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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
PU060222	12/312386

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US2007/022795	October 25, 2007	November 8, 2006

TITLE OF INVENTION
Methods And Apparatus For In-Loop De-Artifact Filtering

APPLICANT(S) FOR DO/EO/US
Meng-Ping Kao, Peng Yin, Oscar Divorra Escoda

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IPR2024-01441

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12/312386	PCT/US2007/022795	PU060222

20. Other items or information:

____x____ Return Postcard
_____ Copy of IB/306 Change of Applicant
_____x___ Certificate of Express Mailing EM 322490026US
_____ Copy of IPER or IPRP

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CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$
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Independent claims	5 - 3 =	2	x $220	$ 440.00
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b. ☑ Please charge my Deposit Account No. 07-0832 in the amount of $ 1720.00 to cover the above fees.
A duplicate copy of this sheet is enclosed.

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SEND ALL CORRESPONDENCE TO:

Robert D. Shedd
Thomson Licensing LLC
Patent Operations
P. O. Box 5312
Princeton, New Jersey 08543-5312

Docket No.: PU060222

Ronald J. Kolczynski
SIGNATURE

Ronald J. Kolczynski
NAME

57,177 Patent Agent
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PU060222	
U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	
12/311986	
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE
PCT/US2007/022795	October 25, 2007
PRIORITY DATE CLAIMED	
November 8, 2006	

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

SEND ALL CORRESPONDENCE TO:

Robert D. Shedd
Thomson Licensing LLC
Patent Operations
P. O. Box 5312
Princeton, New Jersey 08543-5312

Docket No.: PU060222

Ronald J. Kolczynski
SIGNATURE

Ronald J. Kolczynski
NAME

57,177 Patent Agent
REGISTRATION NUMBER

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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
PU060222	
U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	
12/311986	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US2007/022795	October 25, 2007	November 8, 2006

TITLE OF INVENTION
Methods And Apparatus For In-Loop De-Artifact Filtering

APPLICANT(S) FOR DO/EO/US
Meng-Ping Kao, Peng Yin, Oscar Divorra Escoda

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☑ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☑ The US has been elected (Article 31).
5. ☑ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☑ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☑ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☑ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☑ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☑ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☑ A preliminary amendment.
14. ☐ An Application Data Sheet under 37 CFR 1.76.
15. ☐ A substitute specification.
16. ☑ A power of attorney and/or change of address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.2 and 37 CFR 1.821- 1.825.
18. ☐ A second copy of the published International Application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. 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 15 minutes to complete, including gathering information, preparing, and submitting the completed 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: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
12/373,386	PCT/US2007/022795	PU060222

20. Other items or information:

_____x_____ Return Postcard _____ Copy of IB/306 Change of Applicant
_____x___ Certificate of Express Mailing EM 322490026US
_____ Copy of IPER or IPRP

The following fees have been submitted	CALCULATIONS	PTO USE ONLY
21. ☑ Basic national fee (37 CFR 1.492(a)) **$330**	$ 330.00	
22. ☑ Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$220**	$ 220.00	
23. ☑ Search fee (37 CFR 1.492(b)) If the written opinion of the ISA/US or the International preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$100** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$430** All other situations **$540**	$ 430.00	
TOTAL OF 21, 22 and 23 =	$980.00	
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). The fee is **$270** for each additional 50 sheets of paper or fraction thereof.		
Total Sheets: - 100 = / Extra Sheets: /50 = / Number of each additional 50 or fraction thereof (round **up** to a whole number) / RATE: x $270	$ --	
Surcharge of **$130.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$ --	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$
Total claims	25 - 20 =	5	x $ 52	$ 260.00
Independent claims	5 - 3 =	2	x $220	$ 440.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $390	$ --

TOTAL OF ABOVE CALCULATIONS =	$ 1680.00
☐ Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by ½.	--
SUBTOTAL =	$ 1680.00
Processing fee of **$130.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +	$ --
TOTAL NATIONAL FEE =	$ 1680.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +	$ 40.00
TOTAL FEES ENCLOSED =	$ 1720.00
Amount to be refunded:	$
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Docket No.: PU060222

Ronald J. Kolczynski
SIGNATURE

Ronald J. Kolczynski
NAME

57,177 Patent Agent
REGISTRATION NUMBER

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Customer No. 24498

PU060222

12/312386

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Meng-Ping Kao
Peng Yin
Oscar Divorra Escoda

Filed : Herewith

For : METHODS AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING

PRELIMINARY AMENDMENT

Commissioner for Patents
MAIL STOP PCT
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

In the US national phase application of **PCT/US2007/022795** filed herewith, please file the following amendments and enter remarks as follows:

Amendments to the Specification begin on page 2 of this paper.

Listing and amendments to the claims begin on page 3 of this paper.

Amendment to the abstract begins on page 7.

Remarks begin on page 8 of this paper.

Amendments to the Specification

Please **delete** the paragraph at page 1, line 4.

Please **add** the following **new** paragraph at page 1, line 4:

-- This application claims the benefit, under 35 U.S.C. § 365 of International Application **PCT/US2007/022795** filed October 25, 2007, which was published in accordance with PCT Article 21(2) on May 15, 2008 in English and which claims the benefit of United States provisional patent application No. 60/864,917 filed November 8, 2006.

Listing and Amendments to the Claims

This listing of claims will replace the claims that were published in the PCT Application.

1. (currently amended) An apparatus, comprising:

an encoder ~~(300)~~ for encoding an image region, the encoder having at least two filters ~~(365, 344)~~ for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

2. (original) The apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

3. (original) The apparatus of claim 1, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

4. (currently amended) The apparatus of claim 1, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter ~~(365)~~ for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter ~~(344)~~ for performing a second pass to reduce noise as the second type of quantization artifact.

5. (original) The apparatus of claim 1, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

6. (currently amended) A method, comprising:

encoding an image region, wherein the encoding step includes performing in-loop filtering ~~(365, 344, 355, 565, 544, 555)~~ to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

7. (currently amended) The method of claim 6, wherein at least one of the at least two filters is used to enforce at least one compression constraint ~~(355, 555, 645)~~.

8. (currently amended) The method of claim 6, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region ~~(620,630)~~.

9. (currently amended) The method of claim 6, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter ~~(565, 544)~~ having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

10. (original) The method of claim 6, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

11. (currently amended) An apparatus, comprising:

a decoder ~~(400)~~ for decoding an image region, the decoder having at least two filters ~~(465, 444, 455)~~ for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

12. (currently amended) The apparatus of claim 11, wherein at least one ~~(455)~~ of the at least two filters is used to enforce at least one compression constraint.

13. (original) The apparatus of claim 11, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

14. (currently amended) The apparatus of claim 11, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking

filter ~~(465)~~ for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter ~~(444)~~ for performing a second pass to reduce noise as the second type of quantization artifact.

15. (original) The apparatus of claim 11, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

16. (currently amended) A method, comprising:

decoding an image region, wherein the decoding step includes performing in-loop filtering ~~(465, 444, 455, 565, 544, 555)~~ to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

17. (currently amended) The method of claim 16, wherein at least one of the at least two filters is used to enforce at least one compression constraint ~~(455, 555, 745)~~.

18. (currently amended) The method of claim 16, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region ~~(720, 730)~~.

19. (currently amended) The method of claim 16, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter ~~(565, 544)~~ having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

20. (original) The method of claim 16, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

21. (currently amended) A storage media having video signal data encoded thereupon, comprising:

an image region field, encoded using at least two filters for successively performing in-loop filtering ~~(365, 344, 355, 544, 555)~~ to respectively reduce at least a first and a second type of quantization artifact.

22. (original) The storage media of claim 21, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

23. (currently amended) The storage media of claim 22, wherein the at least one compression constraint involves a quantization constraint set ~~(355)~~.

24. (original) The storage media of claim 21, wherein at least one of the two filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

25. (original) The storage media of claim 21, wherein enablement information and/or disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element.

Amendment to the Abstract

Please amend the abstract to read:

-- There are provided methods and apparatus for in-loop artifact filtering. An apparatus includes an encoder ~~(300)~~ for encoding an image region. The encoder ~~(300)~~ has at least two filters ~~(365, 344)~~ for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact. --

Remarks

The specification has been amended to include a reference to the priority application.

The claims have been amended to conform to the requirements of the United States Patent and Trademark Office by removing reference numbers. Claims 2, 3, 10, 13, 15, 20, 22, 24, and 25 are original. Claims 1, 4-9, 11-12, 14, 16-19, 21 and 23 have been amended to remove reference numbers.

No fee is believed to have been incurred by virtue of this amendment. However if a fee is incurred on the basis of this amendment, please charge such fee against deposit account 07-0832.

Respectfully submitted,

Meng-Ping Kao et al.

Patent Agent: Ronald J. Kolczynski
Registration No. 57,177 Agent
Phone: 609/734-6870

Thomson Licensing LLC
Patent Operation
2 Independence Way - Suite 200
PO Box 5312
Princeton, NJ 08543-5312

Date: May 7, 2009

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PTO/SB/01 (10-00)

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	PU060222 12386
First Named Inventor	Meng-Ping Kao
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Methods And Apparatus For In-Loop De-Artifact Filtering

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 10/25/2007 as United States Application Number or PCT International Application Number PCT/US2007/022795 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY) Country	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

ApplicationNumber(s)	Filing Date (MM/DD/YYYY)
60/864,917	11/08/2006

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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Name	JOSEPH J. LAKS, VICE PRESIDENT
Address	THOMSON LICENSING LLC
Address	PO Box 5312

City	State	ZIP
PRINCETON	NJ	08543-5312

Country	Telephone	Fax
USA	609-734-6819	(609) 734 -6888

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 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname
Meng-Ping	Kao

Inventor's Signature	Date
	04/22/08

Residence: City	State	Country	Citizenship
La Jolla	California	USA	Taiwan

Mailing Address 9106 Regents Rd., Apartment C

Mailing Address

City	State	ZIP	Country
La Jolla	California	92037	USA

NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname
Peng	Yin

Inventor's Signature	Date

Residence: City	State	Country	Citizenship
West Windsor	New Jersey	USA	China

Mailing Address 65 Warwick Road

Mailing Address

City	State	ZIP	Country
West Windsor	New Jersey	08550	China

☒ **Additional inventors are being named on the** ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

[Page 2 of 2]

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PTO/SB/02A (11-00)

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 3 of 3

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Oscar		Divorra Escoda	
Inventor's Signature			**Date**
Residence: City Princeton	**State** New Jersey	**Country** USA	**Citizenship** Spain
Mailing Address 1201 Sayre Drive			
Mailing Address			
City Princeton	**State** New Jersey	**ZIP** 08540	**Country** USA

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**Zip**	**Country**

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
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City	**State**	**Zip**	**Country**

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	PU060222
First Named Inventor	Meng-Ping Kao
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Methods And Apparatus For In-Loop De-Artifact Filtering

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 10/25/2007 as United States Application Number or PCT International Application Number PCT/US2007/022795 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

ApplicationNumber(s)	Filing Date (MM/DD/YYYY)
60/864,917	11/08/2006

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 21 minutes to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box → [+]

PTO/SB/01 (10-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION — Utility or Design Patent Application

Direct all correspondence to: ☐ Customer Number or Bar Code Label [24498] *OR* ☐ Correspondance address below

Name	JOSEPH J. LAKS, VICE PRESIDENT
Address	THOMSON LICENSING LLC
Address	PO Box 5312

City	**State**	**ZIP**
PRINCETON	NJ	08543-5312

Country	**Telephone**	**Fax**
USA	609-734-6819	(609) 734 -6888

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 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname
Meng-Ping	Kao

Inventor's Signature	**Date**

Residence: City	**State**	**Country**	**Citizenship**
La Jolla	California	USA	Taiwan

Mailing Address 9106 Regents Rd., Apartment C

Mailing Address

City	**State**	**ZIP**	**Country**
La Jolla	California	92037	USA

NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname
Peng	Yin

Inventor's Signature	**Date**
Peng Yin	9/15/2008

Residence: City	**State**	**Country**	**Citizenship**
West Windsor	New Jersey	USA	China

Mailing Address 65 Warwick Road

Mailing Address

City	**State**	**ZIP**	**Country**
West Windsor	New Jersey	08550	China

☒ **Additional inventors are being named on the** ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

[Page 2 of 2]

Please type a plus sign (+) inside this box → [+]

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 3 of 3

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Oscar		Divorra Escoda	
Inventor's Signature			**Date** 3/15/2008
Residence: City Princeton	**State** New Jersey	**Country** USA	**Citizenship** Spain
Mailing Address 1201 Sayre Drive			
Mailing Address			
City Princeton	**State** New Jersey	**ZIP** 08540	**Country** USA

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**Zip**	**Country**

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])		Family Name or Surname	
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**Zip**	**Country**

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IAP16 Rec'd PCT/PTO 07 MAY 2009

PTO/SB/81 (11-04)
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POWER OF ATTORNEY and CORRESPONDENCE ADDRESS INDICATION FORM

Application Number	12/312386
Filing Date	Herewith
First Named Inventor	Meng-Peng KAO et al.
Title	Methods and Apparatus for In-Loop De-Artifact Filtering
Art Unit	
Examiner Name	
Attorney Docket Number	PU060222

I hereby appoint:

☒ Practitioners at Customer Number **Customer Number 24498**

OR

☐ Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

☐ The above-mentioned Customer Number:

OR

☐ The address associated with Customer Number:

OR

☒ Firm *or* Individual Name	ROBERT D. SHEDD, THOMSON LICENSING LLC				
Address	PATENT OPERATIONS				
Address	P. O. BOX 5312				
City	PRINCETON	State	NJ	ZIP	08543-5312
Country	USA				
Telephone	609-734-6819	Fax	609-734-6888		

I am the:

☐ Applicant/Inventor.

☒ Assignee of record of the entire interest. See 37 CFR 3.71.

Certificate under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

SIGNATURE of Applicant or Assignee of Record

Name	Ronald J. Kolczynski, Reg. NO. 57,177 Patent Agent		
Signature	Ronald J. Kolczynski		
Date	May 7, 2009	Telephone	609/734-6870

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 3 forms are submitted.

This collection of information is required by 37 CFR 1.31 and 1.33. 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 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.**

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!AP16 Rec'd PCT/PTO 07 MAY 2009
12/312386

POWER OF ATTORNEY
THOMSON LICENSING

We, THOMSON LICENSING
46, Quai A. Le Gallo
F-92100 Boulogne-Billancourt
France

do hereby grant Robert D. Shedd
Vice President, U.S. Patent Operations
Thomson Licensing LLC
Two Independence Way
Princeton, New Jersey 08540

a revocable, non-exclusive and delegable power of attorney to act for us (including the signing of requisite documents) in proceedings concerning patents and applications for patents, including international and other multi-country patents and applications for patents, in our name in the Patent Offices in all countries worldwide from January 1, 2009.

DATED this 13 day of January, in the year 2009.

Signature: B. de Russé
Typed Name As Signed: Béatrix de Russé
Title: Executive Vice-President
Licensing, Research & Innovation

POWER OF ATTORNEY
THOMSON LICENSING

THOMSON LICENSING
46, Quai A. Le Gallo
F-92100 Boulogne-Billancourt
France

does hereby grant

Harvey D. Fried - Sr. Patent Counsel/Manager
Robert B. Levy - Sr. Patent Counsel/Manager
Frank Y. Liao - Sr. Patent Counsel/Manager
Reitseng Lin - Sr. Patent Counsel
Guy H. Eriksen - Sr. Patent Counsel
Catherine A. Ferguson - Sr. Patent Counsel
Kuniyuki Akiyama - Sr. Patent Counsel
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Richard LaPeruta - Patent Counsel
Brian J. Cromarty - Patent Counsel
Ronald Kolczynski - Member Patent Staff
Michael A. Pugel - Patent Agent
Paul W. Lyons - Patent Agent
Jeffrey D. Hale - Patent Counsel
Wan Yee Cheung - Patent Counsel
Jerome G. Schaefer - Patent Counsel
James M. McKenzie, Patent Counsel
Thomson Licensing LLC
Two Independence Way
Princeton, New Jersey 08540

a revocable, non-exclusive and delegable power of attorney to act for us (including the signing of requisite documents) in proceedings concerning patents and applications for patents, including international and other multi-country patents and applications for patents, in our name in the Patent Offices in all countries worldwide from January 1, 2007.

DATED this 14 day of January, 2009.

SIGNED Robert D. Shedd

Robert D. Shedd
Vice President, U.S. Patent Operations
Thomson Licensing LLC and
Attorney In Fact for
THOMSON LICENSING

WITNESS Dawn da Fornaratti

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
PU060222		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2007/022795	25/10/2007	08/11/2006
Applicant		
THOMSON LICENSING		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ 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 (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☒ **Unity of invention is lacking** (see Box No III)

4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant
   ☐ the text has been established by this Authority to read as follows:

PU060222
CITED BY APPLICANT

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 3
      ☒ as suggested by the applicant
      ☐ as selected by this Authority, because the applicant failed to suggest a figure
      ☐ as selected by this Authority, because this figure better characterizes the invention
   b. ☐ none of the figures is to be published with the abstract

Form PCT/ISA/210 (first sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/022795

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N7/26 H04N7/50

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, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 781 053 A (LUCENT TECHNOLOGIES INC [US]) 25 June 1997 (1997-06-25) column 3, line 43 - column 4, line 12 column 6, line 50 - column 10, line 14 figure 5 -----	1-4,6-9, 11-14, 16-19, 21-24
X	US 2002/080882 A1 (KITAGAWA MASAO [JP]) 27 June 2002 (2002-06-27) the whole document -----	1-4,6-9, 11-14, 16-19, 21-24

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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
4 July 2008	23/12/2008

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	Lombardi, Giancarlo

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.
X	US 6 909 745 B1 (PURI ATUL [US] ET AL) 21 June 2005 (2005-06-21) figure 14	1-4,6-9, 11-14, 16-19, 21-24
X	LEE Y L ET AL: "Loop-filtering and post-filtering for low bit-rates moving picture coding" IMAGE PROCESSING, 1999. ICIP 99. PROCEEDINGS. 1999 INTERNATIONAL CONFE RENCE ON KOBE, JAPAN 24-28 OCT. 1999, PISCATAWAY, NJ, USA,IEEE, US, vol. 1, 24 October 1999 (1999-10-24), pages 94-98, XP010369215 ISBN: 978-0-7803-5467-8 the whole document	1-4,6-9, 11-14, 16-19, 21-24
A	EP 0 772 365 A (MATSUSHITA ELECTRIC IND CO LTD [JP]) 7 May 1997 (1997-05-07) figure 1	1-4,6-9, 11-14, 16-19, 21-24
A	FAN Z ET AL: "JPEG decompression with reduced artifacts" JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION, vol. 2186, 9 February 1994 (1994-02-09), pages 50-55, XP002116488 ISSN: 0003-1488 page 53, paragraph 2.2	1-4,6-9, 11-14, 16-19, 21-24
A	US 5 590 064 A (ASTLE BRIAN [US]) 31 December 1996 (1996-12-31) column 22, line 28 - column 25, line 55	1-4,6-9, 11-14, 16-19, 21-24

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/022795

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4, 6-9, 11-14, 16-19, 21-24

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4,6-9,11-14,16-19,21-24

Encoding including at least two filters for reduction of quantization artifact, where a filter enforces a compression constraint.

---

2. claims: 1,5,6,10,11,15,16,20

Decoding including at least two filters for reduction of quantization artifact, where the image on display is different from at least one of the input image to the filters and of the output image from the filters.

---

3. claims: 21,24,25

Encoding including at least two filters for reduction of quantization artifact, where filter enablement or disablement information is signaled to the decoder by means of syntax.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0781053 A	25-06-1997	CA 2191907 A1	19-06-1997
		DE 69622518 D1	29-08-2002
		DE 69622518 T2	23-01-2003
		JP 9182075 A	11-07-1997
		US 5850294 A	15-12-1998
US 2002080882 A1	27-06-2002	EP 1223760 A2	17-07-2002
US 6909745 B1	21-06-2005	NONE	
EP 0772365 A	07-05-1997	NONE	
US 5590064 A	31-12-1996	NONE	

AP16 Rec'd PCT/PTO 07 MAY 2009
12/312386

PTO/SB/08A (08-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	KAO
Art Unit	
Examiner Name	
Attorney Docket Number	PU060222

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA	US- 20020080882	6/27/2002	KITAGAWA	
	AB	US- 5590064	12/31/1996	ASTLE	
	AC	US- 6909745	6/21/2005	PURI ET AL.	
		US-			
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		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	AD	EP - 0772365	5/7/1997	MATSUSHITA		
	AE	EP - 0781053	6/25/1997	LUCENT TECH.		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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 2 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, 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 (1-800-786-9199) and select option 2.

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	KAO
Art Unit	
Examiner Name	
Attorney Docket Number	PU060222

NON PATENT LITERATURE DOCUMENTS

Examiner Initials *	Cite No.[1]	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[2]
	AF	FAN ET AL.: "JPEG Decompression with Reduced Artifacts," Journal of the American Veterinary Medical Association, Vol. 2186, February 9, 1994, pp. 50-55, XP002116488.	
	AG	GULERYUZ.: "A Nonlinear Loop Filter for Quantization Noise Removal in Hybrid Video Compression," Image Processing, ICIP 2005, IEEE Int'l. Conference, 11-14 Sept. 2005, pp. II – 333-336.	
	AH	LEE ET AL.: "Loop-Filtering and Post Filtering for Low Bit-Rates Moving Pictures Coding," Image Processing, ICIP 1999, Proceedings Int'l. Conference in Kobe, Japan, Vol. 1, October 24, 1999, pp. 94-98, XP0103669215.	
		COPY OF INTERNATIONAL SEARCH REPORT, dated December 23, 2008.	

Examiner Signature		Date Considered	

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[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.
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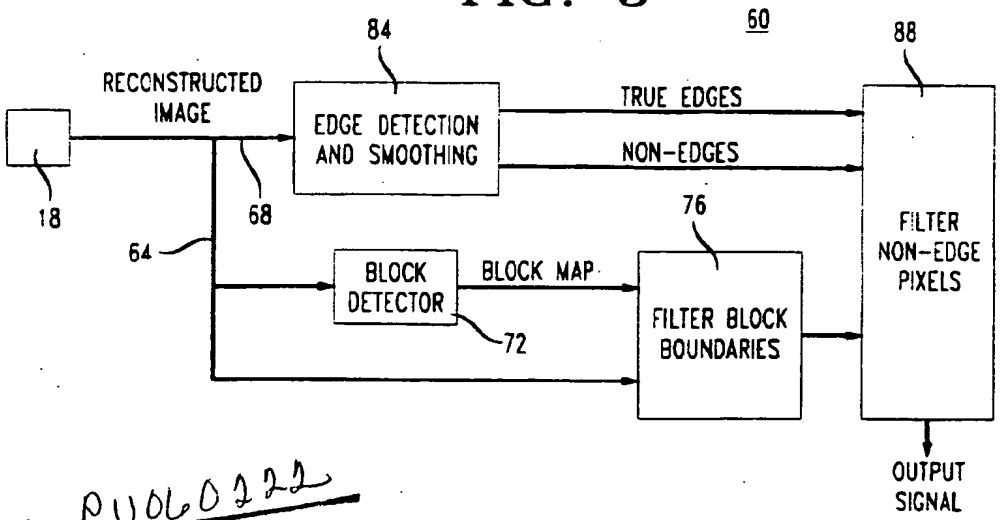
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(54) Method and apparatus for post-processing images

(57) The invention is an image transmitting method and system including receiving encoded images, decoding those images and post-processing the decoded images. The post-processing reduces visual artifacts, such as blocking artifacts and mosquito noise, through separate detection, mapping and smoothing operations while avoiding many of the complexities associated with existing techniques. In detecting blocking artifacts, the inventive method employs DCT-domain detection rather than edge detection in the pixel domain. Also, the interior of a detected block is updated based on the surrounding blocks without disturbing the surrounding blocks. In reducing mosquito noise, the inventive method smoothes the non-edge pixels within blocks containing edge pixels rather than smoothing the edge pixels. Also, distortion-induced false edge pixels are distinguished from true edge pixels and heavily smoothed. The post-processing method and system is generally applicable to Block DCT based compression systems, either intrinsically or extrinsically.

FIG. 5



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Description

Background of the Invention

1. Field of the Invention

The invention relates to methods and systems for processing electronic image signals. More particularly, the invention relates to methods and systems for reducing distortions caused by compressing and reconstructing electronic image signals.

2. Description of the Related Art

An electronic image signal is comprised of a plurality of picture elements, e.g., pixels. A series of electronic image signals are used to form a video or video sequence. When transmitting electronic image signals, an image compression system is often employed.

A typical image compression system 10 is shown in FIG. 1. In general, such systems receive an input image signal, encode the signal with a coder 14 using, e.g., a compression scheme, transmit the encoded signal through a suitable transmission medium 16, then decode or reconstruct the transmitted information with a decoder 18 into an output image signal.

Despite the extensive development of compression systems in recent times, many image compression systems produce significant distortion when operating at bit rates lower than those designed for or when processing complex material. Therefore, when transmitting compressed information over, e.g., analog telephone lines or personal wireless links (which typically have bit rates on the order of 8-40 kb/s), even today's most sophisticated compression techniques have difficulty in delivering low distortion image signals.

Also, when using existing compression standards, e.g., Joint Photographical Expert Group (JPEG), Motion Picture Expert Group (MPEG), H.261, often little can be done to conform the compression coding to fit the particular standard in use because most elements in coder 14 and decoder 18 are fixed. However, an external processor 24 can process the input image signal before the information goes through coder 14 (i.e., "pre-processing") so that the available bit rate for the image processing system will be used for perceptually more important information. Similarly, a post-processor 26 can process an image signal reconstructed by decoder 18 ("post-processing") to reduce or remove visual artifacts resulting from waveform distortions in the reconstructed image signal. Thus, by using pre-processing and/or post-processing techniques, the image quality can be improved without altering existing compression schemes.

In newly designed compression systems, the pre- and post-processing operations often are designed as intrinsic elements of the compression system. However, because such is not possible when using existing compression standards, much effort has been directed toward developing pre-and post-processing enhancements for the existing compression systems.

Both compression techniques and decompression or reconstruction techniques are often expressed conceptually as the combination of three distinct yet interrelated operations: representation, quantization, and codeword. An example of the coding portion of these operations is shown generally in FIG. 2 and an example of the decoding or reconstructing portion of these operations is shown generally in FIG. 3.

The first coding operation, representation, expresses the signal more efficiently and in a manner that facilitates the process of compression. An example of representation is Block DCT (shown as 32 in FIG. 2), which is a particular form of discrete cosine transformation (DCT). A signal representation may contain more pieces of information to describe the signal than the signal itself, however, most of the important information is concentrated in only a small fraction of this description, and thus only this small fraction need be transmitted for appropriate signal reconstruction.

The second coding operation, quantization (shown as 34 in FIG. 2), performs amplitude discretization of the representation information. In the third operation, codeword assignment, e.g., variable length coding (VLC), shown as 36 in FIG. 2, the quantized parameters are encoded in a manner to exploit their statistical redundancy and reduce the average bit rate.

The decoding or reconstructing portion of system 10 is shown in FIG. 3 and generally involves the inverse of those operations performed within coder 14, shown in FIG. 2. For example, within decoder 18 are shown the inverse operations of representation 46 (e.g., inverse discrete cosine transform or IDCT), quantization 44 (Q^{-1}) and codeword assignment 42 (e.g., variable length decoding or VLD).

The image of interest is often partitioned into non-overlapping 8 x 8 blocks, each block is independently transformed (e.g., using 2-D DCT), and the blocks are adaptively processed. The application of DCT in this manner is often referred to as Block DCT.

Partitioning an image into small blocks before applying the DCT affords benefits, including reduced computational and memory requirements, and simplified hardware manufacturing implementation (e.g., via parallel DCT operations) for coder 14 and decoder 18.

In general, a typical video coder is comprised of an image coder plus further process filtering such as temporal filtering and/or spatial filtering. The temporal or time-based filtering is typically performed by a differential pulse code modulation (DPCM)-type or motion-compensation (MC)-type coding scheme. For example, a preceding frame can be used as a reasonable predictor for the current frame, and only the error in the prediction, rather than the entire current frame, needs to be coded and transmitted. Because this error is in the form of a 2-D signal or image, conventional image compression often is applied for its compression (with the differences

in characteristics between an error signal and a typical image being accounted for). The temporal processing, in particular how the prediction is formed and what happens when it fails, is important because it affects the spatial processing and the type of artifacts that may occur.

A spatial filter, particularly a spatial post-filter, is dependent on the location of a particular pixel or set of pixels within a single frame of interest. Typically, spatial post-filters are not time dependent and do not rely on information from frames other than the current frame of interest.

Usually, motion-compensated (MC) prediction and related block-based error coding techniques perform well when the image can be modeled locally as translational motion. However, when there is complex motion or new imagery, these error coding schemes may perform poorly, and the error signal may be harder to encode than the original signal. In such cases, it is sometimes better to suppress the error coding scheme and code the original signal itself. It may be determinable on a block-by-block basis whether to use an error coding scheme and code the error signal, or to simply code the original signal. This type of coding is often referred to as inter/intra processing, because the coder switches between inter-frame and intra-frame processing.

Block-based MC-prediction and inter/intra decision making are the basic temporal processing elements for many conventional video compression standards. Generally, these block-based temporal processing schemes perform well over a wide range of image scenes, enable simpler implementations than other approaches, and interface nicely with any Block DCT processing of the error signal.

For complex scenes and/or low bit rates, a number of visual artifacts may appear as a result of the signal distortion from a compression system. The primary visual artifacts affecting current image compression systems are blocking effects and intermittent distortions, often near object boundaries, called mosquito noise. Other artifacts include ripple, contouring and loss of resolution.

Blocking effects are due to discontinuities in the reconstructed signal's characteristics across block boundaries for a block-based coding system, e.g., Block DCT. Blocking effects are produced because adjacent blocks in an image are processed independently and the resulting independent distortion from block to block causes a lack of continuity among neighboring blocks. The lack of continuity may be in the form of abrupt changes in the signal intensity or signal gradient. In addition, block-type contouring, which is a special case of blocking effect, often results in instances when the intensity of an image is slowly changing.

Mosquito noise is typically seen when there is a sharp edge, e.g., an edge within a block separating two uniform but distinct regions. Block DCT applications are not effective at representing a sharp edge. Accordingly, there is considerable distortion at sharp edges: the reconstructed edges are not as sharp as normal and the adjacent regions are not as uniform as they should be. Mosquito noise is especially evident in images containing text or computer graphics.

Many of the image compression standards available today, e.g., H.261, JPEG, MPEG-1, MPEG-2 and high definition television (HDTV), are based on Block DCT coding. Thus, most of the research into post-processing techniques has focused on reducing the artifacts produced by Block DCT coding, in particular, reducing the blocking artifacts.

Because blocking artifacts are caused primarily by the discontinuities that exist along the block edges, many efforts to reduce these artifacts were motivated by the idea of smoothing these boundaries. In H. Reeve and J. Lim, "Reduction of blocking effects in image coding," *Optical Engineering*, vol. 23, pp. 34-37, Jan/Feb 1984, simple lowpass filtering was applied along the block boundaries. Similarly, in B. Ramamurthi and A. Gersho, "Nonlinear space-variant postprocessing of block coded images," *IEEE Transactions on Acoustics, Speech and Signal Processing*, vol. ASSP-34, pp. 1258-1268, October 1986, lowpass filtering was applied parallel to the image edges to reduce the distortion while preserving the image sharpness.

Conventional post-processing techniques often are split into two basic classes: open-loop approaches and closed-loop approaches. Open-loop approaches are typically simpler, one-pass schemes. They are relatively less complex, yet still achieve adequate performance. Another advantage is that they are not necessarily tied to the details of the particular coder and therefore are more portable because they are often applicable to a large number of coders. For example, coding techniques that simply filter along block boundaries do not require details about the quantization process (only block size information is required). However, open-loop techniques usually do not ensure that the resulting image is relatively close to the original. Thus, the processed signal may differ significantly from the original signal.

Closed-loop approaches, e.g., POCS (projections onto convex sets) based schemes, are typically more computationally complex because they are iterative or multipass in nature. Closed-loop approaches are formulated to converge to something closer to the original signal and often are highly coder-specific, as they exploit more attributes of a given coder (e.g., the specific quantization strategy employed). The greater sophistication and in-depth knowledge of the actual compression provides the potential for higher performance than open-loop schemes. Also, closed-loop schemes typically employ some type of feedback aspect, with "checks" in the feedback loop to ensure that the processed signal does not diverge from the original signal.

In FIG. 4, a conventional, POCS-based artifact reducing scheme 50 is illustrated in operation with the de-

coding portion 18 of compression system 10. As shown, a smoothness constraint operation 52 is applied (in the spatial domain) to the reconstructed signal emerging from decoder 18. Thereafter, a quantization constraint 54 is applied occurs in the DCT domain (i.e., after DCT conversion 56). These constraints are applied recursively until the processed image converges to an image with the desired properties or to an image that is closest to having these properties.

However, despite frequent favorable results, schemes such as that shown in FIG. 4 and similar closed-loop techniques are often computationally intensive. Furthermore, configuring an adequate quantization constraint often requires that the post-processing technique be intrinsically tied to the particular compression system it is supporting, thus possibly limiting the range of applicability of the post-processing technique outside of the supported compression system.

It is desirable to have available a compression method, for use alone or in combination with existing compression coders, that transmits natural looking images over analog telephone lines, personal wireless links and other media that employ bit rates lower than existing compression methods are designed for. Specifically, such a compression method should reduce distortion while preserving image sharpness, naturalness and minimizing system complexity.

Summary of the Invention

The invention is as defined by the claims. Embodiments of the invention include a method and system for transmitting images including receiving encoded images, decoding those images and post-processing the decoded images. In particular, it is a method and system in which post-processing reduces visual artifacts, such as blocking artifacts and mosquito noise, through separate detection, mapping and smoothing operations while avoiding many of the complexities associated with existing techniques. In detecting blocking artifacts, the inventive method employs DCT-domain detection rather than edge detection in the pixel domain. Also, the interior of a detected block is updated based on surrounding blocks without disturbing the surrounding blocks. In reducing mosquito noise, the inventive method smoothes the non-edge pixels within blocks containing edge pixels without smoothing the edge pixels. Also, distortion-induced false edge pixels are distinguished from true edge pixels and heavily smoothed to insure that they do not degrade the post-processed image. The post-processing method and system is generally applicable to Block DCT based compression systems, either intrinsically or extrinsically.

Brief Description of the Drawings

FIG. 1 is a schematic view of a conventional image processing system;

FIG. 2 is a partial schematic view of the compression or coding portion of the image processing system shown in FIG. 1;

FIG. 3 is a partial schematic view of the decoding or reconstruction portion of the image processing system shown in FIG. 1;

FIG. 4 is a partial schematic view of the decoding portion of the image processing system shown in FIG. 1 in operation with a conventional post-processing system;

FIG. 5 is a schematic view of a post-processing system according to an embodiment of the invention,

FIG. 6 is a partial schematic view of a block detector used in the post-processing system of FIG. 5; and

FIG. 7 is a partial schematic view of a edge detector used in the post-processing system of FIG. 5.

Detailed Description

In the following description, similar components are referred to by the same reference numeral in order to simplify the understanding of the drawings.

In many block-based image compression systems, the representation stage (e.g., Block DCT 32 in FIG. 2) preserves the information of the original signal, and hence is lossless or invertible. Similarly, codeword assignment (e.g. VLC 36 in FIG. 2) is invertible. Thus, distortion is introduced during quantization. It is important to realize that while the distortion is introduced by quantization, the form that the distortion takes is a function of the chosen representation. That is, the type of representation used dictates how the distortion manifests itself in the reconstructed image.

Spatially-adaptive processing is necessary in preserving the important image elements, such as edges, texture and uniform areas, while eliminating blocking effects and mosquito noise. As discussed previously, many approaches exist for detecting and processing the different elements in a signal. Artifact detection and reduction is typically performed in the pixel domain. However, because most artifacts result from quantization in the DCT-domain, in some cases, artifact detection should occur in the DCT domain instead of the pixel domain.

Also, to reduce the detected artifacts, there exists a wide range of linear and nonlinear filtering techniques. However, the choice of filter is not as important as the specific details of its incorporation within the post processing scheme.

Referring to FIG. 5, a post-processing system 60 according to an embodiment of the invention is shown. The system comprises two separate yet coexisting processing paths: a first processing path 64 for reducing blocking effects and a second processing path 68 for reducing mosquito noise. As will be evident from further discussion, the two processing paths are independent of one another and can be performed sequentially or in parallel with one another, and their results are combin-

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able without unacceptably affecting image quality.

In general, the first step in reducing blocking effects (i.e., processing path 64) is detecting or identifying, with a block detector 72, the blocks that may exhibit these artifacts. Once these potential problem blocks are identified, a block map is generated showing their respective locations to guide the subsequent filtering or smoothing technique (shown generally as 76).

Since blocking artifacts result from discontinuities in the signal characteristics across block boundaries and these discontinuities are pixel-domain phenomena, many detection techniques search for discontinuities along the boundary pixels (often similar to edge detection at block boundaries). However, according to an embodiment of the invention, block detection is performed in the DCT domain. Therefore, as shown in FIG. 6, block detector 72 uses a Block DCT operation 73 to transform the signal into the DCT domain prior to any actual block detection operation, shown generally as 74.

Specifically, blocking artifacts result when an inadequate number of DCT coefficients (i.e., the data resulting from the application of a DCT operation) represent a particular block. Typically, this occurs when only approximately one to three coefficients are used. Therefore, according to an embodiment of the invention, blocks that potentially exhibit blocking artifacts are found, e.g., by calculating the number of nonzero DCT coefficients in a coded block and comparing that to a threshold.

The computational requirements for this detection technique are not burdensome. For example, in a still-frame compression scheme (e.g., JPEG), if post-processing in this manner is coupled with decoding or reconstruction, all of the nonzero DCT coefficients are already available as a result of the previous coding and decoding.

In highly compressed video, a significant number of the blocking artifacts occur for intra-coded blocks. For these blocks, the decoder already has the nonzero DCT coefficients. For optimal performance, the DCT coefficients also should be computed for all the inter-coded blocks. However, the computational requirements may be reduced considerably by choosing to examine only those blocks that are likely to exhibit blocking effects, e.g. the blocks having relatively significant motion in the current frame. In this manner, redundant smoothing of many blocks smoothed after their initial intra-coding is reduced.

Once potential problem blocks are detected by detector 72, an appropriate filtering or smoothing operation 76 (see FIG. 5) is applied to reduce the blocking effects. It is important to successfully reduce the blocking effects without distorting the image. For example, when processing images with high spatial resolution heavy filtering along the block boundaries produces minimal added distortion to the image. In contrast, when processing low-resolution images, which are characteristics of very-low bit rate compression systems, excessive filtering often has drastic harmful effects on the resulting image quality.

The invention described herein adopts the notion that the pixels within a potential problem block are more distorted than the pixels in the surrounding blocks, i.e., the pixels outside the block in question are more accurate than the pixels inside the block in question. Therefore, the accurate exterior pixels are used to improve the estimate of the distorted interior pixels without altering the exterior pixels.

Such approach is equivalent, essentially, to applying a filter along the boundaries of a detected block but only updating the pixels values within the block. For example, horizontal lowpass filtering is applied to reduce the discontinuity along the left and right boundaries of the distorted block, but only the pixels within the block are actually updated. The pixels in the surrounding blocks are left untouched. Similarly, for example, a vertical lowpass filter is applied along the top and bottom edges of the distorted block to reduce the discontinuity along these edges. Note that if two adjacent blocks are identified as exhibiting blocking artifacts, the resulting processing according to this embodiment of the invention is equivalent to conventional lowpass filtering along the boundary.

The second processing path 68 involves reducing mosquito noise. In general, pixels that potentially may exhibit mosquito noise are detected initially and then smoothed. More specifically, because mosquito noise appears as random noise or oscillatory distortion within an 8x8 pixel block and is especially prominent in blocks containing sharp edges, blocks containing sharp edges are detected using an edge detecting operation 84 and then the non-edge pixels within the identified blocks are smoothed using an appropriate filtering or smoothing operation 88 (see FIG. 5).

This approach relies on the notion that non-edge pixels potentially exhibit mosquito noise. It is important to note that only the non-edge pixels are smoothed in order to retain image sharpness, which implies that preserving the fidelity of the edges is of high priority. The edge pixels exhibit distortion similarly to any pixel in the afflicted block. However, filtering the edge pixels produces an unacceptable amount of blurring and therefore an overall loss of image sharpness. Furthermore, typically, the edge distortion is totally masked by the edge itself. Therefore, the edge pixels must be identified carefully and preserved, and then the remaining non-edge pixels are safely smoothed to reduce the mosquito noise. The non-edge pixels are smoothed, e.g., by any of a number of conventional, smoothing techniques.

In general, one problem with edge detection is that large amplitude distortions, such as mosquito noise, may be falsely detected as edges. As a result, these large amplitude distortions evade the smoothing process and degrade the post-processed image. To counteract this problem, it is necessary to distinguish between true edges and false edges and to heavily smooth

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the false edges.

Therefore, as shown in FIG. 7, edge detection operation 84 uses an edge detector 85 to identify all edges. The identified edges are used to construct an edge map that undergoes a further operation (shown generally as 86) to distinguish the true edges from the false, distortion-induced edges.

One manner of distinguishing true edges and false edges from the edge map is by examining the connectivity of the pixel in question. For example, four 5-point windows are applied to the edge map, each window being centered at the pixel in question and aligned along the horizontal, vertical and diagonal directions, respectively. If the sum of the edge map values along any of the directions is determined to be greater than or equal to a threshold value, an edge is determined to exist along that direction and the pixel in question is assumed to correspond to a true edge. Otherwise, the pixel in question is assumed to be a false edge.

The notion behind this true/false edge detection approach is that a true edge typically will have a string of adjacent edge pixels. Conversely, a distortion-induced false edge is typically characterized by isolated edge pixels (i.e., edge pixels that are not part of a connected string of edge pixels).

Upon conclusion of such determination, the resulting edge map is now a more accurate indicator of the true edges in the image. The false edges are then smoothed heavily, e.g., by an appropriate smoothing scheme 87.

The detected true edge pixels (i.e., the edge pixels that are not identified as false edge pixels) are passed through the system unprocessed in order to retain image sharpness, as discussed previously. The non-edge pixels undergo smoothing via filtering step 88 (see FIG. 5) to reduce the distortion. As mentioned previously, a number of conventional smoothing techniques are suitable. However, several conventional factors associated therewith need to be considered in choosing a suitable smoothing technique, e.g., whether the smoothing technique should be linear or nonlinear, and how "heavy" the smoothing should be. Such considerations can be determined readily by those skilled in the art, and need not be discussed here.

Alternatively, in filtering step 88, it may be beneficial in terms of retaining image sharpness to not only pass each edge pixel unprocessed in smoothing, but also to pass the top, bottom, left, and right adjacent pixels unprocessed. Therefore, each edge pixel as well as its four adjacent pixels is unprocessed. All the remaining pixels will be smoothed, and all the edge pixels will be excluded from the region of support of the smoothing filter.

Finally, because the pixels in the image are smoothed in a sequential manner, there exists the option of using some of the already smoothed (updated) pixels when smoothing the current pixel. That is, within the window for the smoothing filter, some of the already smoothed pixels may be used with the other non-smoothed pixels. Such a smoothing scheme allows in-place processing to be performed.

The artifact reducing techniques described herein are applicable for use with many image processing systems, including most if not all systems that employ block-based DCT coding schemes. Such coding schemes include JPEG, P_xJPEG, MPEG-1, MPEG-2, MPEG4, H.261, H.263, HDTV (High Definition Television) and Dig. NTSC (National Television System Committee). However, it is not required that the inventive features described herein be used with block-based coding schemes. For example, the edge filtering used in reducing mosquito noise is not dependent on block DCT operations being part of the overall coding scheme.

It will be apparent to those skilled in the art that many changes and substitutions can be made to the post-processing method and system herein described without departing from the scope of the invention as defined by the appended claims.

Claims

1. A system (60) for transmitting images including the receipt of an encoded image, the decoding of said image and the post-processing of said decoded image, said image signals comprised of blocks including blocks having blocking effect artifacts and blocks having mosquito noise artifacts, wherein said blocks are comprised of pixels including edge pixels and non-edge pixels, said system comprising:

   a first post-processing coder for reducing said blocking effect artifacts from said blocks, said first post-processing coder including

   a DCT domain detector (72) for detecting blocks having said blocking effect artifacts, and
   a filter (76) for smoothing the edges of said detected blocks based on the blocks adjacent thereto; and

   a second post-processing coder for reducing said mosquito noise artifacts from said blocks, said second post-processing coder including

   a detector (84) for identifying said edge pixels, and
   a filter (88) for smoothing the pixels not identified as said edge pixels by said edge pixel detector.

2. The system as recited in claim 1, wherein said filter further comprises:

   a horizontal lowpass filter for filtering along the

left and right edges of said detected blocks; and a vertical lowpass filter for filtering along the top and bottom edges of said detected blocks.

3. The system as recited in claim 1, wherein said edge pixels include true edge pixels and false edge pixels, wherein said pixel edge detector distinguishes between said true edge pixels and said false edge pixels, and wherein said detector further comprises a filter for smoothing said false edges whereby said false edges are smoothed into non-edge pixels.

4. The system as recited in claim 1, wherein said blocks are comprised of pixels including edge pixels, sharp edge pixels and non-edge pixels, and wherein said second post-processing coder further comprises:

a detector for detecting said blocks having said sharp edge pixels; and
a filter for smoothing the non-edge pixels within those blocks identified as having sharp edge pixels.

5. A method for transmitting images including the receipt of an encoded image, the decoding of said image and the post-processing of said decoded image, said image signals comprised of blocks having edges and including blocks having blocking effect artifacts and blocks having mosquito noise artifacts, said blocks comprised of pixels having values, said blocks comprised of pixels including edge pixels and non-edge pixels, said post-processing comprising the steps of:

reducing said blocking effect artifacts from said blocks, said blocking effect artifacts reducing step including the steps of

detecting blocks having said blocking effect artifacts,
smoothing the edges of each of said detected blocks based on the corresponding edge of blocks adjacent thereto, and
updating the pixel values within said detected block without substantially modifying the pixel values within blocks adjacent to said detected blocks; and

reducing said mosquito noise artifacts from said blocks, said mosquito noise artifacts reducing step including the steps of

identifying said edge pixels, and
filtering the pixels not identified as edge pixels in said identifying step.

6. The method as recited in claim 5, wherein said edge smoothing step includes filtering the boundaries between said detected blocks and blocks adjacent thereto.

7. The method as recited in claim 5, wherein said edge smoothing step further comprises horizontal lowpass filtering along the left and right edges of said detected blocks and vertical lowpass filtering along the top and bottom edges of said detected blocks.

8. The method as recited in claim 5, wherein said edge pixels contain true edge pixels and false edge pixels and wherein said identifying step further comprises the steps of:

distinguishing said edge pixels between said true edge pixels and said false edge pixels;
generating a map based on said distinguishing step; and
smoothing said false edge pixels based on said generated edge map.

9. The method as recited in claim 8, wherein said distinguishing step further comprises the steps of:

comparing each of said pixels with at least one adjacent pixel whereby a degree of connectivity is established; and
determining said true edge pixels based on said degree of connectivity of each of said pixels.

