filtering control device (100) comprising:

a first decision value calculator (110) configured to calculate a first filter decision value for a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, by only using pixels of said block (10), based on:

$$\left| p2_i - 2p1_i + p0_i \right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block (10), a line of pixels being a row or a column of pixels, wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25,27) in said video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1);
a second decision value calculator (120) configured to calculate a second filter decision value for a neighboring block (20), by only using pixels of said neighboring block (20), based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein i=0---N-1 and N is the number of lines of pixels of said neighboring block (20), a line of pixels being a row or a column of pixels, wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1), wherein the first line (12) of pixels and the corresponding first line (22) in the neighboring block (20) are opposing lines with regard to the block boundary (1) and perpendicular to the block boundary (1);
a first pixel determiner (130) configured to determine how many pixels in a first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and
a second pixel determiner (140) configured to determine how many pixels in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120), wherein
further comprising a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and
a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value.

6. The device according to claim 5, wherein
said first decision value calculator (110) is configured to calculate said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary (1), $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary (1), $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary (1), $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block (10), said block boundary (1), $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary (1) and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary (1); and
said second decision value calculator (120) is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block (20) closest to, in said corresponding first line of pixels, said block boundary (1), $q1_0$ denotes said pixel value of said pixel of said neighboring block (20) next closest to, in said corresponding first line of pixels, said block boundary (1), $q2_0$ denotes said pixel value of said pixel in said neighboring block (20) second next closest to, in said corresponding first line of pixels, said block boundary (1), $q0_3$ denotes a pixel value of a pixel in said neighboring block (20) closest to, in a corresponding second line of pixels in said neighboring block (20),
said block boundary (1), $q1_3$ denotes a pixel value of a pixel of said neighboring block (20) next closest to, in said corresponding second line of pixels, said block boundary (1) and $q2_3$ denotes a pixel value of a pixel in said neighboring block (20) second next closest to, in said corresponding second line of pixels, said block boundary (1).

7. The device according to any of the claims 5 to 6, further comprising:

said first pixel determiner (130) is configured to i) determine to filter two pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter one pixel in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and

said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter one pixel in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

8. The device according to any of the claims 5 to 7, further comprising:

a first comparator (180) configured to compare said first filter decision value calculated by said first decision value calculator (110) to a first threshold value; and
a second comparator (182) configured to compare said second filter decision value calculated by said second decision value calculator (120) to a second threshold value, wherein
said first pixel determiner (130) is configured to i) determine to filter two pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is below said first threshold value as determined by said first comparator (180) and ii) determine to filter no pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) relative to said block boundary (1) if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator (180); and
said second pixel determiner (140) is configured to i) determine to filter two pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is below said second threshold value as determined by said second comparator (182) and ii) determine to filter no pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) relative to said block boundary (1) if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator (182).

9. The device according to any of the claims 5 to 8, further comprising a threshold determiner (170) configured to i) determine said first threshold value based on a quantization parameter associated with said block (10), and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block (20).

10. The device according to any of the claims 5-9, further comprising:

a first offset calculator (181) configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel (11) closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1), $p1_j$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1), $q0_j$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in said corresponding first line (22) of pixels (21, 23, 25,27), said block boundary (1) and $q1_j$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1);
a first pixel modifier (190) configured to modify said pixel value of said pixel (11) closest to said block boundary (1) in said first line (12) of pixels (11, 13, 15, 17) by adding said first offset calculated by said first offset calculator (181) to said pixel value of said pixel (11) closest to said block boundary (1) in said first line (12) of pixels (11, 13, 15, 17);
a second pixel modifier (192) configured to modify said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding first line (22) of pixels (21, 23,25,27) by subtracting said first offset calculated by said first offset calculator (181) from said pixel value of said pixel (21) in said neighboring block (20) closest to said block boundary (1) in said corresponding first line (22) of pixels (21,23,25,27);
a second offset calculator (183) configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator (180), a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel (15) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1);
a third pixel modifier (194) configured to modify, if said first filter decision value is below said first threshold as

determined by said first comparator (180), said pixel value of said pixel (13) next closest to said block boundary (1) in said first line (12) of pixels (11, 13, 15, 17) by adding said second offset calculated by said second offset calculator (183) to said pixel value of said pixel (13) next closest to said block boundary (1) in said first line (12) of pixels (11, 13, 15, 17);

a third offset calculator (185) configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator (182), a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel (25) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1); and

a fourth pixel modifier (196) configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator (182), said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding first line (22) of pixels (21, 23, 25, 27) by adding said third offset calculated by said third offset calculator (185) to said pixel value of said pixel (23) in said neighboring block (20) next closest to said block boundary (1) in said corresponding first line (22) of pixels (21,23,25, 27).

11. The device according to any of the claims 5 to 10, further comprising a third comparator (184) configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner (130) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on said first filter decision value calculated by said first decision value calculator (110); and

said second pixel determiner (140) is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator (184), how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value calculated by said second decision value calculator (120).

12. An encoder (40) comprising a filtering control device (100) according to any of the claims 5-11.

13. A user equipment (80) comprising:

a memory (84) configured to store video frames; and

an encoder (40) according to claim 12 configured to encode said video frames into encoded video frames, wherein said memory (84) is further configured to store said encoded video frames.

14. A decoder (60) comprising a filtering control device (100) according to any of the claims 5-11.

15. A user equipment (80) comprising:

a memory (84) configured to store encoded video frames;

a decoder (60) according to claim 14 configured to decode said encoded video frames into decoded video frames; and

a media player (86) configured to render said decoded video frames into video data displayable on a display (88).

16. A computer program (74) for filtering control of a block (10) of multiple pixels (11, 13, 15, 17) in a video frame, each pixel (11, 13, 15, 17) having a respective pixel value, said computer program (74) comprises code means which when run on a computer (70) causes the computer (70) to:

calculate a first filter decision value for said block (10), by only using pixels of said block (10), based on:

$$\left| p2_i - 2p1_i + p0_i \right|$$

wherein i=0...N-1 and N is the number of lines of pixels of said block (10), a line of pixels being a row or a column of pixels, wherein $p0_i$ denotes a pixel value of a pixel (11) closest to, in a first line (12) of pixels (11, 13, 15, 17) in said block (10), a block boundary (1) to a neighboring block (20) of multiple pixels (21, 23, 25,27) in said

video frame, $p1_i$ denotes a pixel value of a pixel (13) next closest to, in said first line (12) of pixels (11, 13, 15, 17, 19), said block boundary (1) and $p2_i$ denotes a pixel value of a pixel (13) second next closest to, in said first line (12) of pixels (11, 13, 15, 17), said block boundary (1);
calculate a second filter decision value for said neighboring block (20), by only using pixels of said neighboring block (20), based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein i=0---N-1 and N is the number of lines of pixels of said neighboring block (20), a line of pixels being a row or a column of pixels, wherein $q0_i$ denotes a pixel value of a pixel (21) in said neighboring block (20) closest to, in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20), said block boundary (1), $q1_i$ denotes a pixel value of a pixel (23) of said neighboring block (20) next closest to,
in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1) and $q2_i$ denotes a pixel value of a pixel (23) in said neighboring block (20) second next closest to, in said corresponding first line (22) of pixels (21, 23, 25, 27), said block boundary (1), wherein the first line (12) of pixels and the corresponding first line (22) in the neighboring block (20) are opposing lines with regard to the block boundary (1) and perpendicular to the block boundary (1);
determine how many pixels in a first line (12) of pixels (11, 13, 15, 17) in said block (10) to filer relative to said block boundary (1) based on said first filter decision value; and
determine how many pixels in a corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on said second filter decision value, wherein determine how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter comprises determining how many pixels in said first line (12) of pixels (11, 13, 15, 17) in said block (10) to filter relative to said block boundary (1) based on a comparison (S20) of said first filter decision value to a first threshold value; and
determine how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter comprises determining how many pixels in said corresponding first line (22) of pixels (21, 23, 25, 27) in said neighboring block (20) to filter relative to said block boundary (1) based on a comparison (S23) of said second filter decision value to a second threshold value.

17. A computer program product (73) comprising computer readable code means and a computer program (74) according to claim 16 stored on said computer readable means.

Patentansprüche

1. Verfahren zur Filterungssteuerung, das auf einen Block (10) von mehreren Pixeln (11, 13, 15, 17) in einem Videobild angewendet werden kann, wobei jedes Pixel (11, 13, 15, 17) einen jeweiligen Pixelwert aufweist, wobei das Verfahren umfasst:

Berechnen (S1) eines ersten Filterentscheidungswerts für den Block (10) nur durch Verwenden von Pixeln des Blocks (10) basierend auf:

$$|p2_i - 2p1_i + p0_i|$$

wobei i = 0...N-1, und N die Anzahl von Zeilen von Pixeln des Blocks (10) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $p0_i$ einen Pixelwert eines Pixels (11) bezeichnet, das in einer ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) am nächsten zu einer Blockgrenze (1) zu einem Nachbarblock (20) von mehreren Pixeln (21, 23, 25, 27) im Videobild ist, $p1_i$ einen Pixelwert eines Pixels (13) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am zweitnächsten zur Blockgrenze (1) ist, und $p2_i$ einen Pixelwert eines Pixels (15) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am drittnächsten zur Blockgrenze (1) ist;
Berechnen (S21) eines zweiten Filterentscheidungswerts für den Nachbarblock (20) nur durch Verwenden von Pixeln des Nachbarblocks (20) basierend auf:

$$|q2_i - 2q1_i + q0_i|$$

wobei i = 0---N-1, und N die Anzahl von Zeilen von Pixeln des Nachbarblocks (20) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $q0_i$ einen Pixelwert eines Pixels (21) im Nachbarblock (20) bezeichnet, das in einer entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) am nächsten zur Blockgrenze (1) ist, $q1_i$ einen Pixelwert eines Pixels (23) des Nachbarblocks (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist, und $q2_i$ einen Pixelwert eines Pixels (25) im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am drittnächsten zur Blockgrenze (1) ist; wobei die erste Zeile (12) von Pixeln und die entsprechende erste Zeile (22) im Nachbarblock (20) gegenüberliegende Zeilen hinsichtlich der Blockgrenze (1) und senkrecht auf die Blockgrenze (1) sind,

Bestimmen (S3), wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf einem Vergleich (S20) des ersten Filterentscheidungswerts mit einem ersten Schwellenwert; und

Bestimmen (S4), wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf einem Vergleich (S23) des zweiten Filterentscheidungswerts mit einem zweiten Schwellenwert.

2. Verfahren nach Anspruch 1, wobei
das Berechnen (S1) des ersten Filterentscheidungswerts ein Berechnen (S1) des Filterentscheidungswerts als

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

umfasst, wobei $p0_0$ den Pixelwert des Pixels bezeichnet, das in einer ersten Zeile von Pixeln am nächsten zur Blockgrenze (1) ist, $p1_0$ den Pixelwert des Pixels bezeichnet, das in der ersten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, $p2_0$ den Pixelwert des Pixels bezeichnet, das in der ersten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist, $p0_3$ einen Pixelwert eines Pixels bezeichnet, das in einer zweiten Zeile von Pixeln im Block (10) am nächsten zur Blockgrenze (1) ist, $p1_3$ einen Pixelwert eines Pixels bezeichnet, das in der zweiten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, und $p2_3$ einen Pixelwert eines Pixels bezeichnet, das in der zweiten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist; und
das Berechnen (S2) des zweiten Filterentscheidungswerts ein Berechnen (S2) des Filterentscheidungswerts als

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

umfasst, wobei $q0_0$ den Pixelwert des Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am nächsten zur Blockgrenze (1) ist, $q1_0$ den Pixelwert des Pixels des Nachbarblocks (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, $q2_0$ den Pixelwert des Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist, $q0_3$ einen Pixelwert eines Pixels im Nachbarblock (20) bezeichnet, das in einer entsprechenden zweiten Zeile von Pixeln im Nachbarblock (20) am nächsten zur Blockgrenze (1) ist, $q1_3$ einen Pixelwert eines Pixels des Nachbarblocks (20) bezeichnet, das in der entsprechenden zweiten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, und $q2_3$ einen Pixelwert eines Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden zweiten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist.

3. Verfahren nach einem der Ansprüche 1 bis 2, wobei
das Bestimmen (S3), wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) gefiltert werden sollen, umfasst:

Vergleichen (S20) des ersten Filterentscheidungswerts mit einem ersten Schwellenwert;
Bestimmen (S21), zwei Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist; und
Bestimmen (S22), ein Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert gleich wie der erste Schwellenwert ist oder diesen überschreitet; und

das Bestimmen (S4), wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) gefiltert werden sollen, umfasst:

Vergleichen (S23) des zweiten Filterentscheidungswerts mit einem zweiten Schwellenwert;
Bestimmen (S24), zwei Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist; und
Bestimmen (S25), ein Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert gleich wie der zweite Schwellenwert ist oder diesen überschreitet.

4. Verfahren nach einem der Ansprüche 1 bis 2, wobei
das Bestimmen (S3), wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) gefiltert werden sollen, umfasst:

Vergleichen (S20) des ersten Filterentscheidungswerts mit einem ersten Schwellenwert;
Bestimmen (S21), zwei Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist; und
Bestimmen (S22), keine Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert gleich wie der erste Schwellenwert ist oder diesen überschreitet; und

das Bestimmen (S4), wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) gefiltert werden sollen, umfasst:

Vergleichen (S23) des zweiten Filterentscheidungswerts mit einem zweiten Schwellenwert;
Bestimmen (S24), zwei Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist; und
Bestimmen (S25), keine Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert gleich wie der zweite Schwellenwert ist oder diesen überschreitet.

5. Filterungssteuervorrichtung (100), umfassend:

einen ersten Entscheidungswertberechner (110), der so konfiguriert ist, dass er einen ersten Filterentscheidungswert für einen Block (10) von mehreren Pixeln (11, 13, 15, 17) in einem Videobild nur durch Verwenden von Pixeln des Blocks (10) basierend auf

$$|p2_i - 2p1_i + p0_i|$$

berechnet, wobei i = 0...N-1, und N die Anzahl von Zeilen von Pixeln des Blocks (10) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $p0_i$ einen Pixelwert eines Pixels (11) bezeichnet, das in einer ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) am nächsten zu einer Blockgrenze (1) zu einem Nachbarblock (20) von mehreren Pixeln (21, 23, 25, 27) im Videobild ist, $p1_i$ einen Pixelwert eines Pixels (13) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am zweitnächsten zur Blockgrenze (1) ist, und $p2_i$ einen Pixelwert eines Pixels (15) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am drittnächsten zur Blockgrenze (1) ist;
einen zweiten Entscheidungswertberechner (120), der so konfiguriert ist, dass er einen zweiten Filterentscheidungswert für einen Nachbarblock (20) nur durch Verwenden von Pixeln des Nachbarblocks (20) basierend auf

$$|q2_i - 2q1_i + q0_i|$$

berechnet, wobei i = 0---N-1, und N die Anzahl von Zeilen von Pixeln im Nachbarblock (20) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $q0_i$ einen Pixelwert eines Pixels (21) im Nachbarblock

(20) bezeichnet, das in einer entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) am nächsten zur Blockgrenze (1) ist, $q1_i$ einen Pixelwert eines Pixels (23) des Nachbarblocks (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist, und $q2_i$ einen Pixelwert eines Pixels (25) im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am drittnächsten zur Blockgrenze (1) ist; wobei die erste Zeile (12) von Pixeln und die entsprechende erste Zeile (22) im Nachbarblock (20) gegenüberliegende Zeilen hinsichtlich der Blockgrenze (1) und senkrecht auf die Blockgrenze (1) sind;

einen ersten Pixelbestimmer (130), der so konfiguriert ist, dass er basierend auf dem vom ersten Entscheidungswertberechner (110) berechneten ersten Filterentscheidungswert bestimmt, wie viele Pixel in einer ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) gefiltert werden sollen; und

einen zweiten Pixelbestimmer (140), der so konfiguriert ist, dass er basierend auf dem vom zweiten Entscheidungswertberechner (120) berechneten zweiten Filterentscheidungswert bestimmt, wie viele Pixel in einer entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, wobei

ferner umfassend einen ersten Komparator (180), der so konfiguriert ist, dass er den vom ersten Entscheidungswertberechner (110) berechneten ersten Filterentscheidungswert mit einem ersten Schwellenwert vergleicht; und

einen zweiten Komparator (182), der so konfiguriert ist, dass er den vom zweiten Entscheidungswertberechner (120) berechneten zweiten Filterentscheidungswert mit einem zweiten Schwellenwert vergleicht.

6. Vorrichtung nach Anspruch 5, wobei der erste Entscheidungswertberechner (110) so konfiguriert ist, dass er den ersten Filterentscheidungswert als

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

berechnet, wobei $p0_0$ den Pixelwert des Pixels bezeichnet, das in der ersten Zeile von Pixeln am nächsten zur Blockgrenze (1) ist, $p1_0$ den Pixelwert des Pixels bezeichnet, das in der ersten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, $p2_0$ den Pixelwert des Pixels bezeichnet, das in der ersten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist, $p0_3$ einen Pixelwert eines Pixels bezeichnet, das in einer zweiten Zeile von Pixeln im Block (10) am nächsten zur Blockgrenze (1) ist, $p1_3$ einen Pixelwert eines Pixels bezeichnet, das in der zweiten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, und $p2_3$ einen Pixelwert eines Pixels bezeichnet, das in der zweiten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist; und

der zweite Entscheidungswertberechner (120) so konfiguriert ist, dass er den zweiten Filterentscheidungswert als

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

berechnet, wobei $q0_0$ den Pixelwert des Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am nächsten zur Blockgrenze (1) ist, $q1_0$ den Pixelwert des Pixels des Nachbarblocks (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, $q2_0$ den Pixelwert des Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist, $q0_3$ einen Pixelwert eines Pixels im Nachbarblock (20) bezeichnet, das in einer entsprechenden zweiten Zeile von Pixeln im Nachbarblock (20) am nächsten zur Blockgrenze (1) ist, $q1_3$ einen Pixelwert eines Pixels des Nachbarblocks (20) bezeichnet, das in der entsprechenden zweiten Zeile von Pixeln am zweitnächsten zur Blockgrenze (1) ist, und $q2_3$ einen Pixelwert eines Pixels im Nachbarblock (20) bezeichnet, das in der entsprechenden zweiten Zeile von Pixeln am drittnächsten zur Blockgrenze (1) ist.