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FIG. 1

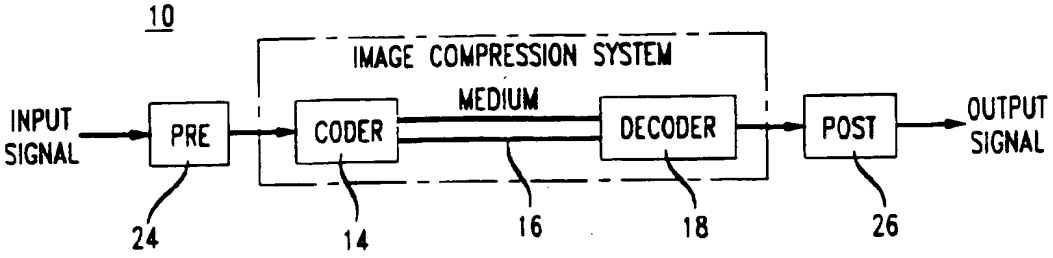


FIG. 2

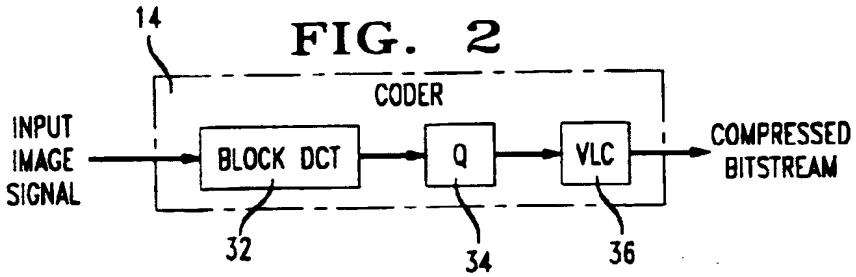


FIG. 3

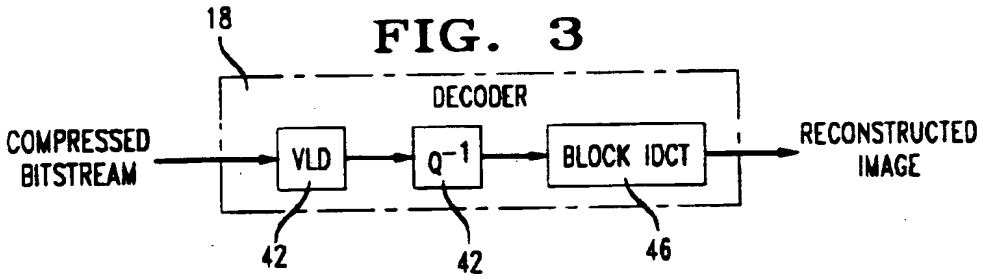
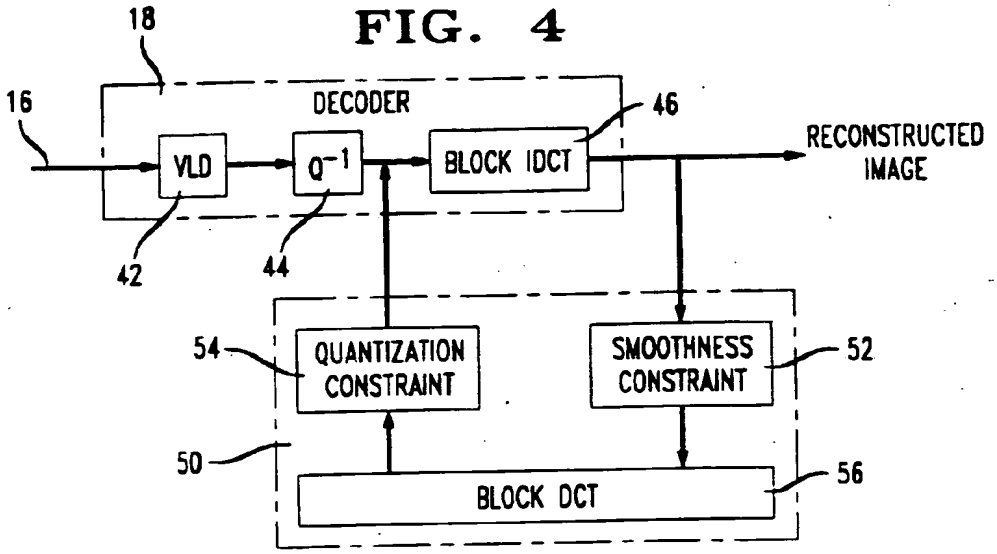


FIG. 4



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FIG. 5

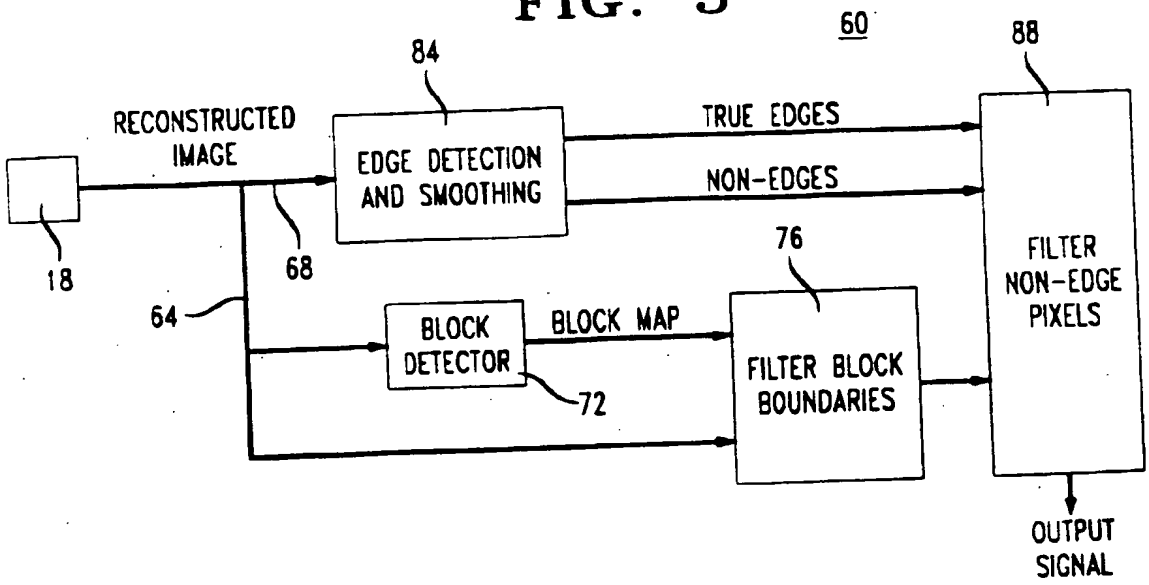


FIG. 6

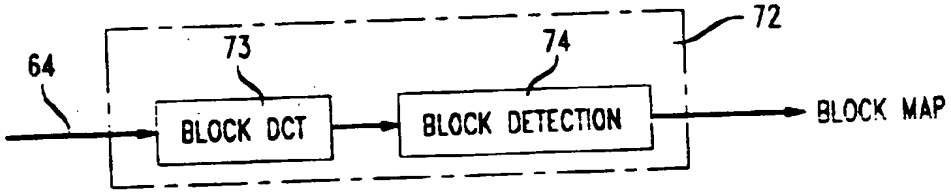
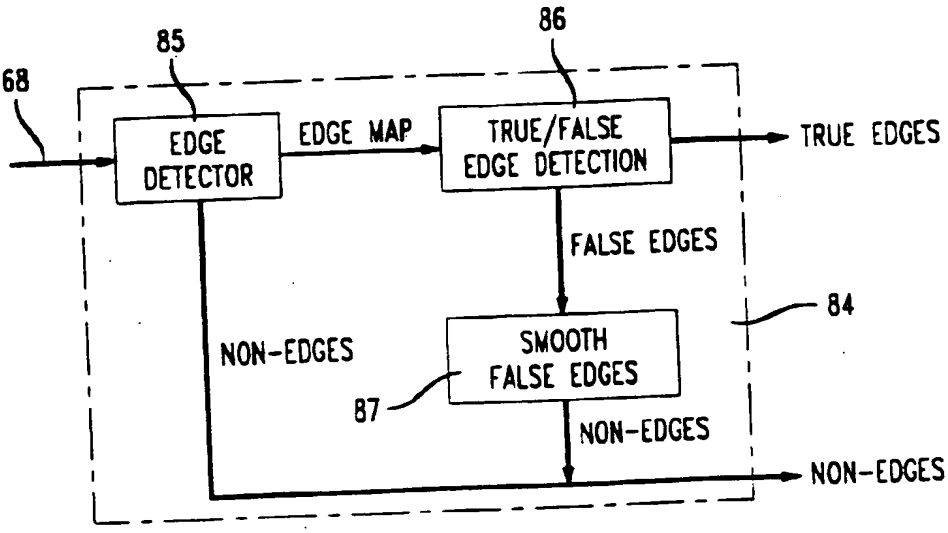


FIG. 7



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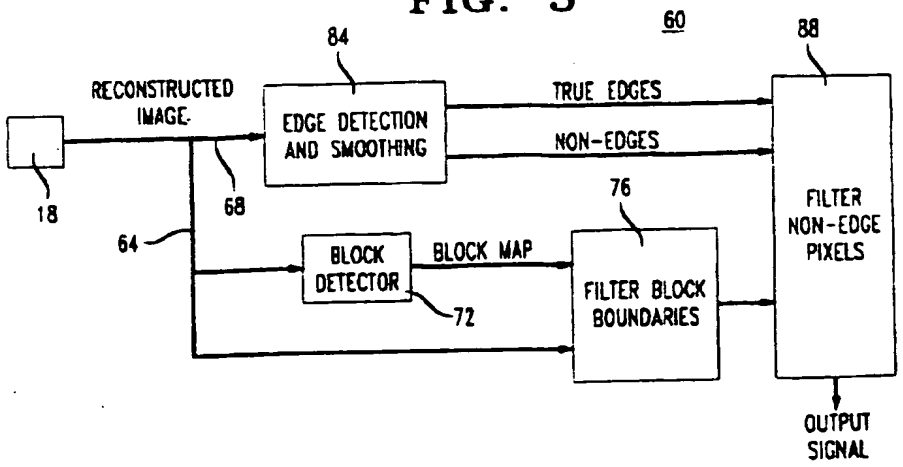
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(54) Method and apparatus for post-processing images

(57) The invention is an image transmitting method and system including receiving encoded images, decoding those images and post-processing the decoded images. The post-processing reduces visual artifacts, such as blocking artifacts and mosquito noise, through separate detection, mapping and smoothing operations while avoiding many of the complexities associated with existing techniques. In detecting blocking artifacts, the inventive method employs DCT-domain detection rather than edge detection in the pixel domain. Also, the interior of a detected block is updated based on the surrounding blocks without disturbing the surrounding blocks. In reducing mosquito noise, the inventive method smoothes the non-edge pixels within blocks containing edge pixels rather than smoothing the edge pixels. Also, distortion-induced false edge pixels are distinguished from true edge pixels and heavily smoothed. The post-processing method and system is generally applicable to Block DCT based compression systems, either intrinsically or extrinsically.

FIG. 5



EP 0 781 053 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 8735

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Y	EP 0 526 885 A (EASTMAN KODAK CO) 10 February 1993 * abstract * * page 3, column 3, line 22 - line 33 * * page 3, column 4, line 26 - line 31 * * page 4, column 5, line 28 - line 41 * * page 4, column 6, line 6 - line 58 *	1,2,4-7	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 March 1999	Marie-Julie, J-M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

NSDOCID: <EP_____0781053A3_I_>

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 8735

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X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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BNSDOCID: <EP 0781053A3 | >

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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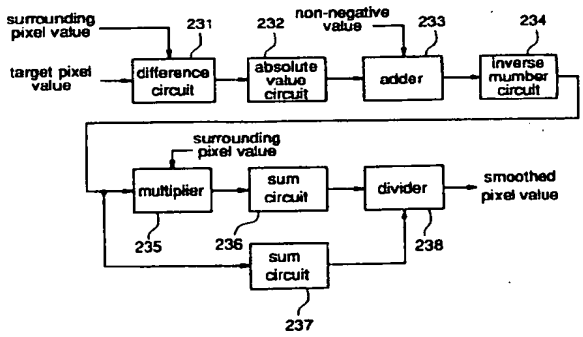
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(54) Method and device for filtering a picture signal, and encoding/decoding using the same

(57) A great decrease of a step, i.e., block distortion, of such as antifact brightness and color, on a block boundary, leads to much visual improvement of picture quality.

Against a picture that has been encoded and decoded by block, the smoothing filter characteristics is changed according to quantizing parameter, block activity of a decoded picture, the activity of each pixel of the decoded picture, and the position with respect to a block boundary of a pixel. A smoothing filter utilizes a weighted mean whose weight is the inverse number of a difference between a target pixel and its surrounding pixels. The weighted mean is obtained by adding a certain number to a weight before taking its inverse number. The value to be added is controlled by the parameter. Similarly, the mixing ratio of a pixel value after performing the smoothing filter and a decoded pixel value is changed depending on the parameter. A filter having strong edge preserving property is utilized for the inside of a block, and a filter having weak edge preserving property is utilized for a block boundary. A filter having edge preserving property is utilized for the post/loop filter.

FIG.2



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Description

FILED OF THE INVENTION

The present invention relates to a picture signal smoothing device, i.e., a picture filter, and its method in which against a picture that has been encoded and decoded by block, a smoothing filter processing whose strength changes depending on quantizing parameter and block activity of a decoded picture, is performed on each pixel position to obtain high quality picture free from antifact noise; and a picture encoding device and its method, and a picture decoding device and its method, all of which utilize the above filter as a postfilter or a loop filter.

BACKGROUND OF THE INVENTION

In order to encode a picture signal at high efficiency, there has been frequently used a moving picture encoding and decoding system and its device that appropriately encode a picture signal mainly by block. As a typical one, TV Conference system based on International Telegraph and Telephone Standard (ITU-T H. 261 standard) is generally used. By such encoding systems, however, a block-shaped step, i.e., block noise, due to quantizing error is perceived in a decoded picture. Further, it is known that if there is a rapid pixel change such as a character on a flat background, pseudo edge called as mosquito noise occurs in its surrounding. The block-shaped noise can be observed when a step of antifact brightness, color and the like occurs on a block boundary. In prior art techniques, a smoothing filter for decreasing such a step is utilized against the entire decoded picture or a pixel exists on the block boundary, to reduce the block-shaped noise.

Figure 24 is a block diagram of an inter-frame encoding and decoding system of the ITU-T H. 261 standard, and indicates the position at which block-shaped noise reducing process is performed. In this figure, a subtracter 11 generates a difference between an input picture signal 10 and a picture signal 24 of the previous frame that has been encoded, decoded and reconstituted. The difference is encoded in an encoder 12 by means of DCT, quantization and Huffman coding. An encoded error signal 13 is transmitted to a decoder 25, and is again returned to a difference signal in a local decorder 14 by means of inverse Huffman coding, inverse quantization and inverse DCT. This difference signal 15 contains operation errors in the encoder 12 and the local decorder 14, resulting in a value different from the difference generated in the subtracter 11.

Then, the difference signal 15 and the picture signal 24 of the previous frame are added in an adder 16 to generate a picture signal 17, which is then stored in a frame memory 18, standing by for the next picture signal input. In these operations, the processing is performed by block of a picture divided into 8×8 dot size.

When taking, in the subtracter 11, the difference between the input picture signal 10 and the previous picture signal 24 from the frame memory 18, there is generally employed technique called motion estimation and compensation. This technique is performed by a motion vector detector 19. Specifically, to obtain a difference between a signal stored in the frame memory 18 and an input signal, the detector 19 reads out the previous picture signal 21 from the frame memory 18, and slide the signal 21 up and down, and right and left, to obtain differences, thereafter, select a slide quantity with which the difference becomes the smallest, as a motion vector 22, which is then transmitted to a decoding side by multiplexing with an error signal 13 that has been multiplexed by a multiplexer 29a. The motion vector 22 is returned to the frame memory 18 as an address signal, to obtain a motion compensation predictive signal 20. The constitution of the encoder side is as mentioned above.

In the decoder side, a transmitted difference signal 13 is decoded in the decorder 25 by means of inverse Huffman coding, inverse quantization, and inverse DCT and motion vector extraction, and the motion vector 22 is given to the motion compensation frame memory 18 to read the motion compensation predictive signal 20 obtained by sliding, from the frame memory 18. The difference signal 15 decoded in the decorder 25, and the signal 20 read out from the frame memory 18 are added in the adder 16 to generate a picture signal 17, i.e., a local decoded signal. Against the picture signal 17 thus encoded, decoded and reconstructed, a filtering using a postfilter 26 is performed.
Alternatively, a filtering using a filter inside loop 23 is performed on the output from the frame memory 18, to reduce a block-shaped noise. Prior art techniques utilized in the above filterings will be described.

As a prior art 1, there is discussed the technique disclosed in "Study of the Method for Improving the Image Quality of Block Encoding Picture by Post Filter Process" by Mitsuya et al. (TECHNICAL REPORT OF IEICE, IE84-46), as shown in Figure 22. In this technique, the filtering is limited to a block that has less brightness change of an obtained decoded picture, in other words, a block at whose boundary a block distortion is liable to be actualized.
That is, a strong smoothing filtering is performed only on a pixel 50 on a block boundary. This filtering is performed by a low-pass filter (hereinafter referred to as "LPF") that takes a simple average of equal weight against nine pixels of a target pixel 40 and its surrounding eight pixels 41 to 48 in Figure 21. In this figure, numerals 51 and 52 designate a pixel inside a block and a block boundary, respectively.

As a prior art 2, there is discussed the technique described in "Postprocessing Algorithms for Noise Reduction of MPEG Coded Video" by Nakajima et al. (TECHNICAL REPORT OF IEICE, IE94-7, DSP94-7 (1994-04), (hereinafter

referred to as "technique of Nakajima")). In the technique of Nakajima, the mixing ratio of a decoded pixel value and a simple average of its surrounding pixel values is changed appropriately depending on the local activity of a picture, quantizing parameter, block activity and the position relation with a block boundary.

Assuming that a local region of the surrounding of the target pixel is a picture region (hereinafter referred to as "local region") of 3×3 pixels as shown in Figure 21, and that a region (hereinafter referred to as "picture block")in which σ_b^2 (block activity) is computed is a region of 8×8 pixel in which DCT operation as shown in Figure 20 is performed, the quantizing parameter in decoding is stored for each picture block.

In the local region as shown in Figure 20, a local average $\langle d(x, y)\rangle$ is defined by the equation (1) for each of the entire pixels of a decoded picture.

In taking the sum (Σ) of the local averages, if a pixel is outside the range of a picture region depending on the values of i and j, the value of a target pixel is employed instead of the pixel outside of the picture range. Note that d(x, y) is a decoded pixel value of the coordinate (x, y).

$$\langle d(x, y)\rangle = \frac{1}{9}\sum_{i=-1}^{+1}\sum_{j=-1}^{+1} d(x+i, y+j) \tag{1}$$

Then, each pixel dispersion (hereinafter referred to as "local activity") as defined by the equation (2) is obtained in the local region. As the definition of the dispersion, the sum of the square the difference between the local region and the local average of the equation (1) is obtained in each pixel as in the equation (1).

$$\sigma_d^2(x, y) = \frac{1}{9}\sum_{i=-1}^{+1}\sum_{j=-1}^{+1}(d(x+i, y+j)-\langle d(x, y)\rangle)^2 \tag{2}$$

Picture block dispersion (hereinafter referred to as "block activity") is defined by the equation (3). The block activity is defined for each of the picture blocks B_{00} to B_{22}, as shown in Figure 20.

$$\sigma_{bavg}^2(x, y) = \frac{1}{64}\sum_{i=0}^{+7}\sum_{k=0}^{+7}\sigma_d^2(x_b+k, y_b+1) \tag{3}$$

wherein x_b, y_b are values of the upper left corner coordinate that belongs to the picture block number b_n.

An m(x, y), d(x, y) and $\langle d(x, y)\rangle$ are respectively, a corrected pixel value, a decoded pixel value and a simple average pixel value of a local region, in the coordinate (x, y).

$$m(x, y) = (1-\beta)\langle (x, y)\rangle + \beta d(x, y) \tag{4}$$

Here, β is a mixing ratio of a decoded value and a value smoothed in the local region.

$$\beta = \frac{\sigma_d^2(x, y) - \sigma n^2(x, y)}{\sigma_d^2(x, y)} \tag{5}$$

In the pixel inside the picture block,

$$\sigma_n^2(x, y) = \sigma_{bn}^2\frac{\sigma_{bavg}^2}{\sigma_d^2(x, y)} \tag{6}$$

In the pixel on the picture block boundary,

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$$\sigma_n^2(x, y) = \sigma_{bn}^2 \quad (7)$$

In this case, σ_{bn}^2 is a functional value whose variable are quantizing parameter and block activity, and also the experimental value illustrated with the graph in the report. In accordance with the report of Nakajima, β in the above equation (4) is changed so as to increase the proportion of the simple average, in the event that various picture noises are liable to occur, that is, under the following conditions:

a. when quantizing parameter is rough;
b. when block activity is high;
c. when noise occurs in a certain region of a picture; and
d. when a sharp edge exists inside a picture block.

As a prior art 3, a description will be given of the technique of "Gradient Inverse Weighted Smoothing Scheme and the Evaluation of its Performance" by D.C.C. Wang, A.H.Vagnucci and C.C.Li (Comp. Graphics Image Processing, Vol. 15, pp.167-181, 1981) (hereinafter referred to as "technique of Wang"). The technique of Wang is one which takes weighted mean of a target pixel and its surrounding pixels. Its weighting factor is the inverse number of the absolute value of the difference between the target pixel and its surrounding pixels, and defined by the following equations (8) to (11), wherein d(x, y) is a decoded pixel value of the coordinate (x, y); and m(x, y) is a pixel value after taking weighted mean in the coordinate (x, y).

$$m(x, y) = \frac{\sum_{i=-1}^{+1}\sum_{j=-1}^{+1} w(i, j)\, d(x+i, y+j)}{\sum_{i=-1}^{+1}\sum_{j=-1}^{+1} w(i,j)} \quad (8)$$

where,

$$\Delta D_{ij}(x, y) = |d(x+i, y+j) - d(x, y)| \quad (9)$$

provided that when $\Delta_{ij}(x, y)=0$, $\Delta D_{ij}(x, y)=2$,

$$w(i, j) = \frac{1}{\Delta_{ij}(x, y)} \quad (10)$$

(i, j = -1, 0, +1)
where

$$w(0, 0) = \frac{1}{2} \text{ and } \sum_{i=-1}^{+1}\sum_{j=-1}^{+1} w(i, j) = \frac{1}{2} \quad (11)$$

(i and j are not 0 at the same time)

In this technique, if the difference between a target pixel and its surrounding pixels is small, the weighting factor increases, so that the surrounding pixels are homogenized with a filtered target pixel value. On the contrary, if the difference is great, i.e., if an edge exists, the weighting factor decreases, leading to a filtering that preserves the edge.

As a prior art 4, there will be discussed the technique of a filter utilized in ITU-T advice H. 261 (hereinafter referred to as "H. 261 standard") which was approved by World Telecommunication Standardization Commission. The above filter is employed for an output of a frame memory in which a picture signal of the preceding frame is stored, that is, before obtaining a difference between the present picture signal and an input picture signal (see an in-loop filter 23 in Figure 24). The output of the above frame memory is filtered by 8×8 picture blocks.

The above filter is constituted by operating a primary filter horizontally or vertically, that is, a non-recursive filter having coefficients of 1/4, 1/2, 1/4 against a pixel inside a picture block. In cases where a pixel employed in filter operation is outside the picture block, the above filter functions as a primary filter having coefficients of 0, 1, 0. The filter coefficient

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at the respective position of the 8×8 picture blocks are indicated in Figure 23, wherein numerals 61, 62, 63 and 64 designate filter coefficients in four corners, up and down ends, right and left ends, and an inner region, respectively. For the up and down ends, and the left and right ends, there are six pixels respectively. In the inner region, there are 36 pixels. The filter coefficient is slided when applying to each pixel.

In these basic filters of the prior art constitution, however, edge information that is inherently possessed by a picture except block noise is to be reduced because uniform filtering is performed on the entire decoded picture. In the case where only a block boundary is filtered using the technique of Mitsuya, when a continuous stroke originally crosses the block boundary, the continuous stroke blurs only on the block boundary. As a result, an observer will have an impression that such a block boundary is antifact.

The technique of Nakajima utilizes a mixture of a simple average of a decoded pixel value and its surrounding pixels values, so that its filtering blurs edge information within a picture block. Further, as defined in the equation (4), the proportion of a filter having no edge preserving property is enhanced on block boundaries, causing the same problem as in the technique of Mitsuya.

In the technique of Wang having the edge preserving property, the weighting factor of a target pixel is fixed at 1/2, and therefore, plural processing are needed in the identical picture. Further, the replacement of a weighting factor when a pixel difference value ΔD_{ij} is 0, may underestimate the weighting factor. Since this technique does not take into consideration block noise phenomenon on a block boundary, which occurs in diving a picture into blocks, a step of a block boundary might be erroneously recognized as an edge to be processed.

The filter of the H. 261 standard also does not have the edge preserving property, causing a blur of a decoded picture.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a picture signal smoothing device and its method that can reduce the deterioration of a decoded picture while suppressing a decrease in resolution of the entire picture.

It is a further object of the present invention to provide a picture encoding device and its method that can reduce deterioration of a decoded picture while suppressing a decrease in resolution of the entire picture.

It is a further object of the present invention to provide a picture decoding device and its method that can reduce deterioration of a decoded picture while suppressing a decrease in resolution of the entire picture.

Other objects and advantages of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific embodiment are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to the those skilled in the art from this detailed description.

According to a first aspect of the present invention, a picture signal smoothing device that performs a smoothing process is performed by applying a smoothing filter in which a sampled and digitized picture signal is filtered by weighted mean of a target pixel and its surrounding pixels, includes means for detecting a difference between a target pixel and its surrounding pixels; means for taking the absolute value of the difference; means for adding a non-negative value (m) to the absolute value of the difference thus detected; means for taking the inverse number (weighting factor) of the value after the adding; means for multiplying the value after taking of the inverse number and the surrounding pixels values together; means for taking a sum (A) of the value after the multiplying; means for taking a sum (B) of the inverse number (the weighting factor) alone; and means for dividing the sum (A) by the sum (B) of the weighting factor and normalizing (A/B).

Since the smoothing is performed by the inverse number of a difference value, if a target pixel is an isolated point, a difference value between the target pixel and each of its surrounding pixels is great, so that every surrounding has a similar weight. In the case where an edge exists near a target pixel, although the difference between the target pixel and the edge is great, the difference between the target pixel and its surrounding pixel except the edge is small. This leads to a constitution in which weighted mean is taken such that the weight of the edge side is small. A continuous edge can be preserved by this constitution, and the isolated point can be smoothed. In addition, by adding a non-negative value, the degree of noise influence can be controlled in the operation, and there is no possibility that the operation result after taking the inverse number is infinity.

According to a second aspect of the present invention, the picture signal smoothing device of the first aspect includes means for diving a picture to be filtered into blocks; and means for appropriately changing a non-negative value to be added to the difference value between the target pixel and its surrounding pixels, according to the roughness of quantizing parameter of each block that is represented by quantizing characteristics utilized in encoding or decoding each block of a picture signal.

Therefore, by controlling a non-negative value added prior to taking the inverse number in computing a weighting factor, using quantizing parameter, it is possible to erase noise that enlarges with enlarging quantizing error.

According to a third aspect of the present invention, the picture signal smoothing device of the first aspect includes means for dividing a picture to be filtered into blocks; means for computing a block activity indicating a change degree

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of a pixel by block; and means for appropriately changing a non-negative value to be added to a difference value between the target pixel and its surrounding pixels, according to the respective block activity.

When a picture is flat and has low block activity, it is easy to observe noise. In such a case, however, it is possible to prevent noise from being recognized by enlarging a noise recognizable width and enhancing flat smoothing characteristics.

According to a fourth aspect of the present invention, the picture signal smoothing device of the first aspect includes means for dividing a picture to be filtered into blocks; means for detecting whether a target pixel exists on a block boundary; means that if the target pixel exists on a block boundary, detects a block activity (adjacent block activity) of a block adjacent to the block boundary; and means for appropriately changing a non-negative value to be added to the difference value between the target pixel and its surrounding pixels, according to the adjacent block activity.

When a picture is adjacent to a flat block, on its boundary, a continuous edge of brightness (hue) often occurs. In such a case, therefore, by detecting that an adjacent block is flat and has low block activity, the smoothing characteristics of a point at which the flat block touches is enhanced to blur the step on the boundary.

According to a fifth aspect of the present invention, the picture signal smoothing device of the first aspect includes means for dividing a picture to be filtered into blocks; means for mixing a signal value after the smoothing process by block, and a signal value prior to the smoothing process; means for appropriately changing the mixing ratio according to the roughness of quantizing parameter of each block that is represented by quantizing property utilized in encoding and decoding each block of a picture signal.

Therefore, the constitution that the final filtering value of a target pixel is obtained by mixing the smoothed signal value and the signal value prior to the smoothing, allows to change the filtering characteristics by picture block, according to the respective pixel character. When a quantizing parameter is 1, no quantizing error occurs, and therefore, no further process is required against the value after the final filtering, that is, the signal prior to the smoothing can be utilized as it is. This leads to the constitution that the mixing ratio is controlled by quantizing parameter, and it is possible that a smoothed signal value is not utilized in the filtering.

According to a sixth aspect of the present invention, the picture signal smoothing device of the first aspect includes means for dividing a picture to be filtered into blocks; means for mixing a signal value after the smoothing process by block, and a signal value prior to the smoothing process; means for appropriately changing the mixing ratio according to the respective block activity in a picture signal.

Thus, for a flat block having low block activity, by making the final filtering value include more smoothed and flat signal values, it is possible to erase noise that is noticeable in a flat block.

According to a seventh aspect of the present invention, the picture signal smoothing device of the first aspect includes means for dividing a picture to be filtered into blocks; means for mixing a signal value after the smoothing process by block, and a signal value prior to the smoothing process; means for detecting whether a target pixel exists on a block boundary; and means that if the target pixel exists on a block boundary, appropriately changes the mixing ratio according to an adjacent block activity of a block adjacent to the target pixel.

When a picture is adjacent to a flat block having low block activity, on its boundary, a continuous edge of brightness (hue) often occurs. In such a case, therefore, by detecting that an adjacent block is flat, the flatness of filtering characteristics of a point at which the flat block touches is enhanced to blur the boundary.

According to an eighth first aspect of the present invention, a picture signal smoothing device in which a filtering of a sampled and digitized picture signal is performed by a smoothing filter, includes means for dividing a picture to be filtered into blocks; means for detecting whether a target pixel exists on a block boundary; means for performing a filtering whose edge preserving property is weakened, if the target pixel exists on a block boundary; and means for performing a filtering having edge preserving property if the target pixel exists inside a block.

Therefore, by enhancing the edge preserving property inside a block and weakening it on a block boundary, it is possible to perform a filtering that retains edge being important element of a picture signal as much as possible.

According to a ninth aspect of the present invention, the picture signal smoothing device of the eighth aspect includes means for dividing a picture to be filtered into blocks; means for detecting whether a target pixel exists on a block boundary; means for computing the activity of the target pixel from the target pixel value and its surrounding pixels values; and means that if the target exists on a block boundary, appropriately changes the strength of edge preserving property of a filter according to the activity of the target pixel.

When a target pixel exists on a block boundary and its activity is high, a step often occurs on the block boundary. In such a case, therefore, by increasing the flatness of smoothing characteristics and the proportion of smoothing characteristics in filtering characteristics, such a step can be erased.

According to a tenth aspect of the present invention, the picture signal smoothing device of the eighth aspect includes means for dividing a picture to be filtered into blocks; means for detecting whether a target pixel exists on a block boundary; means for detecting whether a block boundary on which the target pixel exists, continues horizontally or vertically; and means for appropriately changing the strength of edge preserving property according to the direction of the block boundary to which the target pixel belongs.

Since a block noise occurs in the direction that a block boundary continues, by less preserving edge in that direc-

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tion, it is possible to erase a block noise while strongly preserving an edge being vertical with respect to the block boundary.

According to an eleventh aspect of the present invention, a picture signal smoothing method in which a smoothing process is performed by applying a smoothing filter that performs a filtering of a sampled and digitized picture signal by weighted mean of a target pixel and its surrounding pixels, includes the steps of detecting a difference between a target pixel and its surrounding pixels; taking the absolute value of the difference; adding a non-negative value (m) to the absolute value of the difference thus detected; taking the inverse number (weighting factor) of the value after the adding; multiplying the value after taking of the inverse number and the surrounding pixels values together; taking a sum (A) of the value after the multiplying; taking a sum (B) of the inverse number (the weighting factor) alone; and dividing the sum (A) by the sum (B) of the weighting factor and normalizing (A/B).

Since the smoothing is performed by the inverse number of a difference value, if a target pixel is an isolated point, a difference value between the target pixel and each of its surrounding pixels is great, so that the entire surrounding has a similar weight. In the case where an edge exist near a target pixel, although the difference between the target pixel and the edge is great, the difference between the target pixel and its surrounding pixel except the edge is small. This leads to a constitution in which a weighted mean is taken such that the weight of the edge side is small. A continuous edge can be preserved by this constitution, and the isolated point can be smoothed. In addition, by adding a non-negative value, the degree of noise influence can be controlled in the operation, and there is no possibility that the operation result after taking the inverse number is infinity.

According to a twelfth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of diving a picture to be filtered into blocks; and appropriately changing a non-negative value to be added to the difference value between the target pixel and its surrounding pixels, according to the roughness of quantizing parameter in each block, which is represented by quantizing characteristics utilized in encoding and decoding each block of a picture signal.

Therefore, by controlling a non-negative value that is added prior to taking the inverse number in computing a weighting factor, using quantizing parameter, it is possible to erase noise that enlarges with enlarging quantizing error.

According to a thirteenth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of dividing a picture being to be filtered into blocks; computing a block activity indicating a change degree of a pixel, by block; and appropriately changing a non-negative value to be added to a difference value between the target pixel and its surrounding pixels, according to the respective block activity.

When a picture is flat and has low block activity, it is easy to observe noise. In such a case, however, it is possible to prevent noise from being recognized by enlarging a noise recognizable width and enhancing flat smoothing characteristics.

According to a fourteenth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of dividing a picture to be filtered into blocks; detecting whether a target pixel exists on a block boundary; if the target pixel exists on a block boundary, detecting a block activity (adjacent block activity) of a block adjacent to the block boundary; appropriately changing a non-negative value to be added to the difference value between the target pixel and its surrounding pixels, according to the adjacent block activity.

When a picture is adjacent to a flat block, on its boundary, a continuous edge of brightness (hue) often occurs. In such a case, therefore, by detecting that an adjacent block is flat having low block activity, the flatness of the smoothing characteristics of a point at which the flat block touches is enhanced to blur the step on the boundary.

According to a fifteenth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of dividing a picture to be filtered into blocks; mixing a signal value after the smoothing process by block, and a signal value prior to the smoothing process; and appropriately changing the mixing ratio according to the roughness of quantizing parameter of each block, which is represented by quantizing characteristics utilized in encoding and decoding each block of a picture signal.

Therefore, the constitution in which the final filtering value of a target pixel is obtained by mixing the smoothed signal value and the signal value prior to the smoothing, allows to change the filtering characteristics of each picture block, according to the respective pixel character. When the quantizing parameter is 1, no quantizing error occurs, and therefore, no further process is required against the value after the final filtering, that is, the previous signal can be utilized as it is. This leads to the constitution that the mixing ratio is controlled by the quantizing parameter, and it is possible that a smoothed signal value is not utilized in the filtering.

According to a sixteenth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of dividing a picture being to be filtered into blocks; mixing a signal value after the smoothing process by block, and a signal value prior to the smoothing process; and appropriately changing the mixing ratio according to the respective block activity in a picture signal.

Thus, for a flat block having low block activity, by making the final filtering value include more smoothed and flat signal values, it is possible to erase noise being noticeable in a flat block.

According to a seventeenth aspect of the present invention, the picture signal smoothing method of the eleventh aspect includes the steps of dividing a picture to be filtered into blocks; mixing a signal value after the smoothing proc-

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ess by block, and a signal value prior to the smoothing process; detecting whether a target pixel exists on a block boundary; and if the target pixel exists on a block boundary, appropriately changing the mixing ratio according to an adjacent block activity of an adjacent block that touches the target pixel.

When a picture is adjacent to a flat block having low block activity, on its boundary, a continuous edge of brightness (hue) often occurs. In such a case, therefore, by detecting that an adjacent block is flat, the flatness of the filtering characteristics of a point at which the flat block touches is enhanced to blur the boundary.

According to an eighteenth aspect of the present invention, a picture signal smoothing method in which a filtering of a sampled and digitized picture signal is performed by a smoothing filter, includes the steps of dividing a picture to be filtered into blocks; detecting whether a target pixel exists on a block boundary; performing a filtering whose edge preserving property is weakened, if the target pixel exists on a block boundary; and performing a filtering having edge preserving property if the target pixel exists inside a block.

Therefore, by enhancing edge preserving property inside a block and weakening it on a block boundary, it is possible to perform a filtering that retains edge being important element of a picture signal as much as possible.

According to a nineteenth aspect of the present invention, the picture signal smoothing method of the eighteenth aspect includes the steps of dividing a picture to be filtered into blocks; detecting whether a target pixel exists on a block boundary; computing an activity of the target pixel from the target pixel value and its surrounding pixels values; and appropriately changing the strength of edge preserving property of a filter according to the activity of the target pixel, if the target pixel exists on a block boundary.

When a target pixel exists on a block boundary and its activity is high, a step often occurs on the block boundary. In such a case, therefore, by increasing the flatness of smoothing characteristics and the proportion of smoothing characteristics in filtering characteristic, such a step can be erased.

According to a twentieth aspect of the present invention, the picture signal smoothing method of the eighteenth aspect includes the steps of dividing a picture to be filtered into blocks; detecting whether a target pixel exists on a block boundary; detecting whether a block boundary at which the target pixel exists, continues horizontally or vertically; and appropriately changing the strength of edge preserving property according to the direction of the block boundary to which the target pixel belongs.

Since a block noise occurs in the direction that a block boundary continues, the employment of a filter that weakly preserves the edge in that direction, allows to erase a block noise while strongly preserving the edge being vertical with respect to the block boundary.

According to a twenty-first aspect of the present invention, a picture encoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, is characterized in that a filter having edge preserving property is employed as the above filter, and a picture signal after being processed in a picture signal smoothing device is input, as a local decoding signal, to the frame memory storing a picture signal of the previous frame.

Thus, the construction that a pixel value after the filtering is written to a decoded signal in the frame memory, allows to reduce a block noise while retaining edge, to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a twenty-second aspect of the present invention, the picture encoding device of the twenty-first aspect includes means for dividing a picture into blocks and computing an inter-frame difference by block; means for determining whether the difference exceeds a certain threshold value; and means that only when the difference exceeds the threshold value, the corresponding block is processed by a filter having edge preserving property.

When there exists a picture block to which no additional difference component is added (i.e., a picture block signal that has been filtered and stored in the frame memory), by not making another filtering against the identical picture, a picture blur can be prevented.

According to a twenty-third aspect of the present invention, a picture encoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, includes means for computing a motion vector; means for reading a picture value stored in the frame memory with consideration of the motion vector; and a filter having edge preserving property, which filter processes an output signal of the frame memory.

Therefore, the feature that an in-loop filter inside an encoding loop is constituted by the above filter, enables to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a twenty-fourth aspect of the present invention, a picture decoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, is characterized in that a filter having edge preserving property is employed as the above filter, and a picture signal after being processed in a picture signal smoothing device is input, as a local decoding signal, to the frame memory storing

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the picture signal of the previous frame.

Therefore, the construction that a pixel value after the filtering is written to a decoded signal in the frame memory, allows to reduce a block noise while retaining edge, to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a twenty-fifth aspect of the present invention, the picture decoding device of the twenty-fourth aspect includes means for dividing a picture into blocks and computing an inter-frame difference by block; means for determining whether the difference exceeds a certain threshold value; and means that only when the difference exceeds the threshold value, the corresponding block is processed by a filter having edge preserving property.

In the case where there exists a picture block to which no additional difference component is added (i.e., a picture block signal that has been filtered and stored in the frame memory), by not performing another filtering against the identical picture, a picture blur can be prevented.

According to a twenty-sixth aspect of the present invention, a picture decoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, includes means for computing a motion vector; means for reading a picture value stored in the frame memory with consideration of the motion vector; and a filter having edge preserving property, which filter processes an output signal of the frame memory.

Therefore, the feature that an in-loop filter inside an encoding loop is constituted by the above filter, enables to decrease predictive error in input picture signal between the present frame and the next frame, and to realize a picture signal decoding that reduces transmission bit quantity.

According to a twenty-seventh aspect of the present invention, a picture encoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, includes the steps of performing a process using a filter having edge preserving property; and inputting a picture signal after being processed in a picture signal smoothing device to the frame memory storing a picture signal of the previous frame, as a local decoding signal.

Therefore, the feature that an in-loop filter inside an encoding loop is constituted by the above filter, enables to decrease a block noise while retaining edge, to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a twenty-eighth aspect of the present invention, the picture encoding method of the twenty-seventh aspect includes the step of dividing a picture into blocks and computing an inter-frame difference by block; the step of determining whether the difference exceeds a certain threshold value; and the step in which only when the difference exceeds the threshold value, such a block is processed by a filter having edge preserving property.

In the case where there exists a picture block to which no additional difference component is added (i.e., a picture block signal that has been filtered and stored in the frame memory), by not performing another filtering against the identical picture, a picture blur can be prevented.

According to a twenty-ninth aspect of the present invention, a picture encoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, includes the steps of computing a motion vector; reading a picture value stored in a frame memory with consideration of a motion vector; and processing an output signal of the frame memory by using a filter having edge preserving property.

Therefore, the feature that an in-loop filter inside an encoding loop is constituted by the above filter, enables to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a thirtieth aspect of the present invention, a picture decoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, includes the steps of performing a process using a filter having edge preserving property; and inputting a picture signal after being processed in a picture signal smoothing device to the frame memory storing the picture signal of the previous frame, as a decoded signal.

Therefore, the construction that a pixel value after the filtering is written to a decoded signal in the frame memory, allows to reduce a block noise while retaining edge, to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

According to a thirty-first aspect of the present invention, the picture decoding method of the thirtieth aspect includes the step of dividing a picture into blocks and computing an inter-frame difference by block; the step of determining whether the difference exceeds a certain threshold value; and the step that only when the difference exceeds the threshold value, the corresponding block is processed by a filter having edge preserving property.

In the case where there exists a picture block to which no additional difference component is added (i.e., a picture

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block signal that has been filtered and stored in the frame memory), by not performing another filtering against the identical picture, a picture blur can be prevented.

According to a thirty-second aspect of the present invention, a picture decoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal corresponding to one or a plurality of frames or fields, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, includes the steps of computing a motion vector; reading a picture value stored in the frame memory with consideration of the motion vector; and processing an output signal of the frame memory by using a filter having edge preserving property.

Therefore, the features that an in-loop filter inside an encoding loop is constituted by the above filter, enables to decrease predictive error in input picture signal between the present frame and the next frame, and to reduce transmission bit quantity.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating an inter-frame encoding system to which the present invention is applied.
Figure 2 is a block diagram illustrating a constitution of a smoothing filter of the present invention.
Figure 3 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 4 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 5 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 6 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 7 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 8 is a block diagram of a further constitution that is added to the smoothing filter of Figure 2.
Figure 9 is a block diagram of a constitution of the smoothing filter of the present invention.
Figure 10 is a block diagram of a further constitution of the smoothing filter of the present invention.
Figure 11 is a block diagram of a further constitution of the smoothing filter of the present invention.
Figure 12 is a block diagram of a further constitution of the smoothing filter of the present invention.
Figure 13 is a detail flow chart of a filter controlling of the present invention.
Figure 14 is a detail flow chart of a further filter controlling of the present invention.
Figure 15 is a detail flow chart of a further filter controlling of the present invention.
Figure 16 is a detail flow chart of a further filter controlling of the present invention.
Figure 17 is a detail flow chart of a further filter controlling of the present invention.
Figure 18 is a detail flow chart of a further filter controlling of the present invention.
Figure 19 is a schematic flow chart of a further filter controlling of the present invention.
Figure 20 is a diagram illustrating block dividing and adjacent blocks adjacent to a target pixel.
Figure 21 is a diagram illustrating local regions of the equations (1), (2) and (7).
Figure 22 is a diagram explaining one example of IE84-46 in the TECHNICAL REPORT OF IEICE.
Figure 23 is a diagram explaining filter coefficients of the H. 261 standard.
Figure 24 is a block diagram of an inter-frame encoding system to which a prior art filtering system is applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A description will be given of embodiments of the present invention, referring to Figure 1 through Figure 20.

[Embodiment 1]

In order to reduce deterioration of a decoded picture and suppress a decrease of resolution of the entire picture, the embodiment 1 of the present invention has a constitution in which after adding a non-negative value to a difference value between a decoded target pixel and its surrounding pixel, an inverse number is taken and, there is employed a smoothing filter that utilizes such an inverse number as a weight and has edge preserving property. In this smoothing filter, a smoothing is performed by the inverse number of a difference value, and therefore, if a target pixel is an isolated point, the difference between the target pixel and every surrounding pixel is great and all surrounding pixels have a similar weight. If there is an edge adjacent to a target pixel, a difference between the target pixel and the edge is great, but the difference between the target pixel and the surrounding pixel except the edge is small. This leads to a constitution in which a weighted mean is taken so that the weight of the edge side is small. A continuous edge can be preserved by this constitution, and the isolated point can be smoothed. By controlling a non-negative value that is added prior to taking the inverse number in computing a weighting factor, it is possible to erase noise of not more than a certain value, as well as quantizing error. Further, the use of the above smoothing filter enables to greatly reduce distortion occurred on block boundaries, leading to much visual improvement of picture quality. Furthermore, since in the smoothing process, characteristics of the smoothing filter is changed according to the roughness of a decoded parameter and the activity

of a picture signal, it is possible to suppress deterioration of resolution of the entire decoded picture, to obtain a decoding picture that is visually legible and has high quality.

Figure 1 is a block diagram of a picture encoding and decoding device in the present invention. There are indicated the positions of an in-loop filter 23 and a postfilter 26, in addition to the constitution as previously described in the prior art.

Figure 2 shows a constitution of a block of a smoothing filter that is installed in the in-loop filter 23 or the postfilter 26 in Figure 1. A difference circuit 231 detects a difference between a target pixel value and its surrounding pixel value, and an absolute value circuit 232 takes the absolute value of the detected difference. The absolute value is added to a non-negative value m in an adder 233, and the inverse number of a resultant value thus added is taken in an inverse number circuit 234, to obtain a weighting factor. The weighting factor is multiplied by the surrounding pixel value in a multiplier 235. A sum circuit 236 takes the sum of the multiplied values. A sum circuit 237 takes the sum of the weighting factors. The sum taken in the sum circuit 236 is divided by the sum taken by the sum circuit 237, to obtain a smoothed pixel value.

Figure 3 shows a constitution added to the smoothing filter in Figure 2. A picture block divider 2331 divides a picture to be filtered into blocks. A quantizing parameter for each picture of a block thus divided is computed in a quantizing parameter computer 2332. According to roughness of the quantizing parameter, a non-negative added value variant part 2333 changes a non-negative value m to be added in the adder 233.

Figure 4 shows a further constitution to be added to the smoothing filter in Figure 2. A block activity computer 2334 computes an activity of each picture in a divided block. According to the block activity, the non-negative added value variant part 2333 changes a non-negative value m to be added in the adder 233 in Figure 2.

Figure 5 shows a further constitution to be added to the smoothing filter in Figure 2. A pixel position detector 2335 detects whether a target pixel exists on a block boundary. If the target pixel exists on the block boundary, the block activity computer 2334 detects the activity of a block adjacent to the target pixel, and the non-negative added value variant part 2333 changes a non-negative value m to be added in the adder 233 in Figure 2.

Figure 6 shows a further constitution to be added to the smoothing filter in Figure 2. The quantizing parameter computer 2332 computes a quantizing parameter of each block in a picture signal. According to roughness of the respective quantizing parameter, a signal mixer 2336 appropriately changes the mixing ratio of a signal value after being smoothed by block in a picture signal, and a signal value before being smoothed.

Figure 7 shows a further constitution to be added to the smoothing filter in Figure 2. The block activity computer 2334 computes the activity of each block in a picture signal. According to the respective activity, the signal mixer 2336 appropriately changes the mixing ratio of a signal value after being smoothed by block in a picture signal, and a signal value before being smoothed.

Figure 8 shows a further constitution to be added to the smoothing filter in Figure 2. The pixel position detector 2335 detects whether a target pixel exists on a block boundary. If the target pixel is in such a position that it contacts with the block boundary, the signal mixer 2336 appropriately changes the mixing ratio of a signal value after being smoothed by block in a picture signal, and a signal value before being smoothed.

Figure 9 shows a constitution of the smoothing filter in Figure 2. The pixel position detector 2335 detects whether a target pixel exists on a block boundary. If the target pixel exists on the block boundary, there is selected a filter circuit 2337 that performs a smooth filtering whose edge preserving property is weakened. If the target pixel exists inside a block, there is selected a filter circuit 2338 that performs a smooth filtering having edge preserving property.

Figure 10 shows a further constitution of the smoothing filter in Figure 2. The pixel position detector 2335 detects whether a target pixel exists on a block boundary. If the target pixel exists on the block boundary, the activity computer 2340 computes the activity of the target pixel from the target pixel value and its surrounding pixel value. According to the activity, the filter circuit 2337 that performs a smooth filtering whose edge preserving property is weakened, or the filter circuit 2338 that performs a smooth filtering having edge preserving property is selected.

Figure 11 shows a further constitution of the smoothing filter in Figure 2. The pixel position detector 2335 detects whether a target pixel exists on a block boundary. If the target pixel exists on the block boundary, a boundary continuous direction detector 2341 detects whether the block boundary to which the target pixel belongs continues horizontally or vertically. According the direction of the block to which the target pixel belongs, the filter circuit 2337 that performs a smooth filtering whose edge preserving property is weakened, or the filter circuit 2338 that performs a smooth filtering having edge preserving property is selected.

Figure 12 shows a constitution in which the picture encoding and decoding device in Figure 1 or the smoothing filter in Figure 2 through Figure 11 is realized by software. A picture input part 300 inputs a picture data. The input picture data is input directly to a CPU 100 via a bus 150, alternatively, after the input picture data is stored in a picture memory 200, it is read from the picture memory 200 and input to the CPU 100. The picture data input to the CPU 100 is processed by software and input directly to a picture output part 400 via the bus 150, alternatively, after the input picture data is stored in the picture memory 200, it is read from the picture memory 200 and input to the picture output part 400.

In order to clarify the definition of the technique of the embodiment 1 of the present invention, similar equations as defined in the description of the prior art will be defined here.

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Assuming that a local region of the surrounding of a target pixel (hereinafter referred to as "local region") is a picture region of 3×3 pixels as shown in Figure 21, and that a region in which σ_b^2 (block activity) is computed is a region (hereinafter referred to as "picture block") of 8×8 pixels in which DCT operation as shown in Figure 20 is performed, a quantizing parameter in decoding is stored by picture block.

Against each of the entire pixels of a decoded picture, a local average value $\langle d(x, y) \rangle$ is defined in a local region as shown in Figure 21, based on the equation (12).

In taking the sum Σ of the local average values, if the value is outside of the range of the picture region depending on the values of i and j, the value of the target pixel is employed. Note that d(x, y) is a decoded pixel value of the coordinate (x, y).

$$\langle d(x, y) \rangle = \frac{1}{9} \sum_{i=-1}^{+1} \sum_{j=-1}^{+1} d(x+i, y+j) \tag{12}$$

Then, a dispersion of each pixel (hereinafter referred to as "local activity"), as defined by the equation (13), is obtained in the local region. Here, the sum of the square of the difference between the local region and the local average of the equation (12) is obtained as the definition of the dispersion. This definition is given to every pixel as in the equation (12).

$$\sigma_d^2(x, y) = \frac{1}{9} \sum_{i=-1}^{+1} \sum_{j=-1}^{+1} (d(x+i, y+j) - \langle d(x, y) \rangle)^2 \tag{13}$$

Picture block dispersion (hereinafter referred to as "block activity") is defined by the equation (14). The block activity is defined by block, as shown in Figure 20.

$$\sigma_b^2[bn] = \frac{1}{64} \sum_{t=0}^{+7} \sum_{k=0}^{+7} \sigma_d^2(x_b+k, y_b+1) \tag{14}$$

wherein x_b, y_b are values of the upper left corner coordinate that belongs to the picture block number b_n.

An m(x, y), d(x, y) and $\langle s(x, y) \rangle$ are respectively a corrected pixel value, a decoded pixel value and a pixel value that has been smoothed by local region.

$$m(x, y) = (1-\lambda)\, d(x, y) + \lambda s(x, y) \tag{15}$$

Here, λ is a mixing ratio of a decoded value and a value smoothed by local region. The mixing ratio is defined by the following equations (16) to (18), wherein QP is a quantizing parameter in decoding, σ_b^2 is a block activity computed by the equation (14).

If the quantizing parameter is great, quantizing error is liable to occur. If the block activity of a decoded picture is great, many steps of a pixel value present. For this, it is so constituted that the smoothing characteristics is enhanced. Thus it is possible to change filtering characteristics by picture block, depending on each pixel character. Additionally, when the quantizing parameter is 1, no quantizing error occurs, so that the value after the final filtering can be held at a signal prior to the smoothing process. As a result, the constitution in which the mixing ratio is controlled by quantizing parameter, enables to prevent a smoothed signal value from being utilized in the filtering, allowing to skip the filtering process. Therefore, when the device is constituted by CPU or DSP, its processing time can be reduced.

In a flat block having low block activity, by making the final filtering value contain smoothed and flat signals as much as possible, it is possible to erase noise being noticeable in a flat block.

$$\lambda = \sqrt{\left(\frac{QP[bn]}{31} \times \frac{\sigma_b^2[bn]}{\delta_1}\right)} \tag{16}$$

A decoded value d(x, y) in the coordinate (x, y) is not included in the smoothing of the second term s(x, y) in the right side as defined in the equation (15). From the definitions of the equations (18) and (21), the pixel value of a target

position d(x, y) is not included in the pixel value s(x, y) after the smoothing. Therefore, the range of the value λ is as set below.

$$0 \leqq \lambda \leqq \lambda_{max} \tag{17}$$

When λ of the equation (16) results in underflow with a value in the range of the equation (17), it is fixed at the minimum value. In overflow, it is fixed at the maximum value.

Next defined is a pixel value computing of a smoothing of the second term in the right side as employed in the equation (15).

The smoothing is to take a weighted mean of a surrounding pixel according to a weight as defined in the equation (21). Since the weight is defined by the inverse number of a difference between pixel values, a place such as an edge in which the difference between pixel values is great, has no influence on the smoothing. That is, the smoothing is so performed that edge is preserved.

$$s(x, y) = \frac{\sum_{i=-1}^{+1}\sum_{j=-1}^{+1} w(i, j)\, d(x+i, y+j)}{\sum_{i=-1}^{+1}\sum_{j=-1}^{+1} w(i,j)} \tag{18}$$

A difference from a surrounding pixel of the coordinate (x, y) is taken by local region and, for normalization, a non-negative number m is added to the absolute value of the difference from each pixel. By the action of this term, even if d(x, y)-d(x+i, y+j)=0 , there is no possibility that the equation (21) becomes infinity.

Further, when the difference value from the surrounding pixel is m or less, by the action of this term, a value near a simple average of the surrounding pixels is to be computed.

Thus, since the smoothing is performed by the inverse number of the difference value as previously described, a continuous edge can be preserved by this constitution, and an isolation point can be smoothed. Furthermore, by adding a non-negative value, it is possible that the operation result after taking the inverse number will be infinity.

$$\Delta D_{ij}(x, y) = |d(x+1, y+j)-d(x, y)|+m \tag{19}$$

If the value m of the second term in the right side is great, there functions to mask a pixel value difference (the first term in the right side) being the edge preserving effect. Although the mask value may be replaced with a fixed value, in order that the change of quantizing error is reflected, it is controlled by the quantizing parameter as indicated in the equation (20). This enables to erase noise that enlarges with enlarging the quantizing error.

$$m = \frac{QP[bn]}{2} \tag{20}$$

$$w(i, j) = \frac{1}{\Delta D_{ij}(x, y)} \tag{21}$$

(i, j = -1, 0, +1; and w(0, 0) = 0)

When block distortion occurs, the local activity δ_b^2 is 0, inside a block. A pixel on a block boundary has a great local activity because a surrounding pixel touches an adjacent block to cause a step. In such circumstances, however, since an average is taken by block, the block activity δ_b^2 is below a certain threshold value δ_2. In order to strongly erase a block distortion, an additional limiting item is set to λ being computed by the equations (16) and (17). This enables to enlarge a noise recognizable width and enhance flat smoothing characteristics, thereby preventing noise from being recognized.

When

$$\sigma_b^2[bn] \leqq \delta_2,\ m=QP[bn],\ \lambda=\lambda_{max} \tag{22}$$

If a target pixel exists on a block boundary and is under the following conditions of (i) and (ii), the smoothing characteristics is enhanced. These conditions leads to such a filtering that the edge preserving property is strong inside a block and is weak on a block boundary.

Therefore, if a picture is adjacent to a flat block, it is detected that such an adjacent block is flat and has low block

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activity, so that the flatness of the smoothing characteristics of a point at which the flat block touches, is increased to blur a predictable boundary step.

If a picture is adjacent to a flat block having low block activity, it is detected that such an adjacent block is flat, so that the flatness of the smoothing characteristics of a point at which the flat block touches, is increased to blur a predictable boundary step.

If a target point exists on a block boundary and has high activity, the flatness of the smoothing characteristics and the proportion of the smoothing characteristics in filtering characteristics are increased to erase a predictable step.

$$m = QP[bn],\ \lambda = \lambda_{max} \tag{23}$$

(i) In the case where a block activity of a block adjacent to a picture block to which a target pixel touches is lower than a certain threshold value δ_2.

In the equation (22), only an activity of a block to which a target pixel belongs is determined. The conditions (i) determines an activity of an adjacent block.

In Figure 20, provided that the number 30 is a target pixel, the number 31 is an adjacent block.

(ii) In the case where a local activity of a target pixel is higher than a certain threshold value δ_3. This corresponds to the case where a waveform that is composed of a frequency component having a high rectangular conversion (DCT conversion), is cut on a block boundary, and a step occurs between the waveform and an adjacent block.

Each example of the threshold values λ_{max}, δ_1, δ_2 and δ_3 is as below.

$$\lambda_{max} = 0.75 \tag{24}$$

$$\delta_1 = \frac{\sigma_{pic}}{25} \times \sigma_{pic} \tag{25}$$

$$\delta_2 = 75 \text{ for a brightness (Y)}$$

$$\delta_2 = 30 \text{ for a hue (U, V)} \tag{26}$$

$$\delta_3 = 35 \times \delta_{pic} \tag{27}$$

$$\sigma_{pic} = \frac{1}{M \times N} \sum_{M} \sum_{N} \sigma_b^{\,2}[bn] \tag{28}$$

wherein σ_{pic} is a mean of block activities in the entire picture; M is the block number in the horizontal direction; and N is the block number in the vertical direction.

When a picture is divided into blocks of 8×8, x of the coordinate (x, y) is a multiple of 8, or a surplus of the multiple of 8 is 7, there exists a block boundary that continues in the vertical direction.

Similarly, when y is a multiple of 8, or a surplus of the multiple of 8 is 7, there exists a block boundary that continues in the horizontal direction.

(iii) In the case where a target pixel belongs to a block boundary, and its local activity is higher than δ_3

Since it is determined that a block noise occurs on a block boundary, the above equations (19) and (20) should be newly defined as follows:

$$\Delta D_{ij}(x, y) = |d(x+1, y+j) - d(x, y)| + m(i, j) \tag{29}$$

$$m(i, j) = QP[bn]\ (i, j = -1, 0, +1) \tag{30}$$

When a coordinate where the block boundary that continues in the horizontal direction, is under the above conditions (iii), a horizontal block noise occurs, to weak smoothing characteristics of a pixel horizontally adjacent to a target pixel.

When

$$i=0;\ \text{and}\ j=-1, +1,\ m(0, j)=2\times QP[bn] \tag{31}$$

Similarly, for a vertical block noise:

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When

$$i=-1, +1; \text{ and } j=0, m(i, 0)=2\times QP[bn] \quad (32)$$

The above constitution underestimates weighting factors of two pixels facing each other across a target pixel being parallel to a block noise. This leads to a strong function of filter characteristics in the vertical direction with respect to the block noise direction. This enables to erase block noise and strongly preserve an edge being vertical with respect to the direction of a block boundary. As a result, it is possible to perform such a filtering that retains edge being important element of a picture signal as much as possible.

The operation of the filter 23 or 26 in Figure 1 will be described in accordance with flow charts of Figures 13 through Figure 18, which illustrate the actual computing procedure for the device as shown in Figure 12.

In Step S1, against every pixel of a picture signal, a local mean $\langle d(x, y)\rangle$ for each pixel of a decoded picture is computed based on the equation (12).

In Step S2, similarly to S1, a local activity $\sigma_d^2(x, y)$ is computed based on the equation (13).

In Step S3, a block activity $\sigma_b^2[bn]$ for each picture block of 8×8 dot is computed based on the equation (14), and a quantizing parameter QP[bn] is read in.

In Steps S4, S5 and S25, a loop is turned on every picture block. In each loop, the following calculations is made on each block.

In Step S6, a mixing ratio λ is computed based on the equation (16). At this time, δ_1 is a fixed value.

In Step S7, a non-negative value m is determined based on the equation (20).

In Steps S8 and S9, if a mixing ratio λ exceeds a limit range, the λ is limited to λ_{max} (see the equation (17)).

In Steps S10 and S11, if the block activity $\sigma_b^2[bn]$ of a picture block as computed in S3 is not more than a certain threshold value δ_2, it is replaced with $\lambda=\lambda_{max}$, m=QP[bn], as indicated in the equation (22).

In Steps S12, S13, S14, S21, S22, S23 and S24, a loop is turned on every pixel in a picture block. Variables k and l are incremental in x and y directions, respectively. Since the size of the picture block is 8×8, there increases in a range of 0 to 7. Each of x_b and y_b is the upper left corner coordinate in a target pixel block.

In Step S16, it is determined whether when the variables k and l are 0 or 7, a target pixel exists on a block boundary as shown by the circles in Figure 20.

In Steps S26, S27 and S28, when the variable l is 0, the target pixel is at the upper side of a target block B_{11} in Figure 20. Therefore, if a block B_{01} adjacent to the upper side of the target block is $\sigma_b^2[bn-M] \leqq \delta_2$, there is replaced with $\lambda=\lambda_{max}$, m=QP[bn] (see the equation (23) and the conditions (i)).

In Steps S29, S30 and S31, when the variable k is 7, the target pixel is at the right side of the target block B_{11}. Therefore, a block B_{12} adjacent to the right of the target block is $\sigma_b^2[bn+1] \leqq \delta_2$, there is replaced with $\lambda=\lambda_{max}$, m=QP[bn]

In Steps S32, S33 and S34, when the variable 1 is 7, the target pixel is at under side of the target block B_{11}. Therefore, if a block B_{21} adjacent to the bottom of the target block is $\sigma_b^2[bn+M] \leqq \delta_2$, there is replaced with $\lambda=\lambda_{max}$, m=QP[bn]

In Steps S35, S36 and S37, when the variable k is 0, the target pixel is at the left side of the target block B_{11}. Therefore, if a block B_{10} adjacent to the bottom of the target block is $\sigma_b^2[bn-1] \leqq \delta_2$, there is replaced with $\lambda=\lambda_{max}$, m=QP[bn].

In Steps 38 and S39, when the local activity $\sigma_d^2(x, y)$ is not less than the threshold value δ_3, there is replaced with $\lambda=\lambda_{max}$, m=QP[bn] (see the equation (23) and the condition (ii)).

In Step 17, setting the variable i and j be ±1, a difference between a target pixel and its surrounding pixel is computed, and a non-negative value m is added to the absolute value of the difference (see the equation (19)). The inverse number of the equation (19) is employed as a weight w(i, j) of the target pixel (see the equation (21)).

In Steps 18 and 19, the sum A of the product of the weight computed in S17 and a pixel value of a corresponding pixel is computed. The sum B of the weight is computed. Then, A/B is computed to obtain a smoothing value s.

In Step S20, as in the equation (15), a target pixel value and a smoothing value is mixed according to a mixing ratio λ, to obtain a pixel value of the filtered target pixel.

Figure 19 is a flow chart illustrating the outline of the processes shown in Figure 13 through Figure 18. Therefore, the corresponding relation alone is illustrated.

INSDOCID: <EP_____0772365A2_I_>

Table 1

Fig. 8	Figs. 2-7
S1	S1, S2, S3
S2	S6
S3, S4	S10, S11
S5, S12	S12, S13, S14, S21, S22, S23, S24
S6, S7, S8	S16, S26 to S39
S9	S17
S10	S18, S19
S11	S20

[Embodiment 2]

In the embodiment 2, a constitution shown by the solid line 17 in Figure 1 is replaced with that shown by a broken line 28. A filter having edge preserving property that is employed as the postfilter 26 is the same as described in the embodiment 1. This constitution allows to suppress a random noise that occurs in encoding and decoding of a picture, and also allows to smooth a picture signal and preserve edge. As a result, predictive error between the present picture signal and an input picture signal of the next frame can be decreased, and transmission bit quantity in encoding and decoding can be reduced.

A description will be given of a device and method that performs a processing in the case where a step computed by the subtracter 11 in Figure 1, is below a certain threshold value, that is, the case where a step is not encoded in the encoder 12 in Figure 1 (e.g., a meaningless block in the H. 261 standard). Therefore, this case corresponds to a picture of a corresponding picture block which has just being read from the frame memory 18 in Figure 1. In this case, the picture stored in the frame memory has already filtered by the previous frame. Thus, against the picture data of the frame memory itself, another filtering is unnecessary. Accordingly, a filtering having edge preserving property is performed only on a meaningful block whose step has been encoded, and therefore, another filtering is not performed on the identical picture, thereby preventing a picture blur.

A description will be given of the case where the smoothing method of the present invention is applied to an in-loop filter (i.e., reference numeral 23 in Figure 1) in the encoding part and the decoding part.

The numeral 20 in Figure 1 designates a picture signal given motion compensation. Therefore, a quantizing parameter and a block activity which are stored by block do not agree with a DCT block division. For this, the value λ in the equation (16) is fixed, and against the picture block given motion compensation, the equation (14) is computed from the equation (12). At this time, the motion compensation is computed using a pixel value that the frame memory stores prior to the filtering, and an input signal.

$$\lambda = \lambda_{fix} \tag{33}$$

When the block activity is smaller than a certain threshold value δ_2, provided that:

when

$$\sigma_b^2 \leqq \delta_2, \lambda=\lambda_{max}, m=\delta_4 \tag{34}$$

the mean square error (the equation (35)) of between the input picture and the frame memory is greater than the mean square error (the equation (36)) of the input picture and the frame memory after filtering, an in-loop filter in a decoding loop is constituted by the equations (15), (18) and (21).

$$MSE1 = \frac{1}{64}\sum_{i=0}^{+7}\sum_{k=0}^{+7}(d(x+1, y+k)-i(x+1, y+k))^2 \tag{35}$$

RNSDOCID: <EP 0772365A2 I >

$$MSE2 = \frac{1}{64}\sum_{i=0}^{+7}\sum_{k=0}^{+7}(m(x+1, y+k)-i(x+1, y+k))^2 \quad (36)$$

wherein d(x, y) is a picture value that is stored in the frame memory and given motion compensation; i(x, y) is an input picture signal; and m(x, y) is a picture value obtained by applying the filter of the present invention to a picture block given motion compensation.

Accordingly, the feature that the in-loop filter in the encoding loop and the decoding loop is constituted by the filter having edge preserving property, allows to reduce predictive error in input picture signal between the present frame and the next frame, thereby decreasing the transmission bit quantity.

An example of the equations (33) and (34) will be given below.

$$\lambda_{fix} = 0.5, \delta_4 = 8 \quad (37)$$

As described above, according to the embodiment 2, the smoothing filter greatly decreases distortion occurred on a block boundary, leading to much visual improvement of picture quality. Further, since the smoothing process is performed by changing the smoothing filter characteristics according to the roughness of a decoding parameter and the activity of a picture signal, it is possible to decrease the resolution of the entire decoded picture, leading to a decoded picture that has high quality and is visually legible. Furthermore, since the smoothing filter is used in a decoding loop, predictive difference signal becomes small, thereby reducing the transmission bit quantity.

Claims

1. A picture signal smoothing device that performs a smoothing process by applying a smoothing filter that performs a filtering of a sampled and digitized picture signal by weighted mean of a target pixel and its surrounding pixel, including:

   means for detecting a difference between the target pixel and the surrounding pixel;
   means for taking an absolute value of the difference;
   means for adding a non-negative value (m) to the absolute value of the difference thus detected;
   means for taking an inverse number (weighting factor) of the value after the adding;
   means for multiplying a value after taking of the inverse number, and the surrounding pixel value together;
   means for taking a sum (A) of a value after the multiplying;
   means for taking a sum (B) of the inverse number (the weighting factor) alone; and
   means for dividing the sum (A) by the sum (B) of the weighting factor and then normalizing (A/B).

2. A picture signal smoothing device according to claim 1 including:

   means for diving a picture to be filtered into blocks; and
   means for appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to roughness of quantizing parameter of each block, which is represented by quantizing characteristics utilized in encoding or decoding each block of a picture signal.

3. A picture signal smoothing device according to claim 1 including:

   means for dividing a picture to be filtered into blocks;
   means for computing block activity indicating a change degree of a pixel in each block; and
   means for appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to the block activity.

4. A picture signal smoothing device according to claim 1 including:

   means for dividing a picture to be filtered into blocks;
   means for detecting whether a target pixel exists on a block boundary;
   means that if the target pixel exists on a block boundary, detects a block activity of a block adjacent to the block boundary, i.e., adjacent block activity; and
   means for appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to the adjacent block activity.

Page 67 of 526

NSDOCID: <EP_____0772365A2_I_>

5. A picture signal smoothing device according to claim 1 including:

means for dividing a picture to be filtered into blocks;
means for mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process; and
means for appropriately changing the mixing ratio according to a roughness of quantizing parameter of each block, which is represented by quantizing characteristics utilized in encoding and decoding each block of a picture signal.

6. A picture signal smoothing device according to claim 1 including:

means for dividing a picture to be filtered into blocks;
means for mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process; and
means for appropriately changing the mixing ratio according to each block activity in a picture signal.

7. A picture signal smoothing device according to claim 1 including:

means for dividing a picture to be filtered into blocks;
means for mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process;
means for detecting whether a target pixel exists on a block boundary; and
means that if the target pixel exists on a block boundary, appropriately changes the mixing ratio according to an adjacent block activity of a block adjacent to the target pixel.

8. A picture signal smoothing device that performs a filtering of a sampled and digitized picture signal by a smoothing filter, including:

means for dividing a picture to be filtered into blocks;
means for detecting whether a target pixel exists on a block boundary;
means for performing a filtering whose edge preserving property is weakened, if the target pixel exists on a block boundary; and
means for performing a filtering having edge preserving property if the target pixel exists inside a block.

9. A picture signal smoothing device according to claim 8 including:

means for dividing a picture to be filtered into blocks;
means for detecting whether a target pixel exists on a block boundary;
means for computing an activity of the target pixel from the target pixel value and the surrounding pixel value; and
means that if the target exists on a block boundary, appropriately changes strength of edge preserving property of a filter according to the activity of the target pixel.

10. A picture signal smoothing device according to claim 8 including:

means for dividing a picture to be filtered into blocks;
means for detecting whether a target pixel exists on a block boundary;
means for detecting whether a block boundary at which the target pixel exists, continues either of horizontally and vertically; and
means for appropriately changing strength of edge preserving property according to a direction of a block boundary to which the target pixel belongs.

11. A picture signal smoothing method in which a smoothing process is performed by applying a smoothing filter that performs a filtering of a sampled and digitized picture signal by weighted mean of a target pixel and its surrounding pixel, including the steps of:

detecting a difference between a target pixel and its surrounding pixel;
taking an absolute value of the difference;
adding a non-negative value (m) to the absolute value of the difference thus detected;

BNSDOCID: <EP 0772365A2 I >

taking an inverse number (weighting factor) of a value after the adding;
multiplying a value after taking of the inverse number and the surrounding pixel value together;
taking a sum (A) of a value after the multiplying;
taking a sum (B) of the inverse number (the weighting factor) alone; and
dividing the sum (A) by the sum (B) of the weighting factor and then normalizing (A/B).

12. A picture signal smoothing method according to claim 11, including the steps of:

diving a picture to be filtered into blocks; and
appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to roughness of quantizing parameter of each block, which is represented by quantizing characteristics utilized in encoding and decoding each block of a picture signal.

13. A picture signal smoothing method according to claim 11 including the steps of:

dividing a picture to be filtered into blocks;
computing a block activity indicating a change degree of a pixel in each block; and
appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to the block activity.

14. A picture signal smoothing method according to claim 11 including the steps of:

dividing a picture to be filtered into blocks;
detecting whether a target pixel exists on a block boundary;
if the target pixel exists on a block boundary, appropriately changing a block activity of a block adjacent to the block boundary, i.e., adjacent block activity; and
appropriately changing a non-negative value to be added to the difference value between the target pixel and the surrounding pixel, according to the adjacent block activity.

15. A picture signal smoothing method according to claim 11 including the steps of:

dividing a picture to be filtered into blocks;
mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process; and
appropriately changing the mixing ratio according to a roughness of quantizing parameter of each block, which is represented by quantizing characteristics utilized in encoding and decoding each block of a picture signal.

16. A picture signal smoothing method according to claim 11 including the steps of:

dividing a picture to be filtered into blocks;
mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process; and
appropriately changing the mixing ratio according to each block activity in picture signal.

17. A picture signal smoothing method according to claim 11 including the steps of:

dividing a picture to be filtered into blocks;
mixing a signal value after the smoothing process by block and a signal value prior to the smoothing process;
detecting whether a target pixel exists on a block boundary; and
if the target pixel exists on a block boundary, appropriately changing the mixing ratio according to an adjacent block activity of a block adjacent to the target pixel.

18. A picture signal smoothing method in which a filtering of a sampled and digitized picture signal is performed by a smoothing filter, including the steps of:

dividing a picture to be filtered into blocks;
detecting whether a target pixel exists on a block boundary;
performing a filtering whose edge preserving property is weakened, if the target pixel exists on a block boundary; and

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performing a filtering having edge preserving property if the target pixel exists inside a block.

19. A picture signal smoothing method according to claim 18 including the steps of:

dividing a picture to be filtered into blocks;
detecting whether a target pixel exists on a block boundary;
computing an activity of the target pixel from a target pixel value and its surrounding pixel value; and
appropriately changing strength of edge preserving property of a filter according to the activity of the target pixel.

20. A picture signal smoothing method according to claim 18 including the steps of:

dividing a picture to be filtered into blocks;
detecting whether a target pixel exists on a block boundary;
detecting whether a block boundary at which the target pixel exists, continues either of horizontally and vertically; and
appropriately changing strength of edge preserving property according to a direction of a block boundary to which the target pixel belongs.

21. A picture encoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least frame and at least one field, and an inter-frame encoding between is performed by a corresponding pixel between an input signal and the frame memory, is characterized in that:

a filter having edge preserving property is employed as the above filter; and
a picture signal after being processed in a picture signal smoothing device is input to the frame memory storing a picture signal of a preceding frame, as a local decoding signal.

22. A picture encoding device according to claim 21 including:

means for dividing a picture into blocks and computing an inter-frame difference by block;
means for determining whether the difference exceeds a certain threshold value; and
means that only when the difference exceeds the threshold value, a corresponding block is processed by a filter having edge preserving property.

23. A picture encoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, including:

means for computing a motion vector;
means for reading a picture value stored in the frame memory with consideration of the motion vector; and
a filter having edge preserving property, which filter processes an output signal of the frame memory.

24. A picture decoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, is characterized in that:

a filter having edge preserving property is employed as the above filter; and
a picture signal after being processed in a picture signal smoothing device is input to a frame memory storing a picture signal of the previous frame, as a decoding signal.

25. A picture decoding device according to claim 24 including:

means for dividing a picture into blocks and computing an inter-frame difference by block;
means for determining whether the difference exceeds a certain threshold value; and
means that only when the difference exceeds the threshold value, a corresponding block is processed by a filter having edge preserving property.

26. A picture decoding device in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame decoding is performed by

BNSDOCID: <EP 0772365A2 I >

a corresponding pixel between an input signal and the frame memory, including:

means for computing a motion vector;
means for reading a picture value stored in the frame memory with consideration of the motion vector; and
a filter having edge preserving property, which filter processes an output signal of the frame memory.

27. A picture encoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, including the steps of:

performing a process using a filter having edge preserving property; and
inputting a picture signal after being processed in a picture signal smoothing device to the frame memory storing a picture signal of a preceding frame, as a local decoding signal.

28. A picture encoding method according to claim 27 including:

dividing a picture into blocks and computing an inter-frame difference by block;
determining whether the difference exceeds a certain threshold value; and
only when the difference exceeds the threshold value, a corresponding block is processed by a filter having edge preserving property.

29. A picture encoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame encoding is performed by a corresponding pixel between an input signal and the frame memory, including the steps of:

computing a motion vector;
reading a picture value stored in the frame memory with consideration of the motion vector; and
processing an output signal of the frame memory by using a filter having edge preserving property.

30. A picture decoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, including the steps of:

performing a process using a filter having edge preserving property; and
inputting a picture signal after being processed in a picture signal smoothing device to the frame memory storing a picture signal of a preceding frame, as a decoding signal.

31. A picture decoding method according to claim 30 including the steps of:

dividing a picture into blocks and computing an inter-frame difference by block;
determining whether the difference exceeds a certain threshold value; and
only when the difference exceeds the threshold value, a corresponding block is processed by a filter having edge preserving property.

32. A picture decoding method in which a filter is attached to a decoding loop having a frame memory for storing a signal that corresponds to either of at least one frame and at least one field, and an inter-frame decoding is performed by a corresponding pixel between an input signal and the frame memory, including the steps of:

computing a motion vector;
reading a picture value stored in the frame memory with consideration of a motion vector; and
processing an output signal of the frame memory by using a filter having edge preserving property.

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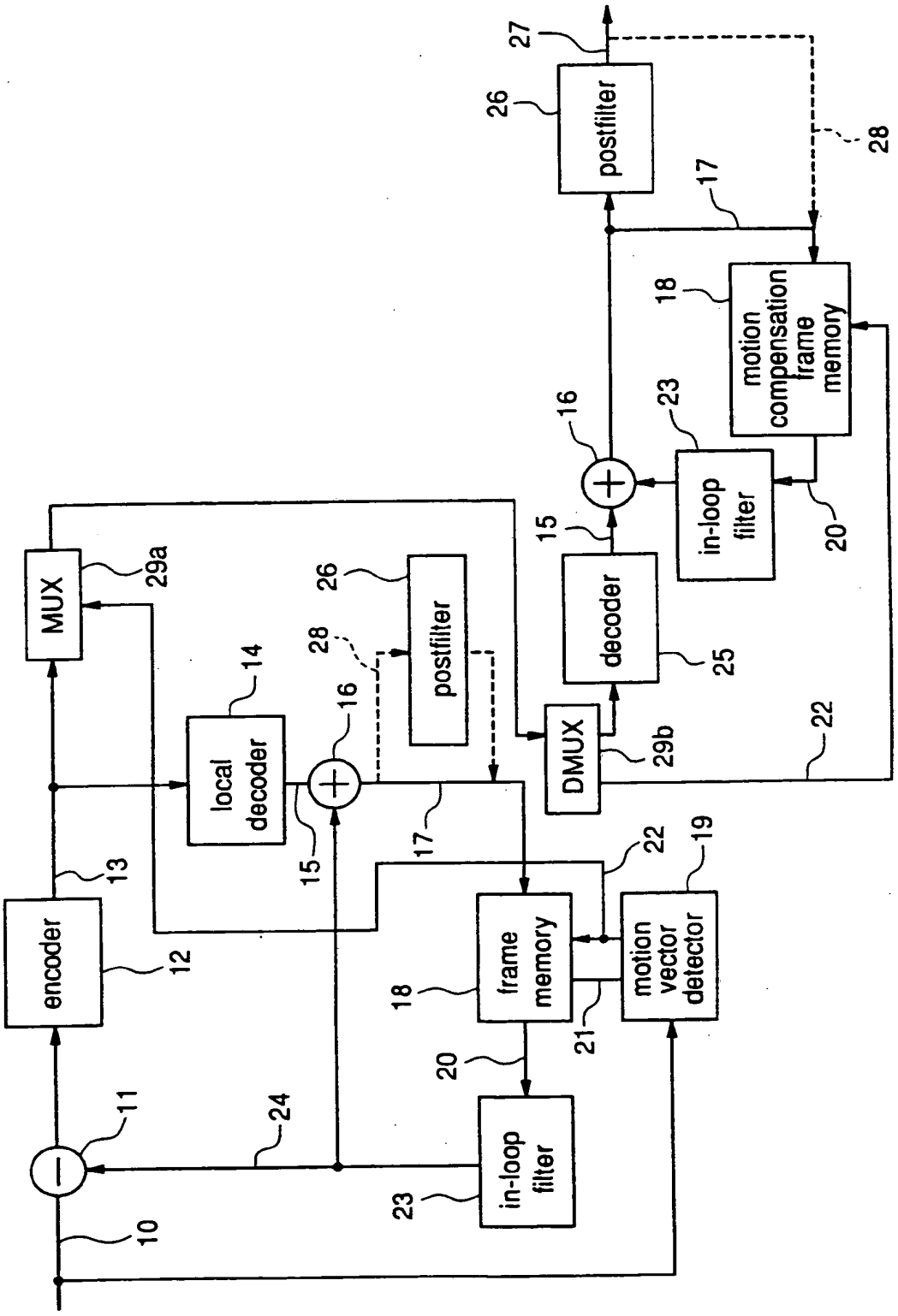

MUX
29a
encoder
12
13
local decoder
14
postfilter
26
28
16
15
17
DMUX
29b
decoder
25
postfilter
27
26
28
17
motion compensation frame memory
18
16
23
in-loop filter
20
15
22
19
frame memory
18
motion vector detector
21
20
in-loop filter
23
11
24
10

FIG.1

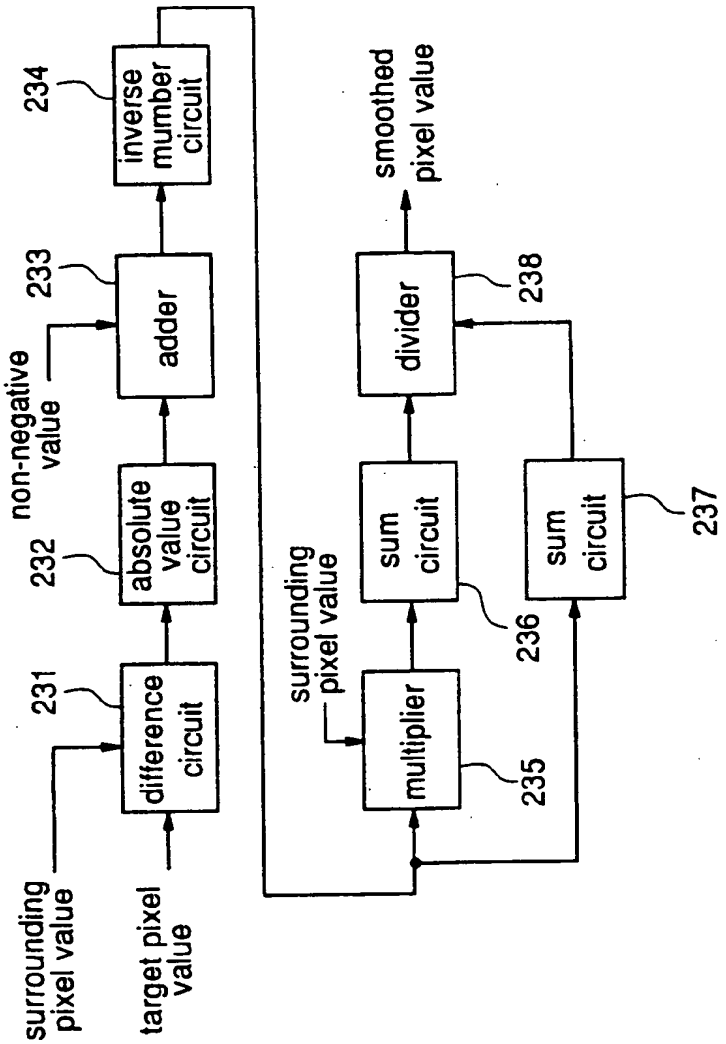


FIG.2

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FIG.3

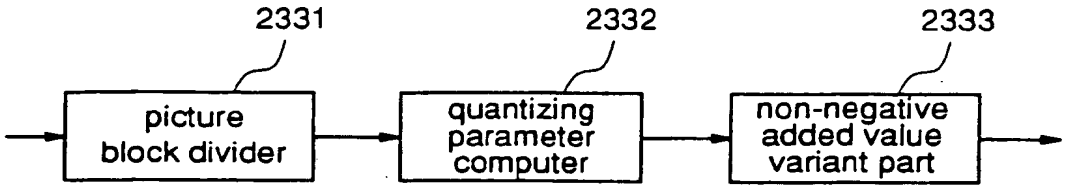


FIG.4

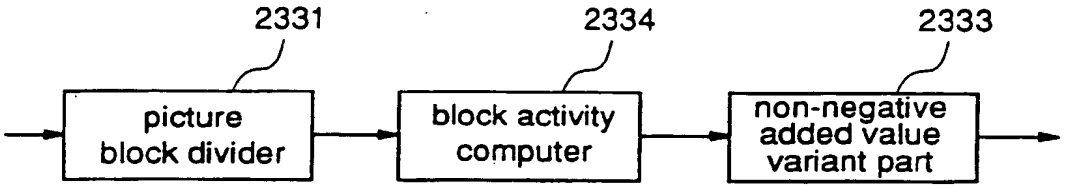
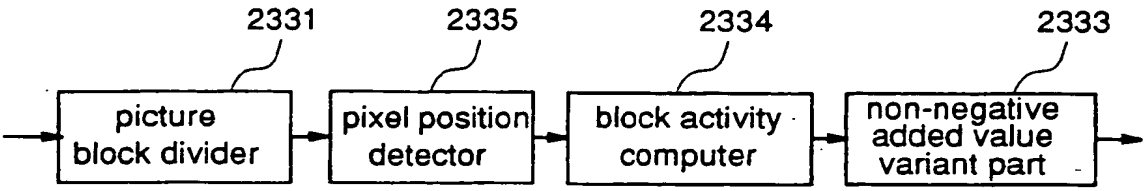


FIG.5



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FIG.6

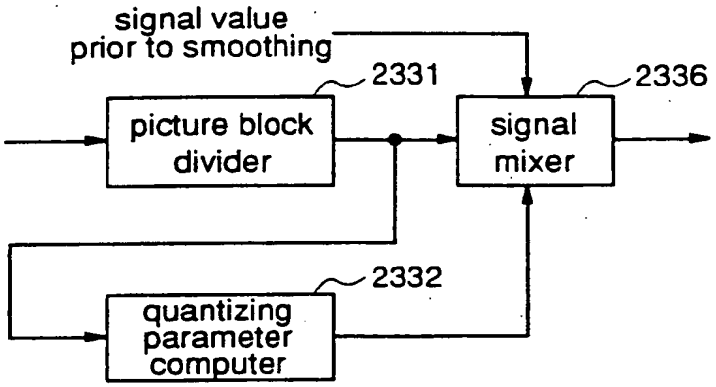
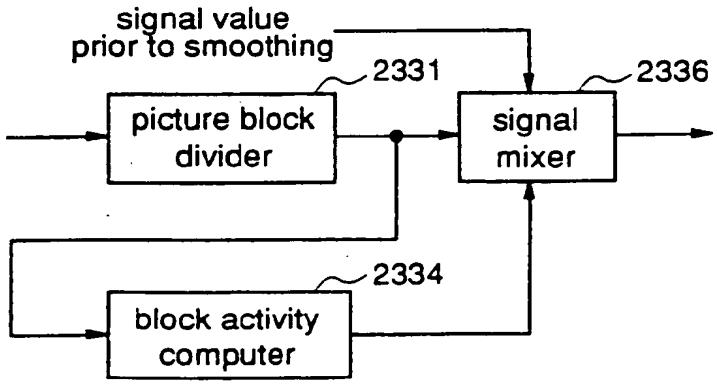


FIG.7



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FIG.8

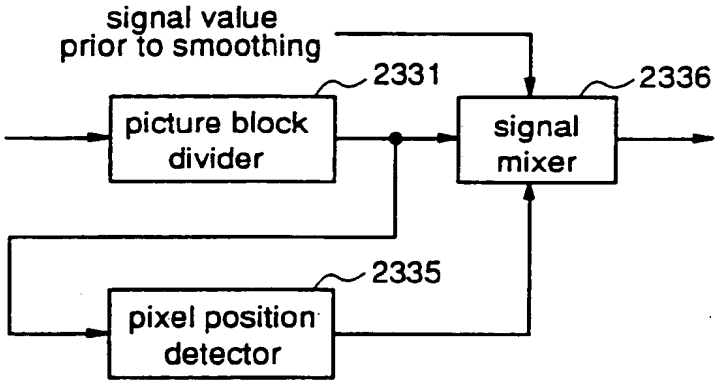
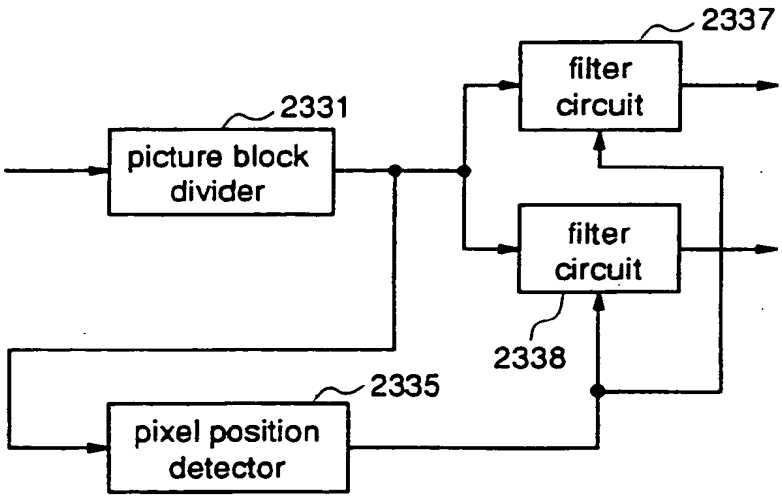


FIG.9



3NSDOCID: <EP_____0772365A2_I_>

FIG.10

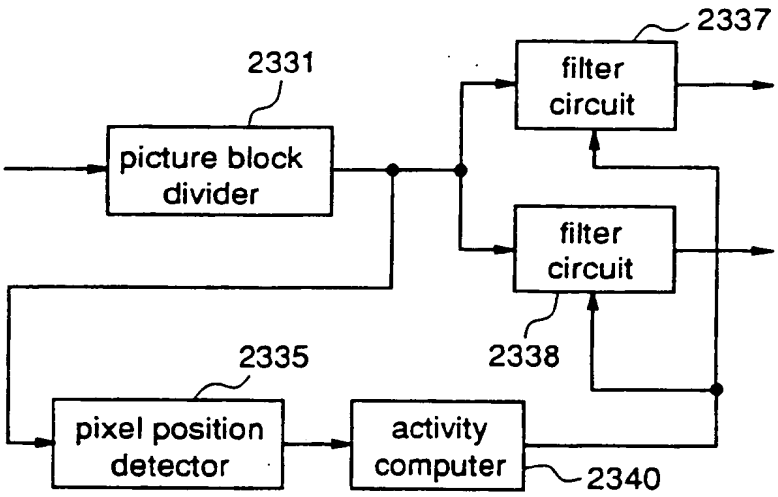
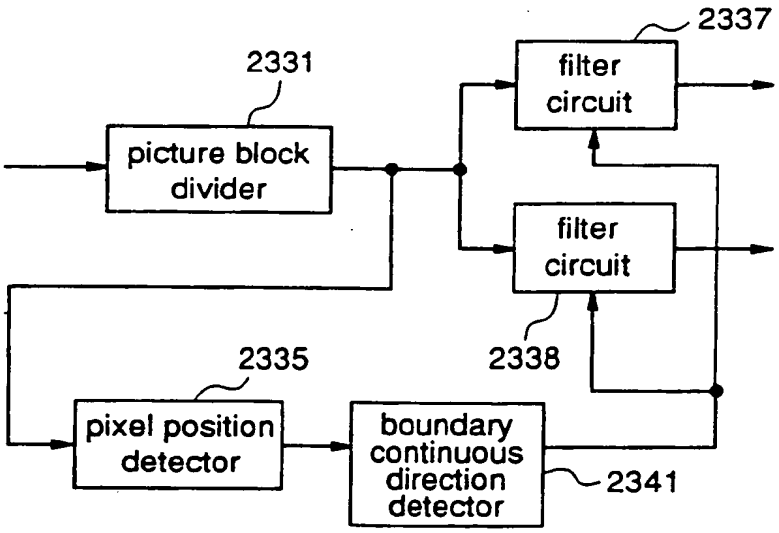
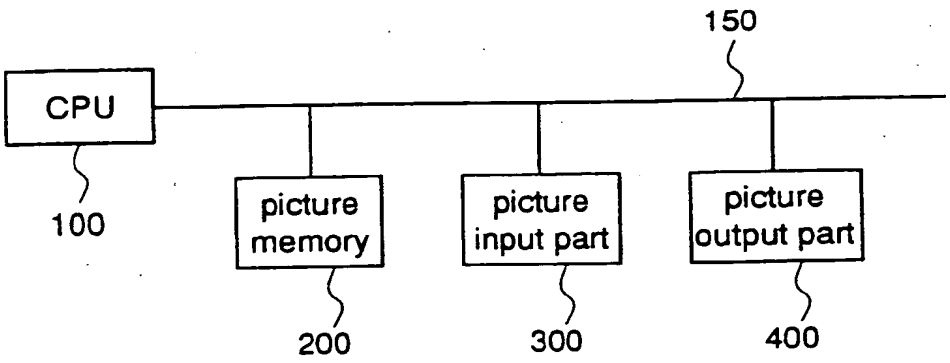


FIG.11



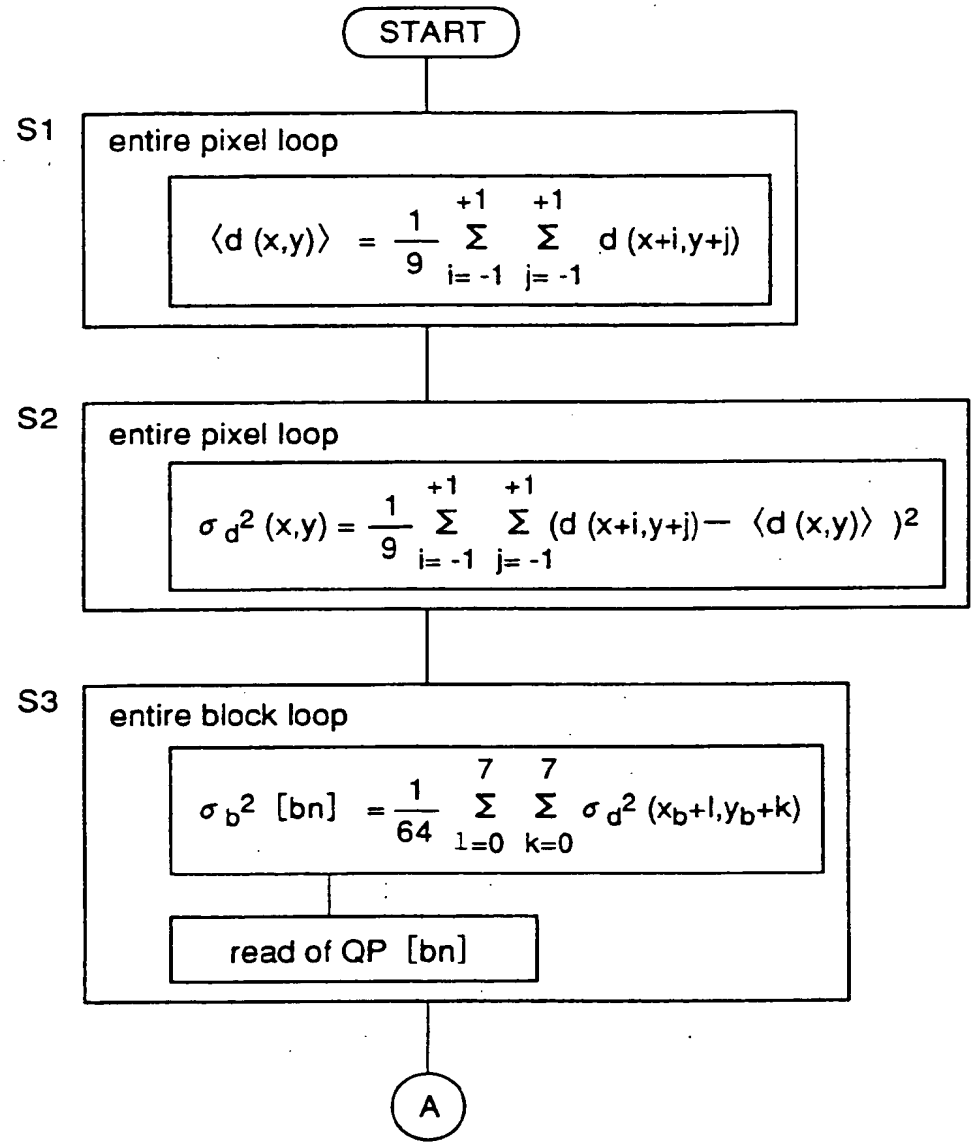
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FIG.12



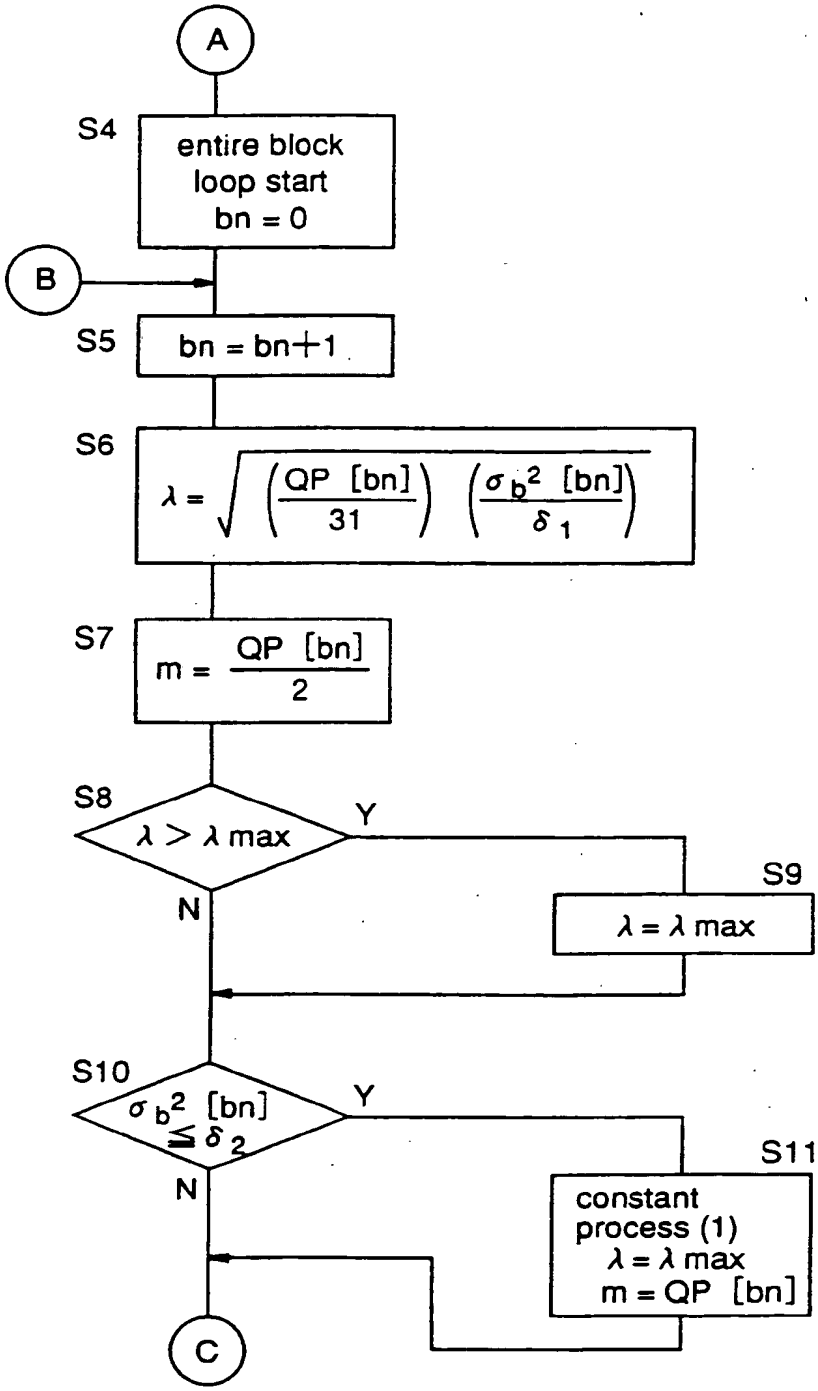
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FIG.13