7. Vorrichtung nach einem der Ansprüche 5 bis 6, ferner umfassend, dass:

der erste Pixelbestimmer (130) so konfiguriert ist, dass er i) bestimmt, zwei Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist, wie durch den ersten Komparator (180) bestimmt, und ii) bestimmt, ein Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert gleich wie der erste Schwellenwert ist oder diesen überschreitet, wie durch den ersten Komparator (180) bestimmt; und

der zweite Pixelbestimmer (140) so konfiguriert ist, dass er i) bestimmt, zwei Pixel in der entsprechenden ersten

Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist, wie durch den zweiten Komparator (182) bestimmt, und ii) bestimmt, ein Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert gleich wie der zweite Schwellenwert ist oder diesen überschreitet, wie durch den zweiten Komparator (182) bestimmt.

8. Vorrichtung nach einem der Ansprüche 5 bis 7, ferner umfassend:

einen ersten Komparator (180), der so konfiguriert ist, dass er den vom ersten Entscheidungswertberechner (110) berechneten ersten Filterentscheidungswert mit einem ersten Schwellenwert vergleicht; und
einen zweiten Komparator (182), der so konfiguriert ist, dass er den vom zweiten Entscheidungswertberechner (120) berechneten zweiten Filterentscheidungswert mit einem zweiten Schwellenwert vergleicht, wobei
der erste Pixelbestimmer (130) so konfiguriert ist, dass er i) bestimmt, zwei Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist, wie durch den ersten Komparator (180) bestimmt, und ii) bestimmt, keine Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) zu filtern, wenn der erste Filterentscheidungswert gleich wie der erste Schwellenwert ist oder diesen überschreitet, wie durch den ersten Komparator (180) bestimmt; und
der zweite Pixelbestimmer (140) so konfiguriert ist, dass er i) bestimmt, zwei Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock(20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist, wie durch den zweiten Komparator (182) bestimmt, und ii) bestimmt, keine Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) zu filtern, wenn der zweite Filterentscheidungswert gleich wie der zweite Schwellenwert ist oder diesen überschreitet, wie durch den zweiten Komparator (182) bestimmt.

9. Vorrichtung nach einem der Ansprüche 5 bis 8, ferner umfassend einen Schwellenbestimmer (170), der so konfiguriert ist, dass er i) den ersten Schwellenwert basierend auf einem Quantisierungsparameter bestimmt, der mit dem Block (10) assoziiert ist, und ii) den zweiten Schwellenwert basierend auf einem Quantisierungsparameter bestimmt, der mit dem Nachbarblock (20) assoziiert ist.

10. Vorrichtung nach einem der Ansprüche 5 bis 9, ferner umfassend:

einen ersten Offset-Berechner (181), der so konfiguriert ist, dass er einen ersten Offset Δ basierend auf $\frac{9\times(q0_j - p0_j)-3\times(q1_j - p1_j)}{16}$ berechnet, wobei $p0_j$ einen Pixelwert eines Pixels (11) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am nächsten zur Blockgrenze (1) ist, $p1_j$ einen Pixelwert eines Pixels (13) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am zweitnächsten zur Blockgrenze (1) ist, $q0_j$ einen Pixelwert eines Pixels (21) im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am nächsten zur Blockgrenze (1) ist, und $q1_j$ einen Pixelwert eines Pixels (23) des Nachbarblocks (20) bezeichnet, dass in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist;
einen ersten Pixelmodifizierer (190), der so konfiguriert ist, dass er den Pixelwert des Pixels (11), das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am nächsten zur Blockgrenze (1) ist, durch Addieren des vom ersten Offset-Berechner (181) berechneten ersten Offsets zum Pixelwert des Pixels (11) modifiziert, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am nächsten zur Blockgrenze (1) ist;
einen zweiten Pixelmodifizierer (192), der so konfiguriert ist, dass er den Pixelwert des Pixels (21) im Nachbarblock (20), das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am nächsten zur Blockgrenze (1) ist, durch Subtrahieren des vom ersten Offset-Berechner (181) berechneten ersten Offsets vom Pixelwert des Pixels (21) modifiziert, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am nächsten zur Blockgrenze (1) ist;

einen zweiten Offset-Berechner (183), der so konfiguriert ist, dass er, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist, wie durch den ersten Komparator (180) bestimmt, einen zweiten Offset

basierend auf $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$ berechnet, wobei $p2_j$ einen Pixelwert eines Pixels (15) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am drittnächsten zur Blockgrenze (1) ist;

einen dritten Pixelmodifizierer (194), der so konfiguriert ist, dass er, wenn der erste Filterentscheidungswert unter dem ersten Schwellenwert ist, wie durch den ersten Komparator (180) bestimmt, den Pixelwert des Pixels (13), das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am zweitnächsten zur Blockgrenze (1) ist, durch Addieren des vom zweiten Offset-Berechner (183) berechneten zweiten Offsets zum Pixelwert des Pixels (13) modifiziert, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am zweitnächsten zur Blockgrenze (1) ist;

einen dritten Offset-Berechner (185), der so konfiguriert ist, dass er, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist, wie durch den zweiten Komparator (182) bestimmt, einen dritten Offset basierend auf $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$ berechnet, wobei $q2_j$ einen Pixelwert eines Pixels (25) im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am drittnächsten zur Blockgrenze (1) ist;

einen vierten Pixelmodifizierer (196), der so konfiguriert ist, dass er, wenn der zweite Filterentscheidungswert unter dem zweiten Schwellenwert ist, wie durch den zweiten Komparator (182) bestimmt, den Pixelwert des Pixels (23) im Nachbarblock (20), das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist, durch Addieren des vom dritten Offset-Berechner (185) berechneten dritten Offsets zum Pixelwert des Pixels (23) im Nachbarblock (20) modifiziert, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist.

11. Vorrichtung nach einem der Ansprüche 5 bis 10, ferner umfassend einen dritten Komparator (184), der so konfiguriert ist, dass er eine Summe des ersten Filterentscheidungswerts und des zweiten Filterentscheidungswerts mit einem Schwellenwert vergleicht, wobei

der erste Pixelbestimmer (130) so konfiguriert ist, dass er, wenn die Summe des ersten Filterentscheidungswerts und des zweiten Filterentscheidungswerts unter dem Schwellenwert ist, wie durch den dritten Komparator (184) bestimmt, basierend auf dem vom ersten Entscheidungswertberechner (110) berechneten ersten Filterentscheidungswert bestimmt, wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) gefiltert werden sollen; und

der zweite Pixelbestimmer (140) so konfiguriert ist, dass er, wenn die Summe des ersten Filterentscheidungswerts und des zweiten Filterentscheidungswerts unter dem Schwellenwert ist, wie durch den dritten Komparator (184) bestimmt, basierend auf dem vom zweiten Entscheidungswertberechner (120) berechneten zweiten Filterentscheidungswert bestimmt, wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) gefiltert werden sollen.

12. Codierer (40), umfassend eine Filterungssteuervorrichtung (100) nach einem der Ansprüche 5 bis 11.

13. Benutzereinrichtung (80), umfassend:

einen Speicher (84), der so konfiguriert ist, dass er Videobilder speichert; und

einen Codierer (40) nach Anspruch 12, der so konfiguriert ist, dass er die Videobilder in codierte Videobilder codiert, wobei der Speicher (84) ferner so konfiguriert ist, dass er die codierten Videobilder speichert.

14. Decodierer (60), umfassend eine Filterungssteuervorrichtung (100) nach einem der Ansprüche 5 bis 11.

15. Benutzereinrichtung (80), umfassend:

einen Speicher (84), der so konfiguriert ist, dass er codierte Videobilder speichert;

einen Decodierer (60) nach Anspruch 14, der so konfiguriert ist, dass er die codierten Videobilder in decodierte Videobilder decodiert; und

einen Media Player (86), der so konfiguriert ist, dass er die decodierten Videobilder in Videodaten übersetzt, die auf einer Anzeige (88) angezeigt werden können.

16. Computerprogramm (74) zur Filterungssteuerung eines Blocks (10) von mehreren Pixeln (11, 13, 15, 17) in einem Videobild, wobei jedes Pixel (11, 13, 15, 17) einen jeweiligen Pixelwert aufweist, wobei das Computerprogramm (74) Codemittel umfasst, das bei Ausführung auf einem Computer (70) den Computer veranlasst zum:

Berechnen eines ersten Filterentscheidungswerts für den Block (10) nur durch Verwenden von Pixeln des Blocks (10) basierend auf:

$$|p2_i - 2p1_i + p0_i|$$

wobei i = 0...N-1, und N die Anzahl von Zeilen von Pixeln des Blocks (10) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $p0_i$ einen Pixelwert eines Pixels (11) bezeichnet, das in einer ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) am nächsten zu einer Blockgrenze (1) zu einem Nachbarblock (20) von mehreren Pixeln (21, 23, 25, 27) im Videobild ist, $p1_i$ einen Pixelwert eines Pixels (13) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17, 19) am zweitnächsten zur Blockgrenze (1) ist, und $p2_i$ einen Pixelwert eines Pixels (13) bezeichnet, das in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) am drittnächsten zur Blockgrenze (1) ist;
Berechnen eines zweiten Filterentscheidungswerts für den Nachbarblock (20) nur durch Verwenden von Pixeln des Nachbarblocks (20) basierend auf:

$$|q2_i - 2q1_i + q0_i|$$

wobei i = 0---N-1, und N die Anzahl von Zeilen von Pixeln im Nachbarblock (20) ist, wobei eine Zeile von Pixeln eine Reihe oder eine Spalte von Pixeln ist, wobei $q0_i$ einen Pixelwert eines Pixels (21) im Nachbarblock (20) bezeichnet, das in einer entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) am nächsten zur Blockgrenze (1) ist, $q1_i$ einen Pixelwert eines Pixels (23) des Nachbarblocks (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am zweitnächsten zur Blockgrenze (1) ist, und $q2_i$ einen Pixelwert eines Pixels (23) im Nachbarblock (20) bezeichnet, das in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) am drittnächsten zur Blockgrenze (1) ist; wobei die erste Zeile (12) von Pixeln und die entsprechende erste Zeile (22) im Nachbarblock (20) gegenüberliegende Zeilen hinsichtlich der Blockgrenze (1) und senkrecht auf die Blockgrenze (1) sind;
Bestimmen, wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf dem ersten Filterentscheidungswert; und
Bestimmen, wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf dem zweiten Filterentscheidungswert, wobei das Bestimmen, wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) gefiltert werden sollen, ein Bestimmen, wie viele Pixel in der ersten Zeile (12) von Pixeln (11, 13, 15, 17) im Block (10) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf einem Vergleich (S20) des ersten Filterentscheidungswerts mit einem ersten Schwellenwert umfasst; und
das Bestimmen, wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) gefiltert werden sollen, ein Bestimmen, wie viele Pixel in der entsprechenden ersten Zeile (22) von Pixeln (21, 23, 25, 27) im Nachbarblock (20) in Bezug auf die Blockgrenze (1) gefiltert werden sollen, basierend auf einem Vergleich (S23) des zweiten Filterentscheidungswerts mit einem zweiten Schwellenwert umfasst.

17. Computerprogrammprodukt (73), umfassend computerlesbare Codemittel und ein Computerprogramm (74) nach Anspruch 16, das auf den computerlesbaren Mitteln gespeichert ist.

Revendications

1. Procédé de filtrage de commande applicable à un bloc (10) de pixels multiples (11, 13, 15, 17) dans une trame vidéo, chaque pixel (11, 13, 15, 17) ayant une valeur de pixel respective, ledit procédé comprenant :

le calcul (S1) d'une première valeur de décision de filtre pour ledit bloc (10), par l'utilisation uniquement de pixels dudit bloc (10), sur la base de :

$$\left|p2_i - 2p1_i + p0_i\right|$$

où i=0...N-1 et N est le nombre de lignes de pixels dudit bloc (10), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel $p0_i$ représente une valeur de pixel d'un pixel (11) le plus proche, dans une première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10), d'une frontière de bloc (1) avec un bloc voisin (20) de pixels multiples (21, 23, 25, 27) dans ladite trame vidéo, $p1_i$ représente une valeur de pixel d'un pixel (13) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1) et $p2_i$ représente une valeur de pixel d'un deuxième pixel (15) suivant le plus proche, dans ladite première ligne (12) de pixels (11, 13, 15, 17), de ladite frontière de bloc (1) ;
le calcul (S2) d'une deuxième valeur de décision de filtre pour ledit bloc voisin (20), par l'utilisation uniquement des pixels dudit bloc voisin (20) sur la base de :

$$\left|q2_i - 2q1_i + q0_i\right|$$

où i=o...N-1 et N est le nombre de lignes de pixels dudit bloc voisin (20), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel q0i représente une valeur de pixel d'un pixel (21) dans ledit bloc voisin (20) le plus proche de, dans une première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20), ladite frontière de bloc (1), $q1_i$ représente une valeur de pixel d'un pixel (23) dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) et $q2_i$ représente une valeur de pixel d'un pixel (25) dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) ; dans lequel la première ligne (12) de pixels et la première ligne correspondante (22) dans le bloc voisin (20) sont des lignes opposées par rapport à la frontière de bloc (1) et perpendiculaires à la frontière de bloc (1),
la détermination (S3) du nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer par rapport à ladite frontière de bloc (1) sur la base d'une comparaison (S20) de ladite première valeur de décision de filtre à une première valeur de seuil ; et
la détermination (S4) du nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer par rapport à ladite frontière de bloc (1) sur la base d'une comparaison (S23) de ladite deuxième valeur de décision de filtre à une deuxième valeur de seuil.

2. Procédé selon la revendication 1, dans lequel :

le calcul (S1) de ladite première valeur de décision de filtre comprend le calcul (S1) de ladite première valeur de décision de filtre en tant qui :

$$\left|p2_0 - 2p1_0 + p0_0\right| + \left|p2_3 - 2p1_3 + p0_3\right|$$

où $P0_o$ représente ladite valeur de pixel dudit pixel le plus proche de, dans une première ligne de pixels, ladite frontière de bloc (1), $p1_o$ représente ladite valeur de pixel dudit pixel suivant le plus proche de, dans ladite première ligne de pixels, ladite frontière de bloc (1), $p2_o$ représente ladite valeur de pixel dudit deuxième pixel suivant le plus proche de, dans ladite première ligne de pixels, ladite frontière de bloc (1), $p0_3$ représente une valeur de pixel d'un pixel le plus proche de, dans une deuxième ligne de pixels dans ledit bloc (10), ladite frontière de bloc (1), $p1_3$ représente une valeur de pixel d'un pixel suivant le plus proche de, dans ladite deuxième ligne de pixels, ladite frontière de bloc (1) et $p2_3$ représente une valeur de pixel d'un deuxième pixel suivant le plus proche de, dans ladite deuxième ligne de pixels, ladite frontière de bloc (1) ; et
le calcul (S2) de ladite deuxième valeur de décision de filtre comprend le calcul (S2) de ladite deuxième valeur de décision de filtre en tant que :

$$\left|q2_0 - 2q1_0 + q0_0\right| + \left|q2_3 - 2q1_3 + q0_3\right|$$

où $q0_o$ représente ladite valeur de pixel dudit pixel dans ledit bloc voisin (20) le plus proche de, dans ladite première ligne correspondante de pixels, ladite frontière de bloc (1), $q1_o$ représente ladite valeur de pixel dudit pixel dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante de pixels, ladite

frontière de bloc (1), $q2_0$ représente ladite valeur de pixel dudit pixel dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante de pixels, ladite frontière de bloc (1), $q0_3$ représente une valeur de pixel d'un pixel dans ledit bloc voisin (20) le plus proche de, dans une deuxième ligne correspondante de pixels dans ledit bloc voisin (20), ladite frontière de bloc (1), $q1_3$ représente une valeur de pixel d'un pixel dudit bloc voisin (20) suivant le plus proche de, dans ladite deuxième ligne correspondante de pixels, ladite frontière de bloc (1) et $q2_3$ représente une valeur de pixel d'un pixel dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite deuxième ligne correspondante de pixels, ladite frontière de bloc (1).

3. Procédé selon une quelconque des revendications 1 à 2, dans lequel :

la détermination (S3) du nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer comprend :

la comparaison (S20) de ladite première valeur de décision de filtre à une première valeur de seuil ;
la détermination (S21) de filtrer deux pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil ; et
la détermination (S22) de filtrer un pixel dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est supérieure ou égale à ladite première valeur de seuil ; et

la détermination (S4) du nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer comprend :

la comparaison (S23) de ladite deuxième valeur de décision de filtre à une deuxième valeur de seuil ;
la détermination (S24) de filtrer deux pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil ; et
la détermination (S25) de filtrer un pixel dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est supérieure ou égale à ladite deuxième valeur de seuil.

4. Procédé selon une quelconque des revendications 1 à 2, dans lequel :

la détermination (S3) du nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer comprend :

la comparaison (S20) de ladite première valeur de décision de filtre à une première valeur de seuil ;
la détermination (S21) de filtrer deux pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil ; et
la détermination (S22) de ne filtrer aucun pixel dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est supérieure ou
égale à ladite première valeur de seuil ; et

la détermination (S4) du nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer comprend :

la comparaison (S23) de ladite deuxième valeur de décision de filtre à une deuxième valeur de seuil ;
la détermination (S24) de filtrer deux pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil ; et
la détermination (S25) de ne filtrer aucun pixel dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est supérieure ou égale à ladite deuxième valeur de seuil.

5. Dispositif de commande de filtrage (100) comprenant :

un calculateur de première valeur de décision (110) configuré pour calculer une première valeur de décision de filtre pour un bloc (10) de pixels multiples (11, 13, 15, 17) dans une trame vidéo, par l'utilisation uniquement des pixels dudit bloc (10), sur la base de :

$$\left|p2_i - 2p1_i + p0_i\right|$$

où i=0...N-1 et N est le nombre de lignes de pixels dudit bloc (10), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel $p0_i$ représente une valeur de pixel d'un pixel (11) le plus proche, dans une première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10), d'une frontière de bloc (1) avec un bloc voisin (20) de pixels multiples (21, 23, 25, 27) dans ladite trame vidéo, $p1_i$ représente une valeur de pixel d'un pixel (13) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1) et $p2_i$ représente une valeur de pixel d'un deuxième pixel (15) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1) ;
un calculateur de deuxième valeur de décision (120) configuré pour calculer une deuxième valeur de décision de filtre pour un bloc voisin (20), par l'utilisation uniquement des pixels dudit bloc voisin (20) sur la base de :

$$\left|q2_i - 2q1_i + q0_i\right|$$

où i=0...N-1 et N est le nombre de lignes de pixels dudit bloc voisin (20), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel q0i représente une valeur de pixel d'un pixel (21) dans ledit bloc voisin (20) le plus proche de, dans une première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20), ladite frontière de bloc (1), $q1_i$ représente une valeur de pixel d'un pixel (23) dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) et $q2_i$ représente une valeur de pixel d'un pixel (25) dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1), dans lequel la première ligne (12) de pixels et la première ligne correspondante (22) dans le bloc voisin (20) sont des lignes opposées par rapport à la frontière de bloc (1) et perpendiculaires à la frontière de bloc (1),
un premier déterminateur de pixel (130) configuré pour déterminer le nombre de pixels dans une première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite première valeur de décision de filtre calculée par ledit calculateur de première valeur de décision (110) ; et
un deuxième déterminateur de pixel (140) configuré pour déterminer le nombre de pixels dans une première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite deuxième valeur de décision de filtre calculée par ledit calculateur de deuxième valeur de décision (120),
comprenant en outre un premier comparateur (180) configuré pour comparer ladite première valeur de décision de filtre calculée par ledit calculateur de première valeur de décision (110) à une première valeur de seuil ; et un deuxième comparateur (182) configuré pour comparer ladite deuxième valeur de décision de filtre calculée par ledit calculateur de deuxième valeur de décision (120) à une deuxième valeur de seuil.