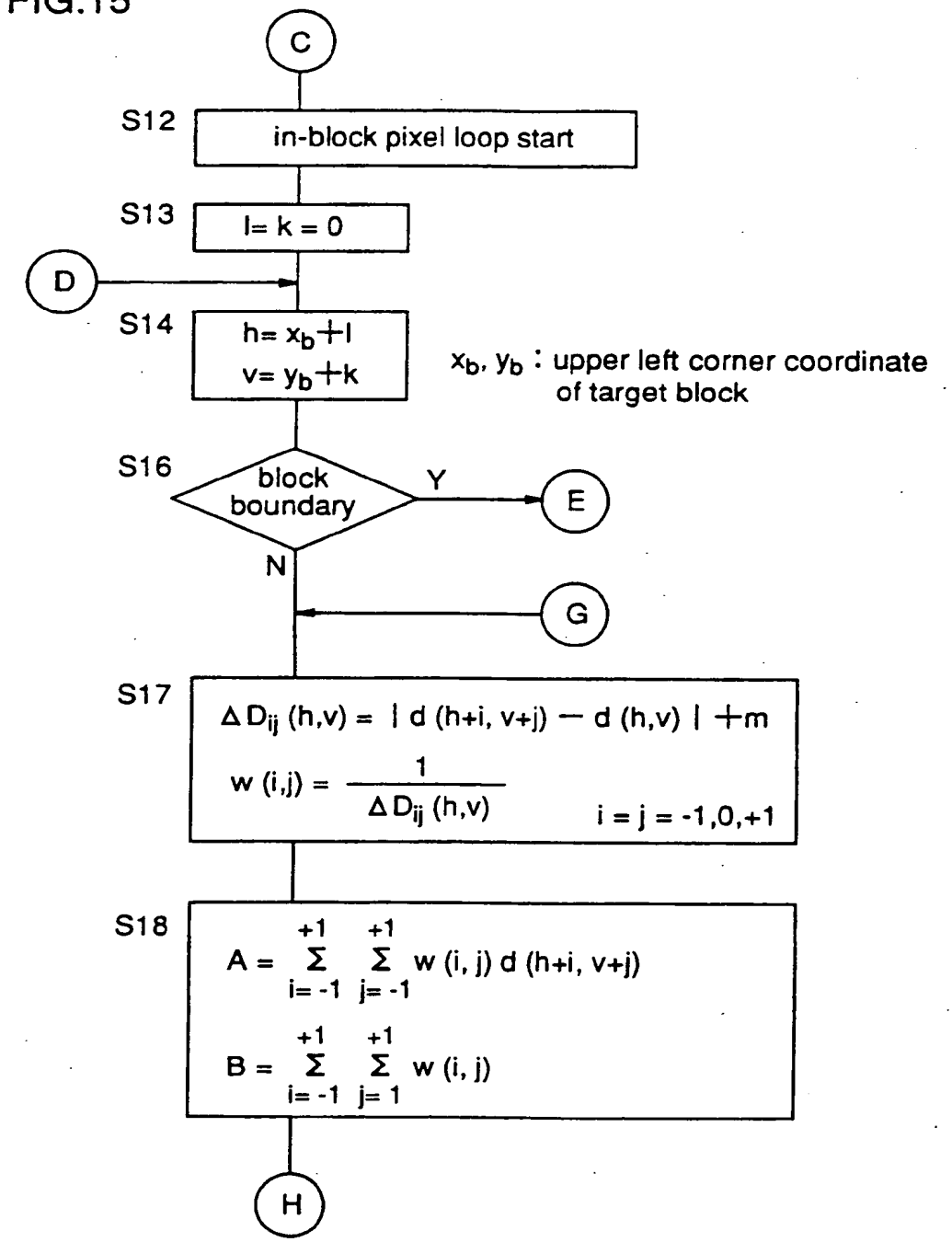
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FIG.14



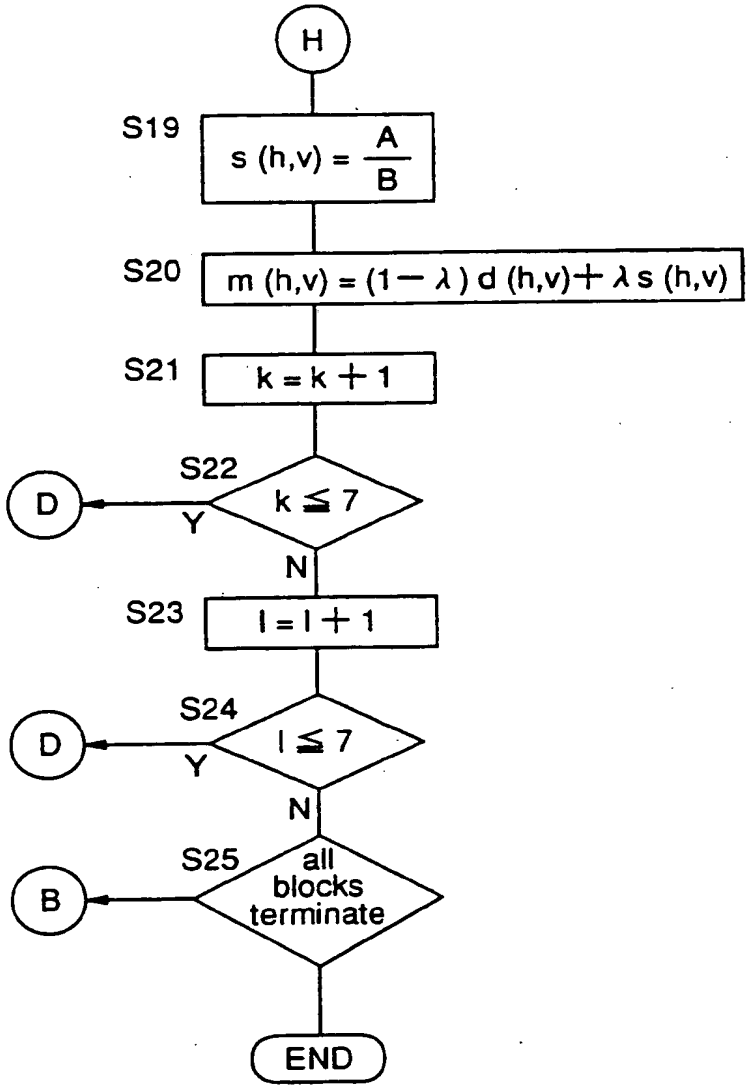
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FIG.15



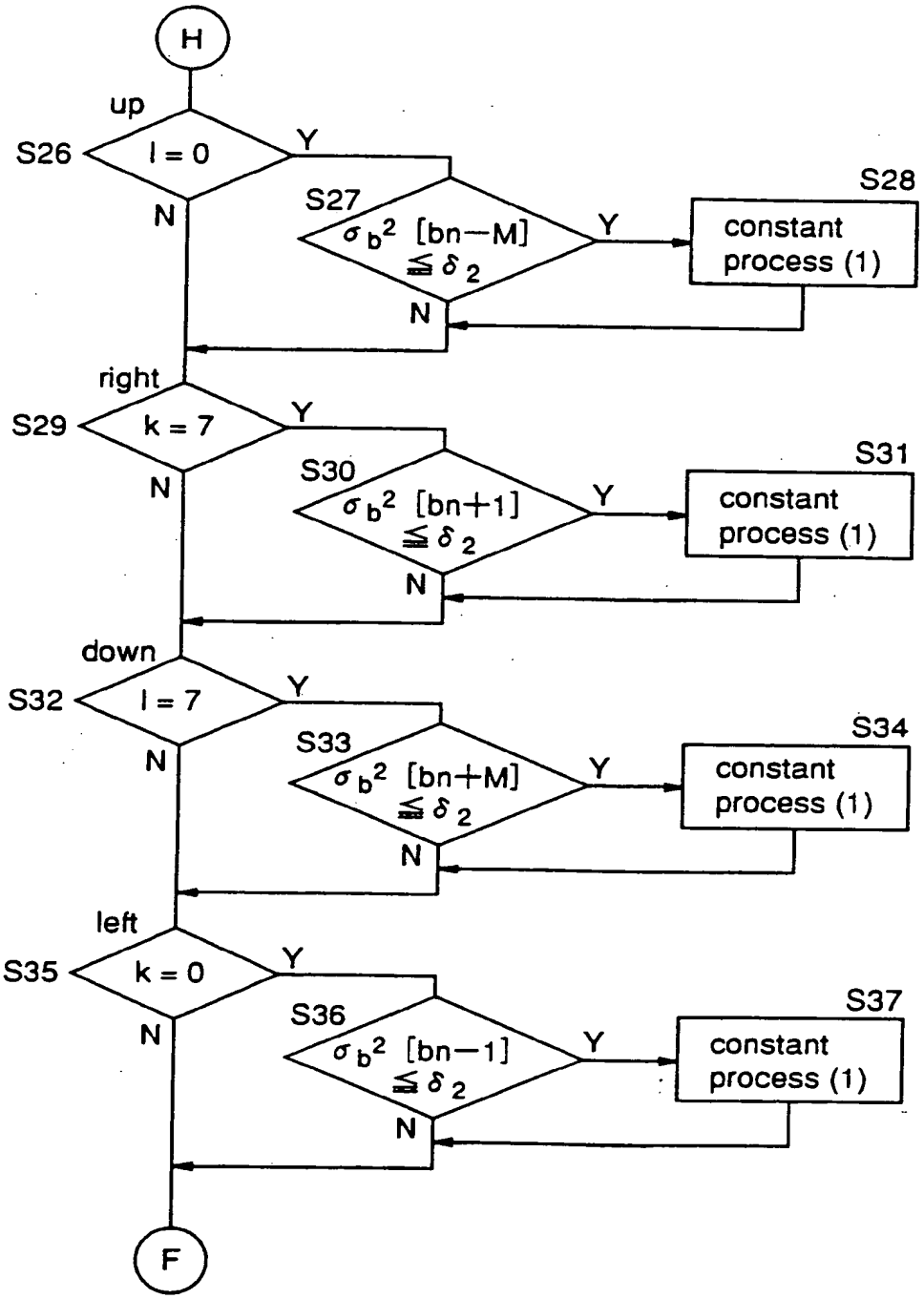
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FIG.16



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FIG.17



\SDOCID: <EP_____0772365A2_I_>

FIG.18

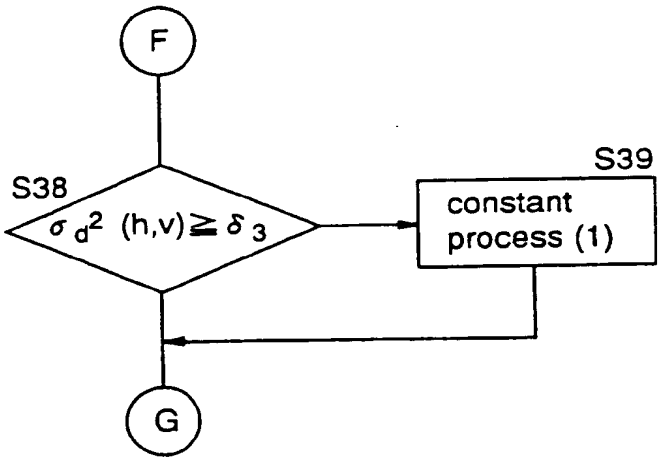
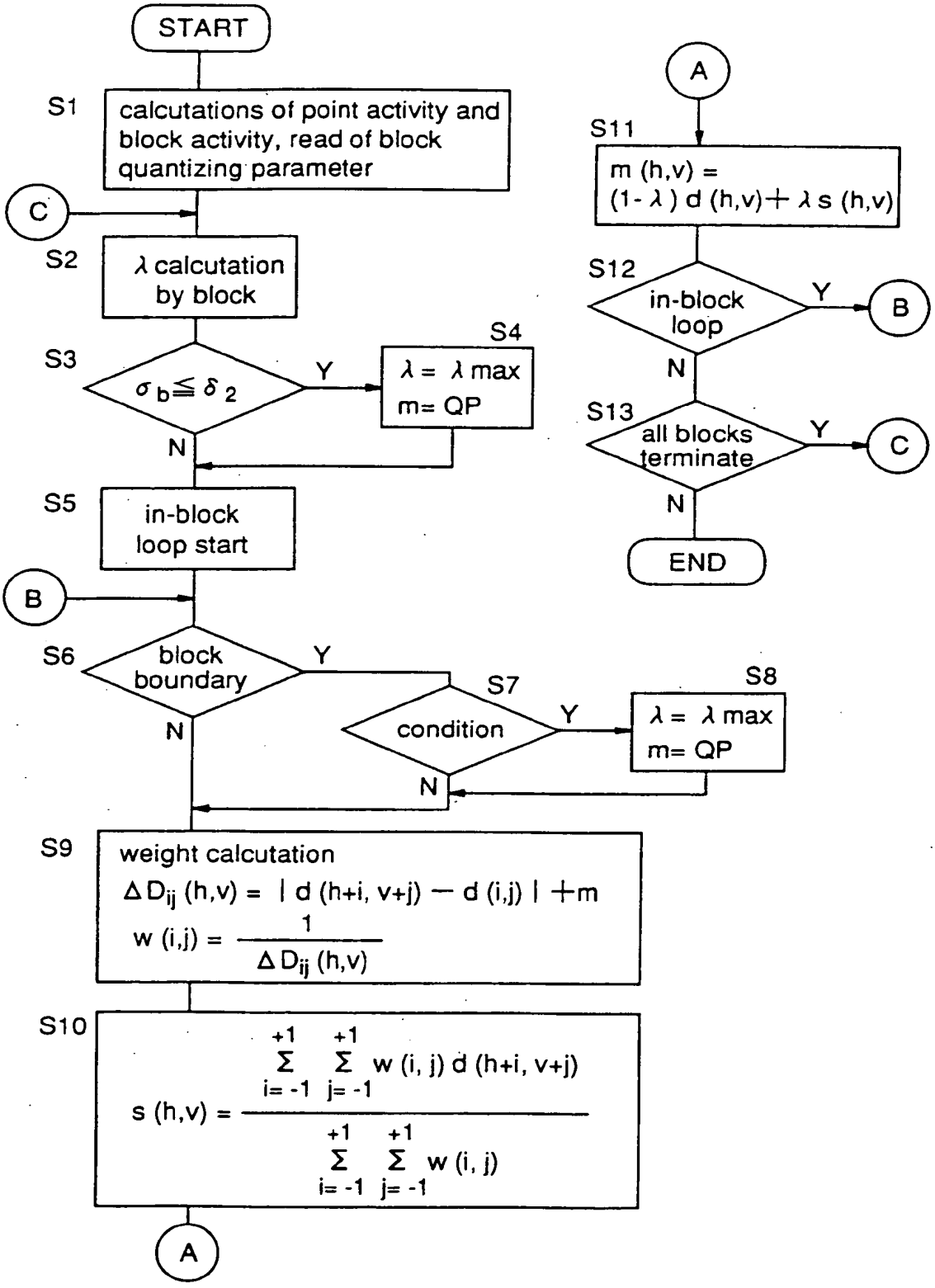
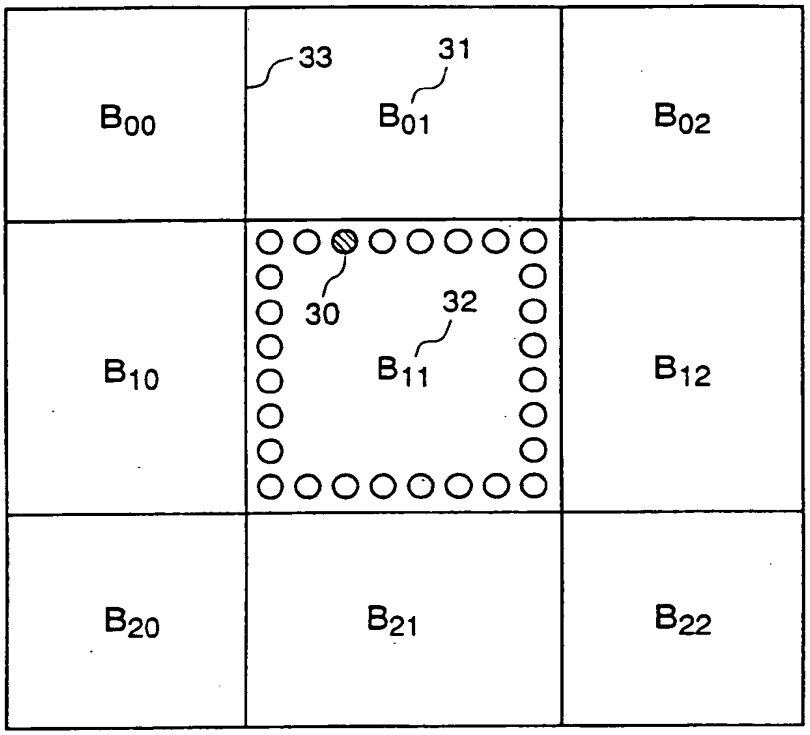


FIG.19



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FIG.20



BNSDOCID: <EP_____0772365A2 I_>

FIG.21

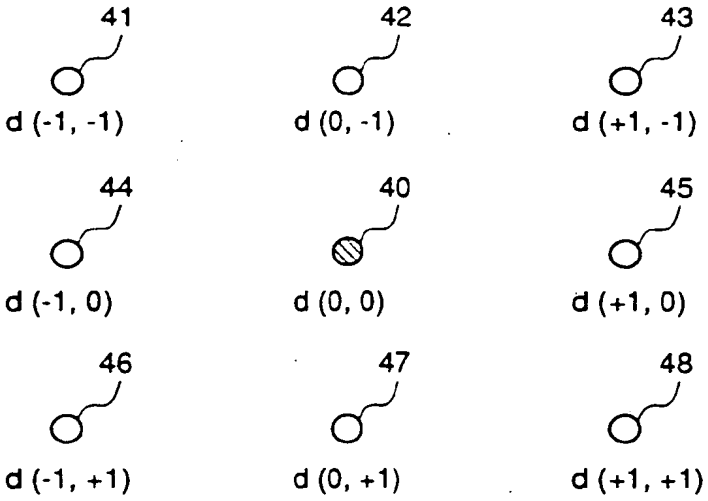
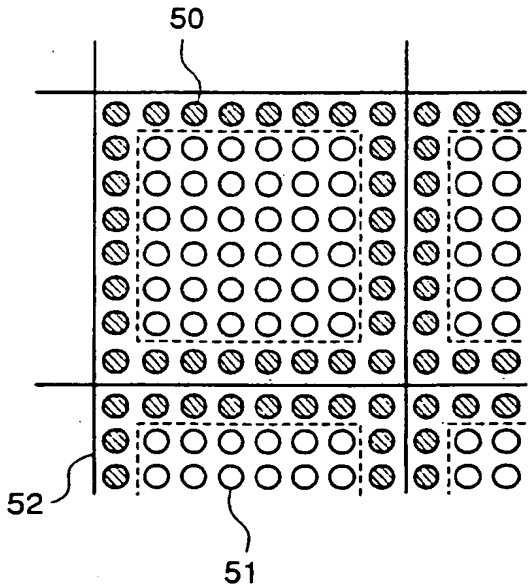
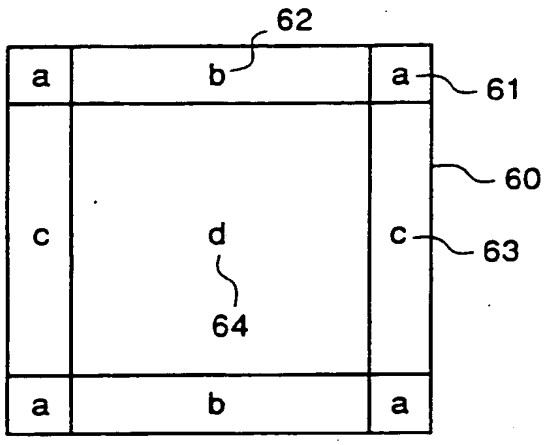


FIG.22 PRIOR ART

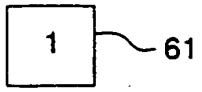


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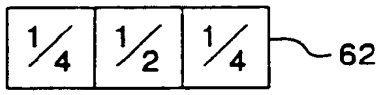
FIG.23 PRIOR ART



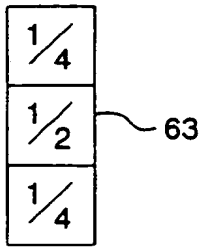
four corners



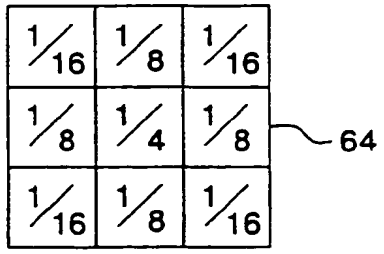
up and down ends



right and left ends

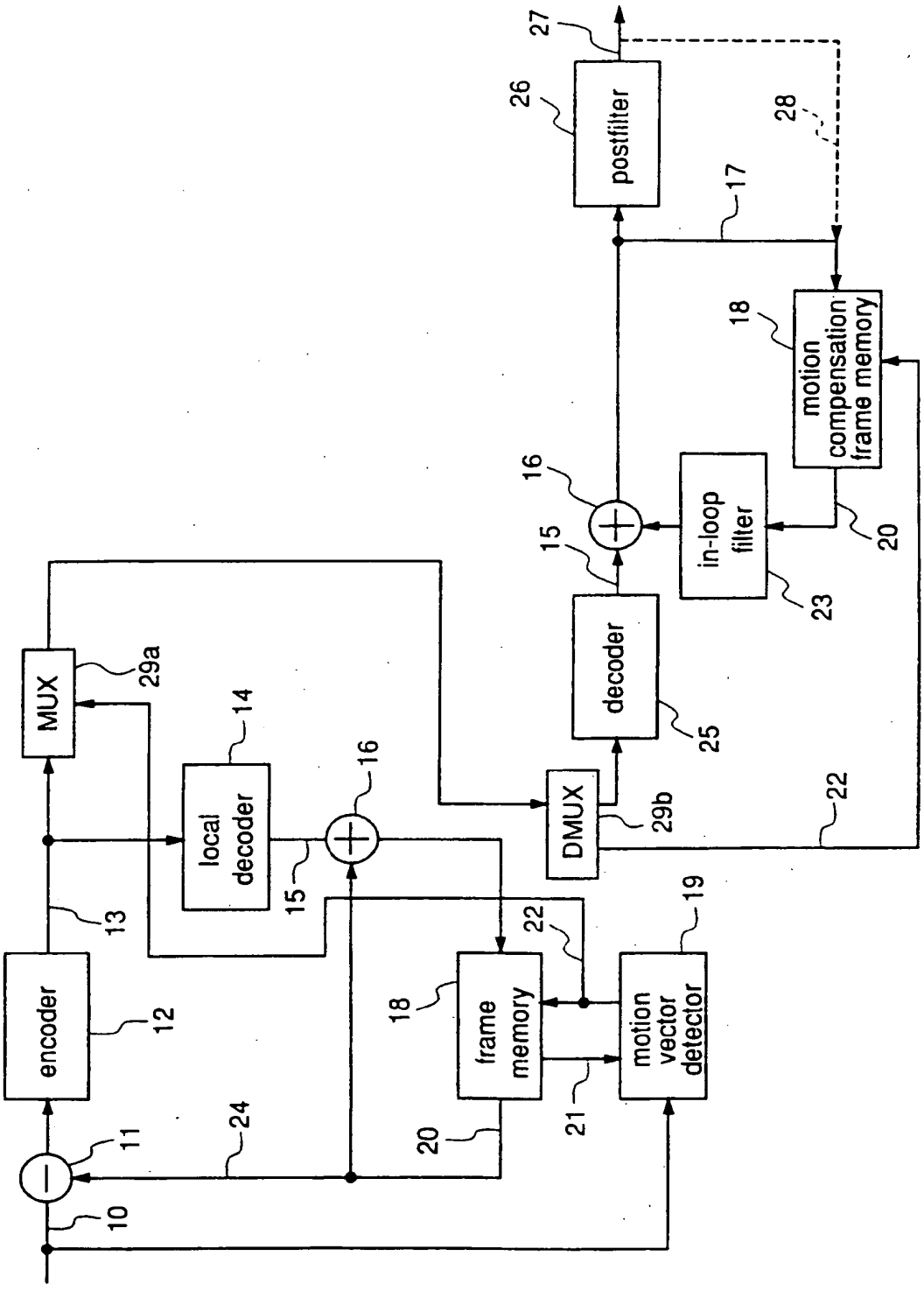


inside



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FIG.24 PRIOR ART



NSDOCID: <EP_____0772365A2_I_>

(19) Europäisches Patentamt
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(43) Date of publication A2:
07.05.1997 Bulletin 1997/19

(21) Application number: **96117549.4**

(22) Date of filing: **01.11.1996**

(51) Int. Cl.[6]: **H04N 7/30**, H04N 7/26

(84) Designated Contracting States:
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- **Etoh, Minoru**
  Osaka 576-0034 (JP)

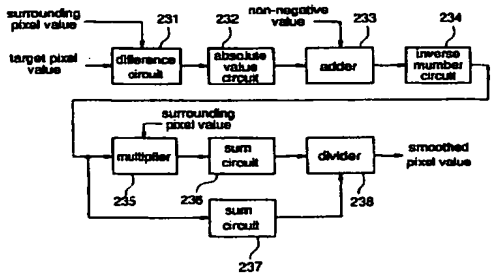
(74) Representative:
Kügele, Bernhard et al
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1202 Genève (CH)

(54) Method and device for filtering a picture signal, and encoding/decoding using the same

(57) A great decrease of a step, i.e., block distortion, of such as antifact brightness and color, on a block boundary, leads to much visual improvement of picture quality.

Against a picture that has been encoded and decoded by block, the smoothing filter characteristics is changed according to quantizing parameter, block activity of a decoded picture, the activity of each pixel of the decoded picture, and the position with respect to a block boundary of a pixel. A smoothing filter utilizes a weighted mean whose weight is the inverse number of a difference between a target pixel and its surrounding pixels. The weighted mean is obtained by adding a certain number to a weight before taking its inverse number. The value to be added is controlled by the parameter. Similarly, the mixing ratio of a pixel value after performing the smoothing filter and a decoded pixel value is changed depending on the parameter. A filter having strong edge preserving property is utilized for the inside of a block, and a filter having weak edge preserving property is utilized for a block boundary. A filter having edge preserving property is utilized for the post/loop filter.

FIG.2



EP 0 772 365 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 11 7549

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	PLOMPEN RONALD: "Motion Video Coding for Visual Telephony" 1990 , PTT RESEARCH NEHER LABS , NL, LEIDSCHENDAM XP002096009 198180 * page 179 - page 208 *	21,23, 24,26, 27,29, 30,32 22,25, 28,31	H04N7/30 H04N7/26
A	XIN WANG: "ON THE GRADIENT INVERSE WEIGHTED FILTER" IEEE TRANSACTIONS ON SIGNAL PROCESSING, vol. 40, no. 2, 1 February 1992, pages 482-484, XP000292345 * the whole document *	1,6, 8-11,16, 18,20	
A	GB 2 287 153 A (KOKUSAI DENSHIN DENWA CO LTD) 6 September 1995 * page 3, line 19 - page 5, line 12 * * page 7, line 7 - line 17 * * page 9, line 10 - page 10, line 12 *	1-7, 11-17	
A	EP 0 593 099 A (VICTOR COMPANY OF JAPAN) 20 April 1994 * page 10, line 17 - line 49 *	1,2,5, 11,12,15	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04N G06T
A	US 5 367 385 A (YUAN XIANCHENG) 22 November 1994 * column 2, line 3 - line 28 * * column 5, line 61 - column 6, line 50 * * column 9, line 20 - column 10, line 42 *	8-10, 18-20	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 March 1999	Marie-Julie, J-M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

INSDOCID: <EP_____0772365A3_I_>

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 96 11 7549

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-03-1999

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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PATENT APPLICATION SERIAL NO._____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

05/11/2009 CNGUYEN2 00000003 070832 12312386

01 FC:1631	330.00	DA
02 FC:1633	220.00	DA
03 FC:1642	430.00	DA
04 FC:1615	260.00	DA
05 FC:1614	440.00	DA

PTO-1556
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PCT/US2007/022795

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(25) Filing Language: English

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(30) Priority Data:
60/864,917 8 November 2006 (08.11.2006) US

(71) Applicant *(for all designated States except US)*: **THOMSON LICENSING** [FR/FR]; 46, Quai A. Le Gallo, F-92100 Boulogne-billancourt (FR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **KAO, Meng-ping** [CN/US]; 9106 Regents Rd., Apt. C, La Jolla, CA 92037-1460 (US). **YIN, Peng** [CN/US]; 65 Warwick Road, West Windsor, NJ 08550 (US). **DIVORRA ESCODA, Oscar** [ES/US]; 1201 Sayre Drive, Princeton, NJ 08540 (US).

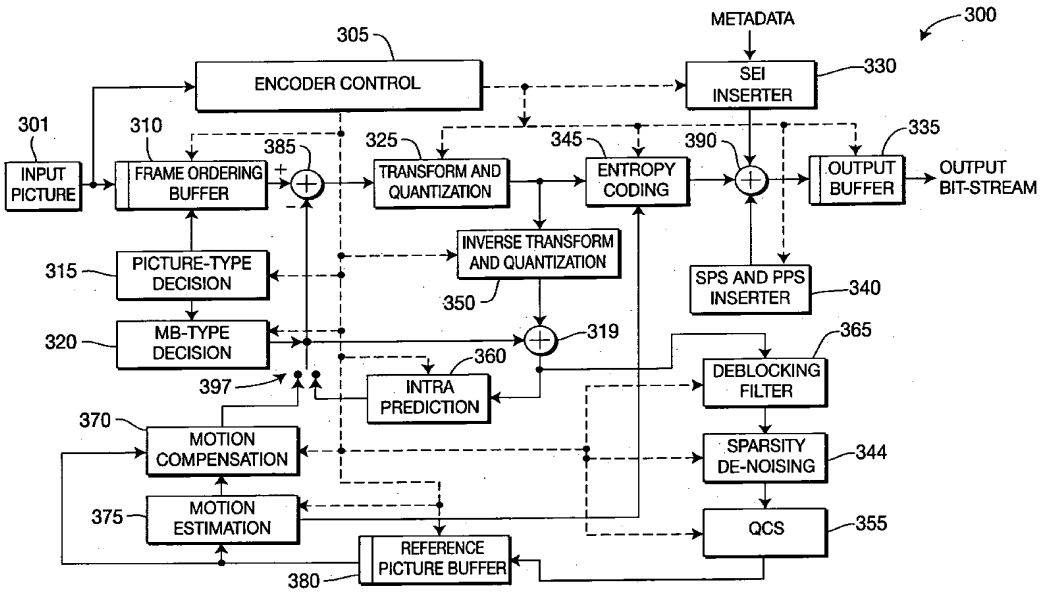
(74) Agents: **LAKS, Joseph, J.** et al.; Thomson Licensing Llc, Two Independence Way, Suite 200, Princeton, NJ 08540 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) **Title:** METHODS AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING



(57) **Abstract:** There are provided methods and apparatus for in-loop artifact filtering. An apparatus includes an encoder (300) for encoding an image region. The encoder (300) has at least two filters (365, 344) for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

WO 2008/057308 A2

METHODS AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Serial No. 60/864,917, filed November 8, 2006, which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present principles relate generally to video encoding and decoding and, more particularly, to methods and apparatus for in-loop de-artifact filtering.

BACKGROUND

All video compression artifacts result from quantization, which is the only lossy coding part in a hybrid video coding framework. However, those artifacts can be present in various forms such as, for example, as a blocky artifact, a ringing artifact, an edge distortion, and/or texture corruption. In general, the decoded sequence may be composed of all types of visual artifacts, but with different severances. Among the different types of visual artifacts, blocky artifacts are common in block-based video coding. These artifacts can originate from both the block-based transform stage in residue coding and from the motion compensation stage. Adaptive deblocking filters have been studied in the past and some well-known deblocking filtering methods have been proposed and adopted in various standards (such as those adopted in, for example, the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Moving Picture Experts Group-4 (MPEG-4) Part 10 Advanced Video Coding (AVC) standard/International Telecommunication Union, Telecommunication Sector (ITU-T) H.264 recommendation (hereinafter the "MPEG-4 AVC standard"). When designed well, a deblocking filter can improve both objective and subjective video quality. In state of the art video encoders and/or decoders such as, for example, those corresponding to the MPEG-4 AVC Standard, an adaptive in-loop deblocking filter is designed to reduce blocky artifacts, wherein the strength of filtering is controlled by the values of several syntax elements. The basic idea is that if a relatively large absolute difference between samples near a block edge is measured, that difference

is likely a blocking artifact and should thus be reduced. However, if the magnitude of that difference is so large that it cannot be explained by the coarseness of the quantization used in the encoding, the edge is more likely to reflect the actual behavior of the source picture and should not be smoothed over. In this way, the blockiness of the content is reduced, while the sharpness of the content is basically unchanged. The deblocking filter is adaptive on several levels. On the slice level, the global filtering strength can be adjusted to the individual characteristics of the video sequence. On the block-edge level, filtering strength is made dependent on the inter/intra prediction decision, motion differences, and the presence of coded residuals in the two neighboring blocks. On macroblock boundaries, special strong filtering is applied to remove "tiling artifacts". On the sample level, sample values and quantizer-dependent thresholds can turn off filtering for each individual sample.

Deblocking filtering in accordance with the MPEG-4 AVC Standard is well designed to reduce the blocky artifact, but it does not try to correct other artifacts caused by quantization noise. For example, deblocking filtering in accordance with the MPEG-4 AVC Standard leaves edges and textures untouched. Thus, it cannot improve distorted edges or texture. One reason for this lack of capability is that the MPEG-4 AVC Standard deblocking filter applies a smooth image model and the designed filters typically include a bank of low-pass filters. However, images include many singularities, texture, and so forth and, thus, they are not handled correctly by the MPEG-4 AVC Standard deblocking filter.

In order to overcome the limitations of the MPEG-4 AVC Standard deblocking filter, an approach has been recently proposed involving a de-noising type nonlinear in-loop filter. In this proposed approach, a nonlinear de-noising filter adapts to non-stationary image statistics which exploits a sparse image model using an over complete set of linear transforms and hard-thresholding. The nonlinear de-noising filter automatically becomes high-pass, or low-pass, or band-pass, and so forth, depending on the region the filter is operating on. The nonlinear de-noising filter can address all types of quantization noise. This particular de-noising approach basically includes three steps: transform; transform coefficients threshold; and inverse transform. Then several de-noised estimates provided by de-noising with an over complete set of transforms (typically produced by applying de-noising with shifted

versions of the same transform) are combined using weighted averaging at every pixel.

Sparsity based de-noising tools could reduce quantization noise over video frames that include locally uniform regions (smooth, high frequency, texture, and so forth) separated by singularities. However, the de-noising tool was designed for additive, independent and identically distributed (i.i.d.) noise removal, while quantization noise has significantly different properties, which can present significant issues in terms of proper distortion reduction and visual de-artifacting. This implies that these techniques may get confused by true edges or false blocky edges. A possibility for a solution is spatio-frequential threshold adaptation, which may be able to correct the decision, but it is not trivial in its implementation. A possible consequence of inadequate threshold selection is that sparse de-noising might result into over-smoothed reconstructed pictures, or a blocky artifact(s) may still be present despite the filtering procedure. In particular, for the smooth picture regions, the signal as well as the blocky artifact added to the signal would probably have sparse representation at the filtering stage if the same transform is used for compression and denoising. So a thresholding operation would probably still keep the artifact. At present, it has been observed that sparsity based de-noising techniques, even though they present a higher distortion reduction in terms of objective measures (e.g., mean squared error (MSE)) than other techniques, they may present important visual artifacts that need to be addressed.

It has been observed that the use of a single de-noising filter is not very efficient or effective in removing coding artifacts. The reason for this is that a general purpose de-noising filter is usually based on a distortion model which does not exactly match the actual scenario to which it is applied. This model does not consider the local structure of blocky artifact. A special purpose de-artifacting filter, on the other hand, is designed to relieve a certain type of artifact. Accordingly, a special purpose de-noising filter is not sufficient to correct the rest of the quantization noises. For example, the in-loop deblocking filter used in the MPEG-4 AVC Standard is a special purpose filter which is not designed to remove the noise/artifacts at pixels away from the boundaries, within textures or to correct the distorted edges.

Turning to FIG. 1, a video encoder capable of performing video encoding in accordance with the MPEG-4 AVC standard is indicated generally by the reference numeral 100.

The video encoder 100 includes a frame ordering buffer 110 having an output in signal communication with a non-inverting input of a combiner 185. An output of the combiner 185 is connected in signal communication with a first input of a transformer and quantizer 125. An output of the transformer and quantizer 125 is connected in signal communication with a first input of an entropy coder 145 and a first input of an inverse transformer and inverse quantizer 150. An output of the entropy coder 145 is connected in signal communication with a first non-inverting input of a combiner 190. An output of the combiner 190 is connected in signal communication with a first input of an output buffer 135.

A first output of an encoder controller 105 is connected in signal communication with a second input of the frame ordering buffer 110, a second input of the inverse transformer and inverse quantizer 150, an input of a picture-type decision module 115, an input of a macroblock-type (MB-type) decision module 120, a second input of an intra prediction module 160, a second input of a deblocking filter 165, a first input of a motion compensator 170, a first input of a motion estimator 175, and a second input of a reference picture buffer 180.

A second output of the encoder controller 105 is connected in signal communication with a first input of a Supplemental Enhancement Information (SEI) inserter 130, a second input of the transformer and quantizer 125, a second input of the entropy coder 145, a second input of the output buffer 135, and an input of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 140.

A first output of the picture-type decision module 115 is connected in signal communication with a third input of a frame ordering buffer 110. A second output of the picture-type decision module 115 is connected in signal communication with a second input of a macroblock-type decision module 120.

An output of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 140 is connected in signal communication with a third non-inverting input of the combiner 190.

An output of the inverse quantizer and inverse transformer 150 is connected in signal communication with a first non-inverting input of a combiner 119. An output

of the combiner 119 is connected in signal communication with a first input of the intra prediction module 160 and a first input of the deblocking filter 165. An output of the deblocking filter 165 is connected in signal communication with a first input of a reference picture buffer 180. An output of the reference picture buffer 180 is connected in signal communication with a second input of the motion estimator 175. A first output of the motion estimator 175 is connected in signal communication with a second input of the motion compensator 170. A second output of the motion estimator 175 is connected in signal communication with a third input of the entropy coder 145.

An output of the motion compensator 170 is connected in signal communication with a first input of a switch 197. An output of the intra prediction module 160 is connected in signal communication with a second input of the switch 197. An output of the macroblock-type decision module 120 is connected in signal communication with a third input of the switch 197. The third input of the switch 197 determines whether or not the "data" input of the switch (as compared to the control input, i.e., the third input) is to be provided by the motion compensator 170 or the intra prediction module 160. The output of the switch 197 is connected in signal communication with a second non-inverting input of the combiner 119 and with an inverting input of the combiner 185.

Inputs of the frame ordering buffer 110 and the encoder controller 105 are available as input of the encoder 100, for receiving an input picture 101. Moreover, an input of the Supplemental Enhancement Information (SEI) inserter 130 is available as an input of the encoder 100, for receiving metadata. An output of the output buffer 135 is available as an output of the encoder 100, for outputting a bitstream.

Turning to FIG. 2, a video decoder capable of performing video decoding in accordance with the MPEG-4 AVC standard is indicated generally by the reference numeral 200.

The video decoder 200 includes an input buffer 210 having an output connected in signal communication with a first input of the entropy decoder 245. A first output of the entropy decoder 245 is connected in signal communication with a first input of an inverse transformer and inverse quantizer 250. An output of the inverse transformer and inverse quantizer 250 is connected in signal communication

with a second non-inverting input of a combiner 225. An output of the combiner 225 is connected in signal communication with a second input of a deblocking filter 265 and a first input of an intra prediction module 260. A second output of the deblocking filter 265 is connected in signal communication with a first input of a reference picture buffer 280. An output of the reference picture buffer 280 is connected in signal communication with a second input of a motion compensator 270.

A second output of the entropy decoder 245 is connected in signal communication with a third input of the motion compensator 270 and a first input of the deblocking filter 265. A third output of the entropy decoder 245 is connected in signal communication with an input of a decoder controller 205. A first output of the decoder controller 205 is connected in signal communication with a second input of the entropy decoder 245. A second output of the decoder controller 205 is connected in signal communication with a second input of the inverse transformer and inverse quantizer 250. A third output of the decoder controller 205 is connected in signal communication with a third input of the deblocking filter 265. A fourth output of the decoder controller 205 is connected in signal communication with a second input of the intra prediction module 260, with a first input of the motion compensator 270, and with a second input of the reference picture buffer 280.

An output of the motion compensator 270 is connected in signal communication with a first input of a switch 297. An output of the intra prediction module 260 is connected in signal communication with a second input of the switch 297. An output of the switch 297 is connected in signal communication with a first non-inverting input of the combiner 225.

An input of the input buffer 210 is available as an input of the decoder 200, for receiving an input bitstream. A first output of the deblocking filter 265 is available as an output of the decoder 200, for outputting an output picture.

SUMMARY

These and other drawbacks and disadvantages of the prior art are addressed by the present principles, which are directed to methods and apparatus for in-loop de-artifact filtering.

According to an aspect of the present principles, there is provided an apparatus. The apparatus includes an encoder for encoding an image region. The encoder has at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

According to another aspect of the present principles, there is provided a method. The method includes encoding an image region. The encoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

According to yet another aspect of the present principles, there is provided an apparatus. The apparatus includes a decoder for decoding an image region. The decoder has at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

According to still another aspect of the present principles, there is provided a method. The method includes decoding an image region. The decoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

These and other aspects, features and advantages of the present principles will become apparent from the following detailed description of exemplary embodiments, which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present principles may be better understood in accordance with the following exemplary figures, in which:

FIG. 1 shows a block diagram for a video encoder capable of performing video encoding in accordance with the MPEG-4 AVC Standard;

FIG. 2 shows a block diagram for a video decoder capable of performing video decoding in accordance with the MPEG-4 AVC Standard;

FIG. 3 shows a block diagram for a video encoder capable of performing video encoding in accordance with the MPEG-4 AVC Standard, modified and/or extended for use with the present principles, according to an embodiment of the present principles;

FIG. 4 shows a block diagram for a video decoder capable of performing video decoding in accordance with the MPEG-4 AVC Standard, modified and/or

extended for use with the present principles, according to an embodiment of the present principles;

FIG. 5 shows a diagram for an exemplary succession of de-artifact filters, according to an embodiment of the present principles;

FIG. 6 shows a flow diagram for an exemplary method for encoding image data using in-loop de-artifact filtering, according to an embodiment of the present principles;

FIG. 7 shows a flow diagram for an exemplary method for decoding image data using in-loop de-artifact filtering, according to an embodiment of the present principles;

FIG. 8 shows an exemplary apparatus for performing quantization constraint set (QCS) coefficients correction after artifact removal/reduction, according to an embodiment of the present principles; and

FIG. 9 shows exemplary quantization bins for an over-filtering problem and a correction approach using QCS in video encoding/decoding, according to an embodiment of the present principles.

DETAILED DESCRIPTION

The present principles are directed to methods and apparatus for in-loop de-artifact filtering.

The present description illustrates the present principles. It will thus be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the present principles and are included within its spirit and scope.

All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the present principles and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions.

Moreover, all statements herein reciting principles, aspects, and embodiments of the present principles, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known

equivalents as well as equivalents developed in the future, i.e., any elements developed that perform the same function, regardless of structure.

Thus, for example, it will be appreciated by those skilled in the art that the block diagrams presented herein represent conceptual views of illustrative circuitry embodying the present principles. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudocode, and the like represent various processes which may be substantially represented in computer readable media and so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

The functions of the various elements shown in the figures may be provided through the use of dedicated hardware as well as hardware capable of executing software in association with appropriate software. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be shared. Moreover, explicit use of the term "processor" or "controller" should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor ("DSP") hardware, read-only memory ("ROM") for storing software, random access memory ("RAM"), and non-volatile storage.

Other hardware, conventional and/or custom, may also be included. Similarly, any switches shown in the figures are conceptual only. Their function may be carried out through the operation of program logic, through dedicated logic, through the interaction of program control and dedicated logic, or even manually, the particular technique being selectable by the implementer as more specifically understood from the context.

In the claims hereof, any element expressed as a means for performing a specified function is intended to encompass any way of performing that function including, for example, a) a combination of circuit elements that performs that function or b) software in any form, including, therefore, firmware, microcode or the like, combined with appropriate circuitry for executing that software to perform the function. The present principles as defined by such claims reside in the fact that the functionalities provided by the various recited means are combined and brought

together in the manner which the claims call for. It is thus regarded that any means that can provide those functionalities are equivalent to those shown herein.

Reference in the specification to "one embodiment" or "an embodiment" of the present principles means that a particular feature, structure, characteristic, and so forth described in connection with the embodiment is included in at least one embodiment of the present principles. Thus, the appearances of the phrase "in one embodiment" or "in an embodiment" appearing in various places throughout the specification are not necessarily all referring to the same embodiment.

As used herein, "high level syntax" and "high level syntax element" interchangeably refer to syntax present in the bitstream that resides hierarchically above the macroblock layer. For example, high level syntax, as used herein, may refer to, but is not limited to, syntax at the slice header level, Supplemental Enhancement Information (SEI) level, picture parameter set level, sequence parameter set level and network abstraction layer (NAL) unit header level.

As used herein, "block level syntax" and "block level syntax element" interchangeably refer to syntax present in the bitstream that resides hierarchically at any of the possible coding units structured as a block or partitions of a block in a video coding scheme. For example, block level syntax, as used herein, may refer to, but is not limited to, syntax at the macroblock level, the 16x8 partition level, the 8x16 partition level, the 8x8 sub-block level, and general partitions of any of these. Moreover, block level syntax, as used herein, may also refer to blocks issued from the union of smaller blocks (e.g., unions of macroblocks).

The phrase "image data" is intended to refer to data corresponding to any of still images and moving images (i.e., a sequence of images including motion).

It is to be appreciated that the use of the term "and/or", for example, in the case of "A and/or B", is intended to encompass the selection of the first listed option (A), the selection of the second listed option (B), or the selection of both options (A and B). As a further example, in the case of "A, B, and/or C", such phrasing is intended to encompass the selection of the first listed option (A), the selection of the second listed option (B), the selection of the third listed option (C), the selection of the first and the second listed options (A and B), the selection of the first and third listed options (A and C), the selection of the second and third listed options (B and C), or the selection of all three options (A and B and C). This may be extended, as

readily apparent by one of ordinary skill in this and related arts, for as many items listed.

Moreover, it is to be appreciated that while one or more embodiments of the present principles are described herein with respect to the MPEG-4 AVC standard, the present principles are not limited to solely this standard and, thus, may be utilized with respect to other video coding standards, recommendations, and extensions thereof, including extensions such as scalable (and non-scalable) extensions and/or multi-view (and non-multi-view) extensions of the MPEG-4 AVC standard, while maintaining the spirit of the present principles.

Turning to FIG. 3, a video encoder capable of performing video encoding in accordance with the MPEG-4 AVC standard, modified and/or extended for use with the present principles, is indicated generally by the reference numeral 300.

The video encoder 300 includes a frame ordering buffer 310 having an output in signal communication with a non-inverting input of a combiner 385. An output of the combiner 385 is connected in signal communication with a first input of a transformer and quantizer 325. An output of the transformer and quantizer 325 is connected in signal communication with a first input of an entropy coder 345 and a first input of an inverse transformer and inverse quantizer 350. An output of the entropy coder 345 is connected in signal communication with a first non-inverting input of a combiner 390. An output of the combiner 390 is connected in signal communication with a first input of an output buffer 335.

A first output of an encoder controller 305 is connected in signal communication with a second input of a frame ordering buffer 310, a second input of the inverse transformer and inverse quantizer 350, an input of a picture-type decision module 315, a first input of a macroblock-type (MB-type) decision module 320, a second input of an intra prediction module 360, a second input of a deblocking filter 365, a first input of a motion compensator 370, a first input of a motion estimator 375, a second input of a reference picture buffer 380, a first input of a sparsity de-noising filter, and a first input of a quantization constraint set (QCS) 355.

A second output of the encoder controller 305 is connected in signal communication with a first input of a Supplemental Enhancement Information (SEI) inserter 330, a second input of the transformer and quantizer 325, a second input of

the entropy coder 345, a second input of the output buffer 335, and an input of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 340.

A first output of the picture-type decision module 315 is connected in signal communication with a third input of the frame ordering buffer 310. A second output of the picture-type decision module 315 is connected in signal communication with a second input of a macroblock-type decision module 320.

An output of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 340 is connected in signal communication with a third non-inverting input of the combiner 390.

An output of the inverse quantizer and inverse transformer 350 is connected in signal communication with a first non-inverting input of a combiner 319. An output of the combiner 319 is connected in signal communication with a first input of the intra prediction module 360 and a first input of the deblocking filter 365. An output of the deblocking filter 365 is connected in signal communication with a second input of the sparsity de-noising filter 344. An output of the sparsity de-noising filter 344 is connected in signal communication with a second input of the quantization constraint set (QCS) 355. An output of the quantization constraint set (QCS) 355 is connected in signal communication with a first input of the reference picture buffer 380. An output of the reference picture buffer 380 is connected in signal communication with a second input of the motion estimator 375 and a second input of the motion compensator 370. A first output of the motion estimator 375 is connected in signal communication with a third input of the motion compensator 370. A second output of the motion estimator 375 is connected in signal communication with a third input of the entropy coder 345.

An output of the motion compensator 370 is connected in signal communication with a first input of a switch 397. An output of the intra prediction module 360 is connected in signal communication with a second input of the switch 397. An output of the macroblock-type decision module 320 is connected in signal communication with a third input of the switch 397. The third input of the switch 397 determines whether or not the "data" input of the switch (as compared to the control input, i.e., the third input) is to be provided by the motion compensator 370 or the intra prediction module 360. The output of the switch 397 is connected in signal

communication with a second non-inverting input of the combiner 319 and with an inverting input of the combiner 385.

Inputs of the frame ordering buffer 310 and the encoder controller 305 are available as input of the encoder 300, for receiving an input picture 301. Moreover, an input of the Supplemental Enhancement Information (SEI) inserter 330 is available as an input of the encoder 300, for receiving metadata. An output of the output buffer 335 is available as an output of the encoder 300, for outputting a bitstream.

Turning to FIG. 4, a video decoder capable of performing video decoding in accordance with the MPEG-4 AVC standard, modified and/or extended for use with the present principles, is indicated generally by the reference numeral 400.

The video decoder 400 includes an input buffer 410 having an output connected in signal communication with a first input of the entropy decoder 445. A first output of the entropy decoder 445 is connected in signal communication with a first input of an inverse transformer and inverse quantizer 450. An output of the inverse transformer and inverse quantizer 450 is connected in signal communication with a second non-inverting input of a combiner 425. An output of the combiner 425 is connected in signal communication with a second input of a deblocking filter 465 and a first input of an intra prediction module 460. An output of the deblocking filter 465 is connected in signal communication with a first input of a sparsity de-noising filter 444. An output of the sparsity de-noising filter 444 is connected in signal communication with a first input of a quantization constraint set (QCS) 455. A first output of the quantization constraint set (QCS) 455 is connected in signal communication with a first input of a reference picture buffer 480. An output of the reference picture buffer 480 is connected in signal communication with a second input of a motion compensator 470.

A second output of the entropy decoder 445 is connected in signal communication with a third input of the motion compensator 470 and a first input of the deblocking filter 465. A third output of the entropy decoder 445 is connected in signal communication with an input of a decoder controller 405. A first output of the decoder controller 405 is connected in signal communication with a second input of the entropy decoder 445. A second output of the decoder controller 405 is connected in signal communication with a second input of the inverse transformer

and inverse quantizer 450. A third output of the decoder controller 405 is connected in signal communication with a third input of the deblocking filter 465, a second input of the sparsity de-noising filter 444, and a second input of the quantization constraint set (QCS) 455. A fourth output of the decoder controller 405 is connected in signal communication with a second input of the intra prediction module 460, with a first input of the motion compensator 470, and with a second input of the reference picture buffer 480.

An output of the motion compensator 470 is connected in signal communication with a first input of a switch 497. An output of the intra prediction module 460 is connected in signal communication with a second input of the switch 497. An output of the switch 497 is connected in signal communication with a first non-inverting input of the combiner 425.

An input of the input buffer 410 is available as an input of the decoder 400, for receiving an input bitstream. A second output of the quantization constraint set (QCS) 455 is available as an output of the decoder 400, for outputting an output picture.

With respect to the video decoder 400 of FIG. 4, it is to be appreciated that we can allow output pictures before the application of function block 465, or after the application of function 465, or after application of the function block 444, or after application of the function block 455. That is, we can have the flexibility that the picture for prediction in the reference buffer and the picture for display are different, so we can have a better reference for prediction, and a sharper image for display.

As noted above, the present principles are directed to methods and apparatus for in-loop de-artifact filtering.

In an embodiment, we propose utilizing a succession of filters on coded pictures to reduce the amount of coding artifacts over video frames. The filters are placed in the coding loop (in-loop), so the filtered frames are used as referenced frames for motion compensation of subsequent coded frames. At least one of the filters includes, for example, a deblocking filter, a de-ringing filter, a de-noising filter, a signal estimation filter, a linear filter, and/or a non-linear filter.

In an embodiment, we propose using two-pass filters. In the first pass, we apply an adaptive deblocking filter, which targets removing blocking artifacts. In the second pass, we apply an adaptive sparse de-noising filter, which can further reduce

quantization noise over video frames composed of locally uniform regions (smooth, high frequency, texture, and so forth). To further improve the result, we can enforce compression constraints including, but not limited to, quantization constraints, in order to help restore the image to the artifact-free form.

One or more embodiments herein involve the use of two or more in-loop filters (and/or two or more in-loop filtering passes) to remove or reduce quantization artifacts - the first filter (or filtering pass) to remove or reduce a first type (or group of types) of quantization artifact and the second filter (or filtering pass) to remove or reduce a second type (or group of types) of quantization artifact. It is to be appreciated that the use of even more in-loop filters (or filtering passes) is also contemplated in accordance with embodiments of the present principles. That is, given the teachings of the present principles provided herein, one of ordinary skill in this and related arts will contemplate these and various other implementations and variations of the present principles, while maintaining the spirit of the present principles.

Therefore, in accordance with the principles of the present invention, we suggest using a succession of filters (or filtering passes) to remove or reduce a plurality of possible coding artifact types caused by quantization. If done in this way, different kinds of artifacts and quantization errors are handled by different filters. Hence, by such cascaded filtering of reconstructed video pictures, the decoded sequence is substantially better in both subjective and objective measures. By incorporating this scheme into the encoder/decoder loop, also known as in-loop filtering, the inter prediction process can also benefit from the improvement of decoded reference pictures. Note that by using a succession of filters, we are not limited to a particular set of general or special purpose filters, a particular number of cascaded filters, or even a particular order in which they are combined. Those parameters may be adjusted based on, for example, the encoder and/or decoder to be used and the nature of the video data to be filtered. To prevent the input video signal being over processed, we can also enforce some compression and/or quantization constraints.

An embodiment involves the use of a "two-pass" filter. Turning to FIG. 5, an exemplary succession of de-artifact filters is indicated generally by the reference numeral 500. An adaptive sparse de-noising filter 544 is used as a refinement filter

subsequent to the MPEG-4 AVC Standard deblocking filter 565 and before the quantization constraint set (QCS) filter 555. Since visual blocking artifacts are most successfully removed by the deblocking filter, the remaining quantization noise tends to become more independent and identically distributed (i.i.d.), which conforms to the noise model assumption of an adaptive sparse de-noising filter. After applying the second-pass sparse de-noising filter 544, we use the quantization constraint set filter 555 to reshape the residuals and prevent them from being over-processed. The quantization constraint set filter 555 is used to restrict each transform coefficient to its original quantization interval. This step helps prevent over-smoothing, and makes the outcome of the cascaded set of filters more robust to changes in the settings of filters including, but not limited to, changes in the thresholding parameter for the sparse-based de-noising step.

The adaptive sparse de-noising filter 544 includes a forward transformer 571 having an output in signal communication with an input of a threshold module 573. An output of the threshold module 573 is connected in signal communication with an input of an inverse transformer 575. An output of the inverse transformer 575 is connected in signal communication with an input of an adaptive weighting module 577. An input of the forward transformer is available as an input of the spare de-noising filter 544. An output of the adaptive weighting module 577 is available as an output of the spare de-noising filter 544. An output of the MPEG-4 AVC Standard deblocking filter 565 is connected in signal communication with the input of the forward transformer 571. The output of the adaptive weighting module 577 is connected in signal communication with an input of the quantization constraint set filter 555. An input of the MPEG-4 AVC Standard deblocking filter 565 is available as an input of the succession of de-artifact filters 500. An output of the quantization constraint set filter 571 is available as an output of the succession of de-artifact filters 500.

As examples, FIGs. 3 and 4 illustrate where the adaptive sparse de-noising filter and the quantization constraint set filter may be located within a video encoder structure and a video decoder structure, respectively. In the examples shown, the adaptive sparse de-noising filter and the quantization constraint set filter, one after the other, are located after the deblocking filter. Of course, given the teachings of the present principles provided herein, one of ordinary skill in this and related arts

will contemplate this and other locations for the adaptive sparse de-noising filter and the quantization constraint set filter, while maintaining the spirit of the present principles.

In an embodiment, the adaptive sparse de-noising filter and/or the quantization constraint set filter can be turned on/off at the macroblock level, slice level, picture level, and/or sequence level. For example, we may choose to only apply the sparse de-noising filter and the quantization constraint set filter for intra frames, but not for inter frames.

In an embodiment, the different artifact removing/reducing steps may be selectively switched on/off depending on complexity constraints of the application, distortion measures and/or coding costs. The transform for the sparse de-noising step can be adaptively selected from a set of possible transforms. The selected transform can be indicated and signaled to the decoder using a high level syntax. A proper threshold γ can be signaled to optimize the adaptive sparse de-noising filtering. The signaled threshold γ may need to be adapted to the quantization parameter as well as to the sequence content. The optimal weighting method can also be signaled to maximize the de-noising gain.

TABLE 1 shows exemplary picture parameter set (PPS) raw byte sequence payload (RBSP) syntax for use in in-loop de-artifact filtering in accordance with an embodiment of the present principles.

TABLE 1

pic_parameter_set_rbsp( ) {	C	Descriptor
...		
sparse_filter_control_present_flag	1	u(1)
qcs_control_present_flag	1	u(1)
...		
}		

TABLE 2 shows exemplary slice header syntax for use in in-loop de-artifact filtering in accordance with an embodiment of the present principles.

TABLE 2

slice_header( ) {	C	Descriptor
...		
if(sparse_filter_control_present_flag) {		
disable_sparse_filter_flag	2	u(1)
if(disable_sparse_filter_flag != 1) {		
sparse_threshold	2	u(v)
sparse_tranform_type	2	u(v)
adaptive_weighting_type	2	u(v)
}		
}		
if(qcs_control_present_flag) {		
disable_qcs_flag	2	u(1)
if(disable_qcs _flag != 1) {		
qcs_pullback_model	2	u(v)
}		
}		
...		
}		

With respect to TABLES 1 and 2, the following exemplary syntax definitions are provided. Of course, given the teachings of the present principles provided herein, one of ordinary skill in this and related arts will contemplate these and various other syntaxes and variations thereof for use in accordance with various embodiments of the present principles, while maintaining the spirit of the present principles.

sparse_filter_control_present_flag equal to 1 specifies that a set of syntax elements controlling the characteristics of the sparse de-noising filter is present in the slice header. sparse_filter_control_present_flag equal to 0 specifies that a set of syntax elements controlling the characteristics of the sparse de-noising filter is not present in the slice header and their inferred values are in effect.

qcs_control_present_flag equal to 1 specifies that a set of syntax elements controlling the characteristics of the quantization constraint set (QCS) filter is present in the slice header. qcs_control_present_flag equal to 0 specifies that a set of syntax elements controlling the characteristics of the quantization constraint set (QCS) filter is not present in the slice header and their inferred values are in effect.

disable_sparse_filter_flag specifies whether the operation of the sparse de-noising filter shall be disabled. When disable_sparse_filter_flag is not present in the slice header, disable_sparse_filter_flag shall be inferred to be equal to 0.

sparse_threshold specifies the value of threshold used in sparse de-noising. When sparse_threshold is not present in the slice header, the default value derived based on the slice quantization parameter is used.

sparse_transform_type specifies the type of the transform used in sparse de-noising. sparse_transform_type equal to 0 specifies that a 4x4 transform is used. sparse_transform_type equal to 1 specifies that a 8x8 transform is used.

adaptive_weighting_type specifies the type of weighting used in sparse de-noising. adaptive_weighting_type equal to 0 specifies that sparsity weighting is used. adaptive_weighting_type equal to 1 specifies that average weighting is used.

disable_qcs_flag specifies whether the operation of the quantization constraint set (QCS) filter shall be disabled. When disable_qcs_flag is not present in the slice header, disable_qcs_flag shall be inferred to be equal to 0.

qcs_pullback_model specifies how to re-assign the value of coefficients. qcs_pullback_model equal to 0 specifies to pull back the coefficients to the closest cell boundary (An example of pulling back to the closet cell (or quantization bin) boundary is shown in the last row of FIG. 9, described below.). qcs_pullback_model equal to 1 specifies to pull back the coefficients to the center (also see FIG., if the quantized coefficient value is used instead) or predefined value of a cell.

In an embodiment, an adaptive sparse de-noising filter operation involves the following steps.

In one step, an over complete transform set $\mathbf{H}_i, i = 1, \cdots, M$ is determined. The information related to this particular set may be transmitted to the decoder. The information may be so transmitted at, for example, a slice, picture and/or sequence level. In transmitting such information, high level syntax may be embedded in the

data stream. The high level syntax may be embedded, for example, at the slice, picture and/or sequence level. For example, within the framework of the MPEG-4 AVC Standard, we can reuse the existing 4x4 transform and 8x8 transform and/or the Hadamard transform step.

In another step, a threshold γ (for example, based on a quantization step and/or the statistics of the encoding picture) is determined. γ may be transmitted to the decoder. γ may be transmitted at, for example, a block, a slice, a picture and/or a sequence level. In transmitting such information, at least one block level syntax and/or at least one high level syntax may be embedded in the data stream.

In yet another step, the adaptive weighting method to combine the outcome of the inversed transforms, which may be transmitted to the decoder, is determined. The weights may be transmitted at, for example, a block a slice, picture and/or sequence level. In the event that the weighting is directly derived without explicit transmission thereof, there may still be a need to transmit some auxiliary information related to the weighting step. In transmitting any weighting step information, at least one block level syntax and/or at least one high level syntax may be embedded in the data stream. For example, average weighting or sparsity base weighting, which adapts the weights inverse of number of non-zero coefficients, can be used. Of course, the present principles are not limited to solely the preceding types of weighting and, thus, other types of weighting may also be used in accordance with the present principles, while maintaining the spirit of the present principles.

In an embodiment, an adaptive sparse de-noising filter methodology used for refinement involves obtaining the de-noised estimate $\hat{\mathbf{x}}_i$ from each transform $\mathbf{H}_i$ using the specified threshold γ; and combining $\hat{\mathbf{x}}_i$ using adaptive weightings to get the final de-noised estimate $\hat{\mathbf{x}}$.

In an embodiment, a quantization constraint set methodology is used for a last refinement step as follows:

(1) Calculate the new residual signal $\hat{\mathbf{r}} = \hat{\mathbf{x}} - \mathbf{p}$, where $\mathbf{p}$ is the intra/inter predicted signal.

(2) Apply the same transformation process on $\hat{\mathbf{r}}$ that the MPEG-4 AVC Standard applies on the residual. Presume that the resulting transform coefficients are $\hat{\mathbf{c}}$.

(3) Check if $\hat{\mathbf{c}}$ is in the quantization cell indicated by the originally received transform coefficients. For each coefficient, if after the filtering steps, $\hat{\mathbf{c}}$ has fallen outside its original quantization cell, the new coefficient is corrected and reassigned as the closest original quantization cell boundary value to itself. Alternatively, depending on the statistics of every particular coefficient and/or quantization bin, other possible values from within the original quantization cell can be used for the reassignment procedure. The refined coefficients are denoted as $\mathbf{c}'$.

(4) Take the inverse transform of $\mathbf{c}'$, denoted by $\mathbf{r}'$, and sum together with $\mathbf{p}$ to obtain the final estimate $\mathbf{x}' = \mathbf{p} + \mathbf{r}'$.

The adaptive sparse de-noising filtering is directed to recovering the original signal from an independent and identically distributed (i.i.d.) noisy environment. However, the quantization noise in video compression, and particularly with respect to the MPEG-4 AVC Standard, is usually not independent and identically distributed (i.i.d.). The present principles differ from the prior art in the use of a series of refinement steps (succession of filters) after, for example, the MPEG-4 AVC Standard deblocking filter, each oriented to correct at least one part of the coding artifacts. The signal after deblocking filter is a better match to the independent and identically distributed (i.i.d.) noise presumption. The possible "over filtering problem" resulting from the use and/or combination of deblocking and de-noising filters is solved by the subsequent quantization constraint set (QCS) filter. The succession of filters has shown its superior performance in removing video compression artifacts, both in practice and theory.

Turning to FIG. 6, an exemplary method for encoding image data using in-loop de-artifact filtering is indicated generally by the reference numeral 600.

The method 600 includes a start block 605 that passes control to a function block 610. The function block 610 encodes the current slice, and passes control to a function block 615. The function block 615 decides whether or not a deblocking filter, a sparse de-noising filter, and/or quantization constraint set (QCS) will be applied to the current slice based on statistics of the current slice, and passes

control to a decision block 620. The decision block 620 determines whether or not disable_deblocking_filter_ids is equal to zero. If so, then control is passed to a function block 625. Otherwise, control is passed to a decision block 630.

The function block 625 applies a deblocking filter, and passes control to the decision block 630.

The decision block 630 determines whether or not disable_sparse_filter_flag is equal to zero. If so, then control is passed to a function block 635. Otherwise, control is passed to a decision block 640.

The function block 635 applies the sparsity de-noising filter, and passes control to the decision block 640.

The decision block 640 determines whether or not diable_qcs_flag is equal to zero. If so, then control is passed to a function block 645. Otherwise, control is passed to an end block 699.

The function block 645 applies the quantization constraint set (QCS), and passes control to the end block 699.

Turning to FIG. 7, an exemplary method for decoding image data using in-loop de-artifact filtering is indicated generally by the reference numeral 700.

The method 700 includes a start block 705 that passes control to a function block 710. The function block 710 parses the bitstream, decodes the syntax, and passes control to a function block 715. The function block 715 decodes the current slice, and passes control to a decision block 720. The decision block 720 determines whether or not diable_deblocking_filter_idc is equal to zero. If so, then control is passed to a function block 725. Otherwise, control is passed to a decision block 730.

The function block 725 applies the deblocking filter, and passes control to the decision block 730.

The decision block 730 determines whether or not disable_sparse_filter_flag is equal to zero. If so, then control is passed to a function block 735. Otherwise, control is passed to a decision block 740.

The function block 735 applies the sparsity de-noising filter, and passes control to the decision block 740.

The decision block 740 determines whether or not diable_qcs_flag is equal to zero. If so, then control is passed to a function block 745. Otherwise, control is passed to an end block 799.

The function block 745 applies a quantization constraint set (QCS), and passes control to the end block 799.

Turning to FIG. 8, an exemplary apparatus for performing quantization constraint set (QCS) coefficients correction after artifact removal/reduction is indicated generally by the reference numeral 800. The apparatus 800 includes a combiner 805 having an output in signal communication with an input of a MPEG-4 AVC transformer 810. An output of the MPEG-4 AVC Standard transformer 810 is connected in signal communication with a first input of a comparison and correction module 815. An output of the comparison and correction module 815 is connected in signal communication with an input of a MPEG-4 AVC inverse transformer 820. An output of the MPEG-4 AVC inverse transformer 820 is connected in signal communication with a first non-inverting input of a combiner 825.

A non-inverting input of the combiner 805 is available as an input of the apparatus 800, for receiving a reconstructed and filtered video picture. An inverting input of the combiner 805 is available as an input of the apparatus 800, for receiving a predicted video picture. A second input of the compare and correct module 815 is available as an input of the apparatus 800, for receiving quantization bins pattern. A third input of the compare and correct module 815 is available as an input of the apparatus 800, for receiving decoded coefficients. A second non-inverting input of the combiner 825 is available as an input of the apparatus, for receiving a predicted video picture. An output of the combiner 825 is available as an output of the apparatus, for outputting a reconstructed and filtered and quantization constraint set (QCS) corrected video picture.

The MPEG-4 AVC transformer 810 is applied to the decoded residual. The MPEG-4 AVC inverse transformer 820 is applied to the decoded residual. The compare and correct module 815 compares the decoded and filtered pictures in the transform domain and corrects the coefficients that are over-filtered.

Turning to FIG. 9, exemplary quantization bins for using QCS to correct an over-filtering problem in video encoding/decoding is indicated generally by the reference numeral 900. Presume the original value is x, and the boundary value of

the quantizer is y_i , i=0, 1, 2..n,... The particular bins are denoted by 910, 920, 930, and 940. In bin 910, x is in the quantization bin of $(y_{n-1}, y_n]$. In bin 920, after the quantization process in the encoder, the reconstruction value of x is x', which is in the quantization bin of $(y_{n-1}, y_n]$. In bin 930, after the de-artifacting process, the filtered coefficient of x is x", which is in the quantization bin of $(y_n, y_{n+1}]$. However, the coefficient should not be outside the original quantization bin, which is $(y_{n-1}, y_n]$. In bin 940, we apply the QCS process, and we set x"' equal to y_n, which is the final reconstructed value.

A description will now be given of some of the many attendant advantages/features of the present invention, some of which have been mentioned above. For example, one advantage/feature is an apparatus that includes an encoder for encoding an image region. The encoder has at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

Another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

Yet another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters wherein at least one of the at least two filters is used to enforce at least one compression constraint as described above, wherein the at least one compression constraint involves a quantization constraint set.

Still another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters wherein at least one of the at least two filters is used to enforce at least one compression constraint as described above, wherein at least one of, enablement information or disablement information for the at least one compression constraint and side information corresponding to the image region to adaptively indicate parameters of the at least one compression constraint, is signaled using at least one of at least one high level syntax element and at least one block level syntax element.

Moreover, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters wherein at least one of the at least two filters is used to enforce at least one compression constraint as described above, wherein parameters of the at least one compression constraint is adaptively indicated based

at least in part on at least one of data characteristics and data statistics corresponding to the image region.

Further, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein at least one of the at least two filters includes a deblocking filter, a de-ringing filter, a de-noising filter, a signal estimation filter, a linear filter, and a non-linear filter.

Also, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selectable.

Additionally, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

Moreover, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein enablement information or disablement information for at least one of the two or more filters is signaled using at least one of at least one high level syntax element and at least one block level syntax element.

Further, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein the encoder transmits side information corresponding to the image region to adaptively indicate parameters of at least one of the two or more filters, the side information being transmitted at at least one of a macroblock level, a slice level, a picture level, and a sequence level.

Also, another advantage/feature is the apparatus having the encoder that transmits side information as described above, wherein the parameters of the at least one of the two or more filters are adaptively tuned based at least in part on at least one of data characteristics and data statistics corresponding to the image region.

Additionally, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein the two or more filters are included in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization

artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

Moreover, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters wherein the two or more filters are included in a two-pass filter as described above, wherein the encoder enforces a quantization constraint set subsequent to the second pass.

Further, another advantage/feature is the apparatus having the encoder wherein the two or more filters are included in a two-pass filter as described above, wherein the encoder signals a quantization constraint process pullback method using at least one of at least one high level syntax element and at least one block level syntax element.

Also, another advantage/feature is the apparatus having the encoder wherein the two or more filters are included in a two-pass filter as described above, wherein the encoder signals at least one of a transform type, a threshold, and a weighting method for the sparse de-noising filter in at least one of at least one high level syntax element and at least one block level syntax element.

Additionally, another advantage/feature is the apparatus having the encoder that, in turn, has at least two filters as described above, wherein the at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

These and other features and advantages of the present principles may be readily ascertained by one of ordinary skill in the pertinent art based on the teachings herein. It is to be understood that the teachings of the present principles may be implemented in various forms of hardware, software, firmware, special purpose processors, or combinations thereof.

Most preferably, the teachings of the present principles are implemented as a combination of hardware and software. Moreover, the software may be implemented as an application program tangibly embodied on a program storage unit. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a

computer platform having hardware such as one or more central processing units ("CPU"), a random access memory ("RAM"), and input/output ("I/O") interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit.

It is to be further understood that, because some of the constituent system components and methods depicted in the accompanying drawings are preferably implemented in software, the actual connections between the system components or the process function blocks may differ depending upon the manner in which the present principles are programmed. Given the teachings herein, one of ordinary skill in the pertinent art will be able to contemplate these and similar implementations or configurations of the present principles.

Although the illustrative embodiments have been described herein with reference to the accompanying drawings, it is to be understood that the present principles is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one of ordinary skill in the pertinent art without departing from the scope or spirit of the present principles. All such changes and modifications are intended to be included within the scope of the present principles as set forth in the appended claims.

CLAIMS:

1. An apparatus, comprising:

an encoder (300) for encoding an image region, the encoder having at least two filters (365, 344) for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

2. The apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

3. The apparatus of claim 1, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

4. The apparatus of claim 1, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter (365) for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter (344) for performing a second pass to reduce noise as the second type of quantization artifact.

5. The apparatus of claim 1, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

6. A method, comprising:

encoding an image region, wherein the encoding step includes performing in-loop filtering (365, 344, 355, 565, 544, 555) to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

7. The method of claim 6, wherein at least one of the at least two filters is used to enforce at least one compression constraint (355, 555, 645).

8. The method of claim 6, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region (620,630).

9. The method of claim 6, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter (565, 544) having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

10. The method of claim 6, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

11. An apparatus, comprising:

a decoder (400) for decoding an image region, the decoder having at least two filters (465, 444, 455) for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

12. The apparatus of claim 11, wherein at least one (455) of the at least two filters is used to enforce at least one compression constraint.

13. The apparatus of claim 11, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

14. The apparatus of claim 11, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter (465) for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter (444) for performing a second pass to reduce noise as the second type of quantization artifact.

15. The apparatus of claim 11, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

16. A method, comprising:

decoding an image region, wherein the decoding step includes performing in-loop filtering (465, 444, 455, 565, 544, 555) to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

17. The method of claim 16, wherein at least one of the at least two filters is used to enforce at least one compression constraint (455, 555, 745).

18. The method of claim 16, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region (720, 730).

19. The method of claim 16, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter (565, 544) having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

20. The method of claim 16, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

21. A storage media having video signal data encoded thereupon, comprising:

an image region field, encoded using at least two filters for successively performing in-loop filtering (365, 344, 355, 544, 555) to respectively reduce at least a first and a second type of quantization artifact.

22. The storage media of claim 21, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

23. The storage media of claim 22, wherein the at least one compression constraint involves a quantization constraint set (355).

24. The storage media of claim 21, wherein at least one of the two filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

25. The storage media of claim 21, wherein enablement information and/or disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element.

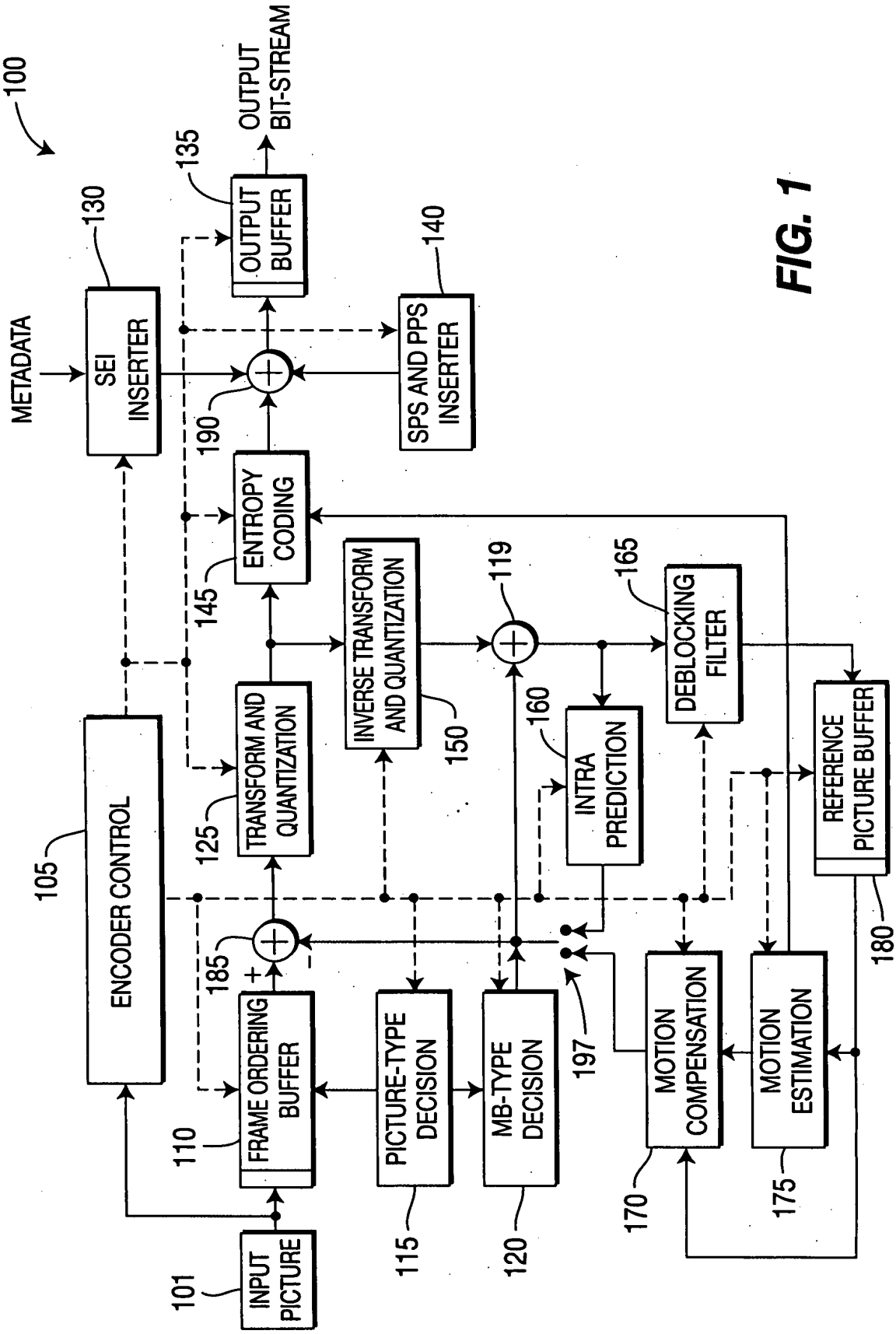

100
OUTPUT BIT-STREAM
135
OUTPUT BUFFER
130
SEI INSERTER
METADATA
140
SPS AND PPS INSERTER
190
ENTROPY CODING
145
INVERSE TRANSFORM AND QUANTIZATION
150
119
165
DEBLOCKING FILTER
160
INTRA PREDICTION
REFERENCE PICTURE BUFFER
180
105
ENCODER CONTROL
125
TRANSFORM AND QUANTIZATION
185
110
FRAME ORDERING BUFFER
PICTURE-TYPE DECISION
115
MB-TYPE DECISION
120
197
MOTION COMPENSATION
170
MOTION ESTIMATION
175
101
INPUT PICTURE

FIG. 1

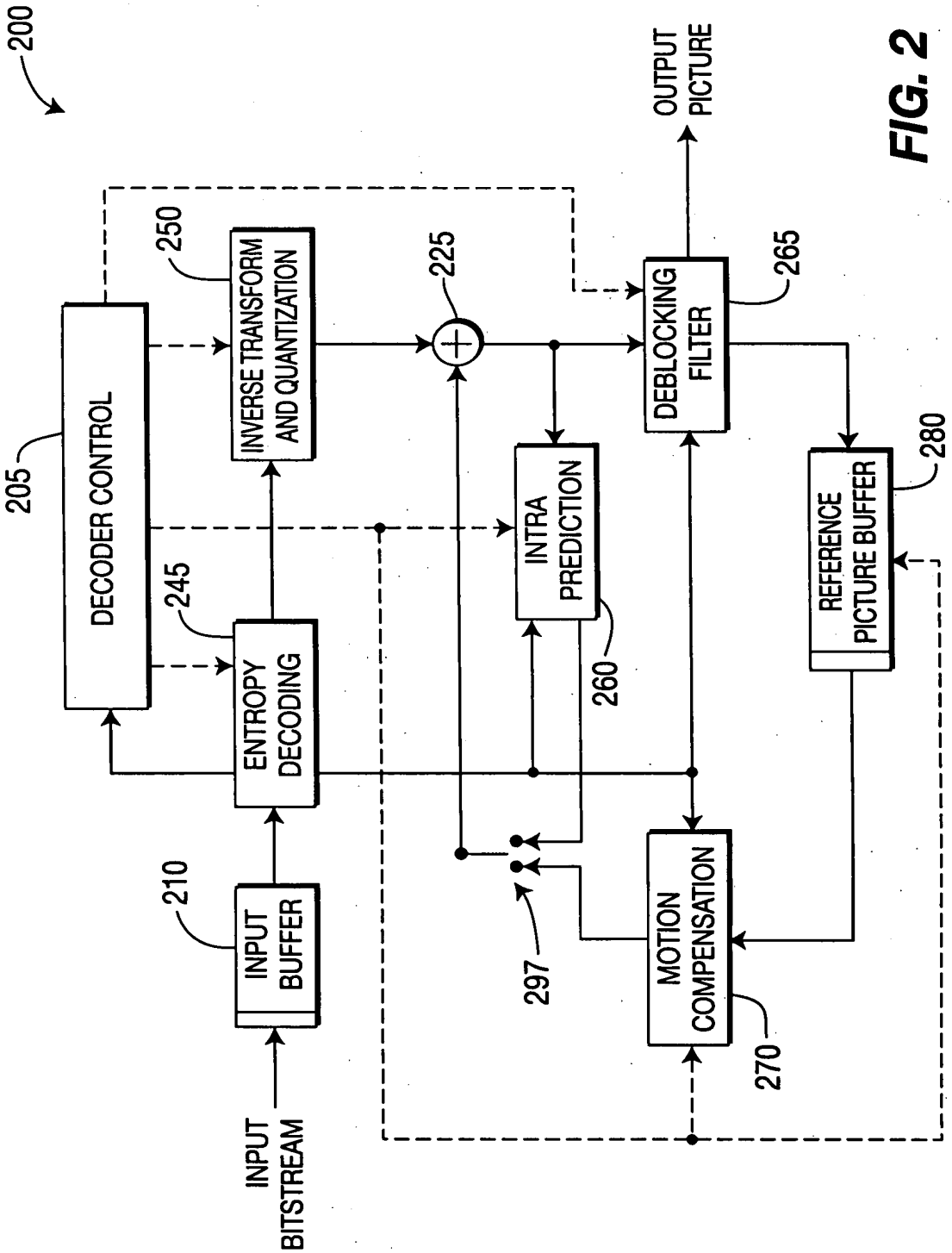

200
OUTPUT PICTURE
250
INVERSE TRANSFORM AND QUANTIZATION
225
DEBLOCKING FILTER
265
205
DECODER CONTROL
INTRA PREDICTION
260
REFERENCE PICTURE BUFFER
280
245
ENTROPY DECODING
210
INPUT BUFFER
297
MOTION COMPENSATION
270
INPUT BITSTREAM

FIG. 2

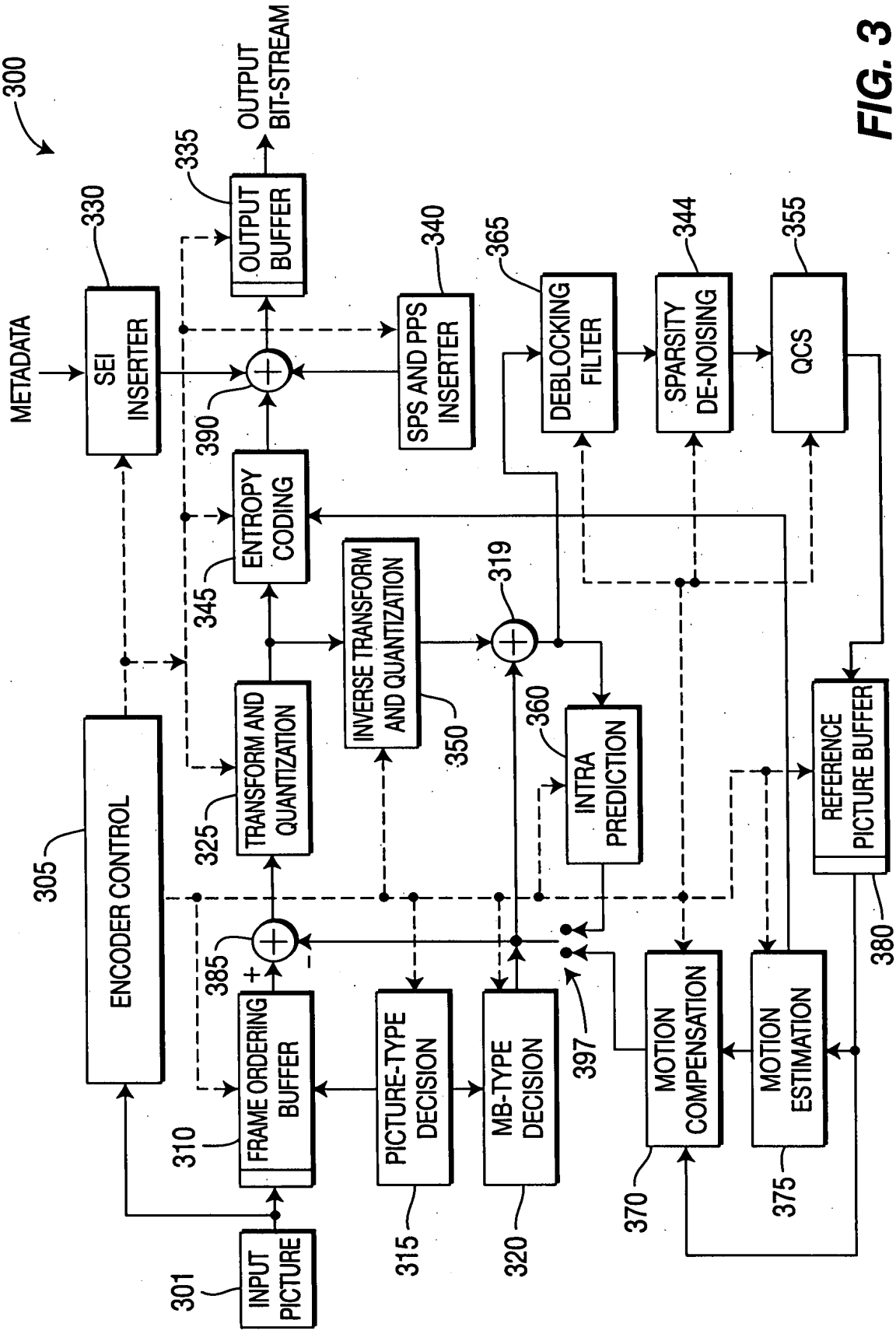

300
METADATA
SEI INSERTER
330
OUTPUT BUFFER
335
OUTPUT BIT-STREAM
SPS AND PPS INSERTER
340
DEBLOCKING FILTER
365
SPARSITY DE-NOISING
344
QCS
355
390
ENTROPY CODING
345
INVERSE TRANSFORM AND QUANTIZATION
350
319
TRANSFORM AND QUANTIZATION
325
INTRA PREDICTION
360
REFERENCE PICTURE BUFFER
380
ENCODER CONTROL
305
385
FRAME ORDERING BUFFER
310
PICTURE-TYPE DECISION
315
MB-TYPE DECISION
320
397
MOTION COMPENSATION
370
MOTION ESTIMATION
375
INPUT PICTURE
301

FIG. 3

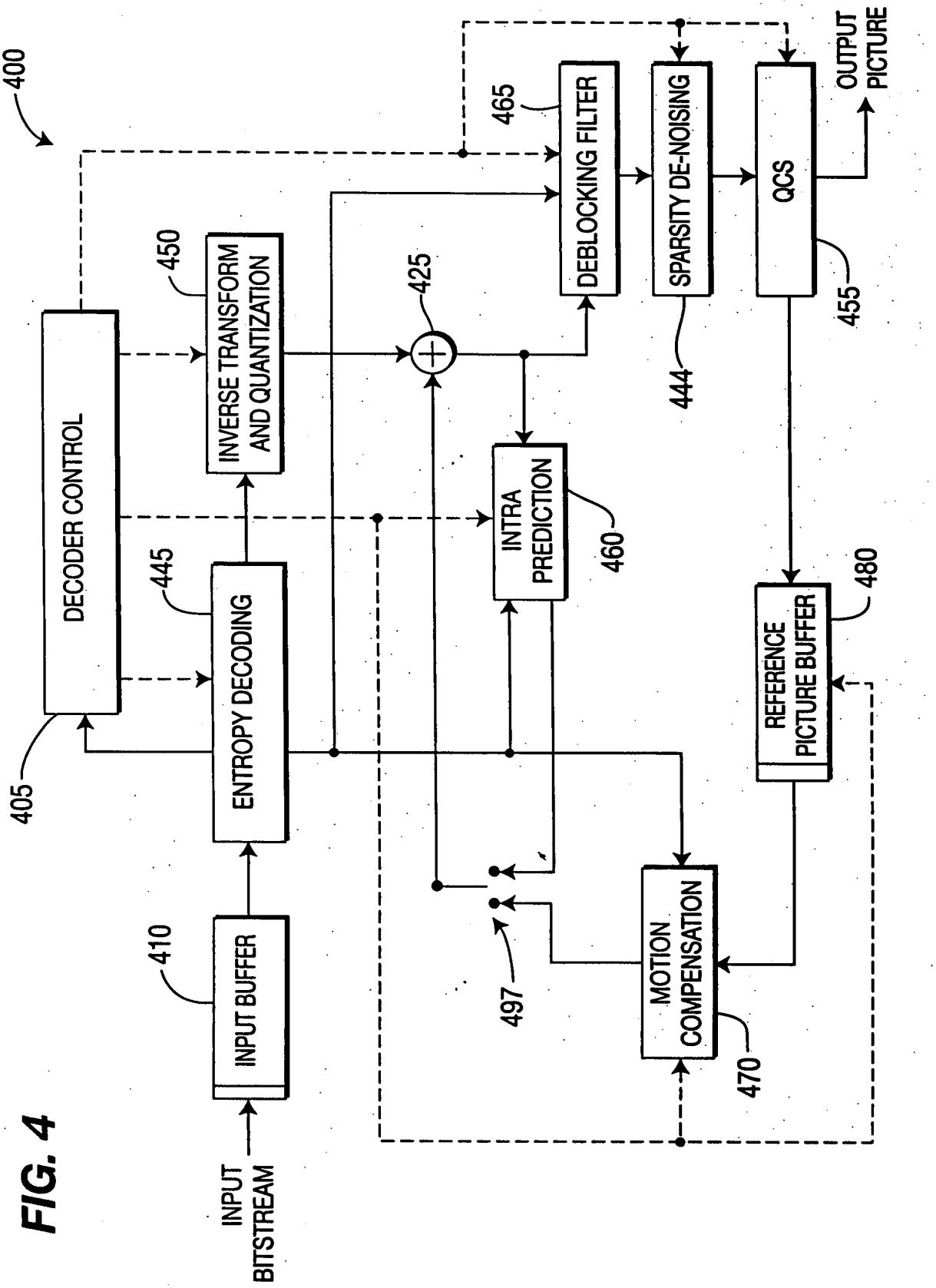

400
405
DECODER CONTROL
410
INPUT BUFFER
INPUT BITSTREAM
445
ENTROPY DECODING
450
INVERSE TRANSFORM AND QUANTIZATION
425
460
INTRA PREDICTION
465
DEBLOCKING FILTER
444
SPARSITY DE-NOISING
455
QCS
OUTPUT PICTURE
480
REFERENCE PICTURE BUFFER
497
MOTION COMPENSATION
470

FIG. 4

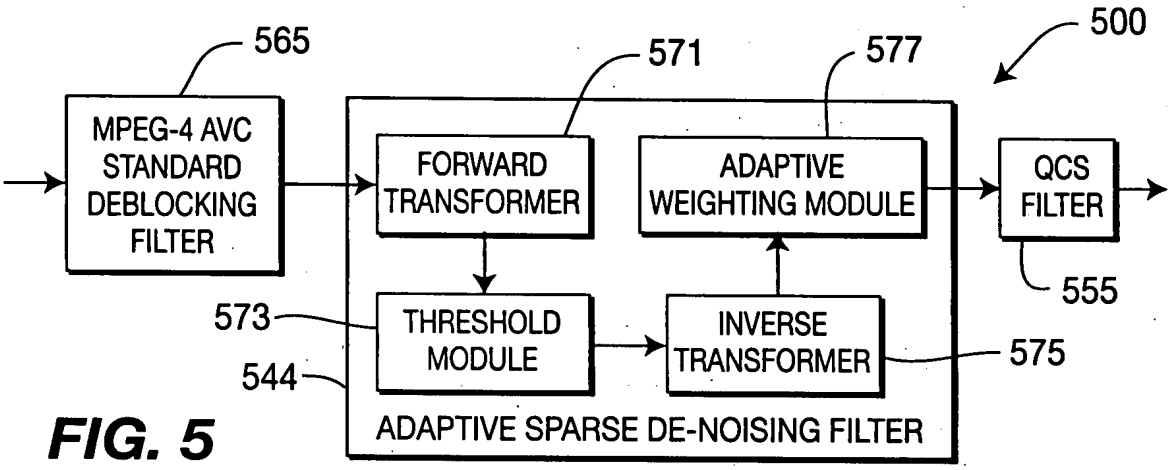

565
571
577
500
MPEG-4 AVC STANDARD DEBLOCKING FILTER
FORWARD TRANSFORMER
ADAPTIVE WEIGHTING MODULE
QCS FILTER
555
573
THRESHOLD MODULE
INVERSE TRANSFORMER
575
544
ADAPTIVE SPARSE DE-NOISING FILTER

FIG. 5

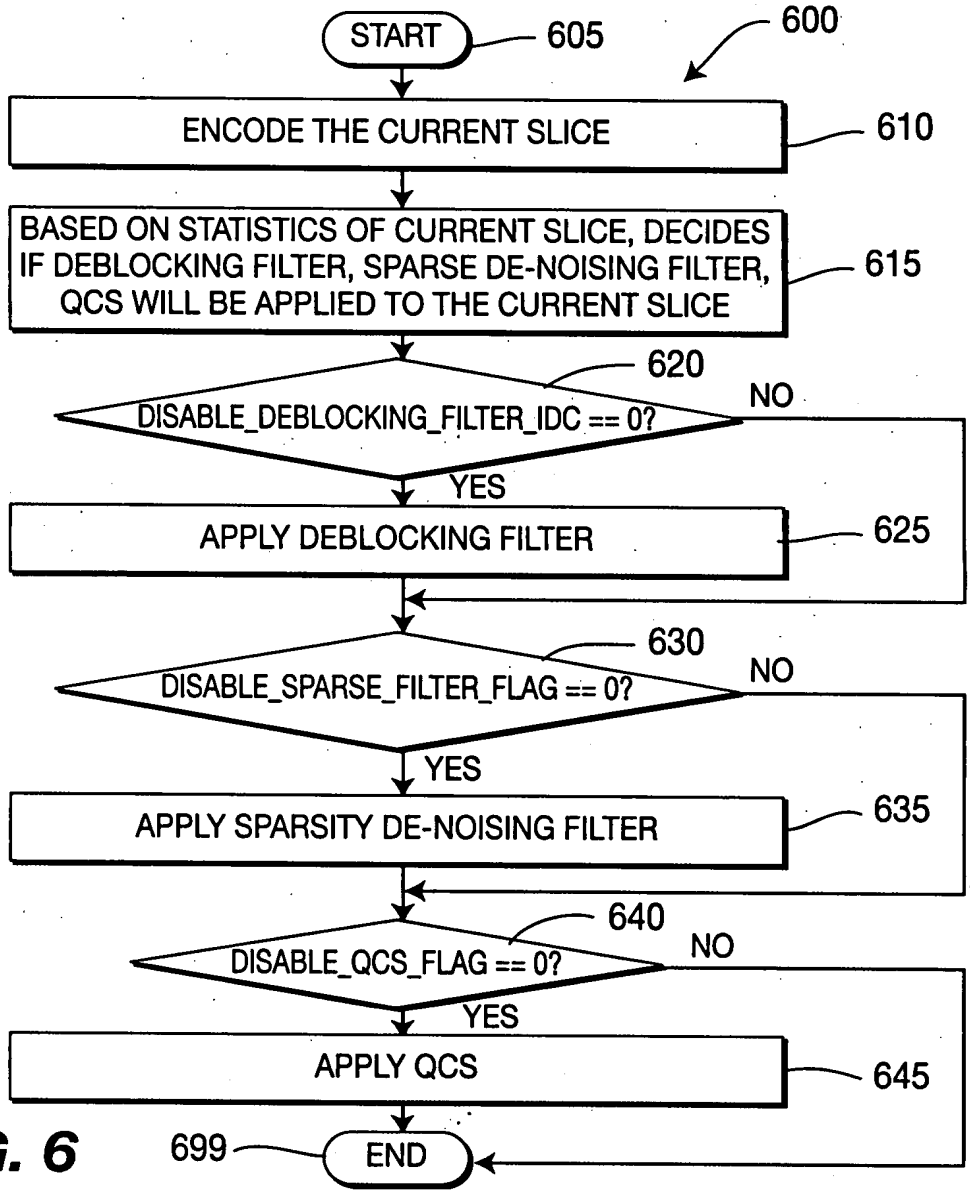

START
605
600
ENCODE THE CURRENT SLICE
610
BASED ON STATISTICS OF CURRENT SLICE, DECIDES IF DEBLOCKING FILTER, SPARSE DE-NOISING FILTER, QCS WILL BE APPLIED TO THE CURRENT SLICE
615
620
DISABLE_DEBLOCKING_FILTER_IDC == 0?
NO
YES
APPLY DEBLOCKING FILTER
625
630
DISABLE_SPARSE_FILTER_FLAG == 0?
NO
YES
APPLY SPARSITY DE-NOISING FILTER
635
640
DISABLE_QCS_FLAG == 0?
NO
YES
APPLY QCS
645
699
END