6. Dispositif selon la revendication 5, dans lequel
ledit calculateur de première valeur de décision (110) est configuré pour calculer ladite première valeur de décision de filtre en tant que :

$$\left|p2_0 - 2p1_0 + p0_0\right| + \left|p2_3 - 2p1_3 + p0_3\right|$$

où $p0_o$ représente ladite valeur de pixel dudit pixel le plus proche de, dans ladite première ligne de pixels, ladite frontière de bloc (1), $p1_0$ représente ladite valeur de pixel dudit pixel suivant le plus proche de, dans ladite première ligne de pixels, ladite frontière de bloc (1), $p2_0$ représente ladite valeur de pixel dudit deuxième pixel suivant le plus proche de, dans ladite première ligne de pixels, ladite frontière de bloc (1), $p0_3$ représente une valeur de pixel d'un pixel le plus proche de, dans une deuxième ligne de pixels dans ledit bloc (10), ladite frontière de bloc (1), $p1_3$

représente une valeur de pixel d'un pixel suivant le plus proche de, dans ladite deuxième ligne de pixels, ladite frontière de bloc (1) et $p2_3$ représente une valeur de pixel d'un deuxième pixel suivant le plus proche de, dans ladite deuxième ligne de pixels, ladite frontière de bloc (1) ; et
ledit calculateur de deuxième valeur de décision (120) est configuré pour calculer ladite deuxième valeur de décision de filtre en tant que :

$$\left|q2_0 - 2q1_0 + q0_0\right| + \left|q2_3 - 2q1_3 + q0_3\right|$$

où $q0_0$ représente ladite valeur de pixel dudit pixel dans ledit bloc voisin (20) le plus proche de, dans ladite première ligne correspondante de pixels, ladite frontière de bloc (1), $q1_0$ représente ladite valeur de pixel dudit pixel dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante de pixels, ladite frontière de bloc (1), $q2_0$ représente ladite valeur de pixel dudit pixel dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante de pixels, ladite frontière de bloc (1), $q0_3$ représente une valeur de pixel d'un pixel dans ledit bloc voisin (20) le plus proche de, dans une deuxième ligne correspondante de pixels dans ledit bloc voisin (20), ladite frontière de bloc (1), $q1_3$ représente une valeur de pixel d'un pixel dudit bloc voisin (20) suivant le plus proche de, dans ladite deuxième ligne correspondante de pixels, ladite frontière de bloc (1) et $q2_3$ représente une valeur de pixel d'un pixel dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite deuxième ligne correspondante de pixels, ladite frontière de bloc (1).

7. Dispositif selon une quelconque des revendications 5 à 6, comprenant en outre :

ledit premier déterminateur de pixel (130) est configuré pour i) déterminer de filtrer deux pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180) et ii) déterminer de filtrer un pixel dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est supérieure ou égale à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180) ; et
ledit deuxième déterminateur de pixel (140) est configuré pour i) déterminer de filtrer deux pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182) et ii) déterminer de filtrer un pixel dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est supérieure ou égale à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182).

8. Dispositif selon une quelconque des revendications 5 à 7, comprenant en outre :

un premier comparateur (180) configuré pour comparer ladite première valeur de décision de filtre calculée par ledit calculateur de première valeur de décision (110) à une première valeur de seuil ; et
un deuxième comparateur (182) configuré pour comparer ladite deuxième valeur de décision de filtre calculée par ledit calculateur de deuxième valeur de décision (120) à une deuxième valeur de seuil, dans lequel
ledit premier déterminateur de pixel (130) est configuré pour i) déterminer de filtrer deux pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180); et ii) déterminer de ne filtrer aucun pixel dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) par rapport à ladite frontière de bloc (1) si ladite première valeur de décision de filtre est supérieure ou égale à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180) ; et
ledit deuxième déterminateur de pixel (140) est configuré pour i) déterminer de filtrer deux pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182); et ii) déterminer de ne filtrer aucun pixel dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) par rapport à ladite frontière de bloc (1) si ladite deuxième valeur de décision de filtre est supérieure ou égale à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182).

9. Dispositif selon une quelconque des revendications 5 à 8, comprenant en outre un déterminateur de seuil (170) configuré pour i) déterminer ladite première valeur de seuil sur la base d'un paramètre de quantification associé au dit bloc (10), et ii) déterminer ladite deuxième valeur de seuil sur la base d'un paramètre de quantification associé au dit bloc voisin (20).

10. Dispositif selon une quelconque des revendications 5 à 9, comprenant en outre :

un calculateur de premier décalage (181) configuré pour calculer un premier décalage Δ sur la base de $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, où $p0_j$ représente une valeur de pixel d'un pixel (11) le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1), $p1_j$ représente une valeur de pixel d'un pixel (13) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1), $q0_j$ représente une valeur de pixel d'un pixel (21) dans ledit bloc voisin (20) le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) et $q1_j$ représente une valeur de pixel d'un pixel (23) dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) ;
un premier modificateur de pixel (190) configuré pour modifier ladite valeur de pixel dudit pixel (1) le plus proche de ladite frontière de bloc (1) dans ladite première ligne (12) de pixels (11, 13, 15, 17) par l'ajout dudit premier décalage calculé par ledit calculateur de premier décalage (181) à ladite valeur de pixel dudit pixel (11) le plus proche de ladite frontière de bloc (1) dans ladite première ligne (12) de pixels (11, 13, 15, 17) ;
un deuxième modificateur de pixel (192) configuré pour modifier ladite valeur de pixel dudit pixel (21) dans ledit bloc voisin (20) le plus proche de ladite frontière de bloc (1) dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) par la soustraction dudit premier décalage calculé par ledit calculateur de premier décalage (181) à ladite valeur de pixel dudit pixel (21) dans ledit bloc voisin (20) le plus proche de ladite frontière de bloc (1) dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) ;
un calculateur de deuxième décalage (183), configuré pour calculer, si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180), un deuxième décalage sur la basé de $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, où $p2_j$ représente une valeur de pixel d'un deuxième pixel (15) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17), ladite frontière de bloc (1) ;
un troisième modificateur de pixel (194) configuré pour modifier, si ladite première valeur de décision de filtre est inférieure à ladite première valeur de seuil comme cela est déterminé par ledit premier comparateur (180), ladite valeur de pixel dudit pixel (13) suivant le plus proche de ladite frontière de bloc (1) dans ladite première ligne (12) de pixels (11, 13, 15, 17) par l'ajout dudit deuxième décalage calculé par ledit calculateur de deuxième décalage (183) à ladite valeur de pixel dudit pixel (13) suivant le plus proche de ladite frontière de bloc (1) dans ladite première ligne (12) de pixels (11, 13, 15, 17) ;
un calculateur de troisième décalage (185) configuré pour calculer, si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182), un troisième décalage sur la base de $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, où $q2_j$ représente une valeur de pixel d'un pixel (25) dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) ; et
un quatrième modificateur de pixel (196) configuré pour modifier, si ladite deuxième valeur de décision de filtre est inférieure à ladite deuxième valeur de seuil comme cela est déterminé par ledit deuxième comparateur (182), ladite valeur de pixel dudit pixel (23) dans ledit bloc voisin (20) suivant le plus proche de ladite frontière de bloc (1) dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) par l'ajout dudit troisième décalage calculé par ledit calculateur de troisième décalage (185) à ladite valeur de pixel dudit pixel (23) dans ledit bloc voisin (20) suivant le plus proche de ladite frontière de bloc (1) dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27).

11. Dispositif selon une quelconque des revendications 5 à 10, comprenant en outre un troisième comparateur (184) configuré pour comparer une somme de ladite première valeur de décision de filtre et ladite deuxième valeur de décision de filtre à une valeur de seuil, dans lequel

ledit premier déterminateur de pixel (130) est configuré pour déterminer, si ladite somme de ladite première valeur de décision de filtre et ladite deuxième valeur de décision de filtre est inférieure à ladite valeur de seuil comme cela est déterminé par ledit troisième comparateur (184), le nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite première valeur de décision de filtre calculée par ledit calculateur de première valeur de décision (110) ; et
ledit deuxième déterminateur de pixel (140) est configuré pour déterminer, si ladite somme de ladite première valeur de décision de filtre et ladite deuxième valeur de décision de filtre est inférieure à ladite valeur de seuil comme cela est déterminé par ledit troisième comparateur (184), le nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite deuxième valeur de décision de filtre calculée par ledit calculateur de deuxième valeur de décision (120).

12. Codeur (40) comprenant un dispositif de commande de filtrage (100) selon l'une quelconque des revendications 5 à 11.

13. Equipement d'utilisateur (80) comprenant :

une mémoire (84) configurée pour mémoriser des trames vidéo ; et
un codeur (40) selon la revendication 12 configuré pour coder lesdites trames vidéo en trames vidéo codées, dans lequel ladite mémoire (84) est en outre configurée pour mémoriser lesdites trames vidéo codées.

14. Décodeur (60) comprenant un dispositif de commande de filtrage (100) selon l'une quelconque des revendications 5 à 11.

15. Equipement utilisateur (80) comprenant :

une mémoire (84) configurée pour mémoriser des trames vidéo codées ;
un décodeur (60) selon la revendication 14 configuré pour décoder lesdites trames vidéo codées en trames vidéo décodées ; et
un lecteur multimédia (86) configuré pour restituer lesdites trames vidéo décodées en données vidéo affichables sur un affichage (88).

16. Programme informatique (74) de commande de filtrage d'un bloc (10) de pixels multiples (11, 13, 15, 17) dans une trame vidéo, chaque pixel (11, 13, 15, 17) ayant une valeur de pixel respective, ledit programme informatique (74) comprenant des moyens de code qui, lorsqu'ils sont exécutés sur un ordinateur (70), amènent l'ordinateur (70) à :

calculer une première valeur de décision de filtre pour ledit bloc (10), par l'utilisation uniquement de pixels dudit bloc (10), sur la base de :

$$\left| p2_i - 2p1_i + p0_i \right|$$

où i=0...N-1 et N est le nombre de lignes de pixels dudit bloc (10), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel $p0_i$ représente une valeur de pixel d'un pixel (11) le plus proche, dans une première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10), d'une frontière de bloc (1) avec un bloc voisin (20) de pixels multiples (21, 23, 25, 27) dans ladite trame vidéo, $p1_i$ représente une valeur de pixel d'un pixel (13) suivant le plus proche de, dans ladite première ligne (12) de pixels (11, 13, 15, 17, 19), ladite frontière de bloc (1) et $p2_i$ représente une valeur de pixel d'un deuxième pixel (13) suivant le plus proche, dans ladite première ligne (12) de pixels (11, 13, 15, 17), de ladite frontière de bloc (1) ;
calculer une deuxième valeur de décision de filtre pour ledit bloc voisin (20), par l'utilisation uniquement de pixels dudit bloc voisin (20), sur la base de :

$$\left| q2_i - 2q1_i + q0_i \right|$$

où i=0...N-1 et N est le nombre de lignes de pixels dudit bloc voisin (20), une ligne de pixels étant une rangée ou une colonne de pixels, dans lequel $q0_i$ représente une valeur de pixel d'un pixel (21) dans ledit bloc voisin

(20) la plus proche de, dans une première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20), ladite frontière de bloc (1), $q1_i$ représente une valeur de pixel d'un pixel (23) dudit bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1) et $q2_i$ représente une valeur de pixel d'un pixel (23) dans ledit deuxième bloc voisin (20) suivant le plus proche de, dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27), ladite frontière de bloc (1), dans lequel la première ligne (12) de pixels et la première ligne correspondante (22) dans le bloc voisin (20) sont des lignes opposées par rapport à la frontière de bloc (1) et perpendiculaires à la frontière de bloc (1) ;

déterminer le nombre de pixels dans une première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite première valeur de décision de filtre ; et

déterminer le nombre de pixels dans une première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer par rapport à ladite frontière de bloc (1) sur la base de ladite deuxième valeur de décision de filtre,

dans lequel la détermination du nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer comprend la détermination du nombre de pixels dans ladite première ligne (12) de pixels (11, 13, 15, 17) dans ledit bloc (10) à filtrer par rapport à ladite frontière de bloc (1) sur la base d'une comparaison (S20) de ladite première valeur de décision de filtre à une première valeur de seuil ; et

la détermination du nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer comprend la détermination du nombre de pixels dans ladite première ligne correspondante (22) de pixels (21, 23, 25, 27) dans ledit bloc voisin (20) à filtrer par rapport à ladite frontière de bloc (1) sur la base d'une comparaison (S23) de ladite deuxième valeur de décision de filtre à une deuxième valeur de seuil.

17. Produit de programme informatique (73) comprenant des moyens de code lisibles par ordinateur et un programme informatique (74) selon la revendication 16 mémorisé sur lesdits moyens lisibles par ordinateur.

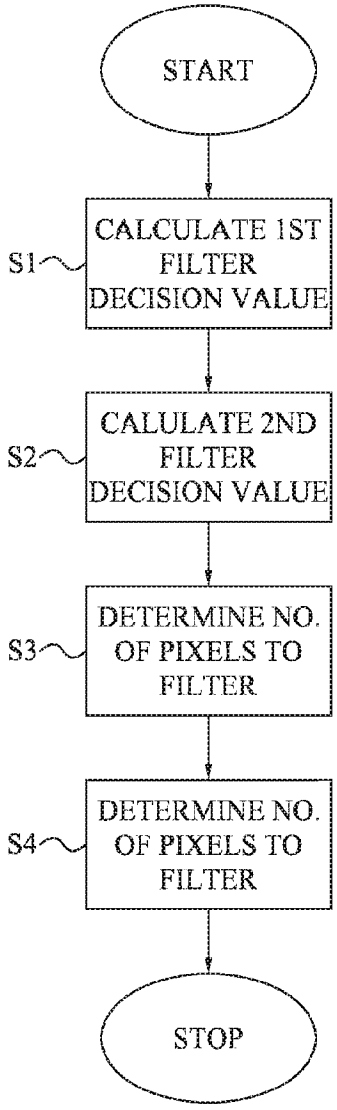


Fig. 1

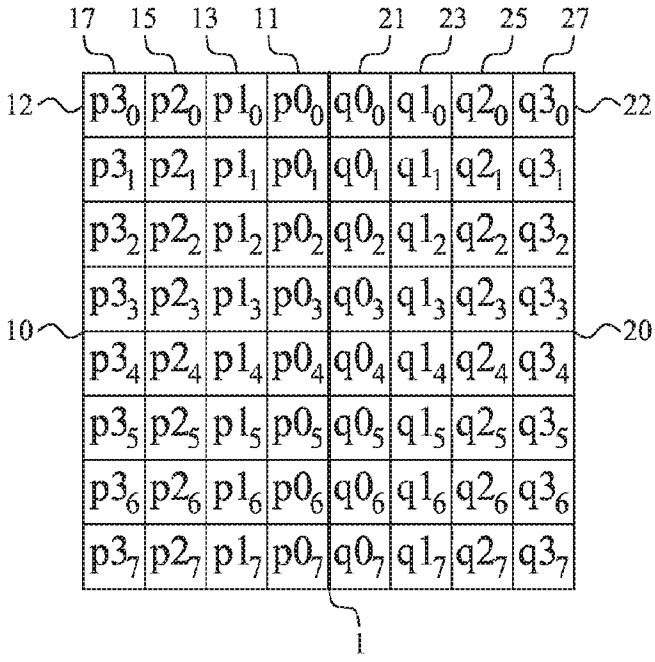


Fig. 2A

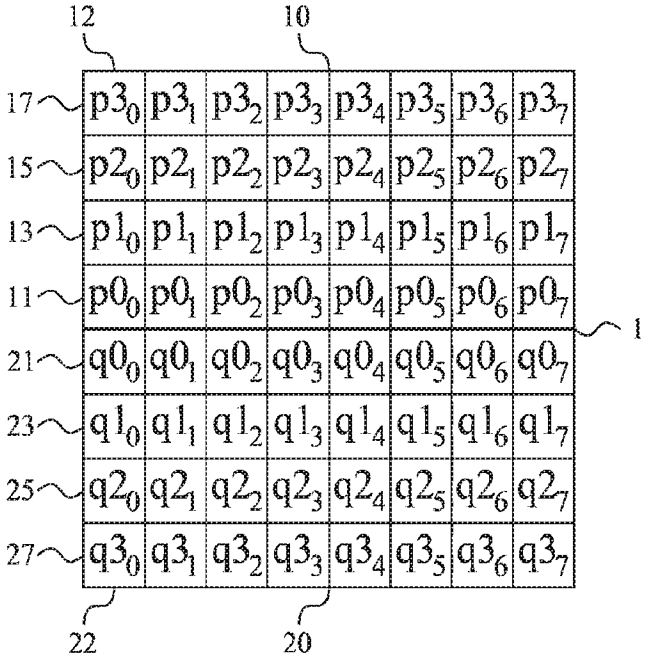


Fig. 2B

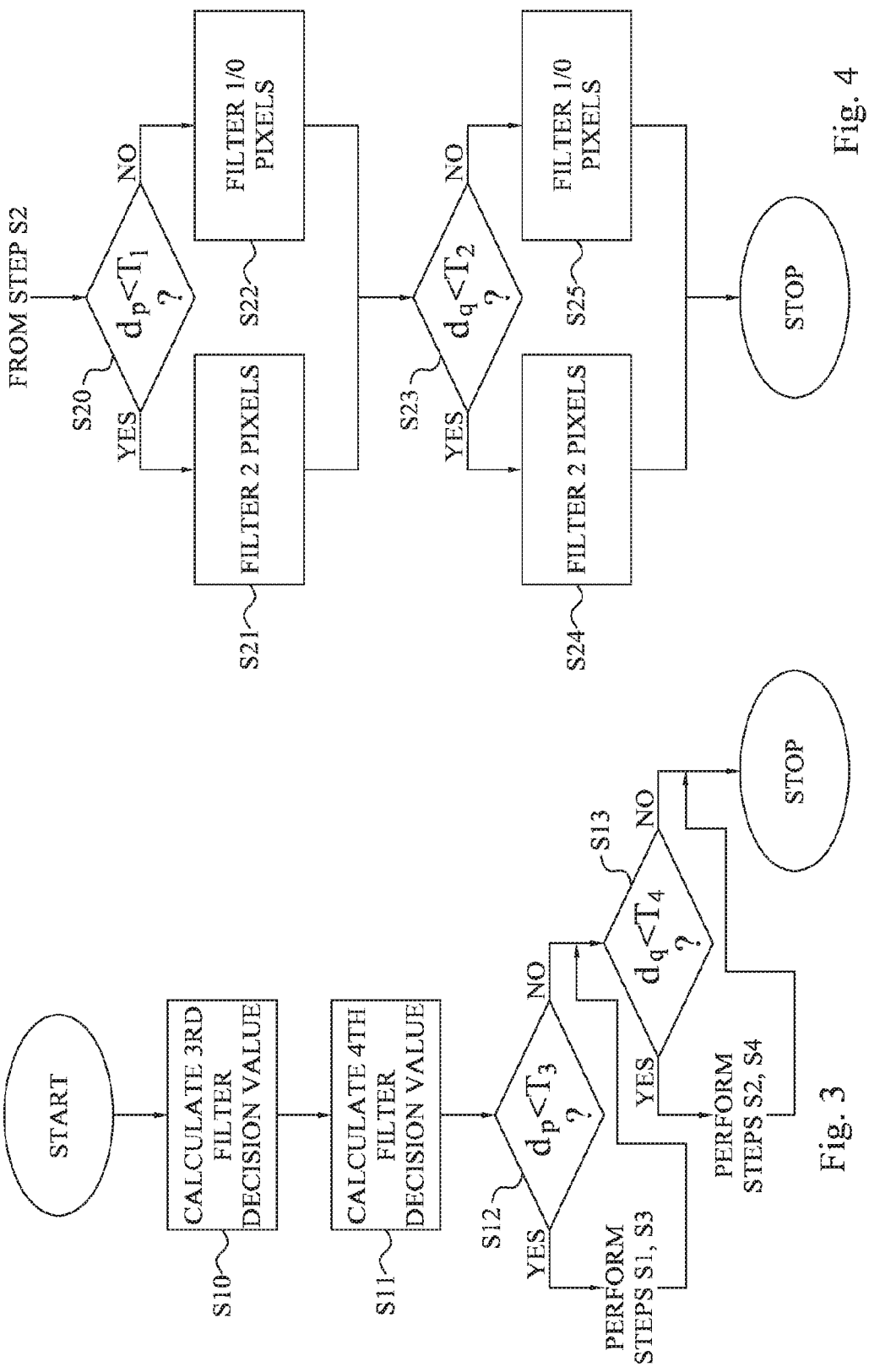

START
CALCULATE 3RD FILTER DECISION VALUE
S10
CALCULATE 4TH FILTER DECISION VALUE
S11
$d_p<T_3$?
S12
NO
YES
PERFORM STEPS S1, S3
$d_q<T_4$?
S13
NO
YES
PERFORM STEPS S2, S4
STOP
FROM STEP S2
$d_p<T_1$?
S20
NO
YES
FILTER 1/0 PIXELS
S22
FILTER 2 PIXELS
S21
$d_q<T_2$?
S23
NO
YES
FILTER 1/0 PIXELS
S25
FILTER 2 PIXELS
S24
STOP

Fig. 3

Fig. 4

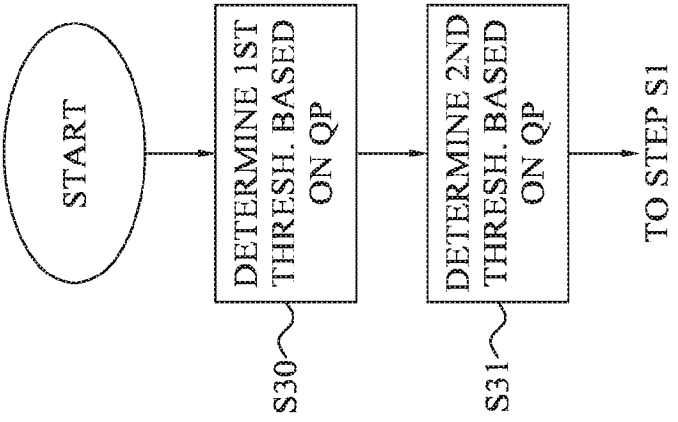

START
DETERMINE 1ST THRESH. BASED ON QP
DETERMINE 2ND THRESH. BASED ON QP
TO STEP S1
S30
S31

Fig. 5

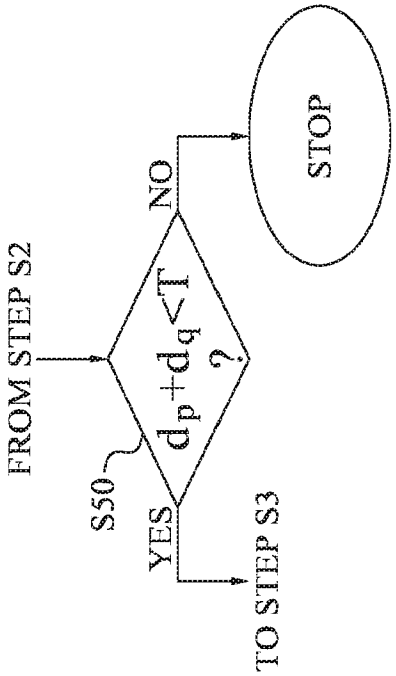

FROM STEP S2
S50
$d_p+d_q<T$?
YES
NO
TO STEP S3
STOP

Fig. 7

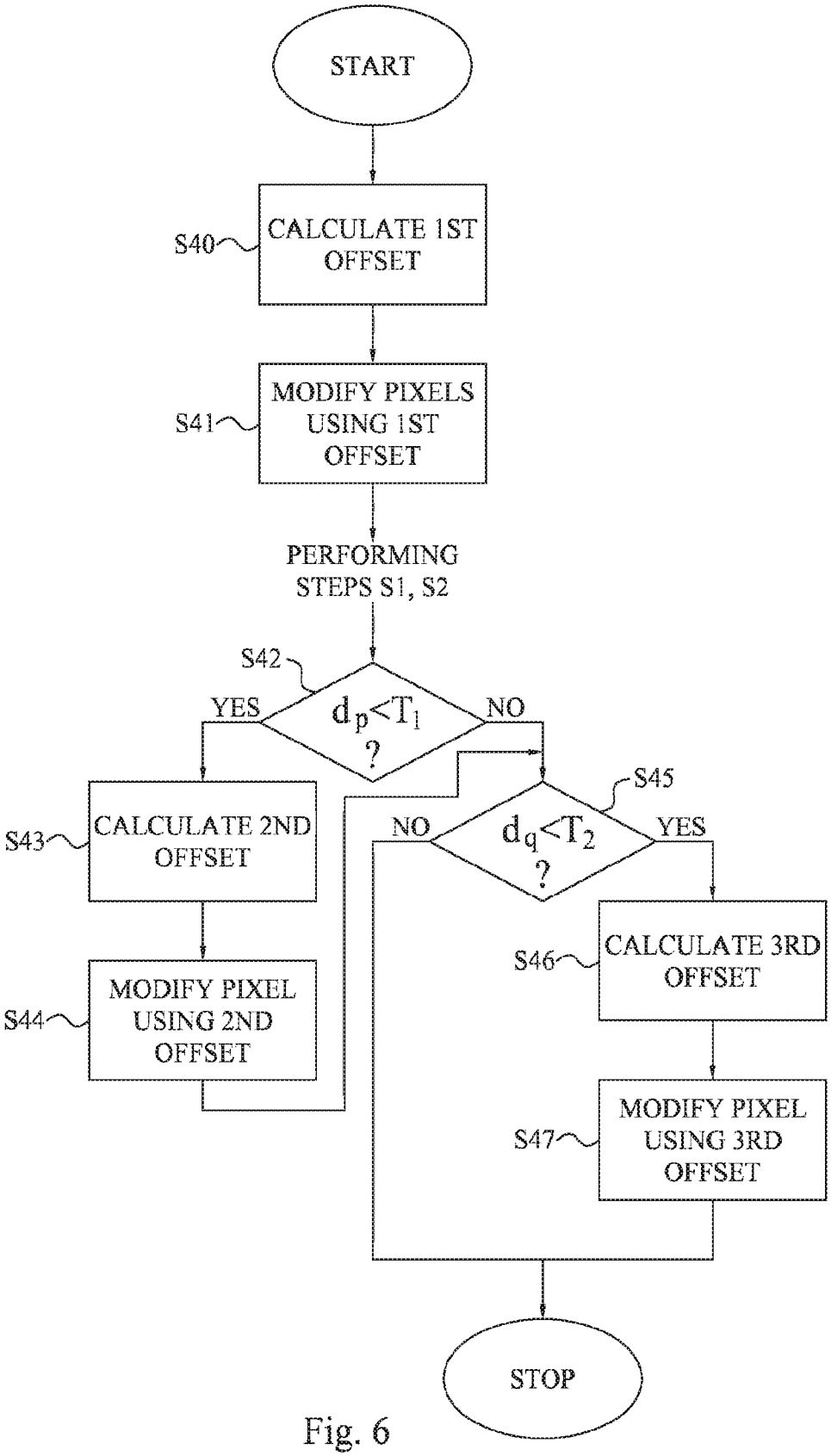

START
S40
CALCULATE 1ST OFFSET
S41
MODIFY PIXELS USING 1ST OFFSET
PERFORMING STEPS S1, S2
S42
YES
$d_p < T_1$?
NO
S43
CALCULATE 2ND OFFSET
S44
MODIFY PIXEL USING 2ND OFFSET
S45
NO
$d_q < T_2$?
YES
S46
CALCULATE 3RD OFFSET
S47
MODIFY PIXEL USING 3RD OFFSET
STOP

Fig. 6

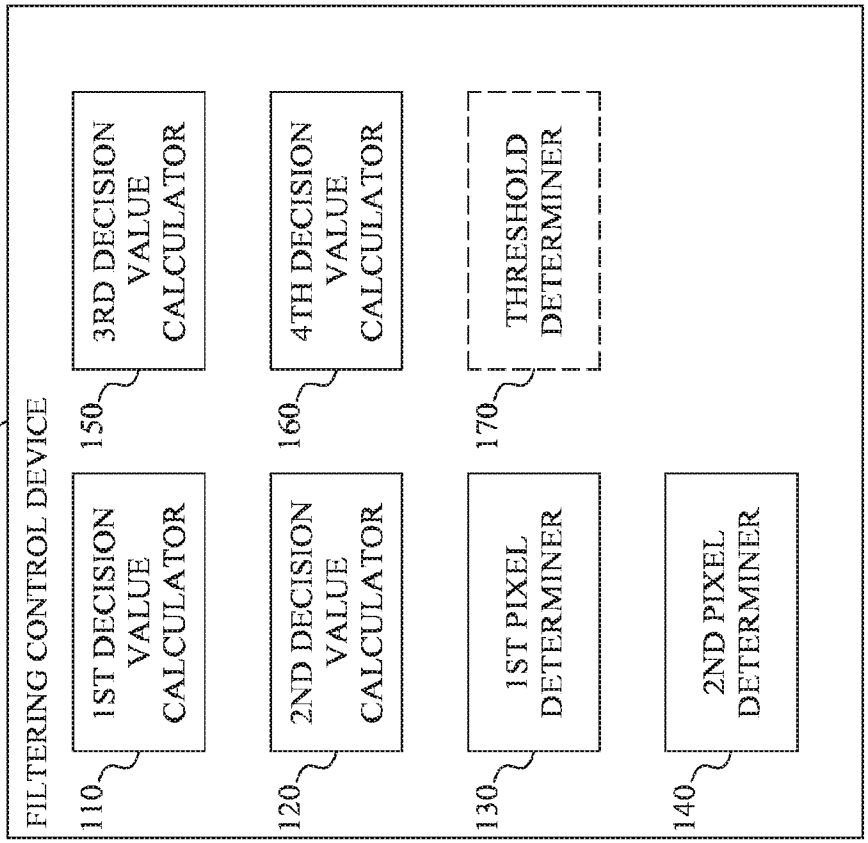

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER
150
3RD DECISION VALUE CALCULATOR
160
4TH DECISION VALUE CALCULATOR
170
THRESHOLD DETERMINER

Fig. 9

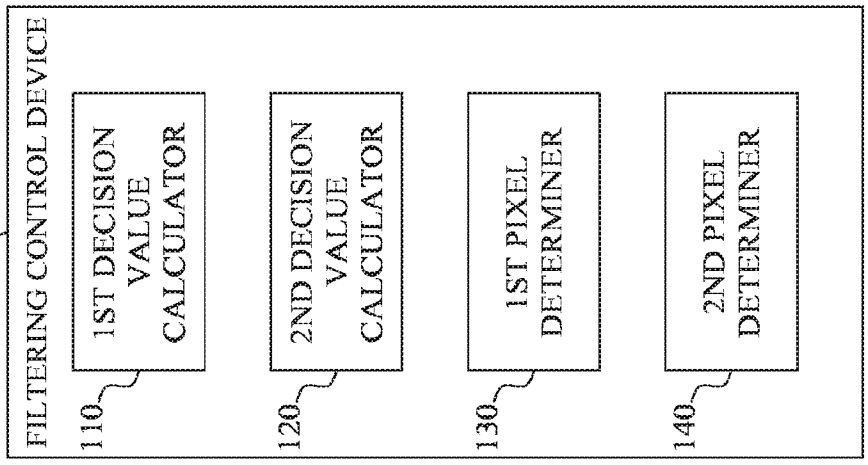

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER

Fig. 8

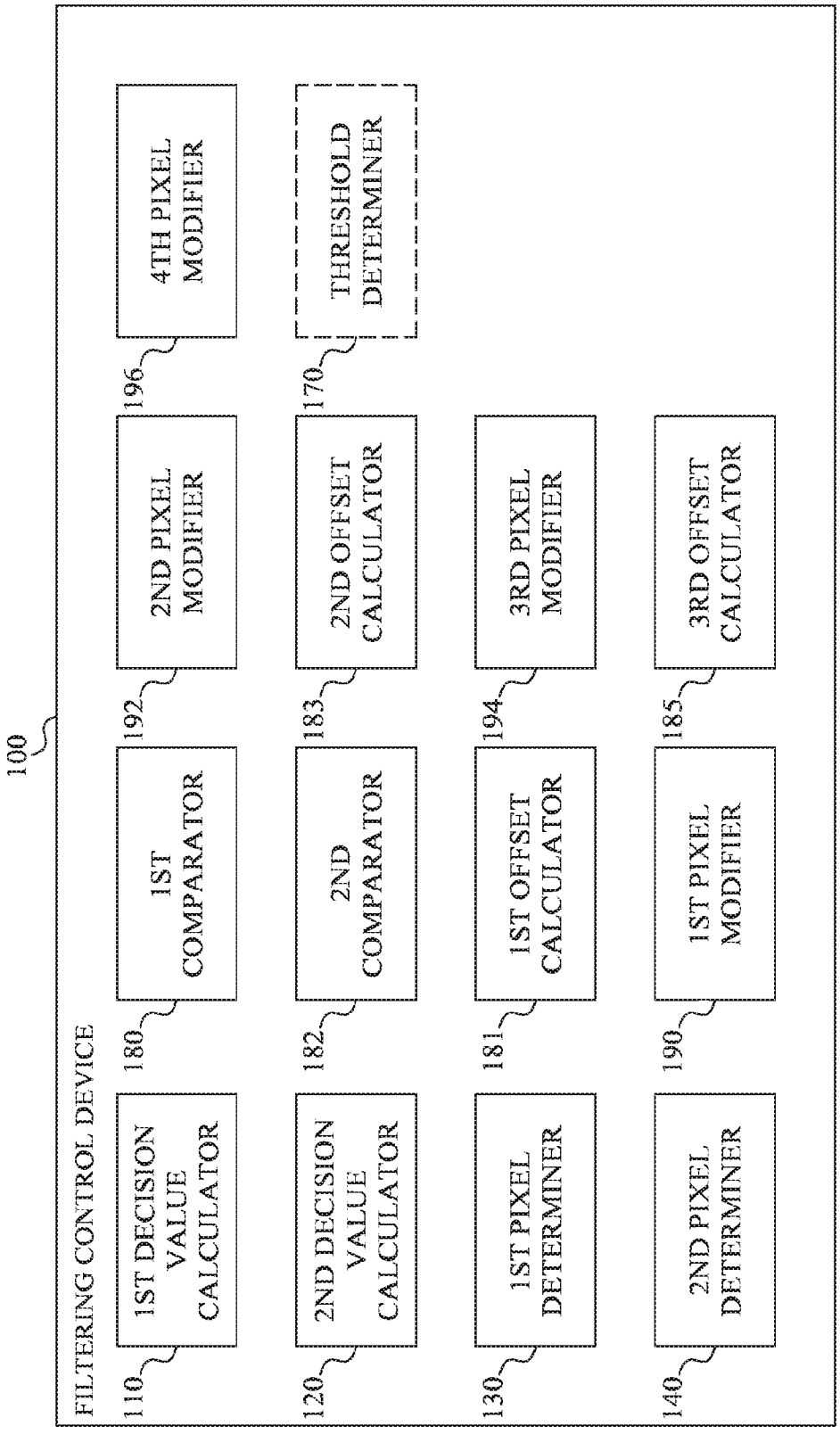

100
FILTERING CONTROL DEVICE
110
1ST DECISION VALUE CALCULATOR
120
2ND DECISION VALUE CALCULATOR
130
1ST PIXEL DETERMINER
140
2ND PIXEL DETERMINER
180
1ST COMPARATOR
182
2ND COMPARATOR
181
1ST OFFSET CALCULATOR
190
1ST PIXEL MODIFIER
192
2ND PIXEL MODIFIER
183
2ND OFFSET CALCULATOR
194
3RD PIXEL MODIFIER
185
3RD OFFSET CALCULATOR
196
4TH PIXEL MODIFIER
170
THRESHOLD DETERMINER