FIG. 6

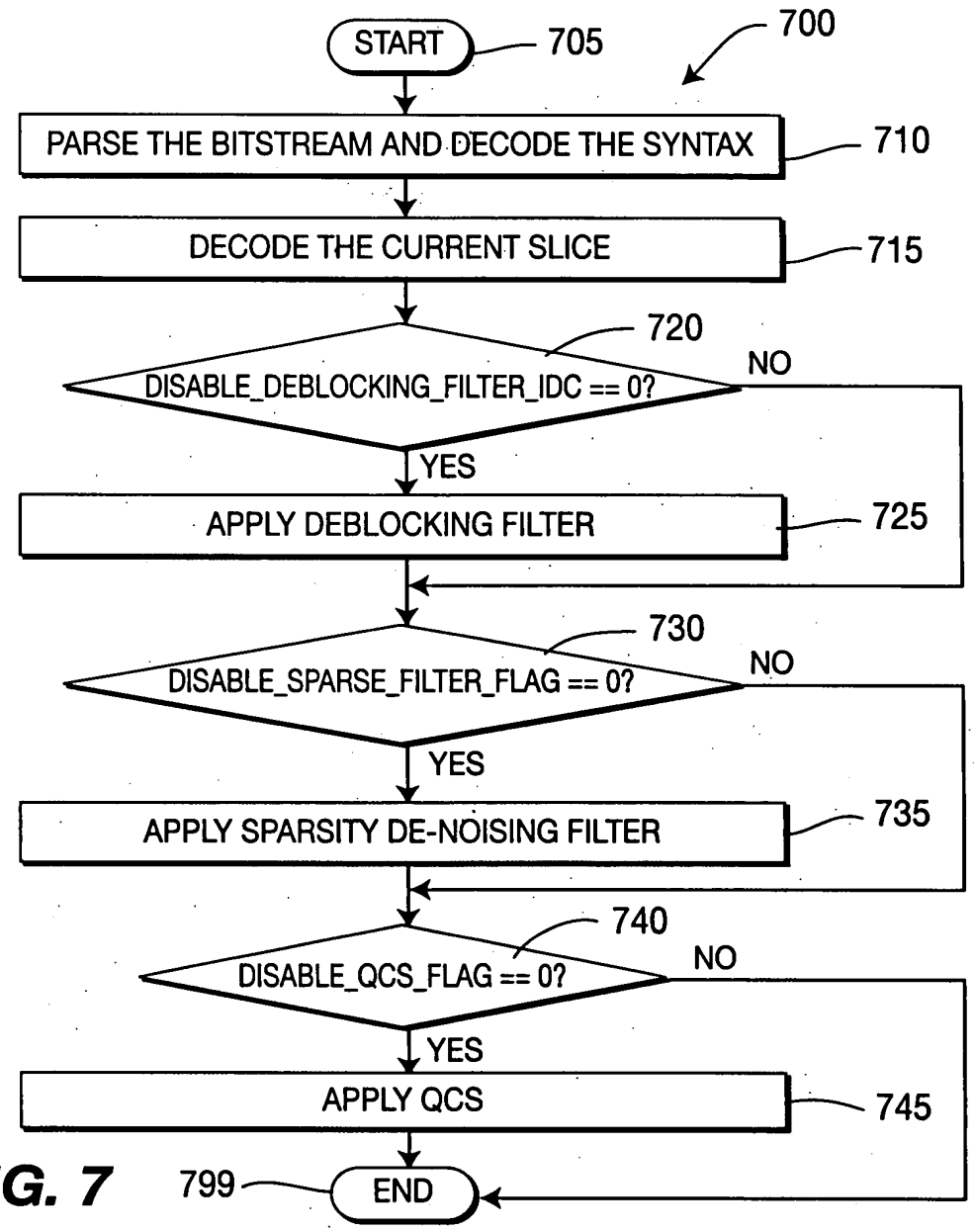

START
705
700
PARSE THE BITSTREAM AND DECODE THE SYNTAX
710
DECODE THE CURRENT SLICE
715
720
DISABLE_DEBLOCKING_FILTER_IDC == 0?
NO
YES
APPLY DEBLOCKING FILTER
725
730
DISABLE_SPARSE_FILTER_FLAG == 0?
NO
YES
APPLY SPARSITY DE-NOISING FILTER
735
740
DISABLE_QCS_FLAG == 0?
NO
YES
APPLY QCS
745
799
END

FIG. 7

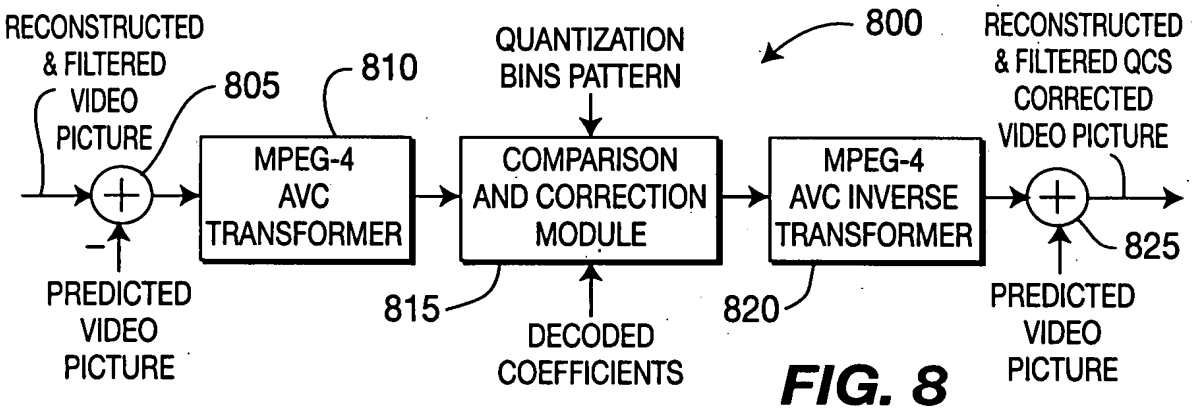

RECONSTRUCTED & FILTERED VIDEO PICTURE
805
810
MPEG-4 AVC TRANSFORMER
QUANTIZATION BINS PATTERN
800
COMPARISON AND CORRECTION MODULE
MPEG-4 AVC INVERSE TRANSFORMER
RECONSTRUCTED & FILTERED QCS CORRECTED VIDEO PICTURE
825
PREDICTED VIDEO PICTURE
815
DECODED COEFFICIENTS
820
PREDICTED VIDEO PICTURE

FIG. 8

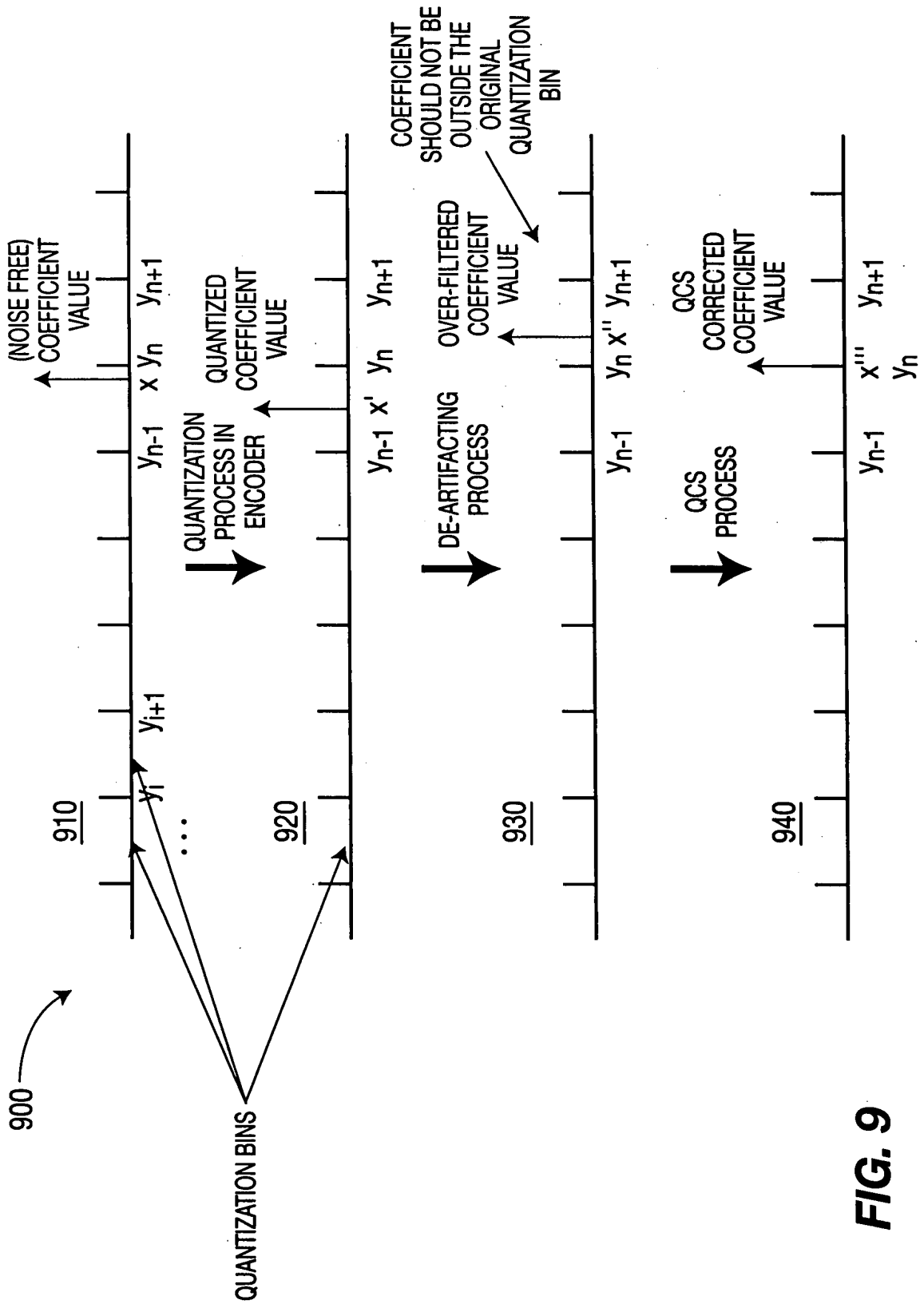

900
910
920
930
940
QUANTIZATION BINS
ORIGINAL (NOISE FREE) COEFFICIENT VALUE
QUANTIZATION PROCESS IN ENCODER
QUANTIZED COEFFICIENT VALUE
DE-ARTIFACTING PROCESS
COEFFICIENT SHOULD NOT BE OUTSIDE THE ORIGINAL QUANTIZATION BIN
OVER-FILTERED COEFFICIENT VALUE
QCS PROCESS
QCS CORRECTED COEFFICIENT VALUE

FIG. 9

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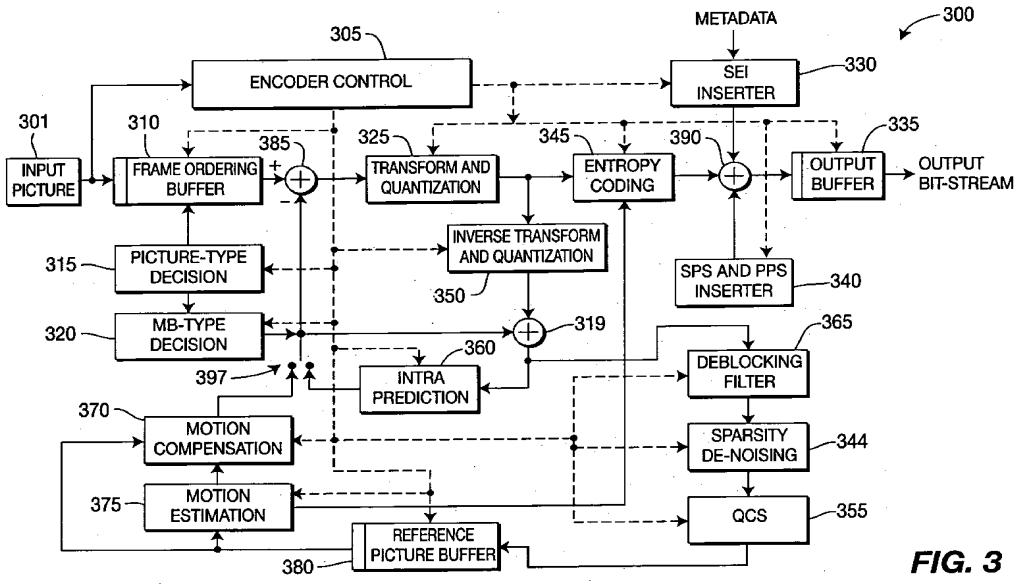


FIG. 3

(57) Abstract: There are provided methods and apparatus for in-loop artifact filtering. An apparatus includes an encoder (300) for encoding an image region. The encoder (300) has at least two filters (365, 344) for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact.

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METHOD AND APPARATUS FOR IN LOOP ARTIFACT FILTERING

All video compression artifacts result from quantization, which is the only lossy coding part in a hybrid video coding framework. However, those artifacts can be present in various appearances and forms, such as a blocky artifact, ringing artifact, edge distortion, or texture corruption. In general, the decoded sequence may be composed of all kinds of visual artifacts, but with different severances. Among them, blocky artifacts are common in block-based video coding. These artifacts can originate from both, the block-based transform stage in residue coding and from the motion compensation stage. Adaptive deblocking filters have been studied in the past and some well-known methods have been proposed and adopted in various standards (such as those adopted in the H.264/MPEG4 Advance Video Coding (AVC) standard (hereinafter referred to as H.264). When designed well, it can improve both objective and subject video quality. In state of the art video codecs such as H.264, an adaptive in-loop deblocking filter is designed to reduce the blocky artifact, wherein the strength of filtering is controlled by the values of several syntax elements. The basic idea is that if a relatively large absolute difference between samples near a block edge is measured, it is quite likely a blocking artifact and should therefore be reduced. However, if the magnitude of that difference is so large that it cannot be explained by the coarseness of the quantization used in the encoding, the edge is more likely to reflect the actual behavior of the source picture and should not be smoothed over. In this way, the blockiness is reduced, while the sharpness of the content is basically unchanged. The deblocking filter is adaptive on several levels. On the slice level, the global filtering strength can be adjusted to the individual characteristics of the video sequence. On the block-edge level, filtering strength is made dependent on the inter/intra prediction decision, motion differences, and the presence of coded residuals in the two neighboring blocks. On macroblock boundaries, special strong filtering is applied to remove "tiling artifact". On the sample level, sample values and quantizer-dependent thresholds can turn off filtering for each individual sample.

H.264 deblocking filtering is well designed to reduce the blocky artifact, but it does not try to correct other artifacts caused by quantization noise. For example, it leaves edges and textures untouched. So it can not improve any distorted edge or texture. One reason behind it is that H.264 deblocking filter applies a smooth image

model and the designed filters typically consist of a bank of low-pass filters. But images contain many singularities, texture, etc, and they are not handled correctly.

In order to overcome the limitations of H.264 deblocking filtering, recently, a denoising type nonlinear in-loop filter has been proposed by Onur G. Guleryuz in "A Nonlinear Loop Filter for Quantization Noise Removal in Hybrid Video Compression," Proc. IEEE Int'l Conf. on Image Proc. (ICIP2005), Genova, Italy, Sep. 2005. In this proposed scheme, a nonlinear denoising filter adapts to non-stationary image statistics which exploits a sparse image model using an overcomplete set of linear transforms and hard-thresholding. It automatically becomes high-pass, or low-pass, or band-pass, etc., depending on the region it is operating on. It can combat all types of quantization noise. The denoising basically consists of three steps: transform-threshold-inverse transform. Then several denoised estimates provided by denoising with an overcomplete set of transforms (typically produced by applying denoising with shifted versions of the same transform) are combined by weighted averaging them at every pixel.

Sparsity based denoising tools could reduce quantization noise over video frames composed of locally uniform regions (smooth, high frequency, texture, etc.) separated by singularities. However, as noted extensively in the literature, the denoising tool was initially designed for additive, i.i.d noise removal, but quantization noise has significantly different properties, which can present significant issues. This implies that these techniques may get confused by true edges or false blocky edges. A possibility for a solution is spatio-frequential threshold adaptation, which may be able to correct the decision, but it is not trivial. A possible consequence of inadequate threshold selection is that sparse denoising might result into over smoothed reconstructed pictures. At present, as observed in our experiments, sparsity based denoising techniques, even though they present a higher distortion reduction in terms of objective measures (e.g. MSE) than other techniques, they may present important visual artifacts that need to be addressed.

Based on our experiments, in order to remove the coding artifacts as much as possible, the use of a single denoising filter is not very efficient or effective. The reason for this is that a general purpose denoising filter is usually based on a perfect model which describes the exact relationship between the original and distorted signals. This global model lacks of local adaptivity to image singularities. A special purpose denoising filter, on the other hand, is designed to relieve a certain type of artifact. It is, of course, not sufficient to correct the rest of quantization noises. For

example, the in-loop deblocking filter used in H.264 is a special purpose filter which neither gives effort on removing the noise at pixels away from the boundaries, nor corrects the distorted edges.

Coarse quantization of the transform coefficients can cause various visually disturbing artifacts, such as blocky artifact, edge artifact and texture artifact, etc. H.264 defines an adaptive in-loop deblocking filter to solve the issue, but it only focuses on blocky edges smoothing. It does not try to correct other artifacts caused by quantization noises, such as distorted edges and texture. This invention proposes to use a second pass filter to further reduce artifacts.

In accordance with the principles of the present invention, we suggest utilizing a succession of filters on coded pictures to reduce the amount of coding artifacts over video frames. The filters are placed in the coding loop (in-loop), so the filtered frames are used as referenced frames for motion compensation of subsequent coded frames. In one embodiment of the invention used to describe the principles at work, we suggest using two-pass filters as an example. In the first pass, we shall apply an adaptive deblocking filter, which targets removing blocking artifacts. In the second pass, we shall apply an adaptive sparse denoising filter, which can further reduce quantization noise over video frames composed of locally uniform regions (smooth, high frequency, texture, etc). To further improve the result, we can enforce compression constraints, such as quantization constraints in order to help restore the image to the artifact-free form. Other embodiments illustrating the principles of the present invention are also presented herein, one common feature shared by the embodiments is the use of two or more in-loop filters (or alternatively, two or more in-loop filtering passes) to remove or reduce quantization artifacts - the first filter (or filtering pass) to remove or reduce a first type of quantization artifact and the second filter (or filtering pass) to remove or reduce a second type of quantization artifact. Use of even more in-loop filters (or filtering passes) are also contemplated in various embodiments of the invention and therefore fall within the claimed scope of the invention.

Therefore, in accordance with the principles of the present invention, we suggest using a succession of filters (or filtering passes) which aims at removing or reducing a plurality of possible coding artifact types caused by quantization. If done in this way, different kinds of artifacts and quantization errors are handled by different filters. Hence, by such cascaded filtering of reconstructed video pictures, the decoded sequence is substantially better in both subjective and objective

measures. By incorporating this scheme into the encoder/decoder loop, also known as in-loop filter, the inter prediction process can also benefit from the improvement of decoded reference pictures. Note that by using a succession of filters, we are not limited to a certain set of general or special purpose filters, the number of cascaded filters, or even the order in which they are combined. Those parameters should be adjusted according to the working codec and the nature of 2D video data to filter. To prevent video signal being over processed, we can also enforce some compression and/or quantization constraints.

One embodiment of our invention is to use a "two-pass" filter. As an example shown in Figure 1 we use the adaptive sparse denoising filter as a refinement filter coming right after H.264 deblocking filter. Since visual blocking artifacts are most successfully removed by the deblocking filter, the remaining quantization noise tends to become more i.i.d., which conforms to the noise model assumption of adaptive sparse denoising filter. At the end, after applying the second-pass sparse denoising filter, we use the quantization constraint set (QCS) to reshape the residuals and prevent them from being over-processed. The QCS is to restrict each transform coefficient to its original quantization interval. This step helps preventing over-smoothing as well as it makes the outcome of the cascaded set of filters more robust to changes in the settings of filters, e.g. changes in the thresholding parameter for sparse-based denoising step.

Figures 2, 3, 4, and 5 show an example where the adaptive sparse denoising filter and the QCS are located within a common video encoder/decoder structure. They are located after the deblocking filter.

An embodiment of such a succession of filters for in-loop de-artifact processing is described in the following:

Position the adaptive sparse denoising filter and the QCS right after the deblocking filter. Both of them can be turned on/off at the slice level, picture level or sequence level. For example, we may choose to only apply sparse denoising filter and QCS for intra frames, but not for inter frames. Also one may switch on/off the different de-artifacting steps depending on complexity constraints of the application. The transform for the sparse denoising step can be adaptively selected from a set of possible transforms. The selected transform can be indicated and signaled to the decoder by means of some high level syntax. A proper threshold γ can be signaled to optimize the adaptive sparse denoising filtering. The signaled threshold γ may need to be adapted to QP as well as to the sequence content. The optimal

weighting method can also be signaled to maximize the denoising gain. An example of a slice based signaling on high level syntax is shown in Figure 6 and Figure 7. The actual adaptive sparse denoising filter operation can be summarized up as follows:

- Determine an overcomplete transform set $\mathbf{H}_i, i = 1, \cdots, M$. The information related to this particular set may be, if needed, transmitted to the decoder at a slice, picture and/or sequence level. In transmitting such information, high level syntax may be embedded in the data stream at the slice, picture and/or sequence level. For example, within the framework of H.264, we can reuse the existing 4x4 transform and 8x8 transform and/or the hadamard transform step.
- Determine a threshold γ (e.g. based on quantization step and the statistics of the encoding picture). γ may be, if needed, transmitted to the decoder at a slice, picture and/or sequence level. In transmitting such information, high level syntax may be embedded in the data stream at the slice, picture and/or sequence level.
- Determine the adaptive weighting method to combine the outcome of inversed transforms, which may be, if needed, transmitted to the decoder at a slice, picture and/or sequence level. In the event that weighting is directly derived without explicit transmission of it, there may still be the need of transmitting some auxiliary information related to it. In transmitting any weighting step information, high level syntax may be embedded in the data stream at the slice, picture and/or sequence level. For example, average weighting or sparsity base weighting, which adapts the weights inverse of number of non-zero coefficients, can be used.

An adaptive sparse denoising filter methodology is used in one embodiment of the present invention for purposes of refinement:

1) Obtain the denoised estimate $\hat{\mathbf{x}}_i$ from each transform $\mathbf{H}_i$ using the specified threshold γ.

2) Combine $\hat{\mathbf{x}}_i$ using adaptive weightings to get the final denoised estimate $\hat{\mathbf{x}}$.

A QCS methodology is used in one embodiment of the present invention for a last refinement step:

1) Calculate the new residual signal $\hat{\mathbf{r}} = \hat{\mathbf{x}} - \mathbf{p}$, where $\mathbf{p}$ is the intra/inter predicted signal.

2) Apply the same H.264/AVC transform on $\hat{\mathbf{r}}$. Assume the resulting transform coefficients are $\hat{\mathbf{c}}$.

3) Check if $\hat{\mathbf{c}}$ is in the quantization cell indicated by the originally received transform coefficients. For each coefficient, if after the filtering steps has fallen outside its original quantization cell, the new coefficient is corrected and reassigned as the closest original quantization cell boundary value to itself. Alternatively, depending on the statistics of every particular coefficient and/or quantization bin, other possible values from within the original quantization cell can be used for the reassignment procedure. The refined coefficients are denoted as $\mathbf{c}'$.

4) Take the inverse transform of $\mathbf{c}'$, denote by $\mathbf{r}'$, and sum together with $\mathbf{p}$ to obtain the final estimate $\mathbf{x}' = \mathbf{p} + \mathbf{r}'$.

The adaptive sparse denoising filtering is designed for recovering the original signal from an i.i.d. noisy environment. However, the quantization noise in video compression, and particularly our example H.264, is never i.i.d. Our algorithm is novel in its proposal of a series of refinement steps (succession of filters) after H.264 deblocking filter. The signal after deblocking filter is a better match to i.i.d. noise assumption. The possible over smoothing problem resulting from the use and/or combination of deblocking and denoising filters is solved by the following QCS. The succession of filters has shown its superior performance to remove the video compression artifacts, both in practice and theory.

Turning back to the syntax in Figure 6 and 7:

sparse_filter_control_present_flag equal to 1 specifies that a set of syntax elements controlling the characteristics of the sparse denoising filter is present in the slice header. sparse_filter_control_present_flag equal to 0, it specifies that a set of syntax elements controlling the characteristics of the sparse denoising filter is not present in the slice header and their inferred values are in effect.

qcs_control_present_flag equal to 1 specifies that a set of syntax elements controlling the characteristics of the QCS is present in the slice header. qcs_control_present_flag equal to 0 specifies that a set of syntax elements controlling the characteristics of the QCS is not present in the slice header and their inferred values are in effect.

disable_sparse_filter_flag specifies whether the operation of the sparse denosing filter shall be disabled. When disable_sparse_filter_flag is not present in the slice header, disable_sparse_filter_flag shall be inferred to be equal to 0.

sparse_threshold specifies the value of threshold used in sparse denosing. When sparse_threshold is not present in the slice header, the default value derived based on slice QP is used.

sparse_transform_type specifies the type of the transform used in sparse denosing. sparse_transform_type equal to 0 specifies that 4x4 transform is used. sparse_transform_type equal to 1 specifies that 8x8 transform is used.

adaptive_weighting_type specifies the type of weighting used in sparse denosing. adaptive_weighting_type equal to 0 specifies that sparsity weighting is used. adaptive_weighting_type equal to 1 specifies that average weighting is used.

disable_qcs_flag specifies whether the operation of the QCS shall be disabled. When qcs_flag is not present in the slice header, disable_qcs_flag shall be inferred to be equal to 0.

qcs_pullback_model specifies how to re-assign the value of coefficients. qcs_pullback_model equal to 0 specifies to pull back the coefficients whose to closest cell boundary. qcs_pullback_model equal to 1 specifies to pull back the coefficients to the center or predefined value of cell.

For further detail, an example of encoder and decoder flow chart is shown in figures 8 and 9.

ADVANTAGES/BENEFITS/ADVANCEMENTS

1. Method and apparatus for a video encoder and/or decoder wherein a plurality of in-loop de-artifact filters are utilized to remove a plurality of artifact types generated by the quantization process.

2. The advantages/benefits/advancements of 1 wherein a compression constraint can be enforced.

3. The advantages/benefits/advancements of 1 wherein the possible de-artifact filter candidates include a deblocking filter, de-ringing filter, denoising filter, signal estimation filter, or any other linear/nonlinear filters.

4. The advantages/benefits/advancements of 2 wherein compression constraint can be quantization constraint set (QCS)

5. The advantages/benefits/advancements of 1 wherein the number of filters, the type of filters, and the order in which they are implemented can be optimally chosen according to a specific application.

6. The advantages/benefits/advancements of 1 wherein the de-artifact filters can be adaptively enabled or disabled depending on data characteristics and/or data statistics, such as coding modes, motion data and/or residue.

7. The advantages/benefits/advancements of 1 wherein enable or disable information for a filter can be signaled by the encoder using some high level syntax at slice, picture and/or sequence level.

8. The advantages/benefits/advancements of 1 wherein some side information may be transmitted by the encoder in order to adaptively indicate the parameters of the refinement filter at the slice, picture and/or sequence level. Adaptation may depend also in part or its totality on data characteristics and/or data statistics, such as coding modes, motion data and/or residue.

9. The advantages/benefits/advancements of 2 wherein enable or disable information for compression constraints can be signaled using some high level syntax at slice, picture and/or sequence level.

10. The advantages/benefits/advancements of 2 wherein some side information may be transmitted in order to adaptively indicate the constraints at the slice, picture and/or sequence level. Adaptation may depend also in part or its totality on data characteristics and/or data statistics, such as coding modes, motion data and/or residue.

11. The advantages/benefits/advancements of 1 wherein it can be implemented by two pass filter, the first pass is deblocking filter and the second pass is sparse denoising filter.

12. The advantages/benefits/advancements of 11 wherein QCS can be further enforced after two pass filter.

13. The advantages/benefits/advancements of 11 wherein transform type, threshold, weighting method for sparse denoising filter can be signaled in some high level syntax at slice, picture and/or sequence level.

14. The advantages/benefits/advancements of 12 wherein QCS pullback method can be signaled in some high level syntax at slice, picture and/or sequence level.

CLAIM

1. A method for video encoding or decoding comprising:
filtering in-loop to reduce a first type of quantization artifact; and
filtering in-loop to reduce a second type of quantization artifact.

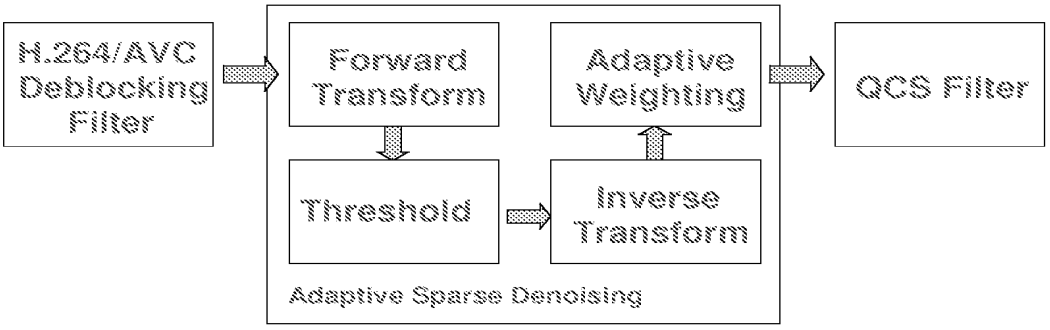


Figure 1

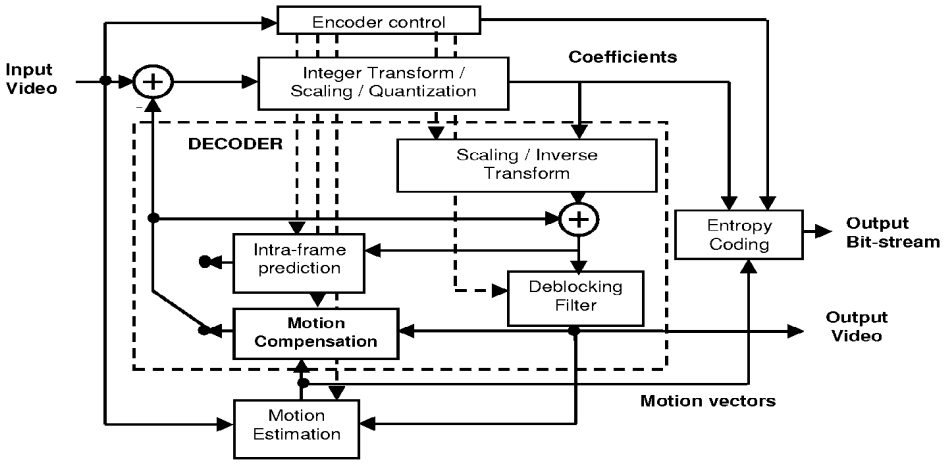


Figure 2

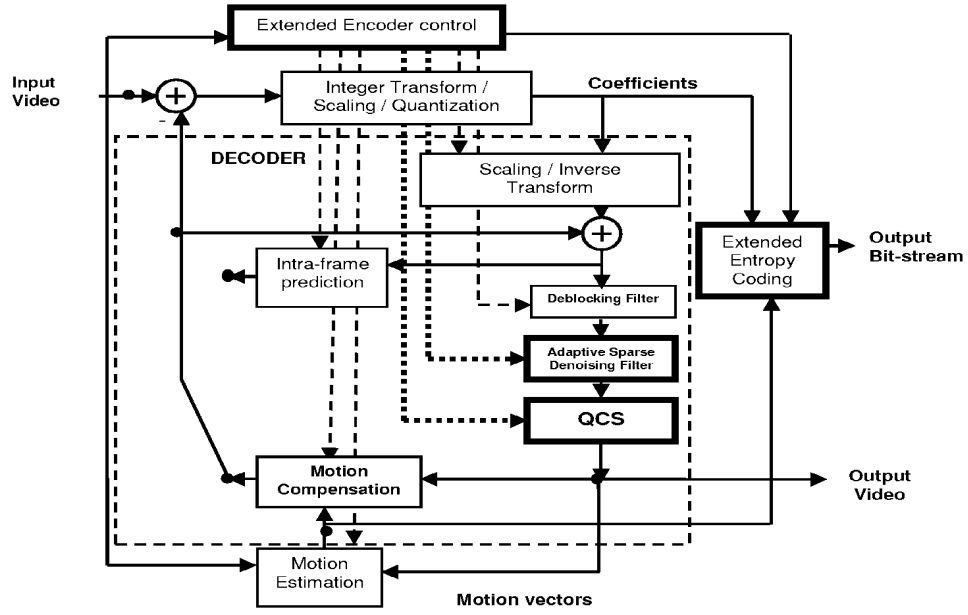


Figure 3: Embodiment of video encoder implementing succession of de-artifact filters.

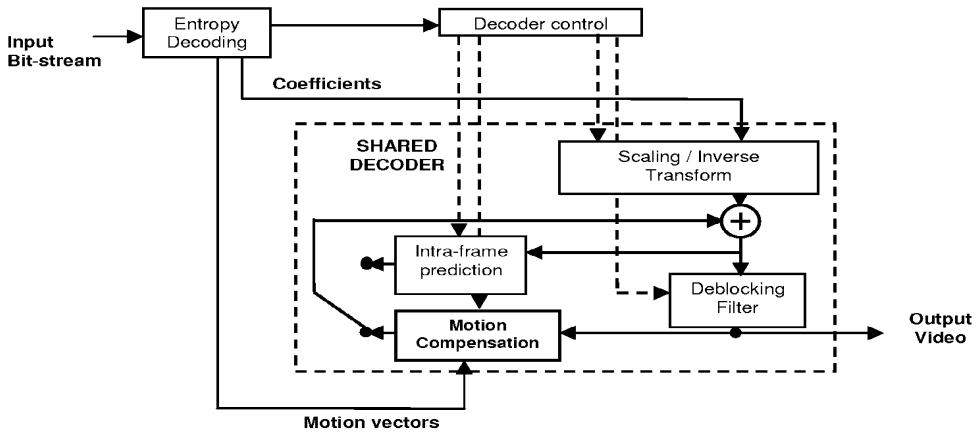


Figure 4

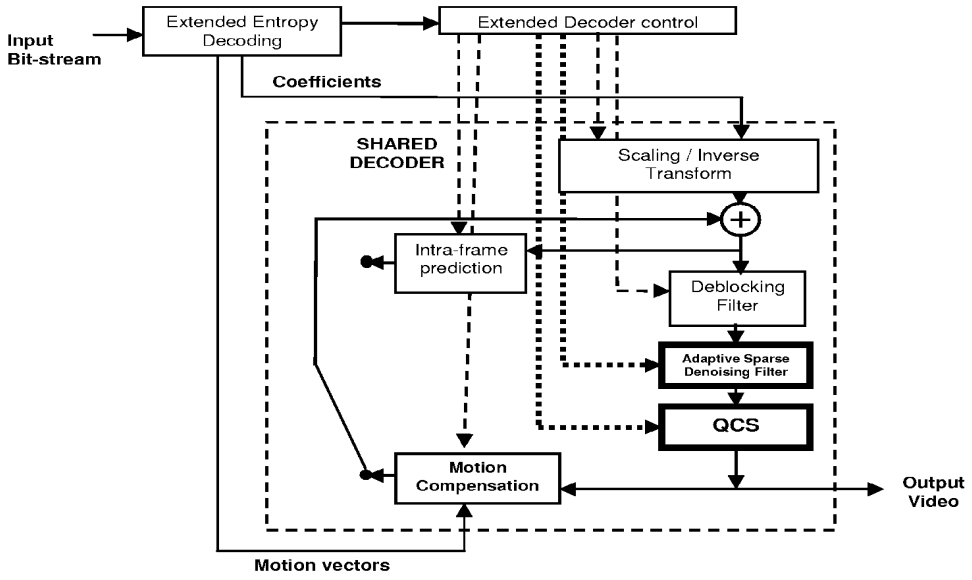


Figure 5: Embodiment of video decoder implementing succession of de-artifact filters.

pic_parameter_set_rbsp( ) {	C	Descriptor
...		
sparse_filter_control_present_flag	1	u(1)
qcs_control_present_flag	1	u(1)
...		
}		

Figure 6: picture parameter set RBSP syntax embodiment

slice_header( ) {	C	Descriptor
...		
if(sparse_filter_control_present_flag) {		
disable_sparse_filter_flag	2	u(1)
if(disable_sparse_filter_flag != 1) {		
sparse_threshold	2	u(v)
sparse_tranform_type	2	u(v)
adaptive_weighting_type	2	u(v)
}		
}		
if(qcs_control_present_flag) {		
disable_qcs_flag	2	u(1)
if(disable_qcs_flag != 1) {		
qcs_pullback_model	2	u(v)
}		
}		
...		
}		

Figure 7: slice header syntax embodiment

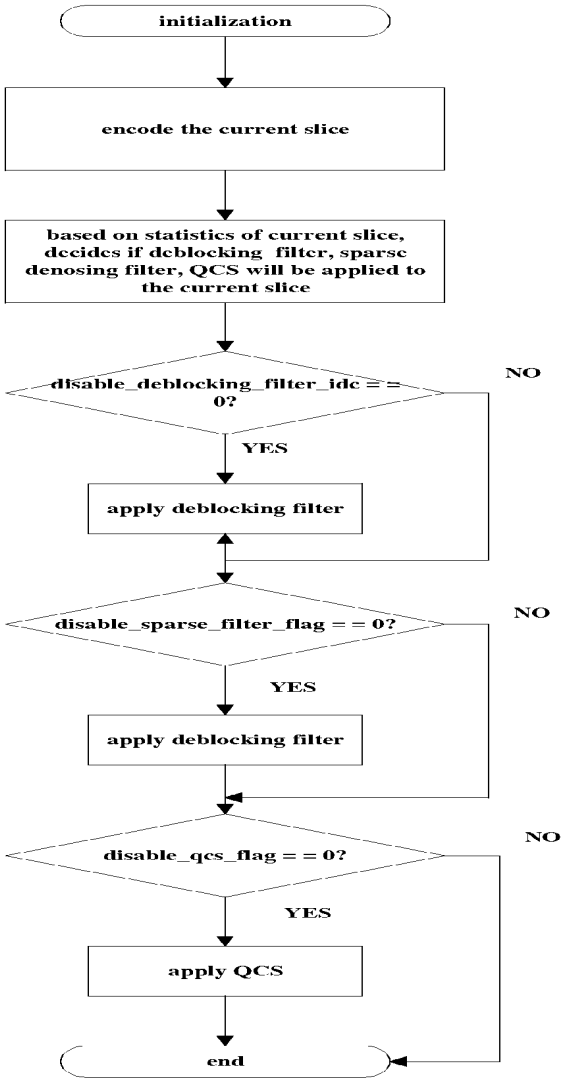

initialization
encode the current slice
based on statistics of current slice, decides if deblocking filter, sparse denosing filter, QCS will be applied to the current slice
disable_deblocking_filter_idc = = 0?
NO
YES
apply deblocking filter
disable_sparse_filter_flag = = 0?
NO
YES
apply deblocking filter
disable_qcs_flag = = 0?
NO
YES
apply QCS
end

Figure 6

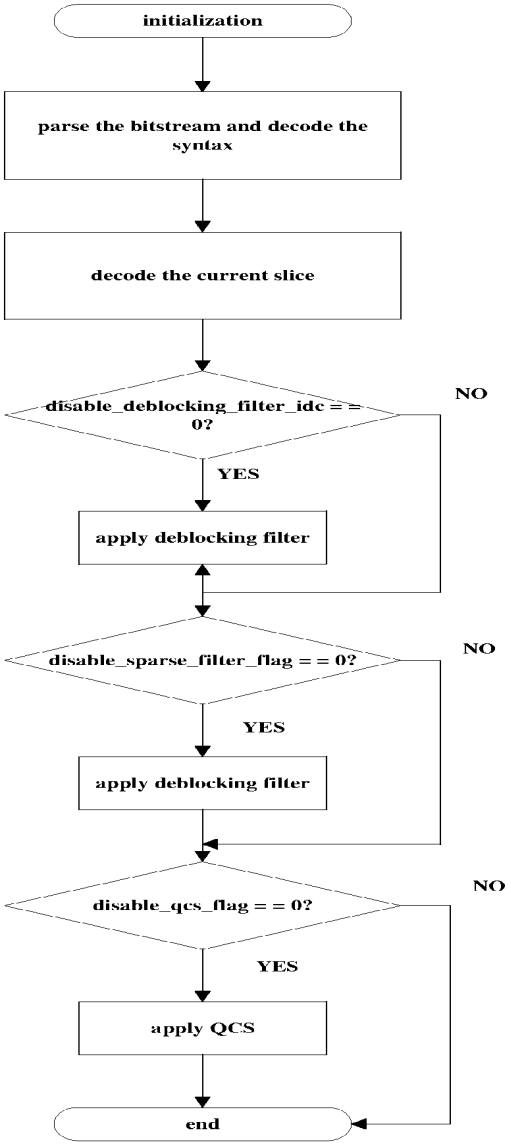

initialization
parse the bitstream and decode the syntax
decode the current slice
disable_deblocking_filter_idc = = 0?
NO
YES
apply deblocking filter
disable_sparse_filter_flag = = 0?
NO
YES
apply deblocking filter
disable_qcs_flag = = 0?
NO
YES
apply QCS
end

Figure 7

Electronic Acknowledgement Receipt	
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International Application Number:	
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	Claims	11	11
	Drawings	12	17

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

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TITLE OF THE INVENTION (500 characters max):

METHOD AND APPARATUS FOR IN LOOP ARTIFACT FILTERING

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ The address corresponding to Customer Number: 24498

OR

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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* 6

☐ Other (specify) _____

☑ Specification (e.g. description of the invention) *Number of Pages* 11

Fees Due: Filing Fee of $200 ($100 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is $250 ($125 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).

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).

☐ Payment by credit card. Form PTO-2038 is attached

☑ The Director is hereby authorized to charge the filing fee and application size fee (if applicable) or credit any overpayment to Deposit Account Number: 07-0832. A duplicative copy of this form is enclosed for fee processing.

$200.00

TOTAL FEE AMOUNT ($)

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/16 (07-06)
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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.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

SIGNATURE /Guy H. Eriksen/ Date 11/8/06

TYPED or PRINTED NAME Guy H. Eriksen REGISTRATION NO. 41,736 *(if appropriate)*

TELEPHONE 609-734-6807 Docket Number: PU060222

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.

PATENT APPLICATION FEE DETERMINATION RECORD

Effective December 8, 2004

Application or Docket Number: 12-312386

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)	SMALL ENTITY TYPE ☐	FEE	OR	OTHER THAN SMALL ENTITY	FEE
U.S. NATIONAL STAGE FEES							
BASIC FEE	SMALL ENT. = $ 150	LARGE ENT. = $ 300	BASIC FEE		OR	BASIC FEE	
EXAMINATION FEE	Satisfies PCT Article 33(1)-(4) = $ 50 / $ 100	All other situations = $ 100 / $ 200	EXAM. FEE			EXAM. FEE	
SEARCH FEE	U.S. is ISA = $ 50 / $ 100 ALL other countries = $ 200 / $ 400	ALL other situations = $ 250 / $ 500	SEARCH FEE			SEARCH FEE	
FEE FOR EXTRA SPEC. PGS.	minus 100 =	/ 50 =	X $ 125 =			X $ 250 =	
TOTAL CHARGEABLE CLAIMS	25 minus 20 =	* 5	X $ 25 =		OR	X $ 50 =	
INDEPENDENT CLAIMS	5 minus 3 =	* 2	X $ 100 =		OR	X $ 200 =	
MULTIPLE DEPENDENT CLAIM PRESENT ☐			+ $ 180 =		OR	+ $ 360 =	
* If the difference in column 1 is less than zero, enter "0" in column 2			TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A	(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY RATE	ADDI-TIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDI-TIONAL FEE
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA					
Total	*	Minus	**	=	X $ 25 =		OR	X $ 50 =	
Independent	*	Minus	***	=	X $ 100 =		OR	X $ 200 =	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐					+ $ 180 =		OR	+ $ 360 =	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1)		(Column 2)	(Column 3)	RATE	ADDI-TIONAL FEE	OR	RATE	ADDI-TIONAL FEE
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA					
Total	*	Minus	**	=	X $ 25 =		OR	X $ 50 =	
Independent	*	Minus	***	=	X $ 100 =		OR	X $ 200 =	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐					+ $ 180 =		OR	+ $ 360 =	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. 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.

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET
(FOR USE WITH FORM PTO-875)

SERIAL NO.	FILING DATE
10-818386	
APPLICANT(S)	

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
1	1					
2		1				
3		1				
4		1				
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9		1				
10		1				
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TOTAL IND.	5	⬇		⬇		⬇
TOTAL DEP.	20	⬅		⬅		⬅
TOTAL CLAIMS	25					

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
51						
52						
53						
54						
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100						
TOTAL IND.		⬇		⬇		⬇
TOTAL DEP.		⬅		⬅		⬅
TOTAL CLAIMS						

PTO - 1360 (REV. 11/04)

U.S. DEPARTMENT of COMMERCE
Patent and Trademark Office

DO/ EO WORKSHEET

Fred Smith, Patent Application Specialist/ National Stage Division

U.S. Appl. No. 12-312380 International Appl. No. PCT/_____

Application filed by : ☐ 20 months ☑ 30 months

WIPO PUBLICATION INFORMATION :

Publication No.: WO2008/057308 Publication Language : ☐ English ☐ German ☐ Japanese ☐ Chinese ☐ Korean ☐ French ☐ Spanish ☐ Russian ☐ Other : _____

Publication Date : 15 May 2008 Not Published : ☐ U.S. only designated ☐ EP request Published : ☑ EP request

INTERNATIONAL APPLICATION PAPERS IN THE APPLICATION FILE :

- ☒ International Application *(RECORD COPY)*
- ☐ Article 19 Amendments
- ☐ PCT/IPEA/409 IPER : ☐ EP ☐ JP ☐ SE ☐ AU ☐ US ☐ FR ☐ CN ☐ ES ☐ RU ☐ AT ☐ KR ☐ ___
- ☐ Annexes to 409
- ☐ PCT/ISA/237 : ☐ EP ☐ JP ☐ SE ☐ AU ☐ US ☐ FR ☐ CN ☐ ES ☐ RU ☐ AT ☐ KR ☐ ___
  - ☐ PCT/IPEA/409 or PCT/ISA/237 was NOT AVAILABLE at the time of paralegal review
- ☐ PCT/IB/306
- ☐ Request form PCT/RO/101
- ☑ PCT/ISA/210 - Search Report : ☑ EP ☐ JP ☐ SE ☐ AU ☐ US ☐ FR ☐ CN ☐ ES ☐ RU ☐ AT ☐ KR ☐ ___ ☐ NONE
- ☐ Search Report References
- ☑ Priority Document (s) No. 1
  - ☐ N/A
  - ☐ Priority Document was NOT AVAILABLE at the time of paralegal review
- ☐ Other : _____

RECEIPTS FROM THE APPLICANT *(other than checked above) :*

- ☐ Basic National Fee *(or authorization to charge)*
- ☑ 27 Description ☑ 4 Claims ☑ 1 Abstract
- ☑ Drawing Figure(s) - (# of drwgs. 7)
- ☐ Translation of Article 19 Amendments ☐ entered ☐ not entered :
  - ☐ not a page for page substitution
  - ☐ replaced by Article 34 Amendment
- ☐ Annexes to 409 ☐ entered ☐ not entered :
  - ☐ not a page for page substitution
  - ☐ no translation ☐ other : _____
- ☐ Application Data Sheet
- ☑ Power of Attorney
- ☐ Change of Address
- ☑ Preliminary Amendment(s) Filed on : 1. ☑ same as 371 request date 2. _____ 3. _____
- ☑ Information Disclosure Statement(s) Filed on : 1. ☑ same as 371 request date 2. _____ 3. _____
- ☐ Assignment Document (forwarded to Assignment Branch)
- ☐ Assignee Statement Under 37 CFR 3.73(b)
- ☐ Assignee PG Publication Notice
- ☐ Substitute Specification Filed on : 1. ☐ same as 371 request date 2. _____ 3. _____
- ☐ Verified Small Status Statement
- ☒ Oath/ Declaration (executed)
- ☐ Oath/ Declaration ☐ unsigned ☐ no citizenship ☐ other
- ☐ DNA Diskette ☐ Sequence Listing
- ☐ Other : _____

NOTES : ☐ I.A. used as Specification ☐ Other :

35 U.S.C. 371 - Receipt of Request (PTO-1390)	mo. 5 / day 7 / yr. 2009
Date Acceptable Oath/ Declaration Received	☐ Same as 371 Req. Date; ☐ mo. / day / yr. 200
Date of Completion of requirements under 35 U.S.C. 371	☐ Same as 371 Req. Date; ☐ Same as OATH Date; ☐ mo. / day / yr. 200
Date of Completion of DO/ EO 903 - Notification of Acceptance	
Date of Completion of DO/ EO 905 - Notification of Missing Requirements	
Date of Completion of DO/ EO 909 - Notification of Abandonment	
Date of Completion of DO/ EO 916 - Notification of Defective Response	
Date of Completion of DO/ EO 922 - Notification to Comply w/ Requirements for Patent Applications Containing Nucleotide and/or Amino Acid Sequence Disclosures	
Date of Completion of DO/ EO 923	

PTO/SB/06 (07-06)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
12/312,386	05/07/2009	

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	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			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 $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 05/07/2009

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 25	Minus	** 25	= 0	X $ =		OR	X $52=	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $ =		OR	X $220=	0
☐ 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	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/ROSA HOLLAND/

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.**

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UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
12/312,386	Meng-Ping Kao	PU060222

24498
Thomson Licensing LLC
P.O. Box 5312
Two Independence Way
PRINCETON, NJ 08543-5312

INTERNATIONAL APPLICATION NO.	
PCT/US2007/022795	
I.A. FILING DATE	PRIORITY DATE
10/25/2007	11/08/2006

CONFIRMATION NO. 8783
371 ACCEPTANCE LETTER

OC000000036778103

Date Mailed: 07/09/2009

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 determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED 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:

05/07/2009	05/07/2009
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) 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).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 05/07/2009
- Copy of the International Search Report filed on 05/07/2009
- Preliminary Amendments filed on 05/07/2009
- Information Disclosure Statements filed on 05/07/2009
- Oath or Declaration filed on 05/07/2009
- Request for Immediate Examination filed on 05/07/2009
- U.S. Basic National Fees filed on 05/07/2009
- Priority Documents filed on 05/07/2009
- Specification filed on 05/07/2009
- Claims filed on 05/07/2009
- Abstracts filed on 05/07/2009
- Drawings filed on 05/07/2009

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)

FREDERICK SMITH

Telephone: (703) 756-1455

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	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/312,386	05/07/2009	2819	1680	PU060222	25	5

CONFIRMATION NO. 8783

24498
Thomson Licensing LLC
P.O. Box 5312
Two Independence Way
PRINCETON, NJ 08543-5312

FILING RECEIPT



Date Mailed: 07/09/2009

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**

Applicant(s)

Meng-Ping Kao, La Jolla, CA;
Peng Yin, West Windsor, NJ;
Oscar Divorra Escoda, Princeton, NJ;

Power of Attorney: The patent practitioners associated with Customer Number 24498

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US2007/022795 10/25/2007
which claims benefit of 60/864,917 11/08/2006

Foreign Applications

If Required, Foreign Filing License Granted: 07/02/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/312,386**

Projected Publication Date: 10/15/2009

Non-Publication Request: No

Early Publication Request: No

Title

METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Preliminary Class

341

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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 (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/312,386	05/07/2009	Meng-Ping Kao	PU060222

CONFIRMATION NO. 8783

24498
Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
P.O. Box 5312
Princeton, NJ 08543-5312

PUBLICATION NOTICE

OC000000038286892

Title:METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Publication No.US-2009-0257664-A1
Publication Date:10/15/2009

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.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 02/22/2012

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
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Princeton, NJ 08543-5312

EXAMINER	
GE, YUZHEN	

ART UNIT	PAPER NUMBER
2624	

NOTIFICATION DATE	DELIVERY MODE
02/22/2012	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):

uspto@technicolor.com
pat.verlangieri@technicolor.com
russell.smith@technicolor.com

Office Action Summary	Application No.	Applicant(s)	
	12/312,386	KAO ET AL.	
	Examiner	Art Unit	
	YUZHEN GE	2624	

-- 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* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 _____.

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) *1-25* 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) *1-25* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *07 May 2009* 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).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *5/7/2009*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ 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.

Claims 21-25 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter as follows. Claims 21-25 recite a storage media storing data which does not impart functionality to a computer or computing device, and is thus considered nonfunctional descriptive material. Such nonfunctional descriptive material, in the absence of a functional interrelationship with a computer, does not constitute a statutory process, machine, manufacture or composition of matter and is thus non-statutory per se.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1-5 and 11-15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

4. Claims 1 and 11 recite "an encoder for encoding"/"a decoder for decoding" which merely specifies a possible state of a particular unit and not necessarily or sufficient condition for said unit to perform particular function. For examination purposes, the examiner will interpret "an encoder for encoding" as "an encoder encoding" and "a decoder for decoding" as "a decoder decoding".

Examiner's Note: All claims intrinsic with the coordinating conjunction "for", linking verb "to be", and the phrases "operable to", "configured to" or "capable of" usually render the following element non-assertive or more simply passive. In others words that which follows "for", "to be", "adapted to", "configured to" and or "capable of" usually does not take place and is merely an intended use, thus non-functional and therefore most likely without patentable weight. In general claim language with "for" usually only suggests intended use and adds no further limitation to the claims. The subject matter of a properly construed claim is defined by the terms that limit its scope. It is this subject matter that must be examined. As a general matter, the grammar and intended meaning of terms used in a claim will dictate whether the language limits the claim scope. Language that suggests or makes optional but does not require steps to be performed or does not limit a claim to a particular structure does not limit the scope of a claim or claim limitation. The following are examples of language that may raise a question as to the limiting effect of the language in a claim:

(A) statements of intended use or field of use,

(B) "operable to", "adapted to" or "adapted for" clauses, (C) "wherein" clauses, or (D) "whereby" clauses.

This list of examples is not intended to be exhaustive. See also MPEP § 2111.04.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 1-25 are rejected under 35 U.S.C. 102(b) as being anticipated by Lee et al (US Patent 6,665,346).

Regarding claim 1, Lee et al teach an apparatus, comprising:

an encoder for encoding an image region, the encoder having at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact (Fig. 1, abstract, col. 2, lines 5-9, col. 6, lines 43-46).

Regarding claim 2, Lee et al teach the apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint (Fig. 1, abstract, col. 2, lines 5-9, col. 6, lines 43-46, it is performed when encoding and therefore it is a compression constraint).

Regarding claim 3, Lee et al teach the apparatus of claim 1, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region (abstract col. 5, lines 1-2 and lines 20-25 and lines 45-49, col. 6, lines 1-7, col. 8, lines 30-38, Fig. 7A and Fig. 7B, col. 17, lines 45-50).

Regarding claim 4, Lee et al teach the apparatus of claim 1, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact

(Fig. 1, col. 5, lines 1-2 and lines 20-25 and lines 45-49, col. 6, lines 1-7, col. 8, lines 30-38, Fig. 7A and Fig. 7B, col. 17, lines 45-50).

Regarding claim 5, Lee et al teach the apparatus of claim 1, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters (Fig. 1, abstract, col. 17, lines 45-50).

Claims 6-10 are the corresponding method claims of claims 1-5. Lee et al teach a method inherent in the apparatus of claims 1-5. Thus Lee et al teach claims 6-10 as evidently explained in the above-cited passages.

Claims 11-15 are the corresponding decoding apparatus claims of claims 1-5. Lee et al teach a decoding apparatus (Fig. 2) and teach the filtering can be applied when decoding (col. 2, lines 10-13, col. 6, lines 8-11 and 43-48, col. 7, lines 5-10 and lines 60-65, col. 8, lines 2-5). Thus Lee et al teach claims 11-15 as evidently explained in the above-cited passages.

Claims 16-20 are the corresponding method claims of claims 11-15. Lee et al teach a method inherent in the apparatus of claims 11-15. Thus Lee et al teach claims 16-20 as evidently explained in the above-cited passages.

Regarding claim 21, Lee et al teach a storage media having video signal data encoded thereupon, comprising: an image region field, encoded using at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact (col. 6, lines 63-67, Fig. 1).

Regarding claims 21-25, because i) a storage medium is a known product. ii) The video signal data encoded thereupon does not have functional connection with the storage media and therefore the rest of the limitations of claim 21 and claims 22-25 are not given patentable weight (In re Ngai, 367 F.3d 1336, 70 USPQ2d 1862 (Fed. Cir. 2004)). In fact for claim 21-25, which are storage media claims, because there is no functional relationship between the descriptive material stored on the storage media in the form of encoded video signal data and the substrate, i.e., the storage media, in a new or unobvious manner, the descriptive material is not given any weight. Any storage media can be used to reject claims 21-25. See MPEP 2106.01, "However, USPTO personnel need not give patentable weight to printed matter absent a new and unobvious functional relationship between the printed matter and the substrate. See ** Lowry, 32 F.3d **>at< 1583-84, 32 USPQ2d **>at< 1035 **; In re Ngai, 367 F.3d 1336, 70 USPQ2d 1862 (Fed. Cir. 2004)." Furthermore, the claims 21-25 are in the form of a product-by-process and the process does not impart structure to the product (the card with the storage medium), and therefore the process limitations are not afforded patentable weight for that reason as well.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YUZHEN GE whose telephone number is (571)272-7636. The examiner can normally be reached on 7:30am-4:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Bella can be reached on 571-272-7778. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/Yuzhen Ge/
Primary Examiner, Art Unit 2624

Notice of References Cited	Application/Control No. 12/312,386	Applicant(s)/Patent Under Reexamination KAO ET AL.	
	Examiner YUZHEN GE	Art Unit 2624	Page 1 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,757,976 A	05-1998	Shu, Joseph S.	382/252
*	B	US-5,877,813 A	03-1999	Lee et al.	375/240.12
*	C	US-6,178,205 B1	01-2001	Cheung et al.	375/240.29
*	D	US-2002/0136303 A1	09-2002	Sun et al.	375/240.16
*	E	US-6,665,346 B1	12-2003	Lee et al.	375/240.29
*	F	US-2003/0235258 A1	12-2003	Kenney et al.	375/344
*	G	US-6,741,665 B2	05-2004	Kenney et al.	375/344
*	H	US-6,931,063 B2	08-2005	Sun et al.	375/240.16
*	I	US-2006/0007999 A1	01-2006	Gomez et al.	375/235
*	J	US-2006/0078048 A1	04-2006	Bjontegaard, Gisle	375/240.03
*	K	US-2006/0153301 A1	07-2006	Guleryuz, Onur G.	375/240.16
*	L	US-2006/0233253 A1	10-2006	Shi et al.	375/240.16
*	M	US-7,136,538 B2	11-2006	Kitagawa, Masao	382/275

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

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	U	
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Notice of References Cited	Application/Control No. 12/312,386	Applicant(s)/Patent Under Reexamination KAO ET AL.	
	Examiner YUZHEN GE	Art Unit 2624	Page 2 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-7,272,186 B2	09-2007	Hong, Min Cheol	375/240.29
*	B	US-2008/0151101 A1	06-2008	Tian et al.	348/448
*	C	US-7,570,182 B2	08-2009	Sheba et al.	341/118
*	D	US-7,822,125 B2	10-2010	Bjontegaard, Gisle	375/240.29
*	E	US-8,023,562 B2	09-2011	Zheludkov et al.	375/240.16
	F	US-			
	G	US-			
	H	US-			
	I	US-			
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	K	US-			
	L	US-			
	M	US-			

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	S					
	T					

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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	YUZHEN GE	2624

✓	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	02/14/2012								
	1	✓								
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	25	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	YUZHEN GE	2624

SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)- See search history printout	2/14/2012	YG

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

	/YUZHEN GE/ Primary Examiner.Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	9	(US-20020080882-$ or US-20060233253-$ or US-20080151101-$).did. or (US-7136538-$ or US-5877813-$ or US-5757976-$ or US-6178205-$ or US-8023562-$ or US-7822125-$).did.	US-PGPUB; USPAT	OR	OFF	2011/09/23 09:03
L3	9540	quantization with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 09:03
L4	3	2 and 3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 09:09
L5	3769	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 09:12
L6	4436	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 09:12
L7	63	6 same (deblock$3 block$3 de adj1 block$3 "deblock") with (loop inloop in adj1 loop)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 09:13
L8	55359	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 09:30
L9	101	8 same (deblock$3 block$3 de adj1 block$3 "deblock") with (loop inloop in adj1 loop)	US-PGPUB; USPAT; USOCR;	OR	ON	2011/09/23 09:31

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
L10	12	9 and 6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 09:31
L11	53	plurality near2 filter$3 same (deblock$3 block$3 de adj1 block$3 "deblock") with (loop inloop in adj1 loop)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 09:42
L12	3	"6909745".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 09:52
L13	2	"5590064".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 09:54
L14	19	(US-20020080882-$ or US-20060233253-$ or US-20080151101-$ or US-20020136303-$ or US-20060153301-$ or US-20060078048-$ or US-20030235258-$ or US-20060007999-$).did. or (US-7136538-$ or US-5877813-$ or US-5757976-$ or US-6178205-$ or US-8023562-$ or US-7822125-$ or US-6931063-$ or US-6665346-$ or US-7272186-$ or US-7570182-$ or US-6741665-$).did.	US-PGPUB; USPAT	OR	OFF	2011/09/23 10:03
L15	0	14 and (sparse near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 10:04
L16	0	14 and (de adj1 noise with filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/23 10:04
L17	1	14 and (de adj1 noise denoise)	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2011/09/23 10:04

			EPO; JPO; DERWENT; IBM_TDB			
L18	3	sparse with (denoise de adj1 nois$3) with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/23 10:06
S1	3	"20020080882"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/22 15:32
S2	21	("5424783" | "5570135" | "5610729" | "5757976" | "5790714" | "5819035" | "5850294" | "5852475" | "5877813" | "5920356" | "5973740" | "6066980" | "6083168" | "6178205" | "6348929").PN. OR ("7136538").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/09/22 15:32
S3	1	S2 and (in near2 loop inloop)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/09/22 15:34
S4	1	S2 and (loop near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/09/22 15:34
S5	20	deblock$3 with (de adj1 nois$3 denois$3 "de-noising")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/22 15:43
S6	99	(de adj1 block$3 deblock$3 block$3) near2 filter$3 same quantization near2 noise	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/22 15:50
S7	20	S6 and (loop near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/22 15:51

9/23/2011 11:12:34 AM
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BIB DATA SHEET

CONFIRMATION NO. 8783

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/312,386	05/07/2009	382	2624	PU060222

APPLICANTS

Meng-Ping Kao, La Jolla, CA;
Peng Yin, West Windsor, NJ;
Oscar Divorra Escoda, Princeton, NJ;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/US2007/022795 10/25/2007
which claims benefit of 60/864,917 11/08/2006

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

07/02/2009

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /YUZHEN GE/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	7	25	5

ADDRESS

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
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Princeton, NJ 08543-5312
UNITED STATES

TITLE

METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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AP16 Rec'd PCT/PTO 07 MAY 2009
12/312386

PTO/SB/08A (08-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	KAO
Art Unit	
Examiner Name	
Attorney Docket Number	PU060222

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number / Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA	US- 20020080882	6/27/2002	KITAGAWA	
	AB	US- 5590064	12/31/1996	ASTLE	
	AC	US- 6909745	6/21/2005	PURI ET AL.	
		US-			
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document / Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	AD	EP - 0772365	5/7/1997	MATSUSHITA		
	AE	EP - 0781053	6/25/1997	LUCENT TECH.		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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 2 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, 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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Sheet 2 of 2

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	KAO
Art Unit	
Examiner Name	
Attorney Docket Number	PU060222

NON PATENT LITERATURE DOCUMENTS

Examiner Initials *	Cite No.[1]	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 [2]
	AF	FAN ET AL.: "JPEG Decompression with Reduced Artifacts," Journal of the American Veterinary Medical Association, Vol. 2186, February 9, 1994, pp. 50-55, XP002116488.	
	AG	GULERYUZ.: "A Nonlinear Loop Filter for Quantization Noise Removal in Hybrid Video Compression," Image Processing, ICIP 2005, IEEE Int'l. Conference, 11-14 Sept. 2005, pp. II – 333-336.	
	AH	LEE ET AL.: "Loop-Filtering and Post Filtering for Low Bit-Rates Moving Pictures Coding," Image Processing, ICIP 1999, Proceedings Int'l. Conference in Kobe, Japan, Vol. 1, October 24, 1999, pp. 94-98, XP0103669215.	
		COPY OF INTERNATIONAL SEARCH REPORT, dated December 23, 2008.	

Examiner Signature	/Yuzhen Ge/	Date Considered	09/23/2011

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[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /Y.G./

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Meng-Ping Kao et al. Serial No.: 12/312,386 Filed: May 7, 2009 For: METHOD AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING	Examiner: Yuzhen Ge Group Art: 2624

AMENDMENT UNDER 37 C.F.R. §1.111

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

Sir:

Please enter and consider the following amendments and remarks.

Amendments to, and Listing of, the Claims begins on page **2** of this paper.

Remarks/Arguments begin on page **8** of this paper.

Amendments to, and Listing of, the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (currently amended) An apparatus, comprising:

an encoder [[for]] encoding an image region, the encoder having at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact, wherein said encoder renders a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

2. (original) The apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

3. (original) The apparatus of claim 1, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

4. (previously presented) The apparatus of claim 1, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

5. (original) The apparatus of claim 1, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

6. (currently amended) A method, comprising:

encoding an image region, wherein the encoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession, wherein said encoding step comprises rendering a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

7. (previously presented) The method of claim 6, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

8. (previously presented) The method of claim 6, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

9. (previously presented) The method of claim 6, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

10. (original) The method of claim 6, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

11. (currently amended) An apparatus, comprising:

a decoder [[for]] decoding an image region, the decoder having at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact, wherein said decoder renders a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

12. (previously presented) The apparatus of claim 11, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

13. (original) The apparatus of claim 11, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

14. (previously presented) The apparatus of claim 11, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

15. (original) The apparatus of claim 11, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

16. (currently amended) A method, comprising:

decoding an image region, wherein the decoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession, wherein said decoding step comprises rendering a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

17. (previously presented) The method of claim 16, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

18. (previously presented) The method of claim 16, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

19. (previously presented) The method of claim 16, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de-noising filter for performing a second pass to reduce noise as the second type of quantization artifact.

20. (original) The method of claim 16, wherein said at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

21. (currently amended) A non-transitory storage media having ~~video signal data encoded thereupon~~ a computer readable program stored thereon that when executed on a computer causes the computer to perform method steps embodied by the program, the method steps comprising:

encoding an image region field, ~~encoded using at least two filters for successively performing in-loop filtering to respectively~~ wherein the encoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession, wherein said encoding step comprises rendering a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

22. (original) The storage media of claim 21, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

23. (previously presented) The storage media of claim 22, wherein the at least one compression constraint involves a quantization constraint set.

24. (original) The storage media of claim 21, wherein at least one of the two filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region.

25. (original) The storage media of claim 21, wherein enablement information and/or disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element.

26. (new) The apparatus of claim 1, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected.

27. (new) The method of claim 6, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected.

28. (new) The apparatus of claim 11, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected.

29. (new) The method of claim 16, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected.

30. (new) The non-transitory storage media of claim 21, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected.

REMARKS

The Office Action mailed February 22, 2012 has been reviewed and carefully considered. No new matter has been added. Reconsideration of the prior rejections in light of the instant amendments and remarks is respectfully requested.

Claims 1, 6, 11, 16, and 21 have been amended. New Claims 26-30 have been added. Claims 1-30 are pending.

Claims 21-25 stand rejected under 35 U.S.C. §101 as being directed to non-statutory subject matter. Accordingly, Claim 21 has been amended to now recite the following:

> 21. (currently amended) A non-transitory storage media having a computer readable program stored thereon that when executed on a computer causes the computer to perform method steps embodied by the program, the method steps comprising:
>
> encoding an image region field, wherein the encoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession, wherein said encoding step comprises rendering a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level.

Support for the amendment to Claim 21 may be found at least at page 26, line 26 to page 27, line 8 of the instant application as filed. Accordingly, Claim 21 now represents a non-transitory storage media having a computer readable program stored thereon that when executed on a computer causes the computer to perform method steps embodied by the program. The method steps comprise encoding an image region field,

wherein the encoding step includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact respectively using at least two filters in succession.

We note the following from MPEP §2100:

> Descriptive material can be characterized as either "functional descriptive material" or "nonfunctional descriptive material." In this context, "functional descriptive material" consists of data structures and computer programs which impart functionality when employed as a computer component. …
> "Nonfunctional descriptive material" includes but is not limited to music, literary works, and a compilation or mere arrangement of data.
> … When functional descriptive material is recorded on some computer-readable medium, it becomes structurally and functionally interrelated to the medium and will be statutory in most cases since use of technology permits the function of the descriptive material to be realized.

Hence, regarding Claim 21, the computer program is recorded on a non-transitory storage media and, thus, is structurally and functionally interrelated to the media and, hence, is statutory since the use of technology permits the function of the descriptive material to be realized. Accordingly, Claim 21 is believed to satisfy the requirements of 35 U.S.C. §101 for at least the preceding reasons. Claims 22-25 depend from Claim 21 and, thus, include all the limitations of Claim 21. Thus, Claims 22-25 are believed to satisfy 35 U.S.C. §101 for at least the same reasons set forth above regarding Claim 21. Thus, reconsideration of the rejection is respectfully requested.

Claims 1-5 and 11-15 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 1 and 11 have been amended in

accordance with the Examiner's interpretation. Claims 2-5 and 12-15 respectively depend from Claims 1 and 11 and, thus, respectively include all the limitations of Claims 1 and 11. Hence, Claims 2-5 and 12-15 are believed to satisfy 35 U.S.C. §112, second paragraph, for at least the same reasons set forth above regarding Claims 1 and 11, respectively. Thus, reconsideration of the rejection is respectfully requested.

Claims 1-25 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,665,346 to Lee et al. (hereinafter "Lee").

The independent claims currently pending are Claims 1, 6, 11, 16, and 21.

It is respectfully asserted that Lee does not teach or suggest the following limitations recited in Claim 1: "wherein said encoder renders a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level."

Moreover, it is respectfully asserted that Lee does not teach or suggest the following limitations recited in Claims 6 and 21: "wherein said encoding step comprises rendering a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level."

Further, it is respectfully asserted that Lee does not teach or suggest the following limitations recited in Claim 11: "wherein said decoder renders a decision to selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level."

Also, it is respectfully asserted that Lee does not teach or suggest the following limitations recited in Claim 16: "wherein said decoding step comprises rendering a decision to

selectively enable or disable each of the at least two filters at a given level, the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level."

In contrast to the preceding limitations recited in Claims 1, 6, 11, 16, and 21, Lee discloses the use of flags corresponding to a block level (see, e.g., Lee, col. 9, line 1 disclosing "Flag Information for Intra-macro Block (Intra MB)"; see also, col. 10, lines 31-33). That is, flags such as a blocking flag and a ring flag are configured in Lee at a block level. We note that Lee fails to include even one occurrence of the terms of art "slice" or "sequence", or the concepts associated therewith, as explicitly recited in Claims 1, 6, 11, 16, and 21.

However, such a rigid approach as disclosed in Lee fails to realize many advantages in being to selectively enable or disable one or more filters in a succession of filters at various levels. For example, the different levels afforded in Claims 1, 6, 11, 16, and 21 permit a fine-level granularity (e.g., in the case of a macroblock level) to a coarse-level granularity (e.g., in the case of a sequence level), as well as levels in between (e.g., in the case of a slice level or a picture level), in the application (or not) of one or more of the filters. To that end, we note that significant bit savings can be realized when filter enablement or disablement can be implemented on a sequence level. These and other attendant advantages are readily realized by one of ordinary skill in the art given the teachings of the present principles as represented in the pending claims.

Hence, Lee fails to teach or suggest the specific limitations recited in Claims 1, 6, 11, 16, and 21.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131, citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Hence, Claims 1, 6, 11, 16, and 21 are patentably distinct and non-obvious over the cited references for at least the reasons set forth above.

Claims 2-5 directly or indirectly depend from Claim 1 and, thus, include all the limitations of Claim 1. Claims 7-10 directly or indirectly depend from Claim 6 and, thus, includes all the limitations of Claim 6. Claims 12-15 directly or indirectly depend from Claim 11 and, thus, include all the limitations of Claim 11. Claims 17-20 directly or indirectly depend from Claim 16 and, thus, includes all the limitations of Claim 16. Claims 22-25 directly or indirectly depend from Claim 21 and, thus, include all the limitations of Claim 21. Accordingly, Claims 2-5, 7-10, 12-15, 17-20, and 22-25 are patentably distinct and non-obvious over the cited references due to their respective dependencies from Claims 1, 6, 11, 16, and 21.

Reconsideration of the rejections is respectfully requested.

Moreover, as noted above, new Claims 26-30 have been added. Support for Claims 26-30 may be found at least at page 15, lines 24-28 and page 25, lines 7-9 of the instant application as filed.

It is respectfully asserted that Lee does not teach or suggest the following limitations recited in Claims 26-30: "wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected." Rather, Lee is completely silent on order and appears from Figure 1 thereof to have a fixed order, particularly given the lack of any description to the contrary. Accordingly, Lee does not teach or suggest the preceding limitations of Claims 26-30. Thus, Claims 26-30 are patentably distinct and non-obvious over Lee for at least the preceding reasons.

In view of the foregoing, Applicants respectfully request that the rejections of the claims set forth in the Office Action of February 22, 2012 be withdrawn, that the pending claims be allowed, and that the case proceed to early issuance of Letters Patent in due course.

The fee of $300.00 for five (5) additional claims in excess of 20 is authorized to be charged to applicants' Deposit Account No. 07-0832. It is believed that no further additional fees or charges are currently due. However, in the event that any additional fees or charges are required at this time in connection with the application, they may be charged to applicants' Deposit Account No. 07-0832.

Respectfully submitted,

By: **/Guy H. Eriksen/**
Guy H. Eriksen, Attorney for Applicants
Registration No.: 41,736

Thomson Licensing Inc. Patent Operations
P.O. Box 5312
Princeton, NJ 08543-5312
(609) 734-6807

April 24, 2012

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Guy H. Eriksen
Attorney Docket Number:	PU060222

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:				
Pages:				
Claims:				
Claims in excess of 20	1615	5	60	300
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**300**

Electronic Acknowledgement Receipt

EFS ID:	12620700
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Guy H. Eriksen
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	24-APR-2012
Filing Date:	07-MAY-2009
Time Stamp:	18:16:09
Application Type:	U.S. National Stage under 35 USC 371

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Payment Type	Deposit Account
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RAM confirmation Number	8444
Deposit Account	070832
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		PU060222_USPTO_Amendment_24_April_2012.pdf	64491 30390fec82a0f44d9117a5d5f35f40dd960da24a	yes	13

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	13

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30125 91db00f067a5d997a821f54a718fc32010887a5c	no	2

Warnings:

Information:

Total Files Size (in bytes):	94616

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 (07-06)
Approved for use through 1/31/2007. 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	Filing Date	☐ To be Mailed
12/312,386	05/07/2009	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
FOR	NUMBER FILED	NUMBER EXTRA					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			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 $250 ($125 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))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT	04/24/2012	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 25	= 5	X $ =		OR	X $60=	300
	Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $ =		OR	X $250=	0
	☐ 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	300

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/DEBRA R. WYATT/

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.

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

24498 7590 07/10/2012

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
P.O. Box 5312
Princeton, NJ 08543-5312

EXAMINER
AHMED, SAMIR ANWAR

ART UNIT	PAPER NUMBER
2624	

DATE MAILED: 07/10/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	10/10/2012

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 SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

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)

24498 7590 07/10/2012

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
P.O. Box 5312
Princeton, NJ 08543-5312

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.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	10/10/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
AHMED, SAMIR ANWAR	2624	382-232000

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 credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information 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.

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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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 07/10/2012

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
P.O. Box 5312
Princeton, NJ 08543-5312

EXAMINER	
AHMED, SAMIR ANWAR	

ART UNIT	PAPER NUMBER
2624	

DATE MAILED: 07/10/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 595 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 595 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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.	Applicant(s)	
	12/312,386	KAO ET AL.	
	Examiner	Art Unit	
	SAMIR AHMED	2624	

-- 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 *amendment filed 4/242012*.
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 *1-30*.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   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. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ 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).
7. ☐ 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. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Samir A. Ahmed/
Primary Examiner, Art Unit 2624

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	(encod$3 and image and two and filters and successively and loop and filter$3 and quantization and artifact and enable and disable and macroblock and level and slice and level and picture and level and sequence and level).CLM.	US-PGPUB; USPAT; UPAD	OR	ON	2012/07/02 17:55

7/2/2012 5:55:55 PM

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2624

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
382	232	G 0 6 K 9 / 36 (2006.01.01)	

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
382	251				

☒ 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		17												
	2		18												
	3		19												
	4		20												
	5		21												
	6		22												
	7		23												
	8		24												
	9		25												
	10		26												
	11		27												
	12		28												
	13		29												
	14		30												
	15														
	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/SAMIR AHMED/ Primary Examiner.Art Unit 2624	7/02/2012	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2624

✓	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	02/14/2012	07/02/2012							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
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	19	✓	=							
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	22	✓	=							
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	25	✓	=							
	26		=							
	27		=							
	28		=							
	29		=							
	30		=							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	22	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:14
L2	13	L1 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:17
L3	19	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:21
L4	1	L2 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:24
L5	2	L1 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:26
L6	22	L1 and level	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:27
L7	13	L2 and level	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:27
L8	13	L7 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:28
L9	11319	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:40
L10	4	L9 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3)	US-PGPUB; USPAT;	OR	ON	2012/07/02 17:41

		same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L11	4	L9 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:41
L12	9	L9 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) and ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:42
L13	1	L10 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:43
L14	1	L12 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:44
L15	5453	L9 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:45
L16	414	L15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:45
L17	22	L6 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:46

7/2/2012 5:50:41 PM

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2624

SEARCHED

Class	Subclass	Date	Examiner
382	232,236,238,251	7/02/2012	/SA/
375	240.02, 240.03, 240.13	7/02/2012	/SA/

SEARCH NOTES

Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)- See search history printout	2/14/2012	YG
Updated East search history, see search history printout	7/02/2012	SA

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
382	232	7/02/2012	SA
	EAST PGPUB text search see interference search printout	7/02/2012	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	12312386	Filing Date	2009-05-07	Docket Number (if applicable)	PU060222	Art Unit	2624
First Named Inventor	Meng-Ping Kao			Examiner Name	Samir Anwar Ahmed		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☒ Other References cited

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 070832

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (07-09)
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.

Signature of Registered U.S. Patent Practitioner			
Signature	/GUY H. ERIKSEN/	Date (YYYY-MM-DD)	2012-10-10
Name	GUY H. ERIKSEN 609-734-6807	Registration Number	41736

This collection of information is required by 37 CFR 1.114. 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.

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 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.

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12312386
Filing Date	2009-05-07
First Named Inventor	Meng-Ping Kao
Art Unit	2624
Examiner Name	Samir Anwar Ahmed
Attorney Docket Number	PU060222; Customer #24498

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
	1					

If you wish to add additional U.S. Patent citation information please click the Add button.

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
	1	20030219073	A1	2003-11-27	Y. Lee et al.	(equivalent of JP2000-059769 listed below)

If you wish to add additional U.S. Published Application citation information please click the Add button.

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]
	1	2000-059769	JP		2000-02-25	Samsung Electronics Co., Ltd.Korean Advanced Inst.	(equivalent of US 2003/0219073 listed above)	☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

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, 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	12312386
	Filing Date	2009-05-07
	First Named Inventor	Meng-Ping Kao
	Art Unit	2624
	Examiner Name	Samir Anwar Ahmed
	Attorney Docket Number	PU060222; Customer #24498

	1	PARK, S.H. ET AL., "Theory of Projection onto the Narrow Quantization Constraint Set and Its Application", IEEE Transactions on Image Processing, October 1999, Vol. 8, No. 10, pp. 1361-1373	☐

If you wish to add additional non-patent literature document citation information please click the Add button

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	12312386
	Filing Date	2009-05-07
	First Named Inventor	Meng-Ping Kao
	Art Unit	2624
	Examiner Name	Samir Anwar Ahmed
	Attorney Docket Number	PU060222; Customer #24498

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	/GUY H. ERIKSEN/	Date (YYYY-MM-DD)	2012-10-10
Name/Print	GUY H. ERIKSEN 609-734-6807	Registration Number	41,736

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.**

Privacy Act Statement

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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 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.

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Guy H. Eriksen/Patricia Fedorowycz
Attorney Docket Number:	PU060222

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:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	1801	1	930	930
		Total in USD ($)		**930**

Electronic Acknowledgement Receipt

EFS ID:	13952870
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Guy H. Eriksen
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	10-OCT-2012
Filing Date:	07-MAY-2009
Time Stamp:	16:15:13
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	$930
RAM confirmation Number	3437
Deposit Account	070832
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	Park_etal_Theory_of_projedtion_onto_the_narrow_quantization_etc.pdf	1340734 a0de85a499eefd14350cca3843dcb0727e53c225	no	13

Warnings:

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:

2	Foreign Reference	JP200059769.pdf	1653340 bec916319f343cf5080dc4611a4a621fa1c386a0	no	25

Warnings:

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:

3	Request for Continued Examination (RCE)	PU060222_RCE_10OCT2012.pdf	145949 6f90e38b9cd3bae42284d604066c75057efb77f3	no	3

Warnings:

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Information:

4	Information Disclosure Statement (IDS) Form (SB08)	PU060222_IDS_Statement_10OCT2012.pdf	165769 56982d44610cd25d746fcf13499f5a5dca3705c2	no	4

Warnings:

Information:

This is not an USPTO supplied IDS fillable form

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

5	Fee Worksheet (SB06)	fee-info.pdf	30468 84bedde2c91579290721aee9a8be26ddcca14bb	no	2

Warnings:

Information:

Total Files Size (in bytes):	3336260

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.

(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2000－59769
（P2000－59769A）
(43)公開日　平成12年２月25日(2000.2.25)

(51)Int.Cl.⁷	識別記号	ＦＩ	テーマコード（参考）
Ｈ０４Ｎ　7/24		Ｈ０４Ｎ　7/13	Ｚ

審査請求　有　　請求項の数29　ＯＬ　（全 25 頁）

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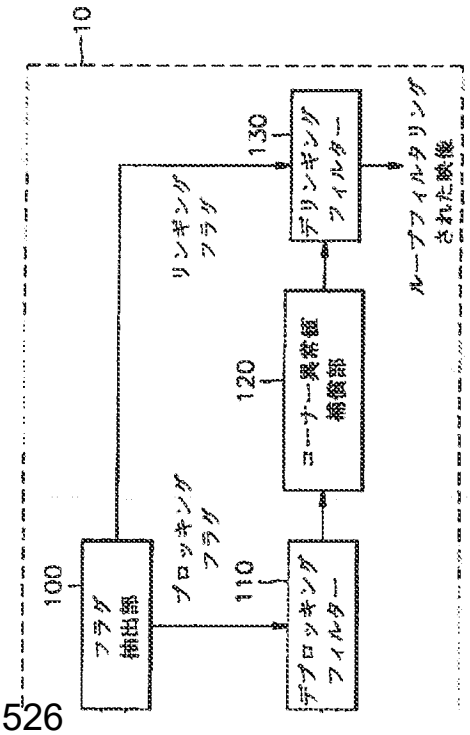
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最終頁に続く

(54)【発明の名称】　映像データループフィルタリング方法及び装置

(57)【要約】
【課題】　量子化効果を低減させ、フィルタリング計算量を減らし、低ビット率の符号化が可能な映像データループフィルタリング方法及び装置を提供する。
【解決手段】　フラグ抽出部１００は、映像データの逆量子化係数の分布及び前フレームと現フレームとの差を示す動きベクトルを用い、映像データのループフィルタリング必要性の可否を示すフラグを抽出し、デブロッキングフィルター１１０は、前記フラグを検査して、前記映像データをデブロッキングフィルタリングし、コーナー異常値補償部１２０は、前記映像データの内コーナー異常値を検出して補償し、デリンギングフィルター１３０は、前記フラグを検査して、前記コーナー異常値補償されたデータをデリンギングフィルタリングする。前記フラグは、ブロッキングフラグとリンギングフラグとからなる。



1

【特許請求の範囲】

【請求項１】　映像データのエンコーディング及びデコーディング時に発生する量子化効果の低減のためのループフィルタリング方法において、

逆量子化された映像データの逆量子化係数の分布及び前フレームと現フレームとの差を示す動きベクトルを用い、前記映像データのループフィルタリングの必要性可否を示すフラグを抽出するフラグ抽出段階と、

前記抽出されたフラグがループフィルタリングが必要有りを示せば、前記フラグに相応する映像データを所定の方法によりフィルタリングするフィルタリング段階とを含むことを特徴とする映像データループフィルタリング方法。

【請求項２】　前記フラグ抽出は、前記ループフィルタリングしようとする映像フレームがイントラフレームであれば、各ブロックの離散余弦変換（ＤＣＴ）ドメインから抽出し、

前記ループフィルタリングしようとする映像フレームがインターフレームであれば、残差信号及び基準フレームのフラグから抽出することを特徴とする請求項１に記載の映像データループフィルタリング方法。

【請求項３】　前記フラグは、

ブロック境界近傍のブロッキングアーチファクトを減少させる必要性の可否を示すブロッキングフラグと、

映像エッジ近傍のリンギングノイズを減少させる必要性の可否を示すリンギングフラグとよりなることを特徴とする請求項２に記載の映像データループフィルタリング方法。

【請求項４】　前記映像データがイントラフレームの場合、前記イントラフレームのブロッキングフラグは、

水平ブロッキングフラグＨＢＦ及び垂直ブロッキングフラグＶＢＦよりなり、

前記イントラフレームの水平及び垂直ブロッキングフラグ抽出は、

ａ）前記圧縮された映像データが逆量子化された後に、前記逆量子化された８×８ブロックに対するＤＣＴ係数を求める段階と、

ｂ）前記８×８ブロックを成す６４個の画素の内前記ブロックの最上及び最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、前記画素Ａの真下の画素を画素Ｃとするとき、前記画素Ａの係数のみが‘０’でない値を有すると、前記ＨＢＦ及びＶＢＦをループフィルタリングする必要ありを示す情報‘１’にセットする段階と、

ｃ）前記逆量子化された８×８ブロックの最上位行のみが‘０’でない値を有する画素を含んでいる時、ＶＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階と、

ｄ）前記逆量子化された８×８ブロックの最左側列のみが‘０’でない値を有する画素を含んでいる時、ＨＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階とを含むことを特徴とする請求項３に記載の映像データループフィルタリング方法。

【請求項５】　前記イントラフレームのリンギングフラグ抽出は、

８×８ブロックを成す６４個の画素の内前記ブロックの最上、最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、かつ前記画素Ａの真下の画素を画素Ｃとするとき、

前記逆量子化された８×８ブロックの画素Ａ，Ｂ及びＣ以外の位置に何れか一つさえ‘０’でない係数値を有する時、リンギングフラグＲＦをループフィルタリングが必要ありを示す情報‘１’にセットすることを特徴とする請求項３に記載の映像データループフィルタリング方法。

【請求項６】　現インターフレームのブロッキングフラグは、

水平ブロッキングフラグ及び垂直ブロッキングフラグよりなり、

前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、

基準フレームが所定の基準ブロックよりなり、前記現インターフレームのブロックＡｃの動きベクトル（ＭＶｘ，ＭＶｙ）により推定される基準フレームのブロックを動きブロックＸとするとき、

前記動きブロックＸが前記基準ブロックと重なった度合いを調べる段階と、

重なった画素数が所定個数以上である基準ブロックのＨＢＦ及びＶＢＦをビット別に論理積演算する段階と、

前記演算の結果を現ＶＯＰのブロックＡｃの水平及び垂直ブロッキングフラグにセットすることを特徴とする請求項３に記載の映像データループフィルタリング方法。

【請求項７】　前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、

現マクロブロックがその動きベクトルの０であるスキップされたマクロブロックであれば、基準マクロブロックのブロッキングフラグを現マクロブロックのブロッキングフラグにセットする段階をさらに具備することを特徴とする請求項６に記載の映像データループフィルタリング方法。

【請求項８】　前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、先ず基準ブロックのブロッキングフラグを複写してパッディングをする段階をさらに具備することを特徴とする請求項７に記載の映像データループフィルタリング方法。

【請求項９】　映像フレームがインターフレームの場合、現インターフレームのブロックＡｃに対するリンギングフラグ抽出は、

‘０’でなければ、現ブロックＡｃのリンギングフラグＲＦを‘１’にセットし、前記ＩＱＣのＡＣ成分がいずれも‘０’であれば、ＲＦを‘０’にする段階と、
マクロブロックＭＢに対する動きベクトルを伝達する８×８予測モードが現ブロックに使用されると、ＲＦを‘１’にセットする段階とよりなることを特徴とする請求項３に記載の映像データループフィルタリング方法。
【請求項１０】　前記映像データがインターフレームの場合、前記インターフレームのリンギングフラグは、第１リンギングフラグＲＦ０及び第２リンギングフラグＲＦ１よりなり、
現インターフレームのブロックＡｃに対する前記第１リンギングフラグＲＦ０及び第２リンギングフラグＲＦ１の抽出は、
インターマクロブロックの８×８ブロックにおいて残差信号の逆量子化係数ＩＱＣのＤＣ成分のみが‘０’でなければ、現ブロックＡｃの第１リンギングフラグＲＦ０を‘１’にセットし、そうでなければＲＦ０を０にする段階と、
インターフレームの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣのＡＣ成分のいずれか一つさえ‘０’でなければ、現ブロックＡｃの第２リンギングフラグＲＦ１を‘１’にセットし、そうでなければＲＦ１を‘０’にする段階とよりなることを特徴とする請求項３に記載の映像データループフィルタリング方法。
【請求項１１】　前記フィルタリング段階のフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
前記ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であり、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デブロッキングフィルタリングを行わないことを特徴とする請求項３に記載の映像データループフィルタリング方法。
【請求項１２】　ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、
ブロックＩ及びブロックＪのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、あるいはブロックＩ及びブロックＪのリンギングフラグＲＦの内少なくともいずれか一方がリンギングノイズを減少させる必要有りを示せば、ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ、前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階とよりなることを特徴とする請求項４または５に記載の映像データループフィルタリング方法。
【請求項１３】　ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、
ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ、前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階と、
ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩまたはブロックＪの残差信号のＩＱＣのＤＣ成分が存在し、ブロックＩ及びブロックＪが共にＨＢＦが‘１’であれば、第１フィルタリングを行う段階と、
ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩまたはブロックＪの残差信号のＩＱＣのＤＣ成分が存在し、ブロックＩ及びブロックＪの内少なくともいずれか一方のＨＢＦが‘０’を示せば、第２フィルタリングを行う段階と、
前記ブロックＩのＲＦがリンギングノイズを減少させる必要有りを示せば、第２フィルタリングを行う段階とよりなることを特徴とする請求項６または９に記載の映像

【請求項１４】　ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、
ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦの内いずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階と、
ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの内少なくともいずれか一方のＲＦＯが１であり、ブロックＩ及びブロックＪのＨＢＦが共に‘１’であれば、第１フィルタリングを行う段階と、
ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの内少なくともいずれか一方のＲＦＯが１であり、ブロックＩ及びブロックＪのＨＢＦの内少なくともいずれか一方が‘１’でなければ、第２フィルタリングを行う段階と、
前記ブロックＩのＲＦＩが‘０’でなければ、第２フィルタリングを行う段階とよりなることを特徴とする請求項７または１０に記載の映像データループフィルタリング方法。
【請求項１５】　前記ブロックＩとブロックＪとを仕切るブロック境界線を介在した６個の画素をＡ，Ｂ，Ｃ，Ｄ，Ｅ及びＦとし、前記画素Ｃ及びＤを前記ブロック境界線に最も隣接した画素、前記画素Ａ及びＦがブロック境界線から最も遠い画素、前記画素Ｂ及びＤが前記Ａ及びＣ，Ｄ及びＦの中間に位置した画素とするとき、
前記第１フィルタリングは、
前記６個の画素に対し７－タブ（１，１，１，２，１，１，１）のローパスフィルタリングを行い、
前記画素Ｃ及びＤに対しフィルタリングを行うが、前記画素Ｃ及びＤの差の絶対値がＨ．２６３の量子化要素ＱＰより小さければ、ＣはＣ＋（Ｄ－Ｃ）／４に、ＤはＤ＋（Ｄ－Ｃ）／４に置き換えることを特徴とする請求項１２または１３または１４に記載の映像データループフィルタリング方法。
【請求項１６】　前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングは、
リンギングフラグがデリンギングフィルタリングが必要有りを示すかどうかを検査し、デリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、そうでなければデリンギングフィルタリングを行わないことを特徴とし、
前記デリンギングフィルタリングは、
映像データの水平エッジ及び垂直エッジを検出するエッジ検出段階と、
リンギングノイズを減少させようとする８×８ブロックに対し２次元信号適応フィルタリングをする信号適応フィルタリング段階とよりなり、
前記エッジ検出段階の水平エッジ検出は、
画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の右側の画素を画素［ｍ］［ｎ＋１］、左側の画素を画素［ｍ］［ｎ－１］、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ１、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ－１］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、
条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞ＱＰ））ｏｒ（Ａ１＞２ＱＰ）ｏｒ（Ａ２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝１となり、
前記エッジ検出段階の垂直エッジ検出は、
画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の上方の画素を画素［ｍ＋１］［ｎ］、下方の画素を画素［ｍ－１］［ｎ］、前記画素［ｍ］［ｎ］と画素［ｍ＋１］［ｎ］との差をＡ’１、前記画素［ｍ］［ｎ］と画素［ｍ－１］［ｎ］との差をＡ’２、Ｈ．２６３の量子化要素をＱＰとするとき、
条件式（（Ａ’１＞ＱＰ）ａｎｄ（Ａ’２＞ＱＰ））ｏｒ（Ａ’１＞２ＱＰ）ｏｒ（Ａ’２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝‘１’となり、
前記信号適応フィルタリング段階は、
４－コネクティッドフィルターウィンドウを前記８×８ブロックに対し適用して、前記フィルターウィンドウの中心画素がエッジであればフィルタリングを行わず、前記フィルターウィンドウの中心画素がエッジでなければ加重フィルタリングを行うことを特徴とする請求項３に記載のループフィルタリング方法。

ギングノイズを減少させるデリンギングフィルタリングの遂行成否は、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
前記ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であり、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デリンギングフィルタリングを行わないことを特徴とする請求項３に記載の映像データループフィルタリング方法。

【請求項１８】　前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングの遂行成否は、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
ブロックＩのリンギングフラグがデリンギングフィルタリングが必要有りを示すかどうかを検査し、デリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、そうでなければデリンギングフィルタリングを行わないことを特徴とする請求項５に記載の映像データループフィルタリング方法。

【請求項１９】　前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングの遂行成否は、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとするとき、
ブロックＩがイントラブロックであればデリンギングフィルタリングを行う段階と、
前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックであれば、デリンギングフィルタリングを行う段階と、
前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックでなく、ブロックＩのＲＦ１がデリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、ブロックＩのＲＦ１がデリンギングフィルタリングが必要無しを示せばデリンギングフィルタリングを行わない段階とよりなることを特徴とする請求項１０に記載の映像データループフィルタリング方法。

【請求項２０】　前記デリンギングフィルタリングは、映像データの水平エッジ及び垂直エッジを検出するエッジ検出段階と、
リンギングノイズを減少させようとする８×８ブロックに対し２次元信号適応フィルタリングをする信号適応フィルタリング段階とよりなり、
前記エッジ検出段階の水平エッジ検出は、画素［m］［n］、前記画素［m］［n］の右側の画素を画素［m］［n＋1］、前記画素［m］［n］と画素［m］［n＋1］との差をＡ１、前記画素［m］［n］と画素［m］［n－1］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞ＱＰ））ｏｒ（Ａ１＞２ＱＰ）ｏｒ（Ａ２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［m］［n］＝１となり、
前記エッジ検出段階の垂直エッジ検出は、画素［m］［n］、前記画素［m］［n］の上方の画素を画素［m＋1］［n］、下方の画素を画素［m－1］［n］、前記画素［m］［n］と画素［m＋1］［n］との差をＡ’１、前記画素［m］［n］と画素［m－1］［n］との差をＡ’２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ’１＞ＱＰ）ａｎｄ（Ａ’２＞ＱＰ））ｏｒ（Ａ’１＞２ＱＰ）ｏｒ（Ａ’２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［m］［n］＝‘１’となり、
前記信号適応フィルタリング段階は、
４－コネクティッドフィルターウィンドウを前記８×８ブロックに対し適用して、前記フィルターウィンドウの中心画素がエッジであればフィルタリングを行わず、前記フィルターウィンドウの中心画素がエッジでなければ加重フィルタリングを行うことを特徴とする請求項１７または１８に記載の映像データループフィルタリング方法。

【請求項２１】　映像データをブロックに基づきエンコーディング及びデコーディングする時、ブロック４つが会うクロスポイントのコーナーで発生するコーナー異常値を低減させるために、
逆量子化された前記映像データの８×８ブロックのコーナー異常値を検出する検出段階と、
前記検出されたコーナー異常値を補償する補償段階とをさらに具備することを特徴とし、
前記検出段階は、前記クロスポイントを中心とした４つの画素を画素Ａ，Ｂ，Ｃ及びＤとし、Ａ，Ｂ，Ｃ、及びＤの各画素値をａ，ｂ，ｃ，ｄとし、平均値Ａｖｅｒａｇｅ＝（ａ＋ｂ＋ｃ＋ｄ＋２）／４とおき、各画素値とＡｖｅｒａｇｅとの差をＨ．２６３の量子化要素ＱＰと比較して、前記差がＱＰより大きければ、コーナー異常値候補画素の個数を累積してコーナー異常値を検出し、
前記補償段階は、前記Ａの属するブロックにおいて前記Ａと隣り合う画素をA_1，A_2とし、前記画素Ａと対角線に位置する画素をA_3とし、その画素値を各々a_1，a_2及びa_3とするとき、前記検出段階で検出されたコーナー異常値候補が一つで、該画素がＡであれば、前記ａとa_3との差が３ＱＰ／２より小さければ、コーナー異常値補償は次式
【数１】

9

画素Ａに対する補償値 a' ＝（４a＋b＋c＋２d＋４）／９

画素A_1に対する補償値 a'_1＝（a'＋３a_1＋２）／４

画素A_2に対する補償値 a'_2＝（a１＋３a_2＋２）／４

のようになり、

前記コーナー異常値候補画素数が二つ以上であれば、（a_3＋b_3＋c_3＋d_3＋２）／４（ここで、b_3，c_3，d_3もa_3と同様の方式で定義される）から最大の差を有する候補が選ばれ、該補償は前記一つの候補の場合でのような方法で行われることを特徴とする請求項１に記載の映像データループフィルタリング方法。

【請求項２２】　映像データをブロックに基づきエンコーディング及びデコーディングする際に発生する量子化効果を低減させるための映像データループフィルタリング装置において、

映像データの逆量子化係数の分布及び前フレームと現フレームとの差を示す動きベクトルを用い、映像データのループフィルタリング必要性の可否を示すフラグを抽出するフラグ抽出部と、

前記フラグ抽出部で抽出されたブロッキングフラグを検査して、前記映像データをデブロッキングフィルタリングするデブロッキングフィルターと、

前記デブロッキングフィルタリングされたデータの内コーナー異常値を検出して補償するコーナー異常値補償部と、

前記フラグ抽出部で抽出されたリンギングフラグを検査して、前記コーナー異常値補償されたデータをデリンギングフィルタリングするデリンギングフィルターとを含むことを特徴とし、