Fig. 10

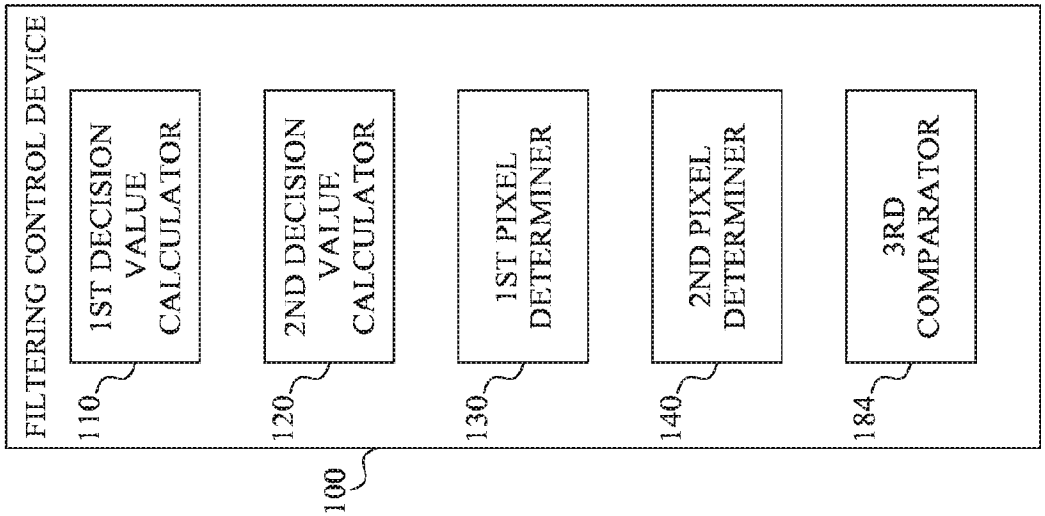

FILTERING CONTROL DEVICE
1ST DECISION VALUE CALCULATOR
2ND DECISION VALUE CALCULATOR
1ST PIXEL DETERMINER
2ND PIXEL DETERMINER
3RD COMPARATOR
110
120
130
140
184
100

Fig. 11

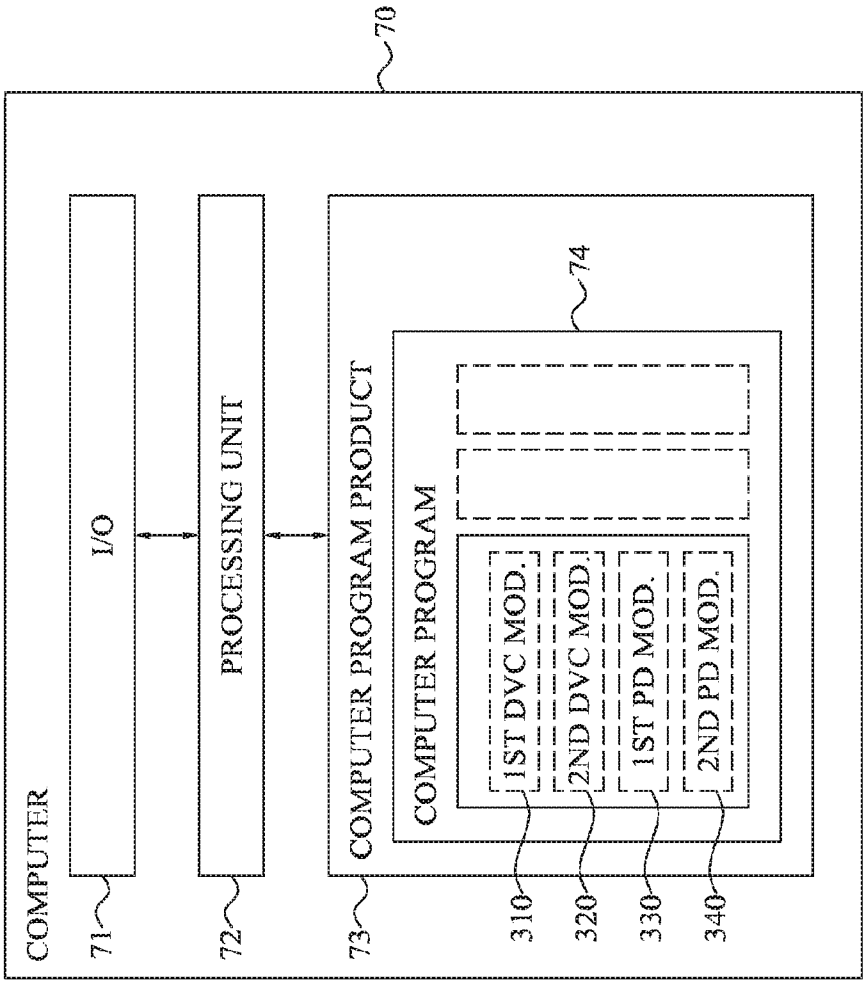

70
COMPUTER
I/O
PROCESSING UNIT
COMPUTER PROGRAM PRODUCT
COMPUTER PROGRAM
74
1ST DVC MOD.
2ND DVC MOD.
1ST PD MOD.
2ND PD MOD.
71
72
73
310
320
330
340

Fig. 12

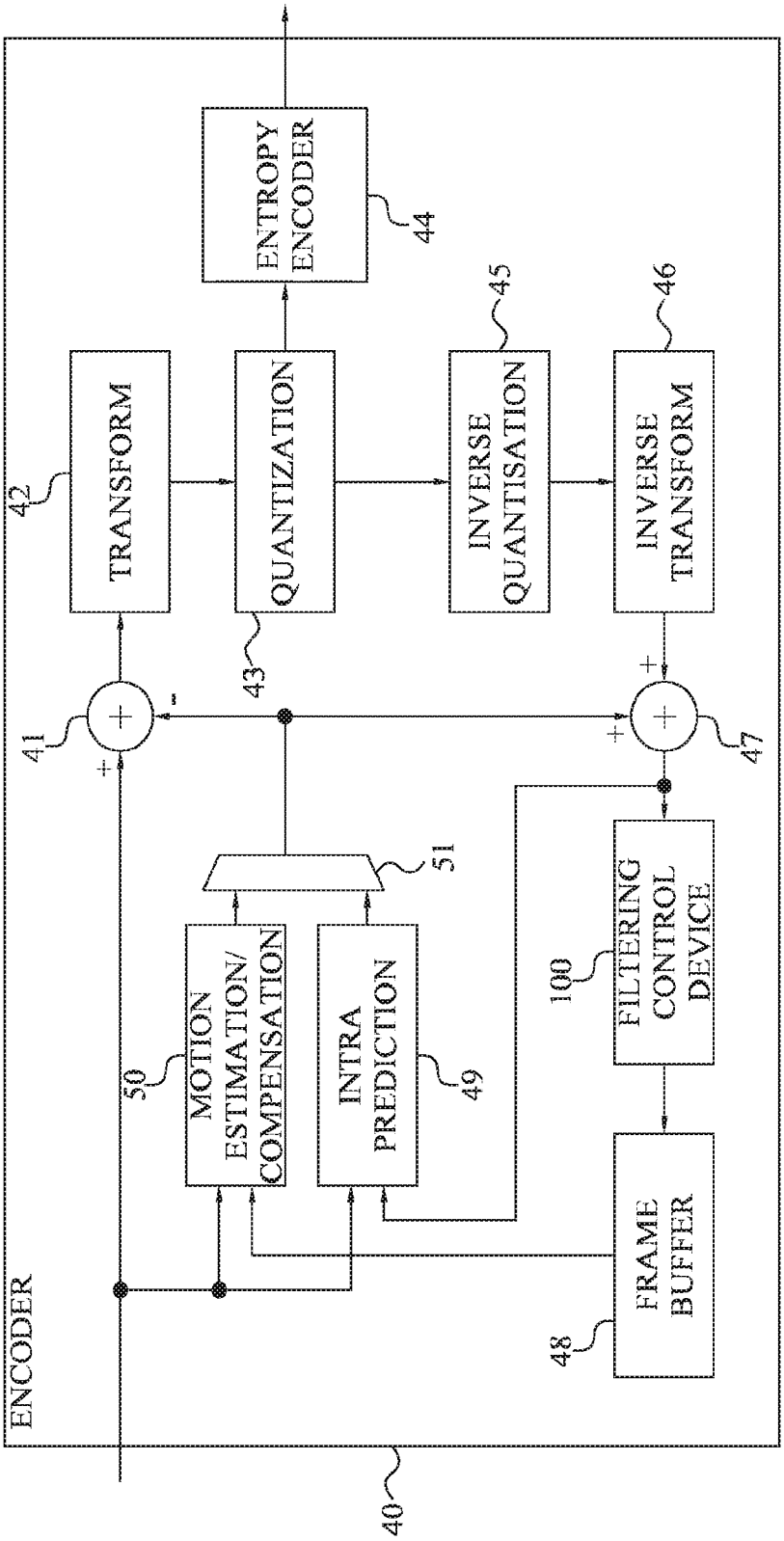

ENCODER
40
41
42
TRANSFORM
43
QUANTIZATION
44
ENTROPY ENCODER
45
INVERSE QUANTISATION
46
INVERSE TRANSFORM
47
FRAME BUFFER
48
INTRA PREDICTION
49
MOTION ESTIMATION/ COMPENSATION
50
51
100
FILTERING CONTROL DEVICE

Fig. 13

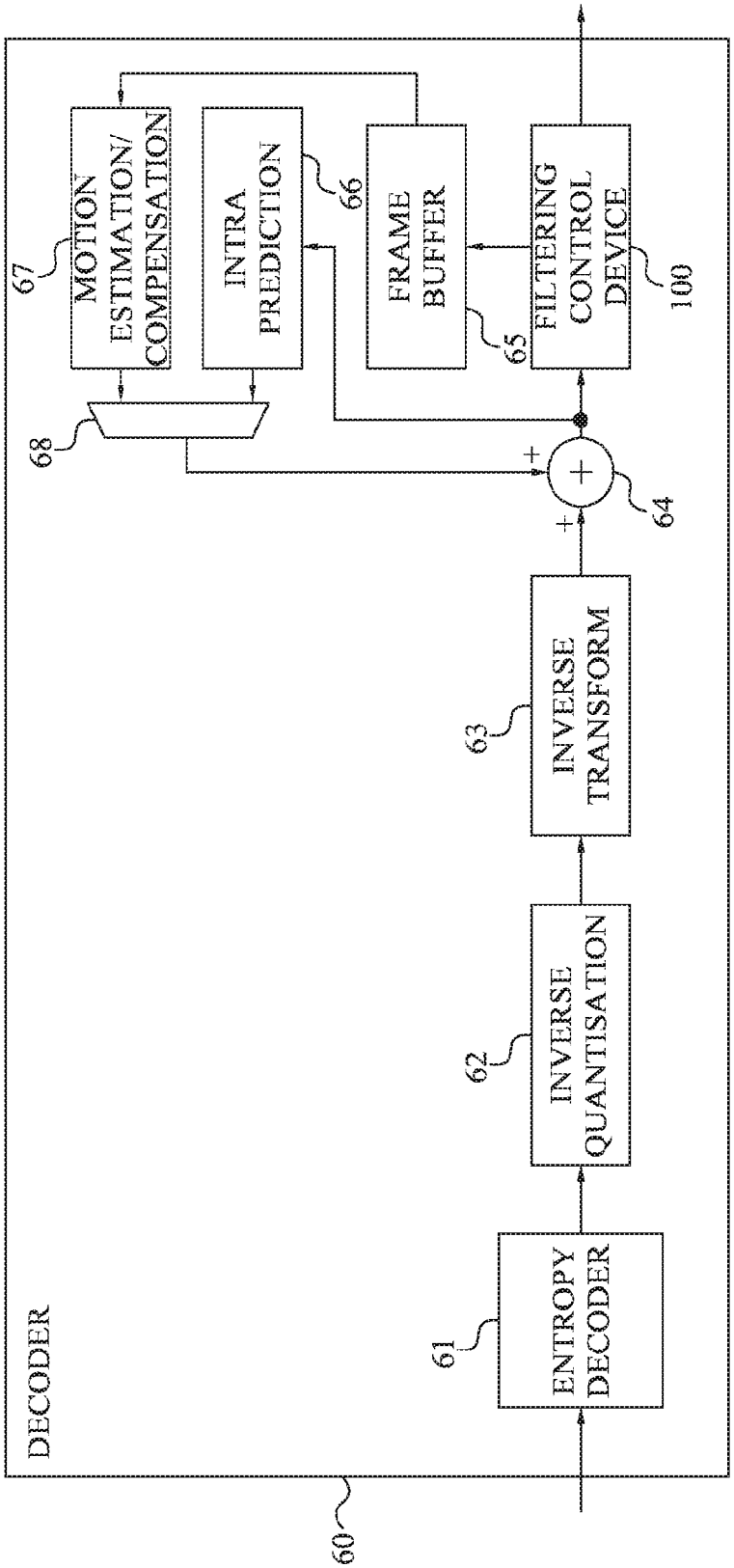

DECODER
60
ENTROPY DECODER
61
INVERSE QUANTISATION
62
INVERSE TRANSFORM
63
64
68
MOTION ESTIMATION/ COMPENSATION
67
INTRA PREDICTION
66
FRAME BUFFER
65
FILTERING CONTROL DEVICE
100

Fig. 14

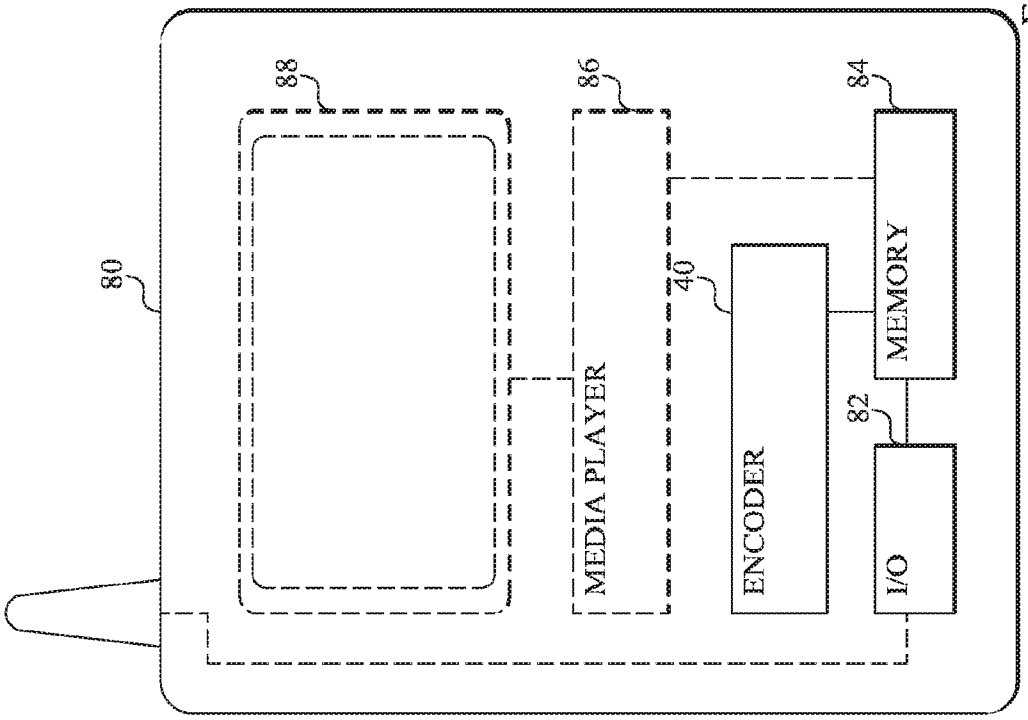

80
88
86
84
MEDIA PLAYER
40
ENCODER
MEMORY
82
I/O

Fig. 16

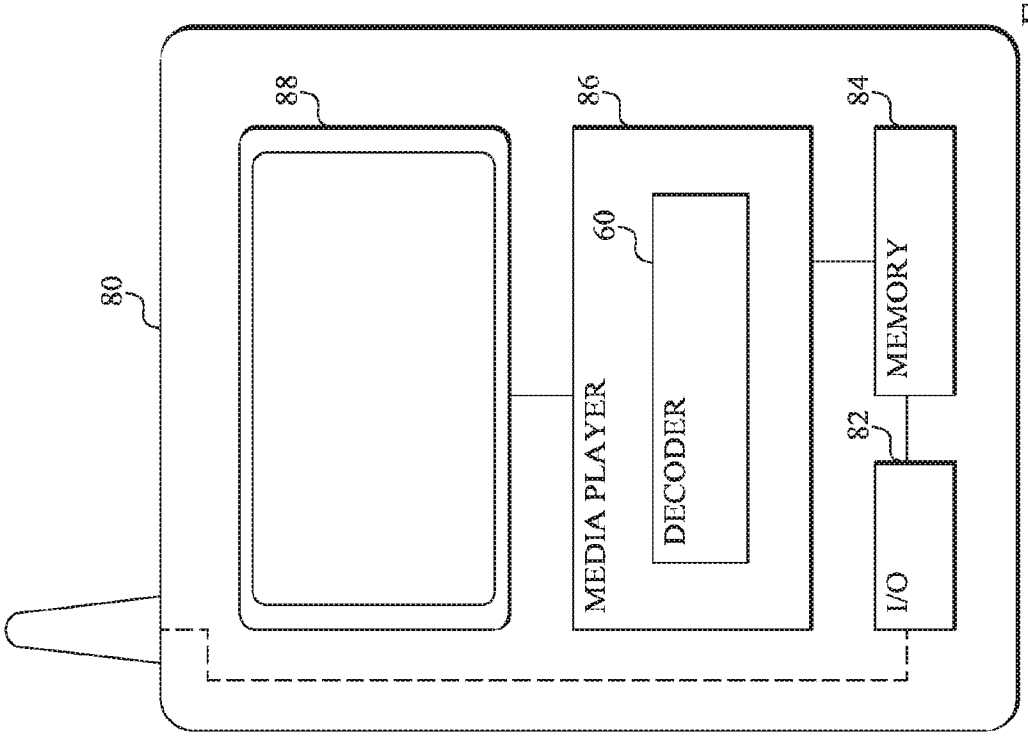

80
88
86
84
MEDIA PLAYER
60
DECODER
MEMORY
82
I/O

Fig. 15

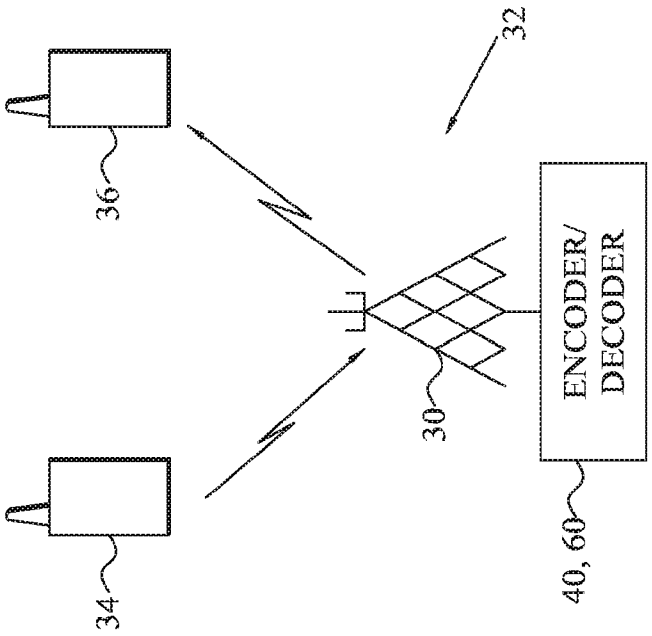


Fig. 17

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2010142844 A1 **[0017]**

Non-patent literature cited in the description

- **LIST et al.** Adaptive Deblocking Filter. *IEEE Transactions on Circuits and Systems for Video Technology*, July 2003, vol. 13 (7 **[0009]**
- Test Model under Consideration. ITU-T SG16 WP3 document, JCTVC-B205 **[0010]**
- **MATTHIAS NARROSCHKE et al.** Reduction of operations in the critical path of the deblocking filter. *MPEG meeting 24-1-2011-28-1-2011; Dagu; no. m18974*, 22 January 2011, 95 **[0016]**

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Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	16-MAR-2016
Filing Date:	26-AUG-2013
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Transmittal.pdf	20372 6546d1bd0b7146380ffacfe8f6fa512387082 4e1	no	1
Warnings:					
Information:					

2	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	33625 1073e03beee8d4fd05619d90d95c0f416b0d1727	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	EP2681913B1.pdf	7486929 2c265ec213a9a40d24f692f9835f6076229261e4	no	51
Warnings:					
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			Total Files Size (in bytes):	7540926	

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: **Norkin**	)	
Serial No.: **14/001,627**	)	PATENT PENDING
Filed: **Aug 26, 2013**	)	Examiner: HESS, MICHAEL J
For: **Deblocking Filtering Control**	)	Group Art Unit: 2481
Attorney's Docket No: **1009-0641 / P33966 US2**	)	Confirmation No.: 2724

MS AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

INFORMATION DISCLOSURE STATEMENT

In accordance with 37 C.F.R. 1.56, counsel wishes to make of record the attached items of information for the Examiner's consideration in connection with this application. Also enclosed is Form PTO/SB/08a for the Examiner's convenience in making such consideration of record. Inclusion herein of any particular item of information is not to be construed as an admission that same is prior art.

The Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account 50-5650.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

/ Daniel P. Homiller, Reg. # 55,275 /

Dated: 2016-03-16

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: **Norkin**	)	
	)	
Serial No.: **14/001,627**	)	PATENT PENDING
	)	
Filed: **Aug 26, 2013**	)	Examiner: KELLEY, CHRISTOPHER S
	)	
For: **Deblocking Filtering Control**	)	Group Art Unit: 2482
	)	
Docket No: **1009-0641 / P33966 US2**	)	Confirmation No.: 2724
	)	
	)	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO OFFICE ACTION

Applicant submits this paper in response to the Office Action mailed 2016-01-21 and requests favorable reconsideration in light of the following remarks and/or amendments. No fees should be required for entry of this response, but the Commissioner is hereby authorized to charge any required fees to Deposit Account No. 50-5650.

LISTING OF THE CLAIMS

1-33. (Canceled)

34. (Previously Presented) A method for filtering control applicable to a block of multiple pixels in a video frame, each pixel having a respective pixel value, said method comprising:

calculating a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$|p2_i - 2p1_i + p0_i|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculating a second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determining how many pixels in said first line of pixels in said block to filter relative to

said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on a comparison of said second filter decision value to a second threshold value.

35. (Previously Presented) The method according to claim 34, wherein

calculating said first filter decision value comprises calculating said first filter decision value as:

$$|p2_0 - 2p1_0 + p0_0| + |p2_3 - 2p1_3 + p0_3|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a pixel second next closest to, in said second line of pixels, said block boundary; and

calculating said second filter decision value comprises calculating said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to,

in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

36. (Previously Presented) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter one pixel in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

37. (Previously Presented) The method according to claim 34, wherein

determining how many pixels in said first line of pixels in said block to filter comprises:

comparing said first filter decision value to a first threshold value;

determining to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value; and

determining to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value; and

determining how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises:

comparing said second filter decision value to a second threshold value;

determining to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value; and

determining to filter no pixels in said corresponding first line of pixels in said

neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value.

38. (Previously Presented) A filtering control device comprising:

a first decision value calculator configured to calculate a first filter decision value for a block of multiple pixels in a video frame, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a second decision value calculator configured to calculate a second filter decision value for a neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$\left|q2_i - 2q1_i + q0_i\right|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel determiner configured to determine how many pixels in a first line of pixels

in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

a second pixel determiner configured to determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator, wherein

further comprising a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value.

39. (Previously Presented) The device according to claim 38, wherein

said first decision value calculator is configured to calculate said first filter decision value as:

$$\left|p2_0 - 2p1_0 + p0_0\right| + \left|p2_3 - 2p1_3 + p0_3\right|$$

wherein $p0_0$ denotes said pixel value of said pixel closest to, in said first line of pixels, said block boundary, $p1_0$ denotes said pixel value of said pixel next closest to, in said first line of pixels, said block boundary, $p2_0$ denotes said pixel value of said pixel second next closest to, in said first line of pixels, said block boundary, $p0_3$ denotes a pixel value of a pixel closest to, in a second line of pixels in said block, said block boundary, $p1_3$ denotes a pixel value of a pixel next closest to, in said second line of pixels, said block boundary and $p2_3$ denotes a pixel value of a

pixel second next closest to, in said second line of pixels, said block boundary; and

said second decision value calculator is configured to calculate said second filter decision value as:

$$|q2_0 - 2q1_0 + q0_0| + |q2_3 - 2q1_3 + q0_3|$$

wherein $q0_0$ denotes said pixel value of said pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary, $q1_0$ denotes said pixel value of said pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary, $q2_0$ denotes said pixel value of said pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary, $q0_3$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding second line of pixels in said neighboring block, said block boundary, $q1_3$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding second line of pixels, said block boundary and $q2_3$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding second line of pixels, said block boundary.

40. (Previously Presented) The device according to claim 38, further comprising:

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter one pixel in said first line of pixels in said

block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value as determined by said second comparator and ii) determine to filter one pixel in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

41. (Previously Presented) The device according to claim 38, further comprising:

a first comparator configured to compare said first filter decision value calculated by said first decision value calculator to a first threshold value; and

a second comparator configured to compare said second filter decision value calculated by said second decision value calculator to a second threshold value, wherein

said first pixel determiner is configured to i) determine to filter two pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is below said first threshold value as determined by said first comparator and ii) determine to filter no pixels in said first line of pixels in said block relative to said block boundary if said first filter decision value is equal to or exceeds said first threshold value as determined by said first comparator; and

said second pixel determiner is configured to i) determine to filter two pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is below said second threshold value

as determined by said second comparator and ii) determine to filter no pixels in said corresponding first line of pixels in said neighboring block relative to said block boundary if said second filter decision value is equal to or exceeds said second threshold value as determined by said second comparator.

42. (Previously Presented) The device according to claim 38, further comprising a threshold determiner configured to i) determine said first threshold value based on a quantization parameter associated with said block, and ii) determine said second threshold value based on a quantization parameter associated with said neighboring block.

43. (Previously Presented) The device according to claim 38, further comprising:

a first offset calculator configured to calculate a first offset Δ based on $\frac{9\times(q0_j - p0_j) - 3\times(q1_j - p1_j)}{16}$, wherein $p0_j$ denotes a pixel value of a pixel closest to, in said first line of pixels, said block boundary, $p1_j$ denotes a pixel value of a pixel next closest to, in said first line of pixels, said block boundary, $q0_j$ denotes a pixel value of a pixel in said neighboring block closest to, in said corresponding first line of pixels, said block boundary and $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary;

a first pixel modifier configured to modify said pixel value of said pixel closest to said block boundary in said first line of pixels by adding said first offset calculated by said first offset calculator to said pixel value of said pixel closest to said block boundary in said first line of pixels;

a second pixel modifier configured to modify said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels by subtracting said first offset calculated by said first offset calculator from said pixel value of said pixel in said neighboring block closest to said block boundary in said corresponding first line of pixels;

a second offset calculator configured to calculate, if said first filter decision value is below said first threshold value as determined by said first comparator, a second offset based on $\frac{p0_j + p2_j - 2p1_j + 2\Delta}{4}$, wherein $p2_j$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

a third pixel modifier configured to modify, if said first filter decision value is below said first threshold as determined by said first comparator, said pixel value of said pixel next closest to said block boundary in said first line of pixels by adding said second offset calculated by said second offset calculator to said pixel value of said pixel next closest to said block boundary in said first line of pixels;

a third offset calculator configured to calculate, if said second filter decision value is below said second threshold value as determined by said second comparator, a third offset based on $\frac{q0_j + q2_j - 2q1_j - 2\Delta}{4}$, wherein $q2_j$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary; and

a fourth pixel modifier configured to modify, if said second filter decision value is below said second threshold as determined by said second comparator, said pixel value of said pixel in said neighboring block next closest to said block boundary in said

corresponding first line of pixels by adding said third offset calculated by said third offset calculator to said pixel value of said pixel in said neighboring block next closest to said block boundary in said corresponding first line of pixels.

44. (Previously Presented) The device according to claim 38, further comprising a third comparator configured to compare a sum of said first filter decision value and said second filter decision value to a threshold value, wherein

said first pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said first line of pixels in said block to filter relative to said block boundary based on said first filter decision value calculated by said first decision value calculator; and

said second pixel determiner is configured to determine, if said sum of said first filter decision value and said second filter decision value is below said threshold value as determined by said third comparator, how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value calculated by said second decision value calculator.

45. (Previously Presented) An encoder comprising a filtering control device according to claim 38.

46. (Previously Presented) A user equipment comprising:

a memory configured to store video frames; and

an encoder according to claim 45 configured to encode said video frames into encoded video frames, wherein said memory is further configured to store said encoded video frames.

47. (Previously Presented) A decoder comprising a filtering control device according to claim 38.

48. (Previously Presented) A user equipment comprising:

a memory configured to store encoded video frames;

a decoder according to claim 47 configured to decode said encoded video frames into decoded video frames; and

a media player configured to render said decoded video frames into video data displayable on a display.

49. (Currently Amended) A non-transitory computer-readable medium comprising, stored thereupon, a computer program for filtering control of a block of multiple pixels in a video frame, each pixel having a respective pixel value, said computer program ~~comprises~~ comprising code means which when run on a computer causes the computer to:

calculate a first filter decision value for said block, by only using pixels $p2_i$, $p1_i$ and $p0_i$, based on:

$$\left|p2_i - 2p1_i + p0_i\right|$$

wherein $p0_i$ denotes a pixel value of a pixel closest to, in a first line of pixels in said block, a block boundary to a neighboring block of multiple pixels in said video frame, $p1_i$ denotes a pixel value of a pixel next closest to, in said first line of

pixels, said block boundary and $p2_i$ denotes a pixel value of a pixel second next closest to, in said first line of pixels, said block boundary;

calculate a second filter decision value for said neighboring block, by only using pixels $q2_i$, $q1_i$ and $q0_i$, based on:

$$|q2_i - 2q1_i + q0_i|$$

wherein $q0_i$ denotes a pixel value of a pixel in said neighboring block closest to, in a corresponding first line of pixels in said neighboring block, said block boundary, $q1_i$ denotes a pixel value of a pixel of said neighboring block next closest to, in said corresponding first line of pixels, said block boundary and $q2_i$ denotes a pixel value of a pixel in said neighboring block second next closest to, in said corresponding first line of pixels, said block boundary;

determine how many pixels in a first line of pixels in said block to filer relative to said block boundary based on said first filter decision value; and

determine how many pixels in a corresponding first line of pixels in said neighboring block to filter relative to said block boundary based on said second filter decision value,

wherein determine how many pixels in said first line of pixels in said block to filter comprises determining how many pixels in said first line of pixels in said block to filter relative to said block boundary based on a comparison of said first filter decision value to a first threshold value; and

determine how many pixels in said corresponding first line of pixels in said neighboring block to filter comprises determining how many pixels in said corresponding first line of pixels in said neighboring block to filter relative to said block boundary

based on a comparison of said second filter decision value to a second threshold value.

50. (Canceled).

REMARKS

Claim Amendments

Claim 49 is amended so that it is directed to a non-transitory computer-readable medium. Claim 50 is canceled. No new subject matter is added to the application.

Claim Rejections – 35 U.S.C. § 103

Claims 34-42 and 44-50 are rejected a s allegedly obvious over Bjontegaard (US 2006/0078048), in view of List ("Adaptive Deblocking Filter," IEEE Trans. on Circuits and Systems for Video Technology, v. 13, no. 7, July 2003). These rejections should be withdrawn, at least because the cited combination of references fails to disclose or suggest a technique that involves separately determining how many pixels to filter on one side of a boundary and determining how many pixels to filter on the other side of the boundary, as required by the present claims.

Claim 34

Independent claim 34 is a method for filtering control applicable to a block of multiple pixels in a video frame. The method comprises (a) calculating a first filter decision value, based on three pixels in a row on side of a block boundary, (b) calculating a second filter decision value, based on three pixels in a row on the opposite side of the block boundary, (c) determining how many pixels to filter on the first side of the block boundary based on a comparison of the first filter decision value to a first threshold value, and (d) determining how many pixels to filter on the other side of the block boundary based on a comparison of the second filter decision value to a second threshold value.

Note that claim 34 recites two separate "determinings" of how many pixels to filter, based on two separate comparisons. This allows asymmetric filtering; i.e., the filtering of different numbers of pixels on either side of the block boundary.

The Office Action alleges, at page 4, that Bjontegaard discloses the two "determining" operations of claim 34, citing Bjontegaard's paragraphs 0045 and 0046. The Applicant respectfully disagrees, and submits that the use of two separate "determining operations," in the manner recited in the claim, is not disclosed or suggested by either of the cited references, whether considered alone or in combination.[1]

The Office Action's analysis of claim 34 cites only to Bjontegaard's paragraphs 0042, 0045, and 0046. It should be noted that paragraph 0042 is actually describing a different embodiment than paragraphs 0045 and 0046. For completeness, Bjontegaard's paragraphs 0041-0046 are reproduced below, along with Bjontegaard's Figure 3, which illustrates the pixel layout against which Bjontegaard's equations should be interpreted:

> ***[0041]*** *As a first embodiment of the present invention, the second line in the FIG. 4 is selected as the "decision line" for the four lines 0-3 crossing the boundary.*
>
> ***[0042]*** *Then, filtering of all 4 edge lines are performed if:*
>
> $$d = (|a1 - 2b1 + c1| + |d1 - 2e1 + f1|) < \beta \ \ (QP)$$
>
> *Otherwise no filtering is performed.*
>
> ***[0043]*** *As opposed to prior art, the test for one line applies*

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[1] The Office Action's analysis of claim 34 provides no specific citations to List, suggesting only that List is "helpful … to understand a full implementation of the H.264 deblocking algorithm." The Applicant agrees that List describes the H.264 deblocking algorithm, but notes that List's pertinence to the specific rejections remains unclear, since the Office Action does not indicate that List provides any suggestion to modify Bjontegaard's teachings in any way.

for all the lines crossing the block boundary. Thus, the value β is not necessarily determined in the same way as the β earlier described herein. E.g. other look-up tables than those depicted in FIGS. 4 and 5 may be used to determine β.

[0044] *In a second embodiment of the present invention, the third and the sixth line of in FIG. 4 in combination are used as the "decision lines" for all the eight lines 0-7 crossing the boundary. Then, filtering of all 8 edge lines are performed if:*

$$d' = (|a2 - 2b2 + c2| + |d2 - 2e2 + f2| + |a5 - 2b5 + c5| + |d5 - 2e5|) < \beta'(QP)$$

[0045] *Otherwise no filtering is performed. β' may also be determined in still a another way than in prior art. A typical relation to β of the first embodiment would be β' =2 β.*

[0046] *Further, if the above tests on the "decision line" is true, a separate calculation is performed for each of the line for deriving delta and a corresponding corrected pixel values. This can generally be expressed as in the following, using the same notation as for the description of prior art:*

$$\Delta = (a - b - 2c + 2d + e - f)/4$$

a0	b0	c0	d0	e0	f0
a1	b1	c1	d1	e1	f1
a2	b2	c2	d2	e2	f2
a3	b3	c3	d3	e3	f3
a4	b4	c4	d4	e4	f4
a5	b5	c5	d5	e5	f5
a6	b6	c6	d6	e6	f6
a7	b7	c7	d7	e7	f7

Bjontegaard's Figure 3

It can be seen that Bjontegaard's paragraphs 0041 and 0042 describe a first embodiment of Bjontegaard's technique for determining when filtering should be performed. In paragraph 0042, Bjontegaard provides an inequality expression in which a summation involving pixel values from a single line is compared to a threshold value β. Note that the pixel values come from opposite sides of a vertical block boundary, separating a first block from a second block. Note also that there is a single calculation for this embodiment, and a single comparison (to the threshold value β), to determine whether filtering should be applied. Finally, note that none of this demonstrates two separate determinations of how many pixels in the first block should be filtered and how many pixels in the second block should be filtered.

Bjontegaard's paragraphs 0044-0046 describe a second embodiment of Bjontegaard's techniques for determining whether or not perform filtering. The difference from the first embodiment is that the inequality expression used to make this decision involves a summation of pixel values from two different lines, as detailed in paragraph 0044. Again, however, there is only a single calculation and a single comparison (to the threshold β' in this case) to make the binary decision of whether filtering should be applied. Finally, once again Bjontegaard does not disclose two separate determinations of how many pixels in the first block should be filtered and how many pixels in the second block should be filtered.

In short, the first embodiment discussed in Bjontegaard has a single comparison, based on the sum of what the Office Action takes to be two separate "filter values." Bjontegaard's second embodiment also involves only a single comparison, in this case based on a sum that involves pixels from two different lines. In both cases, the comparison is used to make a single

decision, i.e., whether or not to perform filtering.[2] This is a decidedly different sequence of operations than what is recited in claim 34, with decidedly different results. Bjontegaard's techniques provides a filter/no-filter decision applicable to both blocks. As far as is disclosed in the references, the subsequent filtering operations (which are not described in Bjontegaard's paragraphs 0041-0046) are symmetrical in that they involve the same number of pixels on either side of the boundary. In contrast, the process recited in claim 34 determines how many pixels on one side of a block boundary are to be filtered, and separately determines how many pixels on the other side of the block boundary. This technique has the advantage of allowing for asymmetric filtering, an advantage that is not provided by Bjontegaard's technique.[3]

Independent Claims 38 and 49 and Dependent Claims 35-37 and 39-48

Independent claim 38 is an apparatus claim corresponding closely to method claim 34, while independent claim 49 is a corresponding computer-readable medium claim. The rejections of these claims should be withdrawn for the same reasons given above for claim 34. The rejections of claims 35-37 and 39-48 should be withdrawn for at least the same reasons.

Conclusion

The present application should be in condition for allowance in view of the amendments and/or remarks made herein. Action to such effect is respectfully requested. The Examiner is

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[2] Note that Bjontegaard does not disclose or suggest that these two different embodiments are used simultaneously. Rather, Bjontegaard is simply explaining that the filter/no-filter decision may be made for four lines at a time, using pixel values from one line in the decision criterion, or for eight lines at a time, using pixel values from two lines in the decision criterion.

[3] Nor does Bjontegaard suggest the desirability of such an approach.

encouraged to contact the undersigned at (919)-948-3390 if any outstanding matters can be readily addressed by a phone call.

Respectfully submitted,
Murphy, Bilak & Homiller, PLLC

/ Daniel P. Homiller, Reg. # 55,275 /

Dated: 20 April 2016

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Facsimile: (919) 948-3357

Electronic Acknowledgement Receipt

EFS ID:	25542667
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Williams
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	20-APR-2016
Filing Date:	26-AUG-2013
Time Stamp:	12:09:58
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Response.pdf	148406 18e4b1f859d8635dc42c1e4d71e484c1137e7ac2	no	21

Warnings:	
Information:	

Total Files Size (in bytes):	148406

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/001,627	Filing Date 08/26/2013	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **04/20/2016**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 15	Minus	** 23	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/MOLIKI MAY/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

102721 7590 12/27/2016

Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

EXAMINER
HESS, MICHAEL J

ART UNIT	PAPER NUMBER
2481	

DATE MAILED: 12/27/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2	2724

TITLE OF INVENTION: Deblocking Filtering Control

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/27/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

102721 7590 12/27/2016
Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2	2724

TITLE OF INVENTION: Deblocking Filtering Control

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/27/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
HESS, MICHAEL J	2481	375-240290

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2	2724

102721 7590 12/27/2016

Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

EXAMINER	
HESS, MICHAEL J	

ART UNIT	PAPER NUMBER
2481	

DATE MAILED: 12/27/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/001,627	Applicant(s) NORKIN ET AL.	
	Examiner Michael J. Hess, Esq.	Art Unit 2481	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the amendments and remarks filed 04/20/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *34-49*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date corrected 1449 dated 01/21/2016 (for IDS 08/26/2013) by adding signature; 03/16/2016
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/Michael J Hess, Esq./ Examiner, Art Unit 2481	/WILLIAM C. VAUGHN JR/ Supervisory Patent Examiner, Art Unit 2481

DETAILED ACTION

Allowable Subject Matter

Claims 34–49 are allowed.

The following is an examiner's statement of reasons for allowance: Examiner adopts as his reasons for allowance the explanation in the submission filed by Applicant on 04/20/2016. Specifically, Applicant's argument, that the claims cover a separate treatment of the pixels on each side of the block boundary, so that the decision to filter a determined number of pixels on one side of a block boundary has no mathematical basis in (no relationship with) the pixels on the other side of the block boundary, was persuasive. Bjontegaard describes filtering equations that consider pixel values on both sides of a block boundary, so that the decision regarding how many pixels to filter is tied to the values of pixels on both sides (i.e., no separation in pixel analysis). Applicant's arguments regarding the prior art's separate embodiments was not persuasive to Examiner. Examiner finds the combination and/or substitutions among/between embodiments disclosed in Bjontegaard would have been obvious in view of the skill in the art.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably

accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

/Michael J Hess, Esq./

Examiner, Art Unit 2481

/WILLIAM C. VAUGHN JR/

Supervisory Patent Examiner, Art Unit 2481

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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BIB DATA SHEET

CONFIRMATION NO. 2724

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/001,627	08/26/2013	375	2481	1009-0641 / P33966 US2

APPLICANTS

INVENTORS

Andrey Norkin, Solna, SWEDEN;
Kenneth Andersson, Gavle, SWEDEN;
Rickard Sjöberg, Stockholm, SWEDEN;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/SE2011/051526 12/16/2011
which claims benefit of 61/447,862 03/01/2011

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

09/04/2013

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /MICHAEL J HESS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		SWEDEN	11	16	3

ADDRESS

Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518
UNITED STATES

TITLE

Deblocking Filtering Control

FILING FEE RECEIVED		
1480	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Norkin
Art Unit	
Examiner Name	
Attorney Docket Number	1009-0641 / P33966 US2

U.S.PATENTS Remove

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Norkin
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1009-0641 / P33966 US2

	1	IKEDA, Masaru et al. "Parallel Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTCJ/SC29/WG, Document to JCT-VC, 11 4th Meeting. January 2011. pp 1-7	☐
	2	NARROSCHKE, Matthias. "Reduction of Operations in the Critical Path of the Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting. 20-28 January, 2011. pp 1-15.	☐
	3	NORKIN, Andrey et al. "CE12.1: Ericsson Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP3 and ISO/I EC JTC1/SC29/WG, Document to JCT-VC, 11 5th Meeting: Geneva, 16-23 March 2011. pp. 1-17.	☐
	4	NORKIN, Andrey et al. "Development of HEVC Deblocking Filter." Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG, Document to JCT-VC, 11 4th Meeting: Daegu, KR. 20-28 January 2011. pp. 1-4.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/MICHAEL J HESS/	Date Considered	12/15/2016

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Norkin
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1009-0641 / P33966 US2

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2013-08-26
Name/Print	Daniel P. Homiller	Registration Number	55275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	30	((Andrey) near2 (Norkin)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/22 11:48
L3	69	((Kenneth) near2 (Andersson)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/22 11:48
S1	1	(14/001627).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/07 23:43
S2	13	(("20060078048") or ("20040101059") or ("20090285308") or ("20050013363") or ("20050276505")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/07 23:49
S3	3	((13/695402) or (13/979006) or (13/021012)).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 13:48
S4	2	(11/250187).APP.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 18:48
S6	3	("20040081368").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/01/08 20:16
S7	24	((Andrey) near2 (Norkin)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/01/12 14:57
S8	63	((Kenneth) near2 (Andersson)).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/01/12 14:57

11/22/2016 11:48:19 AM
C:\Users\mhess\Documents\EAST\Workspaces\14-001-627.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14001627	NORKIN ET AL.
	Examiner	**Art Unit**
	MICHAEL J HESS	2481

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/22/2016								
	34	=								
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	42	=								
	43	=								
	44	=								
	45	=								
	46	=								
	47	=								
	48	=								
	49	=								

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14001627	NORKIN ET AL.
	Examiner	**Art Unit**
	MICHAEL J HESS	2481

CPC						
Symbol					**Type**	**Version**
H04N		19	/	00909	F	2013-01-01
H04N		19	/	176	I	2014-11-01
H04N		19	/	117	I	2014-11-01
H04N		19	/	14	I	2014-11-01
H04N		19	/	82	I	2014-11-01
H04N		19	/	86	I	2014-11-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

/MICHAEL J HESS/ Examiner.Art Unit 2481	11/22/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	16	
/WILLIAM C VAUGHN JR/ Supervisory Patent Examiner.Art Unit 2481	11/23/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14001627	NORKIN ET AL.
	Examiner	**Art Unit**
	MICHAEL J HESS	2481

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	4	N	19 / 117 (2014.01.01)						
CROSS REFERENCE(S)		H	0	4	N	19 / 86 (2014.01.01)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

/MICHAEL J HESS/ Examiner.Art Unit 2481 (Assistant Examiner)	11/22/2016 (Date)	**Total Claims Allowed:** 16
/WILLIAM C VAUGHN JR/ Supervisory Patent Examiner.Art Unit 2481 (Primary Examiner)	11/23/2016 (Date)	O.G. Print Claim(s) 1 O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14001627	NORKIN ET AL.
	Examiner	**Art Unit**
	MICHAEL J HESS	2481

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	34														
2	35														
3	36														
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14	47														
15	48														
16	49														

/MICHAEL J HESS/ Examiner.Art Unit 2481 (Assistant Examiner)	11/22/2016 (Date)	**Total Claims Allowed:** 16	
/WILLIAM C VAUGHN JR/ Supervisory Patent Examiner.Art Unit 2481 (Primary Examiner)	11/23/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14001627	NORKIN ET AL.
	Examiner	Art Unit
	MICHAEL J HESS	2481

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
IEEE Search (Transcoding Complexity Estimations)	01/08/2016	MJH
IP.com Search	01/08/2016	MJH
Google Database Search - Google Scholar	01/08/2016	MJH
Interference Search	01/08/2016	MJH
Inventor Name Search (Double Patenting) - EAST, PALM, eDAN	11/22/2016	MJH
EAST Search (USPAT, USPGPUB, EPO, JPO, DERWENT, IBM) - see attached search history	11/22/2016	MJH

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
375/240		11/22/2016	MJH

/MICHAEL J HESS/ Examiner.Art Unit 2481	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Field

Substitute for PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	14/001,627
Filing Date	Aug 26, 2013
First Named Inventor	Andrey Norkin
Art Unit	2481
Examiner Name	HESS, MICHAEL J
Attorney Docket Number	1009-0641 / P33966 US2

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		20100142844	A1	2010-06-10	Pereira, Rochelle et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number [3]	Country Code [2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T [5]
		2681913	EP	B1	2015-11-25	Telefonaktiebolaget L M Ericsson (publ)		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [5]

EXAMINER SIGNATURE

Examiner Signature	/Michael Hess/	Date Considered	11/22/2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.H./

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Field

Substitute for PTO/SB/08a (01-10)
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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ Daniel P. Homiller, Reg. # 55,275 /	Date (YYYY-MM-DD)	2016-03-16
Name/Print	Daniel P. Homiller	Registration Number	55,275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.H./

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

102721 7590 12/27/2016
Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	08/26/2013	Andrey Norkin	1009-0641 / P33966 US2	2724

TITLE OF INVENTION: Deblocking Filtering Control

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/27/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
HESS, MICHAEL J	2481	375-240290

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Murphy, Bilak & Homiller, PLLC
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Telefonaktiebolaget LM Ericsson (publ)

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Stockholm, Sweden

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 50-5650 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature / Daniel P. Homiller, Reg. # 55,275 / Date 2017-03-24

Typed or printed name Daniel P. Homiller Registration No. 55,275

Electronic Patent Application Fee Transmittal

Application Number:	14001627
Filing Date:	26-Aug-2013
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Filer:	Daniel P. Homiller/Brittany Wage
Attorney Docket Number:	1009-0641 / P33966 US2

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	28734686
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Daniel P. Homiller/Brittany Wage
Filer Authorized By:	Daniel P. Homiller
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	24-MAR-2017
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Application Type:	U.S. National Stage under 35 USC 371

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	transmittal.pdf	109606 ea1d214010944fef0018581e10f71d8be04ef52e	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30383 0c3a1f1d578625b62e4547f11bd694e19304f36d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	139989		

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/001,627	05/02/2017	9641841	1009-0641 / P33966 US2	2724

102721 7590 04/12/2017

Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 700 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Andrey Norkin, Solna, SWEDEN;
Kenneth Andersson, Gavle, SWEDEN;
Rickard Sjöberg, Stockholm, SWEDEN;

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,641,841 B2

APPLICATION NO. : 14/001,627

ISSUE DATE : May 2, 2017

INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Face Page, in Field (57), under "ABSTRACT", in Column 2, Line 3, delete "pixels (11, 13, 15)" and insert - - pixels (11,13,15, 17) - -, therefor.

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 6, delete "vol. 3," and insert - - vol. 13, - -, therefor.

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 18, delete "ISO/IEC JTCJ/SC29/WG," and insert - - ISO/IEC JTC1/SC29/WG, - -, therefor.

In Column 1, Line 42, delete "a, b c" and insert - - a, b, c - -, therefor.

In Column 2, Line 14, delete "of" and insert - - of: - -, therefor.

In Column 2, Line 42, delete "night" and insert - - right - -, therefor.

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 2, Lines 48-49,

delete "$\Delta=\mathrm{Clip}(-t_C,t_C,(13\times(q0_i-p0_i)+4\times(q1_i-p1_i)-5\times(q2_i-p2_i)+16)>>5))$" and

insert -- $\Delta = \mathrm{Clip}(-tc,tc, (13\times(q0_i - p0_i) + 4\times(q1_i - p1_i) - 5\times(q2_i - p2_i)+16)>>5)$ --, therefor.

In Column 2, Line 63,

delete "$p0_i=\mathrm{Clip}_{0.255}((p2_i+2\times p1_i+2\times p0_i+2\times q0_i+q1_i+4)>>3)$," and

insert -- $p0_i=\mathrm{Clip}_{0\text{-}255}((p2_i + 2\times p1_i + 2\times p0_i +2\times q0_i + q1_i + 4)>>3)$ --, therefor.

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

$$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i+3\times p2_i+p1_i+p0_i+q0_i4)>>3)$$

In Column 3, Lines 3-5, delete "$q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i+q0_i+q1_i+3\times q2_i+2\times q3_i+4)>>3)$,

$$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i + 3\times p2_i + p1_i + p0_i + q0_i + 4)>>3)$$

and insert - - $q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i + q0_i + q1_i + 3\times q2_i + 2\times q3_i + 4)>>3)$ - -, therefor.

In Column 4, Line 37, delete "wherein $p0_1$" and insert - - wherein $p0_i$ - -, therefor.

In Column 7, Line 4, delete "frame." and insert - - frame, - -, therefor.

In Column 7, Line 11, delete "q0," and insert - - $q0_i$ - -, therefor.

In Column 7, Lines 36-37, delete "first line 10" and insert - - first line 12 - -, therefor.

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INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 7, Line 38, delete "first line 20" and insert - - first line 22 - -, therefor.

In Column 9, Line 42, delete "boundary." and insert - - boundary; - -, therefor.

In Column 10, Line 29, delete "$|q2_2-2q1_2+q0_2|+|q2_5 2q1_5+q0_5|$,,, and insert - - $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$ - -, therefor.

In Column 10, Lines 63-64, delete "$d_p=|p2_2-2p1_2+p0_2|+|p2_5 2-p1_5+p0_5|$" and insert - - $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ - -, therefor.

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ISSUE DATE : May 2, 2017

INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 12, Line 8, delete "$|q2_4-2q1_4+q0_4+q0_4|+|q2_7-2q1_7+q0_7|$." and insert - - $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$. - -, therefor.

In Column 12, Lines 20-21, delete "$|q2_1-2q1_1+q0_1 1|+|q2_2-2q1_2+q0_2|$." and insert - - $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. - -, therefor.

In Column 13, Line 15, delete "$|q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5$," and insert - - $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, - -, therefor.

In Column 13, Line 29, delete "boundary 20" and insert - - boundary 1 - -, therefor.

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APPLICATION NO. : 14/001,627

ISSUE DATE : May 2, 2017

INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 13, Line 51, delete "2B" and insert - - 2B, - -, therefor.

In Column 15, Line 9, delete "line of " and insert - - line 12 of - -, therefor.

In Column 15, Line 11, delete "line of " and insert - - line 12 of - -, therefor.

In Column 15, Line 62, delete "$T_1 \geq d_p < T_1$," and insert - - $T_1 \leq d_p < T_1$, - -, therefor.

In Column 16, Lines 59-60, delete "or $T_1=T_2=(\beta+\beta>>3$." and insert - - or $T_1=T_2=(\beta+\beta>>1) >>3$. - -, therefor.

In Column 17, Line 2, delete "$\Delta 0$" and insert - - Δ - -, therefor.

In Column 17, Line 9, delete "1, $p1_1$" and insert - - 1, $p1_j$ - -, therefor.

In Column 17, Line 11, delete "15, 1)," and insert - - 15, 17 - -, therefor.

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INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 18, Lines 31-32, delete "$(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8>>4$." and insert - - $(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8)>>4$ - -, therefor.

In Column 18, Line 56, after equation, insert - - . - -, therefor.

In Column 19, Line 40, delete "at lot" and insert - - a lot - -, therefor.

In Column 20, Lines 38-39, delete "$|p2_4-2p1_4+p0_4+|p2_7-2p1_7+p0_7|$" and insert - - $|p2_4-2p1_4+p0_4|+|p2_7-2p1_7+p0_7|$ - -, therefor.

In Column 20, Line 41, delete "a the" and insert - - the - -, therefor.

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INVENTOR(S) : Norkin, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 20, Line 54, delete "$q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5|$." and insert - - $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$. - -, therefor.

In Column 21, Line 9, delete "$|q2_i-2q1_i+q0_i$" and insert - - $|q2_i - 2q1_i + q0_i|$ - -, therefor.

In Column 23, Line 46, delete "pixel" and insert - - filter decision - -, therefor.

In Column 24, Line 39, delete "a inverse" and insert - - an inverse - -, therefor.

In Column 25, Line 1, delete "form the" and insert - - from the - -, therefor.

In Column 25, Line 4, delete "form the" and insert - - from the - -, therefor.

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In Column 25, Line 14, delete "FIGS. 13 and 14" and insert - - FIGS. 13 and 14S - -, therefor.

In Column 25, Lines 47, delete "decoder" and insert - - decoder 60 - -, therefor.

In Column 25, Lines 66, delete "en encoder," and insert - - an encoder, - -, therefor.

In Column 26, Lines 3, delete "equipment" and insert - - equipment 80 - -, therefor.

In Column 27, Lines 49-50, in Claim 3, delete "value; and" and insert - - value; - -, therefor.

In Column 28, Lines 8-9, in Claim 4, delete "value; and" and insert - - value; - -, therefor.

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	14001627
Filing Date:	26-Aug-2013
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Filer:	Steven Ware Smith/Michelle Sanderson
Attorney Docket Number:	1009-0641 / P33966 US2

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of correction	1811	1	100	100

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**100**

Electronic Acknowledgement Receipt

EFS ID:	29704643
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Steven Ware Smith/Michelle Sanderson
Filer Authorized By:	Steven Ware Smith
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	06-JUL-2017
Filing Date:	26-AUG-2013
Time Stamp:	15:06:55
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$100
RAM confirmation Number	070717INTEFSW00001502501379
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	P33966-US2_2017-07-06_CoC_Request_Letter.pdf	261790 fb8da70c83564c5c0001b7a75a5920957cdd5ece	no	8
Warnings:					
Information:					
2	Request for Certificate of Correction	P33966-US2_2017-07-06_CoC_PTO-1050.pdf	314859 6530d9878f096479d955873f99d47c7dc067c61a	no	10
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30184 b11dd71246c1c0af0b79b95be510450153813641	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	606833		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: U.S. Patent No. 9,641,841

USPTO CONFIRMATION CODE: 2724

APPLICATION NO.: 14/001,627

PCT FILED: December 16, 2011

U.S. FILED: August 26, 2013

EXAMINER: William C Vaughn, Jr.

GROUP ART UNIT: 2481

FOR: DEBLOCKING FILTERING CONTROL

37 CFR 1.322 & 37 CFR 1.323 REQUEST FOR CERTIFICATE OF CORRECTION FOR USPTO AND/OR APPLICANT MISTAKE

HONORABLE COMMISSIONER OF PATENTS & TRADEMARKS

SIR:

The following is a request for a certificate of correction in Serial Number 14/001,627, now Patent Number 9,641,841.

A certificate of correction under 35 USC 254 is respectfully requested in the above-identified patent.

The errors were the fault of both the applicant and USPTO and, accordingly, please charge **$100.00** to our Deposit Account No. 50-1379. In the event that a further fee is required, please charge the amount to the same Deposit Account.

The exact locations where the errors appear in the patent and patent application are as follows:

On the Face Page, in Field (57), under "ABSTRACT", in Column 2, Line 3, delete "pixels (11, 13, 15)" and insert - - pixels (11,13,15, 17) - -, therefor.
(ORIGINALLY FILED SPECIFICATION, IN THE ABSTRACT DATED AUGUST 26, 2013, PAGE 1, FIELD (57), LINE 2)

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 6, delete "vol. 3," and insert - - vol. 13, - -, therefor.
(LIST OF REFERENCES CITED BY APPLICANT AND CONSIDERED BY EXAMINER DATED JANUARY 21, 2016, SHEET 2 (PAGE 125 OF FW), UNDER "NON-PATENT LITERATURE DOCUMENTS", ENTRY 2, LINE 2)

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 18, delete "ISO/IEC JTCJ/SC29/WG," and insert - - ISO/IEC JTC1/SC29/WG, - -, therefor.
(LIST OF REFERENCES CITED BY APPLICANT AND CONSIDERED BY EXAMINER DATED DECEMBER 27, 2016, SHEET 2 (PAGE 17 OF FW), UNDER "NON-PATENT LITERATURE DOCUMENTS", ENTRY 1, LINE 2)

In Column 1, Line 42, delete "a, b c" and insert - - a, b, c - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 1, LINE 31)

In Column 2, Line 14, delete "of" and insert - - of: - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 2, LINE 25)

In Column 2, Line 42, delete "night" and insert - - right - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 3, LINE 15)

In Column 2, Lines 48-49, delete
" $\Delta=\mathrm{Clip}(-t_C,t_C,(13\times(q0_i-p0_i)+4\times(q1_i-p1_i)-5\times(q2_i-p2_i)+16)>>5))$ " and
insert - - $\Delta = \mathrm{Clip}(-tc,tc,(13\times(q0_i - p0_i) + 4\times(q1_i - p1_i) - 5\times(q2_i - p2_i)+16)>>5)$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 3, LINE 21)

In Column 2, Line 63, delete
"$p0_i=\mathrm{Clip}_{0\text{-}255}((p2_i+2\times p1_i+2\times p0_i+2\times q0_i+q1_i+4)>>3)$,"
and insert - -
$p0_i=\mathrm{Clip}_{0\text{-}255}((p2_i + 2\times p1_i + 2\times p0_i +2\times q0_i + q1_i + 4)>>3)$ - -
, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 3, LINE 31)

$$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i+3\times p2_i+p1_i+p0_i+q0_i4)>>3)$$

In Column 3, Lines 3-5, delete "$q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i+q0_i+q1_i+3\times q2_i+2\times q3_i+4)>>3)$"
$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i + 3\times p2_i + p1_i + p0_i + q0_i + 4)>>3)$
and insert - - $q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i + q0_i + q1_i + 3\times q2_i + 2\times q3_i + 4)>>3)$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 4, LINES 4-5)

In Column 4, Line 37, delete "wherein $p0_1$" and insert - - wherein $p0_i$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 6, LINE 4)

In Column 7, Line 4, delete "frame." and insert - - frame, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 9, LINE 29)

In Column 7, Line 11, delete "q0," and insert - - $q0_i$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 10, LINE 2)

In Column 7, Lines 36-37, delete "first line 10" and insert - - first line 12 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 10, LINE 18)

In Column 7, Line 38, delete "first line 20" and insert - - first line 22 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 10, LINE 19)

In Column 9, Line 42, delete "boundary." and insert - - boundary; - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 13, LINE 15)

In Column 10, Line 29, delete
“ $|q2_2-2q1_2+q0_2|+|q2_5 2q1_5+q0_5|$ ” and insert - -
$|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 14, LINE 22)

In Column 10, Lines 63-64, delete
“ $d_p=|p2_2-2p1_2+p0_2|+|p2_5 2-p1_5+p0_5|$ ” and insert - -
$d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 15, LINE 12)

In Column 12, Line 8, delete
“ $|q2_4-2q1_4+q0_4+q0_4|+|q2_7-2q1_7+q0_7|$.” and insert - -
$|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 17, LINE 5)

In Column 12, Lines 20-21, delete
“ $|q2_1-2q1_1+q0_1 1|+|q2_2-2q1_2+q0_2|$.” and insert - -
$|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 17, LINE 15)

In Column 13, Line 15, delete
“ $|q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5$,” and insert - -
$|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 18, LINE 26)

In Column 13, Line 29, delete “boundary 20” and insert - - boundary 1 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 19, LINE 3)

In Column 13, Line 51, delete “2B” and insert - - 2B, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 19, LINE 18)

In Column 15, Line 9, delete "line of " and insert - - line 12 of - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 21, LINES 27-28)

In Column 15, Line 11, delete "line of " and insert - - line 12 of - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 21, LINES 28-29)

In Column 15, Line 62, delete "$T_1 \geq d_p < T_1$," and insert - - $T_1 \leq d_p < T_1$, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 22, LINE 16)

In Column 16, Lines 59-60, delete "or $T_1=T_2=(\beta+\beta>>3$." and insert - - or $T_1=T_2=(\beta+\beta>>1) >>3$. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 23, LINE 16)

In Column 17, Line 2, delete "Δ0" and insert - - Δ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 23, LINE 22)

In Column 17, Line 9, delete "1, $p1_1$" and insert - - 1, $p1_j$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 23, LINE 24)

In Column 17, Line 11, delete "15, 1)," and insert - - 15, 17 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 23, LINE 25)

In Column 18, Lines 31-32, delete
"$(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8>>4.$" and insert - -
$(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8)>>4$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 25, LINE 16)

In Column 18, Line 56, after equation, insert - - . - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 26, LINE 6)

In Column 19, Line 40, delete "at lot" and insert - - a lot - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 27, LINE 29)

In Column 20, Lines 38-39, delete
"$|p2_4-2p1_4+p0_4+|p2_7-2p1_7+p0_7|$" and insert - -
$|p2_4 - 2p1_4 + p0_4| + |p2_7 - 2p1_7 + p0_7|$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 29, LINE 6)

In Column 20, Line 41, delete "a the" and insert - - the - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 29, LINE 7)

In Column 20, Line 54, delete "$q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5|$." and insert - - $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 29, LINE 17)

In Column 21, Line 9, delete "$|q2_i-2q1_i+q0_i$" and
insert - - $|q2_i - 2q1_i + q0_i|$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 29, LINE 32)

In Column 23, Line 46, delete "pixel" and insert - - filter decision - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 33, LINE 5)

In Column 24, Line 39, delete "a inverse" and insert - - an inverse - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 34, LINES 14-15)

In Column 25, Line 1, delete "form the" and insert - - from the - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 34, LINE 33)

In Column 25, Line 4, delete "form the" and insert - - from the - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGES 34 & 35, LINES 34 & 1)

In Column 25, Line 14, delete "FIGS. 13 and 14" and
insert - - FIGS. 13 and 14S - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 35, LINE 9)

In Column 25, Lines 47, delete “decoder” and insert - - decoder 60 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 35, LINES 29-30)

In Column 25, Lines 66, delete “en encoder,” and insert - - an encoder, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 36, LINE 9)

In Column 26, Lines 3, delete “equipment” and insert - - equipment 80 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED AUGUST 26, 2013, PAGE 36, LINES 11-12)

In Column 27, Lines 49-50, in Claim 3, delete “value; and” and insert - - value; - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED APRIL 20, 2016, PAGE 4 OF 21, CLAIM 36, LINE 6)

In Column 28, Lines 8-9, in Claim 4, delete “value; and” and insert - - value; - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED APRIL 20, 2016, PAGE 5 OF 21, CLAIM 37, LINE 6)

The requested corrections are attached on Form PTO 1050.

Respectfully Submitted

, 2017

/Ronald J. Ward,Reg#54870/

DATE

Ronald J. Ward
Registration No. 54,870
Attorney of Record

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,641,841 B2
APPLICATION NO. : 14/001627
DATED : May 2, 2017
INVENTOR(S) : Norkin et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

In Item (57), under "ABSTRACT", in Column 2, Line 3, delete "pixels (11, 13, 15)" and insert --pixels (11,13,15, 17)--, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 6, delete "vol. 3," and insert -- vol. 13, --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 18, delete "ISO/IEC JTCJ/SC29/WG," and insert -- ISO/IEC JTC1/SC29/WG, --, therefor.

In the Specification

In Column 1, Line 42, delete "a, b c" and insert -- a, b, c --, therefor.

In Column 2, Line 14, delete "of" and insert -- of: --, therefor.

In Column 2, Line 42, delete "night" and insert -- right --, therefor.

In Column 2, Lines 48-49, delete "$\Delta=\mathrm{Clip}(-t_C,t_C,(13\times(q0_i-p0_i)+4\times(q1_i-p1_i)-5\times(q2_i-p2_i)+16)>>5))$" and insert -- $\Delta = \mathrm{Clip}(-t_C,t_C, (13\times(q0_i - p0_i) + 4\times(q1_i - p1_i) - 5\times(q2_i - p2_i)+16)>>5)$ --, therefor.

In Column 2, Line 63, delete "$p0_i=\mathrm{Clip}_{0.255}((p2_i+2\times p1_i+2\times p0_i+2\times q0_i+q1_i+4)>>3)$" and insert -- $p0_i=\mathrm{Clip}_{0.255}((p2_i + 2\times p1_i + 2\times p0_i +2\times q0_i + q1_i + 4)>>3)$ --, therefor.

Signed and Sealed this
Twenty-fourth Day of October, 2017

Joseph Matal

Joseph Matal
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

$$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i+3\times p2_i+p1_i+p0_i+q0_i4)>>3)$$

In Column 3, Lines 3-5, delete "$q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i+q0_i+q1_i+3\times q2_i+2\times q3_i+4)>>3)$,,

$$p2_i=\mathrm{Clip}_{0\text{-}255}((2\times p3_i + 3\times p2_i + p1_i + p0_i + q0_i + 4)>>3)$$

and insert --$q2_i=\mathrm{Clip}_{0\text{-}255}((p0_i + q0_i + q1_i + 3\times q2_i + 2\times q3_i + 4)>>3)$--, therefor.

In Column 4, Line 37, delete "wherein $p0_1$" and insert -- wherein $p0_i$ --, therefor.

In Column 7, Line 4, delete "frame." and insert -- frame, --, therefor.

In Column 7, Line 11, delete "q0," and insert -- $q0_i$ --, therefor.

In Column 7, Lines 36-37, delete "first line 10" and insert -- first line 12 --, therefor.

In Column 7, Line 38, delete "first line 20" and insert -- first line 22 --, therefor.

In Column 9, Line 42, delete "boundary." and insert -- boundary; --, therefor.

In Column 10, Line 29, delete "$|q2_2-2q1_2+q0_2|+|q2_5 2q1_5+q0_5|$,," and insert -- $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, --, therefor.

In Column 10, Lines 63-64, delete "$d_p=|p2_2-2p1_2+p0_2|+|p2_5 2-p1_5+p0_5|$,, and insert -- $d_p = |p2_2 - 2p1_2 + p0_2| + |p2_5 - 2p1_5 + p0_5|$ --, therefor.

In Column 12, Line 8, delete "$|q2_4-2q1_4+q0_4+q0_4|+|q2_7-2q1_7+q0_7|$.," and insert -- $|q2_4 - 2q1_4 + q0_4| + |q2_7 - 2q1_7 + q0_7|$, --, therefor.

In Column 12, Lines 20-21, delete "$|q2_1-2q1_1+q0_1 1|+|q2_2-2q1_2+q0_2|$. " and insert -- $|q2_1 - 2q1_1 + q0_1| + |q2_2 - 2q1_2 + q0_2|$, --, therefor.

In Column 13, Line 15, delete "$|q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5$," and insert -- $|q2_2 - 2q1_2 + q0_2| + |q2_5 - 2q1_5 + q0_5|$, --, therefor.

In Column 13, Line 29, delete "boundary 20" and insert -- boundary 1 --, therefor.

In Column 13, Line 51, delete "2B" and insert -- 2B, --, therefor.

In Column 15, Line 9, delete "line of" and insert -- line 12 of --, therefor.

In Column 15, Line 11, delete "line of" and insert -- line 12 of --, therefor.

In Column 15, Line 62, delete "$T_1 \geq d_p < T_1$," and insert -- $T_1 \leq d_p < T_1$, --, therefor.

In Column 16, Lines 59-60, delete "or $T_1=T_2=(\beta+\beta>>3$." and insert -- or $T_1=T_2=(\beta+\beta>>1)>>3$. --, therefor.

In Column 17, Line 2, delete "Δ0" and insert -- Δ --, therefor.

In Column 17, Line 9, delete "1, $p1_1$" and insert -- 1, $p1_j$ --, therefor.

In Column 17, Line 11, delete "15, 1)," and insert -- 15, 17 --, therefor.

In Column 18, Lines 31-32, delete "$(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8>>4$," and insert -- $(9\times(q0_j-p0_j)-3\times(q1_j-p1_j)+8)>>4$. --, therefor.

In Column 18, Line 56, after equation, insert -- . --, therefor.

In Column 19, Line 40, delete "at lot" and insert -- a lot --, therefor.

In Column 20, Lines 38-39, delete "$|p2_4-2p1_4+p0_4+|p2_7-2p1_7+p0_7|$," and insert -- $|p2_4-2p1_4+p0_4|+|p2_7-2p1_7+p0_7|$ --, therefor.

In Column 20, Line 41, delete "a the" and insert -- the --, therefor.

In Column 20, Line 54, delete "$q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5|$." and insert -- $|q2_2-2q1_2+q0_2|+|q2_5-2q1_5+q0_5|$. --, therefor.

In Column 21, Line 9, delete "$|q2_i-2q1_i+q0_i$" and insert -- $|q2_i - 2q1_i + q0_i|$ --, therefor.

In Column 23, Line 46, delete "pixel" and insert -- filter decision --, therefor.

In Column 24, Line 39, delete "a inverse" and insert -- an inverse --, therefor.

In Column 25, Line 1, delete "form the" and insert -- from the --, therefor.

In Column 25, Line 4, delete "form the" and insert -- from the --, therefor.

In Column 25, Line 14, delete "FIGS. 13 and 14" and insert -- FIGS. 13 and 14S --, therefor.

In Column 25, Lines 47, delete "decoder" and insert -- decoder 60 --, therefor.

In Column 25, Lines 66, delete "en encoder," and insert -- an encoder, --, therefor.

In Column 26, Lines 3, delete "equipment" and insert -- equipment 80 --, therefor.

In the Claims

In Column 27, Lines 49-50, in Claim 3, delete "value; and" and insert -- value; --, therefor.

In Column 28, Lines 8-9, in Claim 4, delete "value; and" and insert -- value; --, therefor.

PTO/AIA/81A (02-15)
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PATENT - POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Patent Number	9641841
Issue Date	05-02-2017
First Named Inventor	Andrey Norkin
Title	Deblocking Filtering Control
Attorney Docket No.	VEER00107US2

I hereby revoke all previous powers of attorney given in the above-identified patent.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 47391

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified patent to:

☒ The address associated with the above-identified Customer Number.

OR

☐ The address associated with the Customer Number identified in the box at right:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) submitted herewith or filed on _____.

SIGNATURE of Applicant or Patent Owner

Signature	/Kenneth A. McClure/	Date	04/05/2019
Name	Kenneth A. McClure	Telephone	214-765-9500
Title and Company	Vice President, Patent Development		

NOTE: Signatures of all the applicants or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: VELOS MEDIA, LLC

Application No./Patent No.: 9641841 Filed/Issue Date: 05-02-2017

Titled: Deblocking Filtering Control

VELOS MEDIA, LLC, a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: SJOBERG, R.; NORKIN,A.; ANDERSSON, K. To: TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)

   The document was recorded in the United States Patent and Trademark Office at
   Reel 031083, Frame 0206, or for which a copy thereof is attached.

2. From: TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) To: ERICSSON LLC

   The document was recorded in the United States Patent and Trademark Office at
   Reel 047526, Frame 0463, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: ERICSSON LLC To: VELOS MEDIA, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 047526, Frame 0553, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Kenneth A. McClure/	04/05/2019
Signature	Date
Kenneth A. McClure	62886
Printed or Typed Name	Title or Registration Number

[Page 2 of 2]

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	35644157
Application Number:	14001627
International Application Number:	
Confirmation Number:	2724
Title of Invention:	Deblocking Filtering Control
First Named Inventor/Applicant Name:	Andrey Norkin
Customer Number:	102721
Filer:	Kenneth A. McClure/Kara Coffman
Filer Authorized By:	Kenneth A. McClure
Attorney Docket Number:	1009-0641 / P33966 US2
Receipt Date:	05-APR-2019
Filing Date:	26-AUG-2013
Time Stamp:	15:44:13
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	VEER00107US2_PoA_CoA_Velos.pdf	130874 0ce961605fb83fd59023fb40a34e67ead1ad7842	no	2

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	VEER00107US2_Statement_under_37_CFR_373_Velos.pdf	121587 493176d6cffa614029aa58071f185d8cd5515b1b	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	252461	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/001,627	08/26/2013	Andrey Norkin	VEER00107US2

CONFIRMATION NO. 2724

47391
KENNETH A. MCCLURE
MARCONI
1717 MCKINNEY AVENUE
STE 1050
DALLAS, TX 75202

POA ACCEPTANCE LETTER

OC000000107263116

Date Mailed: 04/10/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/05/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mabebe/

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/001,627	08/26/2013	Andrey Norkin	VEER00107US2

CONFIRMATION NO. 2724

POWER OF ATTORNEY NOTICE

102721
Murphy, Bilak & Homiller/Ericsson
1255 Crescent Green
Suite 200
Cary, NC 27518

OC00000107263074

Date Mailed: 04/10/2019

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/05/2019.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mabebe/