前記フラグは、

ブロック境界近傍のブロッキングアーチファクトを減少させる必要性の有無を示すブロッキングフラグと、

映像エッジ近傍のリンギングノイズを減少させる必要性の有無を示すリンギングフラグとよりなる映像データループフィルタリング装置。

【請求項２３】　前記フラグ抽出部は、

イントラフラグ及びインターフラグを抽出し、

前記イントラフラグの抽出は、

逆量子化された前記映像データの逆量子化係数の分布を用い、

前記インターフラグの抽出は、

前フレームと現フレームとの差を示す動きベクトルを用いることを特徴とする請求項２２に記載の映像データループフィルタリング装置。

【請求項２４】　映像データをブロックに基づきエンコーディング及びデコーディングする際に発生する量子化効果を低減させるための映像データループフィルタリングにおいて、

逆量子化された映像データの逆量子化係数の分布及び[illegible]

10

い、前記映像データのループフィルタリングの必要性の有無を示すフラグを抽出するフラグ抽出段階と、

前記抽出されたフラグがループフィルタリングが必要ありを示せば、前記フラグに相応する映像データを所定の方法によりフィルタリングするフィルタリング段階とを含み、

前記フラグ抽出は、前記ループフィルタリングしようとする映像フレームがイントラフレームであれば各ブロックのＤＣＴドメインから抽出し、前記ループフィルタリングしようとする映像フレームがインターフレームであれば残差信号及び基準フレームのフラグから抽出することを特徴とする映像データループフィルタリング方法を実行させるためのプログラムを記録したコンピュータにて読取り可能な記録媒体。

【請求項２５】　前記フラグがブロック境界近傍のブロッキングアーチファクトを減少させる必要性の有無を示すブロッキングフラグと、映像エッジ近傍のリンギングノイズを減少させる必要性の有無を示すリンギングフラグとよりなる時、

前記映像データがイントラフレームの場合、前記イントラフレームのブロッキングフラグはＨＢＦ及びＶＢＦよりなり、

前記イントラフレームの水平及び垂直ブロッキングフラグ抽出は、前記圧縮された映像データが逆量子化された後に、前記逆量子化された８×８ブロックに対するＤＣＴ係数を求める段階と、前記８×８ブロックを成す６４個の画素の内前記ブロックの最上及び最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、前記画素Ａの真下の画素を画素Ｃとするとき、前記画素Ａの係数のみが‘０’でない値を有すると、前記ＨＢＦ及びＶＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階と、前記逆量子化された８×８ブロックの最上位行のみが‘０’でない値を有する画素を含んでいるとき、ＶＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階と、前記逆量子化された８×８ブロックの最左側のカラムのみが‘０’でない値を有する画素を含んでいる時、ＨＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階とよりなり、

前記イントラフレームのリンギングフラグ抽出は、前記８×８ブロックを成す６４個の画素の内前記ブロックの最上、最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、前記画素Ａの真下の画素を画素Ｃとするとき、前記逆量子化された８×８ブロックの画素Ａ，Ｂ及びＣ以外の位置にいずれか一つでも‘０’でない係数値を有する係数値を有する時、リンギングフラグＲＦをループフィルタリングする必要ありを示す情報‘１’にセットし、

[illegible]

グ及び垂直ブロッキングフラグよりなり、
前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、基準フレームが所定の基準ブロックよりなり、前記現インターフレームのブロックＡｃの動きベクトル（ＭＶｘ，ＭＶｙ）により推定される基準フレームのブロックを動きブロックＸとするとき、前記動きブロックＸが前記基準ブロックと重なった度合いを調べる段階と、重なった画素数が所定個数以上である基準ブロックのＨＢＦ及びＶＢＦをビット別に論理積演算する段階と、前記演算の結果を現ＶＯＰのブロックＡｃの水平及び垂直ブロッキングフラグにセットし、
現インターフレームのブロックＡｃに対するリンギングフラグ抽出は、インターフレームの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣが‘０’でなければ現ブロックＡｃのリンギングフラグＲＦを‘１’にセットする段階と、マクロブロックＭＢに対する動きベクトルを伝達する８×８予測モードが現ブロックに使用されるとＲＦを‘１’にセットする段階とよりなることを特徴とする請求項２４に記載の映像データループフィルタリング方法を実行させるためのプログラムを記録したコンピュータにて読取り可能な記録媒体。
【請求項２６】　前記フィルタリング段階のフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、前記ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であり、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デブロッキングフィルタリングを行わないことを特徴とする請求項２５に記載の映像データループフィルタリング方法を実行させるためのプログラムを記録したコンピュータにて読取り可能な記録媒体。
【請求項２７】　ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、
ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、
ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、
ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦの少なくともいずれか一方が必要無しを示せば、あるいはブロックＩ及びブロックＪのリンギングフラグＲＦの少なくともいずれか一方がリンギングノイズを減少させる必要有りを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階とよりなり、
前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した６個の画素をＡ，Ｂ，Ｃ，Ｄ，Ｅ及びＦとし、前記画素Ｃ及びＤを前記水平ブロック境界線に最も隣接した画素、前記画素Ａ及びＦが水平ブロック境界線から最も遠い画素、前記画素Ｂ及びＤが前記Ａ及びＣ，Ｄ及びＦの中間に位置した画素とするとき、
前記第１フィルタリングは、前記６つの画素に対し７－タブ（１，１，１，２，１，１，１）ローパスフィルタリングを行い、
前記第２フィルタリングは、前記画素Ｃ及びＤに対しフィルタリングを行うが、前記画素Ｃ及びＤの差の絶対値がＨ．２６３の量子化要素であるＱＰより小さければ、ＣはＣ＋（Ｄ－Ｃ）／４に、ＤはＤ＋（Ｄ－Ｃ）／４に置き換え、
垂直ブロック境界線を介在した画素に関しては、前記ＶＢＦを用いて前記水平ブロック境界線を介在した画素と同様の方式でフィルタリングをすることを特徴とする請求項２５に記載の映像データループフィルタリング方法を実行させるためのプログラムを記録したコンピュータにて読取り可能な記録媒体。
【請求項２８】　前記フィルタリング段階のデリンギングフィルタリングは、
映像データの水平エッジ及び垂直エッジを検出するエッジ検出段階と、
リンギングノイズを減少しようとする８×８ブロックに関し、２次元信号適応フィルタリングをする信号適応フィルタリング段階とよりなることを特徴とし、
前記エッジ検出段階の水平エッジ検出は、
所定の大きさを有するブロック内の１画素を画素［ｍ］［ｎ］とし、前記画素［ｍ］［ｎ］の右側の画素を画素［ｍ］［ｎ＋１］、左側の画素を画素［ｍ］［ｎ－１］、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ１、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞ＱＰ））ｏｒ（Ａ１＞２ＱＰ）ｏｒ（Ａ２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝１となり、
前記エッジ検出段階の垂直エッジ検出は、
前記画素［ｍ］［ｎ］の上方の画素を画素［ｍ＋１］［ｎ］、前記画素［ｍ］［ｎ］の下方の画素を画素［ｍ－１］［ｎ］、前記画素

13

前記画素［m］［n］と画素［m－１］［n］との差をA’２、H．２６３の量子化要素をＱＰとするとき、条件式（（A’１＞ＱＰ）ａｎｄ（A’２＞ＱＰ））ｏｒ（A’１＞２ＱＰ）ｏｒ（A’２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［m］［n］＝‘１’となり、

前記信号適応フィルタリング段階は、

４－コネクティッドフィルターウィンドウを前記８×８ブロックに対し適用して、前記フィルターウィンドウの中心画素がエッジであればフィルタリングを行わず、前記フィルターウィンドウの中心画素がエッジでなければ加重フィルタリングを行うことを特徴とする請求項２５に記載の映像データループフィルタリング方法を実行させるのためのプログラムを記録したコンピュータにて読取り可能な記録媒体。

【請求項２９】　映像データをブロックに基づきエンコーディング及びデコーディングするとき、ブロック４つが会うクロスポイントのコーナーで発生するコーナー異常値を減少させるために、逆量子化された前記映像データの８×８ブロックのコーナー異常値を検出する検出段階と、前記検出されたコーナー異常値を補償する補償段階とをさらに具備することを特徴とし、

14

前記検出段階は、前記クロスポイントを中心とした４個の画素を画素Ａ，Ｂ，Ｃ及びＤとし、Ａ，Ｂ，Ｃ及びＤの各画素値をａ，ｂ，ｃ，ｄとし、平均値Ａｖｅｒａｇｅ＝（ａ＋ｂ＋ｃ＋ｄ＋２）／４とすれば、各画素値とＡｖｅｒａｇｅとの差をH．２６３の量子化要素ＱＰと比較し、前記差がＱＰより大きければ、コーナー異常値候補画素個数を累積してコーナー異常値を検出し、

前記補償段階は、前記Ａの属するブロックにおいて前記Ａと隣り合う画素をA_1，A_2とし、前記画素Ａと対角線に位置する画素をA_3とし、その画素値を各々a_1，a_2，a_3とするとき、前記検出段階で検出されたコーナー異常値候補が一つで、該画素がＡであれば、前記ａとa_3との差が３ＱＰ／２より小さければ、コーナー異常値補償は次式

【数２】

$$\text{画素Aに対する補償値 } a' = (4a + b + c + 2d + 4) / 9$$

$$\text{画素}A_1\text{に対する補償値 } a'_1 = (a' + 3a_1 + 2) / 4$$

$$\text{画素}A_2\text{に対する補償値 } a'_2 = (a_1 + 3a_2 + 2) / 4$$

のようになり、

前記コーナー異常値候補画素数が二つ以上であれば、$(a_3 + b_3 + c_3 + d_3 + 2) / 4$（ここで、$b_3$，$c_3$，$d_3$も$a_3$と同様の方式で定義される）から最大の差を有する候補が選ばれ、該補償は前記一つの候補の場合でのような方法で行われることを特徴とする請求項２５に記載の映像データループフィルタリング方法を実行させるためのプログラムを記録したコンピュータにて読取り可能な記録媒体。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、映像データ処理に係り、特に、量子化効果を低減させるための映像データループフィルタリング方法及び装置に関する。

【０００２】

【従来の技術】一般に、国際標準化機構（International Organization for Standardization：ＩＳＯ）のＭＰＥＧ及びＩＴＵ（International Telecommunication Union）のH．２６３を含む大部分の画像符号化標準はブロックに基づく動き推定及びブロック離散余弦変換（Discrete Cosine Transform：ＤＣＴ）処理を使用する。また大部分のビデオ符号化標準は、情報を小さい数の変換係数にパックキングするために、８×８画素ブロック単位のＤＣＴを使用する。このブロックに基づくＤＣＴスキームは、映像の局部的な空間相関性質を利用していされた映像データを復元すると、ブロック境界近傍のブロッキングアーチファクト（blocking artifacts）、ブロックのクロスポイントにおけるコーナー異常値（corner outlier）及び映像エッジ近傍のリンギングノイズ（ringing noise）等かなりの映像劣化がもたらされる。というのは、映像データを８×８画素ブロック単位にＤＣＴ変換し、前記変換された係数を量子化するためである。特に、イメージが高圧縮されている時は一層そうである。

【０００４】前記ブロッキングアーチファクトは、相対的に類似した等質領域でのブロック境界に従い発生するグリッドノイズである。前記グリッドノイズは、圧縮されたデータが復元され画面上にディスプレーされる際に、ブロックに基づき処理した痕跡がブロック間の縁部に見られ、これを見る人がブロック間の縁部であることをすぐ分かってしまう。そして前記コーナー異常値は８×８ブロックが合うコーナーポイントで発生する。また前記リンギングノイズは映像を高圧縮するために、前記ＤＣＴの高周波成分の係数を量子化による切り捨てをすることにより発生する典型的なギブズ（Gibb's）現象であって、映像がやや間をおいて多数枚重なって現れるように感じさせる問題を招く。

【０００５】ブロックに基づく符号化により発生する前記ブロッキングアーチファクト、コーナー異常値及びリンギングノイズを減少させるためのいくつかの方法が提

Adaptive Filtering", in press IEEE Trans. on Image Processing, 1997] , [B. Ramamurthi and A.Gersho, "Nonlinear Space Variant Postprocessing of Block Coded Images", IEEE Tans on ASSP, vol.34,no.5, pp1258-1267, 1986] , [Y.Ynag, N.Galatsanos and A.Katsaggelos, "Projection-Based Spatially Adaptive Reconstruction of Block-Transform Compressed Images," IEEE trans. on Image Processing, vol.4, no.7, pp 896-908,July 1995] , および [Z.Xiong, M.T.Orchard, and Y.Q.Zhang, "A DeblockingAlgorithm for JPEG Compressed Images Using Overcomplete Wavelet Representations, "IEEE Trans. Circuits Syst. Video Techno l.,vol.7, no.2, pp 433-437, 1997] 中でも、ＪＰＥＧ－圧縮解除映像の量子化効果を低減させるために、２次元信号適応フィルタリング（Signal-Adaptive Filtering：ＳＡＦ）が提案されている。 [Y.L.Lee, H.C.Kim, and H.W.Park, "Blocking Effect Reduction of JPEG images by Signal Adaptive Filtering", in press IEEE Trans. onImage Processing, 1997] またブロッキングアーチファクトを減少させるために２次元フィルターを用い、階段ノイズの低減のためには１次元フィルターを用いたRamamurthi及びGershoの方法 [B.Ramamurthi and A.Gersho,"Nonlinear Space Variant Postprocessing of Block Coded Images", IEEE Tans on ASSP,vol.34,no.5,pp1258-1267, 1986] は良好な効果をもたらしたこともある。また凸状集合への写像（projections onto convex sets：ＰＯＣＳ）論理を用いた反復的な映像復旧のアルゴリズムも提案されている。 [Y.Ynag,N.Galatsanos and A.Katsaggelos,"Projection-Based Spatially Adaptive Reconstruction of Block-Transform Compressed Images,"IEEE trans. on Image Processing,vol.4, no.7,pp 896-908,July 1995]

しかし乍ら、これらの方法は計算が複雑であるといった欠点がある。

【０００６】

【発明が解決しようとする課題】本発明は上記事情に鑑みて成されたものであり、その目的は、ブロックに基づく映像データの復号化の際にブロッキングアーチファクト、コーナー異常値及びリンギングノイズなどの量子化効果を低減するために、計算が複雑でないほか、低いビット率の符号化が可能な映像データループフィルタリング方法及び装置を提供することにある。

【０００７】

【課題を解決するための手段】前記技術的課題を解決するために、本発明に係る量子化効果の低減のための映像データループフィルタリング方法は、映像データのエンコーディング及びデコーディング時に発生する量子化効果の低減のためのループフィルタリング方法において、逆量子化された映像データの逆量子化係数の分布パターンに基づいて、前記映像データのループフィルタリングの必要性可否を示すフラグを抽出するフラグ抽出段階と、前記抽出されたフラグがループフィルタリングが必要有りを示せば、前記フラグに相応する映像データを所定の方法によりフィルタリングするフィルタリング段階とを含むことを特徴とする。

【０００８】前記フラグ抽出は、前記ループフィルタリングしようとする映像フレームがイントラフレームであれば、各ブロックの離散余弦変換（ＤＣＴ）ドメインから抽出し、前記ループフィルタリングしようとする映像フレームがインターフレームであれば、残差信号及び基準フレームのフラグから抽出することを特徴とする。

【０００９】前記フラグは、ブロック境界近傍のブロッキングアーチファクトを減少させる必要性の可否を示すブロッキングフラグと、映像エッジ近傍のリンギングノイズを減少させる必要性の可否を示すリンギングフラグとよりなる。

【００１０】前記映像データがイントラフレームの場合、前記イントラフレームのブロッキングフラグは、水平ブロッキングフラグ（ＨＢＦ）及び垂直ブロッキングフラグ（ＶＢＦ）よりなる。前記イントラフレームの水平及び垂直ブロッキングフラグ抽出は、前記圧縮された映像データが逆量子化された後に、前記逆量子化された８×８ブロックに対するＤＣＴ係数を求める段階と、前記８×８ブロックを成す６４個の画素の内前記ブロックの最上及び最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、前記画素Ａの真下の画素を画素Ｃとするとき、前記画素Ａの係数のみが‘０’でない値を有すると、前記ＨＢＦ及びＶＢＦをループフィルタリングする必要ありを示す情報‘１’にセットする段階と、前記逆量子化された８×８ブロックの最上位行のみが‘０’でない値を有する画素を含んでいる時、ＶＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階と、前記逆量子化された８×８ブロックの最左側のカラムのみが‘０’でない値を有する画素を含んでいる時、ＨＢＦをループフィルタリングが必要ありを示す情報‘１’にセットする段階とを含むことを特徴とする。

【００１１】前記イントラフレームのリンギングフラグ抽出は、前記８×８ブロックを成す６４個の画素の内前記ブロックの最上、最左側に位置した画素（ＤＣ成分）を画素Ａとし、前記画素Ａのすぐ右側の画素を画素Ｂ、かつ前記画素Ａの真下の画素を画素Ｃとするとき、前記逆量子化された８×８ブロックの画素Ａ，Ｂ及びＣ以外の位置に何れか一つさえ‘０’でない係数値を有する時、リンギングフラグＲＦをループフィルタリングが必要ありを示す情報‘１’にセットすることを特徴とする。

グよりなり、前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、基準フレームが所定の基準ブロックよりなり、前記現インターフレームのブロックＡｃの動きベクトル（ＭＶｘ，ＭＶｙ）により推定される基準フレームのブロックを動きブロックＸとするとき、前記動きブロックＸが前記基準ブロックと重なった度合いを調べる段階と、重なった画素数が所定個数以上である基準ブロックのＨＢＦ及びＶＢＦをビット別に論理積演算する段階と、前記演算の結果を現ＶＯＰ（Video Object Plane）のブロックＡｃの水平及び垂直ブロッキングフラグにセットすることを特徴とする。

【００１３】前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、現マクロブロックがその動きベクトルの０であるスキップされたマクロブロックであれば、基準マクロブロックのブロッキングフラグを現マクロブロックのブロッキングフラグにセットする段階をさらに具備することが好ましい。

【００１４】前記現インターフレームのブロックＡｃに対する水平及び垂直ブロッキングフラグ抽出は、先ず基準ブロックのブロッキングフラグを複写してパッディングをする段階をさらに具備することが好ましい。

【００１５】映像フレームがインターフレームの場合、現インターフレームのブロックＡｃに対するリンギングフラグ抽出は、インターブロックの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣのＡＣ成分のいずれか一つさえ‘０’でなければ、現ブロックＡｃのリンギングフラグＲＦを‘１’にセットし、前記ＩＱＣのＡＣ成分がいずれも‘０’であれば、ＲＦを‘０’にする段階と、マクロブロックＭＢに対する動きベクトルを伝達する８×８予測モードが現ブロックに使用されると、ＲＦを‘１’にセットする段階とよりなることを特徴とする。

【００１６】前記映像データがインターフレームの場合、前記インターフレームのリンギングフラグは、第１リンギングフラグＲＦ０及び第２リンギングフラグＲＦ１よりなる。現インターフレームのブロックＡｃに対する前記第１リンギングフラグＲＦ０及び第２リンギングフラグＲＦ１の抽出は、インターマクロブロックの８×８ブロックにおいて残差信号の逆量子化係数ＩＱＣのＤＣ成分のみが‘０’でなければ、現ブロックＡｃの第１リンギングフラグＲＦ０を‘１’にセットし、そうでなければＲＦ０を０にする段階と、インターフレームの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣのＡＣ成分のいずれか一つさえ‘０’でなければ、現ブロックＡｃの第２リンギングフラグＲＦ１を‘１’にセットし、そうでなければＲＦ１を‘０’にする段階とよりなる。

【００１７】前記フィルタリング段階のフィルタリング[illegible]ている所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、前記ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であり、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デブロッキングフィルタリングを行わないことを特徴とする。

【００１８】ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩとし、前記ブロックＩと隣接したブロックをブロックＪとするとき、ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、ブロックＩ及びブロックＪのリンギングフラグＲＦ共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、あるいはブロックＩ及びブロックＪのリンギングフラグＲＦの内少なくともいずれか一方がリンギングノイズを減少させる必要有りを示せば、ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ、前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階とよりなることを特徴とする。

【００１９】ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ、前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う

ブロックＪが共にイントラでなく、ブロックＩまたはブロックＪの残差信号のＩＱＣのＤＣ成分が存在し、ブロックＩ及びブロックＪが共にＨＢＦが‘１’であれば、第１フィルタリングを行う段階と、ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩまたはブロックＪの残差信号のＩＱＣのＤＣ成分が存在し、ブロックＩ及びブロックＪの内少なくともいずれか一方のＨＢＦが‘０’を示せば、第２フィルタリングを行う段階と、前記ブロックＩのＲＦがリンギングノイズを減少させる必要有りを示せば、第２フィルタリングを行う段階とよりなることを特徴とする。

【００２０】ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う段階と、ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦの内いずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較し、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う段階と、ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの内少なくともいずれか一方のＲＦＯが１であり、ブロックＩ及びブロックＪのＨＢＦが共に‘１’であれば、第１フィルタリングを行う段階と、ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの内少なくともいずれか一方のＲＦＯが１であり、ブロックＩ及びブロックＪのＨＢＦの内少なくともいずれか一方が‘１’でなければ、第２フィルタリングを行う段階と、前記ブロックＩのＲＦＩが‘０’でなければ、第２フィルタリングを行う段階とよりなることを特徴とする。

【００２１】前記第１フィルタリングは、前記ブロックＩとブロックＪとを仕切るブロック境界線を介在した６個の画素をＡ、Ｂ、Ｃ、Ｄ、Ｅ及びＦとし、前記ブロックＩに隣接する画素Ａ及びＦがブロック境界線から最も遠い画素、前記画素Ｂ及びＤが前記Ａ及びＣ，Ｄ及びＦの中間に位置した画素とするとき、前記６個の画素に対し７－タブ（１，１，１，２，１，１，１）ローパスフィルタリングを行う。

【００２２】前記第２フィルタリングは、前記画素Ｃ及びＤに対しフィルタリングを行うが、前記画素Ｃ及びＤの差の絶対値がＨ．２６３の量子化要素ＱＰより小さければ、ＣはＣ＋（Ｄ－Ｃ）／４に、ＤはＤ＋（Ｄ－Ｃ）／４に置き換えることを特徴とする。

【００２３】前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングは、リンギングフラグがデリンギングフィルタリングが必要有りを示すかどうかを検査し、デリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、そうでなければデリンギングフィルタリングを行わないことを特徴とし、映像データの水平エッジ及び垂直エッジを検出するエッジ検出段階と、リンギングノイズを減少させようとする８×８ブロックに対し２次元信号適応フィルタリングをする信号適応フィルタリング段階とよりなる。

【００２４】前記エッジ検出段階の水平エッジ検出は、画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の右側の画素を画素［ｍ］［ｎ＋１］、左側の画素を画素［ｍ］［ｎ－１］、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ１、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ－１］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞ＱＰ））ｏｒ（Ａ１＞２ＱＰ）ｏｒ（Ａ２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝１となる。前記エッジ検出段階の垂直エッジ検出は、画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の上方の画素を画素［ｍ＋１］［ｎ］、下方の画素を画素［ｍ－１］［ｎ］、前記画素［ｍ］［ｎ］と画素［ｍ＋１］［ｎ］との差をＡ’１、前記画素［ｍ］［ｎ］と画素［ｍ－１］［ｎ］との差をＡ’２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ’１＞ＱＰ）ａｎｄ（Ａ’２＞ＱＰ））ｏｒ（Ａ’１＞２ＱＰ）ｏｒ（Ａ’２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝‘１’となる。前記信号適応フィルタリング段階は、４－コネクティッドフィルターウィンドウ（4-connected filter window）を前記８×８ブロックに対し適用して、前記フィルターウィンドウの中心画素がエッジであればフィルタリングを行わず、前記フィルターウィンドウの中心画素がエッジでなければ加重フィルタリングを行う。

【００２５】前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングの遂

ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デリンギングフィルタリングを行わないことを特徴とする。

【００２６】また前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングの遂行成否は、ブロックＩのリンギングフラグがデリンギングフィルタリングが必要有り示すかどうかを検査し、デリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、そうでなければフィルタリングを行わないことを特徴とする。

【００２７】また前記フィルタリング段階におけるリンギングノイズを減少させるデリンギングフィルタリングの遂行成否は、ブロックＩがイントラブロックであればデリンギングフィルタリングを行う段階と、前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックであれば、デリンギングフィルタリングを行う段階と、前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックでなく、ブロックＩのＲＦＩがデリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、ブロックＩのＲＦＩがデリンギングフィルタリングが必要無しを示せばデリンギングフィルタリングを行わない段階とよりなることを特徴とする。

【００２８】前記デリンギングフィルタリングは、映像データの水平エッジ及び垂直エッジを検出するエッジ検出段階と、リンギングノイズを減少させようとする８×８ブロックに対し２次元信号適応フィルタリングをする信号適応フィルタリング段階とよりなる。前記エッジ検出段階の水平エッジ検出は、画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の右側の画素を画素［ｍ］［ｎ＋１］、左側の画素を画素［ｍ］［ｎ－１］、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ１、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ－１］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞ＱＰ））ｏｒ（Ａ１＞２ＱＰ）ｏｒ（Ａ２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝１となる。前記エッジ検出段階の垂直エッジ検出は、画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の上方の画素を画素［ｍ＋１］＊［ｎ］、下方の画素を画素［ｍ－１］［ｎ］、前記画素［ｍ］［ｎ］と画素［ｍ＋１］［ｎ］との差をＡ’１、前記画素［ｍ］［ｎ］と画素［ｍ－１］［ｎ］との差をＡ’２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ’１＞ＱＰ）ａｎｄ（Ａ’２＞ＱＰ））ｏｒ（Ａ’１＞２ＱＰ）ｏｒ（Ａ’２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［ｍ］［ｎ］＝‘１’となる。前記信号適応フィルタリング段階は、４－コネクティッドフィルターウィンドウを前記８×８ブロックに対し適用して、前記フィルターウィンドウの中心画素がエッジであればフィルタリングを行わず、前記フィルターウィンドウの中心画素がエッジでなければ加重フィルタリングを行う。

【００２９】前記本発明に係るループフィルタリング方法は、映像データをブロックに基づきエンコーディング及びデコーディングする際に、ブロック４つが会うクロスポイントのコーナーで発生するコーナー異常値を低減させるために、逆量子化された前記映像データの８×８ブロックのコーナー異常値を検出する検出段階と、前記検出されたコーナー異常値を補償する補償段階とをさらに具備することを特徴とする。

【００３０】前記検出段階は、前記クロスポイントを中心とした４つの画素を画素Ａ，Ｂ，Ｃ及びＤとし、Ａ，Ｂ，Ｃ，及びＤの各画素値をａ，ｂ，ｃ，ｄとし、平均値Ａｖｅｒａｇｅ＝（ａ＋ｂ＋ｃ＋ｄ＋２）／４とおき、各画素値とＡｖｅｒａｇｅとの差をＨ．２６３の量子化要素ＱＰと比較して、前記差がＱＰより大きければ、コーナー異常値候補画素の個数を累積してコーナー異常値を検出する。

【００３１】前記補償段階は、前記Ａの属するブロックにおいて前記Ａと隣り合う画素をA_1，A_2とし、前記画素Ａと対角線に位置する画素をA_3とし、その画素値を各々a_1，a_2及びa_3とするとき、前記検出段階で検出されたコーナー異常値候補が一つで、該画素がＡであれば、前記ａとa_3との差が３ＱＰ／２より小さければ、コーナー異常値補償は次式

【００３２】

【数３】

$$\text{画素Ａに対する補償値}\ a' = (4a+b+c+2d+4)/9$$

$$\text{画素}A_1\text{に対する補償値}\ a'_1 = (a'+3a_1+2)/4$$

$$\text{画素}A_2\text{に対する補償値}\ a'_2 = (a1+3a_2+2)/4$$

【００３３】のようになり、前記コーナー異常値候補画素数が二つ以上であれば、$(a_3+b_3+c_3+d_3+2)/4$（ここで、b_3，c_3，d_3もa_3と同様の方式で定義される）から最大の差を有する候補が選ばれ、該補償は前記一つの候補の場合でのような方法で行われる。

【００３４】本発明に係る映像データループフィルタリング装置は、映像データをブロックに基づきエンコーディング及びデコーディングする際に発生する量子化効果を低減させるための映像データループフィルタリング装置において、映像データの逆量子化係数の分布及び前フレームと現フレームとの差を示す動きベクトルを用い、映像データのループフィルタリング必要性の可否を示すエッジを検出するエッジ検出部と、前記エッジ検出部で

ータをデブロッキングフィルタリングするデブロッキングフィルターと、前記デブロッキングフィルタリングされたデータの内コーナー異常値を検出して補償するコーナー異常値補償部と、前記フラグ抽出部で抽出されたリンギングフラグを検査して、前記コーナー異常値補償されたデータをデリンギングフィルタリングするデリンギングフィルターとを含むことを特徴とする。

【００３５】前記フラグは、ブロック境界近傍のブロッキングアーチファクトを減少させる必要性の有無を示すブロッキングフラグと、映像エッジ近傍のリンギングノイズを減少させる必要性の有無を示すリンギングフラグとよりなる。

【００３６】

【発明の実施の形態】以下、添付された図面に基づき本発明の望ましい実施形態を詳細に説明する。図１は映像データをブロックに基づき符号化及び復号化する際に発生する量子化効果の低減のための映像データループフィルタリング装置１０の構成を示すブロック図である。前記ループフィルタリング装置１０は、一般の復号化器及び復号化器に結ばれて使用される。本発明に係る前記映像データループフィルタリング装置１０は、フラグ抽出部１００、デブロッキングフィルター１１０、コーナー異常値補償部１２０及びデリンギングフィルター１３０を含んでなる。前記フラグ抽出部１００は、逆量子化された前記映像データの逆量子化係数ＩＱＣの分布及び前フレームと現フレームとの差を示す動きベクトルを用いてフラグを抽出する。

【００３７】前記フラグは、復号化された映像のループフィルタリング必要性の有無を示す情報であって、ブロッキングフラグとリンギングフラグとに類別される。前記ブロッキングフラグは、ブロック境界近傍のブロッキングアーチファクトを減少させる必要性の有無を示し、前記リンギングフラグは映像エッジ近傍のリンギングノイズを減少させる必要性の有無を示す。そして前記ブロッキングフラグは、水平ブロック境界線を基準として隣接したブロックの画素に対するループフィルタリングの成否を示す水平ブロッキングフラグ（Horizontal Blocking Flag：ＨＢＦ）及び垂直ブロック境界線を基準として隣接したブロックの画素に対するループフィルタリングの成否を示す垂直ブロッキングフラグ（Vertical Blocking Flag：ＶＢＦ）よりなる。

【００３８】また、前記フラグ抽出は、イントラフレーム及びインターフレームに対して抽出する。本発明では、前記インターフレームはＰフレーム及びＰＢフレームとする。前記イントラフレームに対するフラグ抽出は、逆量子化された前記映像データの逆量子化係数の分布を利用する。前記インターフレームに対するフラグ抽出は前フレームと現フレームとの差を示す動きベクトルを用いるが、さらなる詳細は後述する。

一次元水平及び垂直ローパスフィルター（ＬＰＦ）を使用して、前記フラグ抽出部１００で抽出されたブロッキングフラグを検査して、映像データをデブロッキングフィルタリングする。前記異常値補償部１２０は、前記デブロッキングフィルター１１０でデブロッキングフィルタリングされたデータの内コーナー異常値を検出して補償する。前記デリンギングフィルター１３０は、二次元信号適応フィルターを用い前記フラグ抽出部１００で抽出されたリンギングフラグを検査して、前記コーナー異常値補償されたデータをデリンギングフィルタリングする。

【００４０】本発明に係る映像データループフィルタリング方法の基本概念は、映像データに関し、空間周波数（spatial frequency）及び時間情報（temporal information）を使用することにより適応的に量子化効果を低減するものである。

【００４１】また、主観的な画質、ＰＳＮＲ（peak signal-to-noise ratio）及び計算の複雑性を考慮している。特に、ソフトウェア及びハードウェアにて前記基本概念を具現する際、計算の複雑性は極めて重要な決定要素となる。８×８ブロックごとにブロッキングアーチファクトとリンギングノイズのフラグを抽出するために、周波数領域と動きベクトルにおける逆量子化係数の分布が調べられる。ブロッキングフラグ及びリンギングフラグを使用することにより、１次元ＬＰＦと２次元ＳＡＦが８×８ブロックごとに適応的に適用される。

【００４２】一方、本発明において用いられるリンギングフラグは２種類の実施形態がある。第１実施形態はリンギングフラグをＲＦ一つに設定するものであり、第２実施形態はリンギングフラグを第１リンギングフラグＲＦ０及び第２リンギングフラグＲＦ１の二つに設定するものである。以下、前記第１実施形態及び第２実施形態を具体的に触れないのは第１実施形態及び第２実施形態が共に共通して適用されることを意味する。そして第１実施形態及び第２実施形態のいずれか一方にのみ該当するものは、これを明示する。

【００４３】まず、前記フラグ抽出部１００におけるブロッキングアーチファクトとリンギングノイズに対するフラグ抽出について説明する。

【００４４】１．ブロッキングアーチファクト及びリンギングノイズ情報

Ｈ．２６３＋における量子化効果を低減するために、二種類のフラグが定義される。第一はブロッキングフラグであり、第二はリンギングフラグである。前記ブロッキング及びリンギングフラグはイントラフレームにおいて８×８ブロックのＤＣＴ領域（domain）から抽出される。またインターフレームのフラグは残差信号（residual signal）及び基準ＶＯＰのフラグから計算される。

逆量子化後のＤＣＴ係数である逆量子化係数（ＩＱＣ）の分布がデコーダ及びエンコーダにおいて調べられる。図２は、Ｈ．２６３＋のブロック図及び逆量子化後のＤＣＴ係数を示すものである。図２の８×８逆量子化されたブロックにおいて、係数Ａ，Ｂ及びＣがブロッキングフラグ及びリンギングフラグを決定するのに使用される。

【００４６】図２に示す８×８ブロックの６４個画素のＤＣＴ係数の内位置Ａ、即ちＤＣ成分の係数のみが‘０’でない値を有するとするとき、前記８×８符号化されたブロックの６４画素は空間領域において同一の値を有する。したがって、ＤＣ成分のみを有するブロックは水平及び垂直ブロッキングアーチファクトをもたらすことがある。この場合、水平ブロッキングフラグ（ＨＢＦ）と垂直ブロックキングフラグ（ＶＢＦ）が共に‘１’にセットされる。

【００４７】８×８逆量子化されたブロックの最上位行を成す８画素の係数の内いずれか一つでも‘０’でない値を有する時、各カラムの８個の画素は空間領域において同一の値を有する。このブロックは垂直ブロッキングアーチファクトをもたらし、これによりＶＢＦは‘１’にセットされる。

【００４８】最左側のカラムを成す８画素の係数の内いずれか一つでも‘０’でない値を有する時、各行の８個の画素は空間領域において同一の値を有する。このブロックは水平ブロッキングアーチファクトをもたらし、これによりＨＢＦは‘１’にセットされる。

【００４９】第１実施形態では、図２に示すＡ，Ｂ及びＣ以外の位置にいずれか一つでも‘０’でない係数値を有する時、リンギングフラグＲＦは‘１’にセットされる。そして第２実施形態では、図２に示すＡ，Ｂ及びＣ以外の位置にいずれか一つでも‘０’でない係数値を有する時、第１リンギングフラグＲＦ０は‘１’にセットされる。

【００５０】一方、これらの高周波係数はブロックが映像エッジを含んでいることを意味する。したがって、このブロックは高周波成分係数の切り捨てにより前記映像エッジ近傍にリンギングノイズを生みだす。前記ＨＢＦ，ＶＢＦ及びＲＦは各ブロックにおいてループフィルタリングをするのに使用される。そして第２実施形態においては、第２リンギングフラグＲＦ１はイントラマクロブロックでは使用されない。

【００５１】１．２　インターマクロブロックに対するフラグ情報の伝播

まず、第１実施形態について説明する。基準フレームでのブロッキングフラグは動きベクトルを使用することにより、次インターマクロブロックに伝播される。また、インターブロックの残差信号はインターブロックのフラグを決定するのに使用される。

ンターフレームへ伝播されることを説明すれば次の通りである。図３は、インターフレームの８×８ブロックＡｃと基準フレームにおける隣接ブロックとの関係を示すものである。ブロッキングフラグの伝播は動きベクトル（ＭＶｘ，ＭＶｙ）により次のように記述される。図３においてＡｒ，Ｂｒ，Ｃｒ及びＤｒは基準フレームのブロックである。Ａｃは現インターフレームにおけるブロックであり、Ｘは前記Ａｃの動きブロックである。前記動きブロックＸは動きベクトル（ＭＶｘ，ＭＶｙ）を使用することにより推定される。まず、前記動きブロックＸと前記基準ブロックとの重なった度合いを調べる。もし、前記動きブロックＸと前記基準ブロックとの重なった領域が２×２画素より広いブロックのみ各々計算に使用すれば、前記現ブロックＡｃのＨＢＦ及びＶＢＦは動き推定されたブロックＸによって重なる基準ブロックのＨＢＦ及びＶＢＦをビット別に論理積（bit-wise ＡＮＤ）演算することにより計算できる。

【００５３】例えば、動きベクトルがＭＶｘ＝５，ＭＶｙ＝３．５の時、動き推定されたブロックＸは４つの基準ブロックＡｒ，Ｂｒ，Ｃｒ及びＤｒと重なることになる。ここで、前記４つの重なった領域はいずれも２×２画素より広い。したがって、現ブロックＡｃのＨＢＦ及びＶＢＦは、図４に示すように、４つの基準ブロックＡｒ，Ｂｒ，Ｃｒ及びＤｒから計算できる。ここで、‘＆’はビット別の論理積演算を表す。

【００５４】次に、インターフレームにおけるリンギングフラグについて説明する。まず、インターフレームの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣを検査して、前記ＩＱＣが‘０’でなければ、基準ブロックＡｃのＲＦを‘１’にセットする。一つのマクロブロック（ＭＢ）に対する４つの動きベクトルを伝達することを８×８予測モード（prediction mode）と呼ぶ。前記８×８予測モードは、概して高周波成分を有する領域に適用される。したがって、前記ブロックが８×８予測モードを有するかを検査して、８×８予測モードを有するブロックのＲＦは‘１’にセットされる。

【００５５】次に、第２実施形態におけるインターマクロブロックに関するフラグ情報の伝播について説明する。基準フレーム（Ｉピクチャーまたはピクチャーまたは改善されたＰＢフレームのＰピクチャー部分）におけるブロッキングフラグは動きベクトルを使用することにより、次インターマクロブロックに伝播される。また、インターブロックの残差信号はインターブロックのフラグを決定するのに使用される。現マクロブロックがスキップされたマクロブロック（ＣＯＤ－１）であれば、基準マクロブロックにおける６個のブロック（Ｙ用４つ、Ｃｂ及びＣｒ用各１つ）のブロッキングフラグは現マクロブロックに複写される。

まず、ブロッキングフラグが基準フレ

れば、前記第１実施形態と同様である。ただし、現ブロックＡｃのＨＢＦ及びＶＢＦを求める際に使用されるＡＮＤ演算は、第１実施形態ではブロックＸと重なった度合いが２×２画素より広いブロックに対して行われたが、第２実施形態では１×１画素より広いブロックに対して行われる。例えば、動きベクトルがＭＶｘ＝５，ＭＶｙ＝３．５の時、動き推定されたブロックＸは４つの基準ブロックＡｒ，Ｂｒ，Ｃｒ及びＤｒと重なることになる。ここで、前記４つの重なった領域はいずれも１×１画素より広い。

【００５７】次に、インターフレームにおけるリンギングフラグについて説明する。まず、インターマクロブロックの８×８ブロックにおける残差信号の逆量子化係数ＩＱＣを検査する。前記ＩＱＣのＤＣ成分のみが‘０’でなく、他の成分はいずれも‘０’である時、Ａｃの第１リンギングフラグＲＦＯは‘１’にセットされる。そして前記ＩＱＣのＡＣ成分の内いずれか一つさえ‘０’でなければ、基準ブロックＡｃのＲＦを‘１’にセットする。８×８予測モードはデリンギングフィルタリングにおいて考慮される。

【００５８】２．フラグを用いた映像データループフィルタリング

デブロッキングフィルター１１０、コーナー異常値補償部１２０及びデリンギングフィルター１３０について具体的に説明する。

【００５９】２．１　ブロッキングアーチファクトの低減のためのデブロッキングフィルター

ブロッキングアーチファクトの低減のための一次元ローパスフィルタリングは水平境界及び垂直境界上のブロッキングフラグにより強く（strongly）若しくは弱く（weakly）行われる。ブロッキングアーチファクトを減らすために、大部分のデブロッキング方法は映像エッジ情報を計算し、前記映像エッジに基づくローパスフィルター（ＬＰＦ）を適応的に適用する。しかし乍ら、本発明に係るデブロッキング方法は、上記で求めたブロッキングフラグを用いるので、多くの計算量を要する映像エッジ検出を必要としない。

【００６０】処理されるべき８×８ブロックと隣接ブロックが図５に示されている。ブロックーＩ（ＢＬＯＣＫ－Ｉ）のＨＢＦとブロックーＪ（ＢＬＯＣＫ－Ｊ）のＨＢＦが共に‘１’にセットされているなら、７－タブ（１，１，１，２，１，１，１）ＬＰＦが図５の水平ブロック境界上の画素Ａ，Ｂ，Ｃ，Ｄ，Ｅ及びＦに適用される。

【００６１】まず、第１実施形態における水平デブロッキングフィルタリングをアルゴリズムにより示せば、次のようである。

【００６２】

【数４】

```
if(BLOCK_I==NOT coded && BLOCK_J NOT coded)No deblocking filter;
if(INTRA frame)  {
  if(RF of BLOCK_I==0 && RF of BLOCK_J==0) {/*No Ringing Noise*/
    if(HBF of BLOCK_I==1 && HBF of BLOCK_J==1)
      strong deblocking filtering;
    else
      weak deblocking filtering;
   }
   else weak deblocking filtering;
  }

if(P or PB_frame) {
 if(RF of BLOCK_I==0){/*No Ringing Noise*/
  if(BLOCK_I==INTRA||BLOCK_J==INTRA)  {
    if(HBF of BLOCK_I ++ 1 && HBF of BLOCK_J==1)
      strong deblocking filtering;
    else
      weak deblocking filtering;
    }
  else{
    if(DC component of residual IQC of BLOCK_I or BLOCK_J exist) {
       if(HBS of BLOCK_I==1 && HBF of BLOCK_J==1)
         strong delbocking filtering;
       else
         weak deblocking filtering;
    }
  }
 }
 else/*Ringing Noise*/
  weak deblocking filtering;
}
```

【００６３】前記アルゴリズムを説明すれば、ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩ（ＢＬＯＣＫ＿Ｉ）とし、前記ブロックＩと隣接したブロックをブロックＪ（ＢＬＯＣＫ＿Ｊ）とする時、前記ブロックＩに関し、現ブロックと逆量子化された以前のブロックとの差が所定の値以下で、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デブロッキングフィルタリングを行わない。

【００６４】ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う。

【００６５】前記ブロックＩ及びブロックＪのリンギングフラグＲＦが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦの少なくともいずれか一方さえブロッキングアーチファクトを減少させる必要無しを示せば、あるいはブロックＩ及びブロックＪのリンギングフラグＲＦの少なくともいずれか一方がリンギングノイズを減少させる必要有りを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較して、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う。

【００６６】一方、垂直ブロック境界線を介在した画素に関しては、前記ＶＢＦを用い前記水平ブロック境界線を介在した画素と同様の方式でフィルタリングをする。そしてブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無

ＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリングを行う。

【００６７】ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一方でもブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較して、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリングを行う。

【００６８】ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪが共にＨＢＦが‘１’であれば第１フィルタリングを行う。ブロックＩのリンギングフラグＲＦがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの少なくともいずれか一方のＨＢＦが‘０’を示せば、第２フィルタリングを行う。前記ブロックＩのＲＦが‘０’でなければ、第２フィルタリングを行う。

【００６９】一方、垂直ブロック境界線を介在した画素に関しては、前記ＶＢＦを用い前記水平ブロック境界線を介在した画素と同様の方式でフィルタリングをする。

【００７０】前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した６個の画素をＡ，Ｂ，Ｃ，Ｄ，Ｅ及びＦとし、前記画素Ｃ及びＤを前記水平ブロック境界線に最も隣接した画素、前記画素Ａ及びＦが水平ブロック境界線から最も遠い画素、前記画素Ｂ及びＤが前記Ａ及びＣ，Ｄ及びＦの中間に位置した画素とするとき、前記第１フィルタリングは前記６個の画素に対し７－タプ（１，１，１，２，１，１，１）ローパスフィルタリングを行う。

【００７１】前記第２フィルタリングは前記画素Ｃ及びＤに対してフィルタリングを行うが、前記画素Ｃ及びＤの差の絶対値がＨ．２６３の量子化要素ＱＰより小さければ、ＣはＣ＋（Ｄ－Ｃ）／４に、ＤはＤ＋（Ｄ－Ｃ）／４に置き換える。

【００７２】次に、第２実施形態における水平デブロッキングフィルタリングをアルゴリズムで示せば、次のようである。

【００７３】

【数５】

```
if(BLOCK_I==NOT coded && BLOCK_J NOT coded) No deblocking filter;
if(INTRA frame) {
 if(RF0 of BLOCK_I==0 && RF0 of BLOCK_J==0) {/*No Ringing Noise*/
   if(HBF of BLOCK_I==1 && HBF of BLOCK_J==1)
     strong deblocking filtering;
   else
     weak deblocking filtering;
   }
   else weak deblocking filtering;
 }
if(P or PB_frame) {
  if(RF1 of BLOCK_I==0) {/*NoRingingNoise*/
    if(BLOCK_I==INTRA||BLOCK_J==INTRA) {
      if(HBF of BLOCK_I ++ I && HBF of BLOCK_J==1)
        strong deblocking filtering;
      else
        weak deblocking filtering;
      }
    else{
      if(RF0 of BLOCK_I==1||RF0 of BLOCK_J==1){
          if(HBS of BLOCK_I==1 && HBF of BLOCK_J==1)
            strong delbocking filtering;
          else
            weak deblocking filtering;
      }
    }
   }
   else/*RingingNoise*/
     weak deblocking filtering;
}
```

【００７４】前記アルゴリズムを説明すれば、ループフィルタリングしようとするフレームを成している所定ブロックをブロックＩ（ＢＬＯＣＫ＿Ｉ）とし、前記ブロックＩと隣接したブロックをブロックＪ（ＢＬＯＣＫ＿Ｊ）とするとき、前記ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下で、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デブロッキングフィルタリングを行わない。

【００７５】イントラフレームの場合、ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩ及びブロックＪの第１リンギングフラグＲＦＯが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリング（strong deblocking filter ing）を行う。

ラグＲＦＯが共にリンギングノイズを減少させる必要無しを示し、ブロックＩのＨＢＦとブロックＪのＨＢＦの少なくともいずれか一方さえブロッキングアーチファクトを減少させる必要無しを示せば、あるいはブロックＩ及びブロックＪのリンギングフラグＲＦＯの少なくともいずれか一方がリンギングノイズを減少させる必要有りを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較して、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリング（weak deblocking filtering）を行う。そして垂直ブロック境界線を介在した画素に関しては、前記ＶＢＦを用い前記水平ブロック境界線を介在した画素と同様の方式でフィルタリングをする。

【００７７】一方、インターフレーム（ＰまたはＰＢフレーム）の場合、ブロッキングアーチファクトを減少させるためのデブロッキングフィルタリングは、ブロックＩの第２リンギングフラグＲＦ１がリンギングノイズを減少させる必要無しを示し、ブロックＩがノントラ符号

とブロックＪのＨＢＦが共にブロッキングアーチファクトを減少させる必要有りを示せば、前記ブロックＩとブロックＪとを仕切る水平ブロック境界線を介在した所定個数の画素値を変化させる第１フィルタリング（strong deblocking filtering）を行う。

【００７８】ブロックＩの第２リンギングフラグＲＦＩがリンギングノイズを減少させる必要無しを示し、ブロックＩがイントラ若しくはブロックＪがイントラであり、ブロックＩのＨＢＦとブロックＪのＨＢＦのいずれか一つさえブロッキングアーチファクトを減少させる必要無しを示せば、水平ブロック境界線を挟んで隣接した二画素の差とＨ．２６３の量子化された要素であるＱＰとを比較して、二画素の差がＱＰより小さければ前記第１フィルタリングより小さい個数の画素値を変化させる第２フィルタリング（weak deblocking filtering）を行う。

【００７９】ブロックＩの第２リンギングフラグＲＦＩがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪの少なくともいずれか一方のＲＦＯが１であることを示し、ブロックＩ及びブロックＪが共にＨＢＦが‘１’であれば、第１フィルタリング（strong deblocking filtering）を行う。

【００８０】ブロックＩの第２リンギングフラグＲＦＩがリンギングノイズを減少させる必要無しを示し、ブロックＩ及びブロックＪが共にイントラでなく、ブロックＩ及びブロックＪのいずれか一方のＲＦＯが１であることを示し、ブロックＩ及びブロックＪの少なくともいずれか一方のＨＢＦが‘０’を示せば、第２フィルタリング（weak deblocking filtering）を行う。ブロックＩのＲＦＩが０でなければ、第２フィルタリング（weak deblockingfiltering）を行う。そして前記第１フィルタリング及び第２フィルタリングは第１実施形態における第１フィルタリングと同様の方法で行う。

【００８１】２．２　コーナー異常値補償部

コーナー異常値の補償はイントラフレームでのみ行われる。前記コーナー異常値は、図６（Ａ）乃至図６（Ｂ）に示すように、８×８ブロックのコーナーポイントにおいて隣り合う画素より格段に大きくか若しくは小さい画素により特徴づけられる。図６（Ａ）において斜線で示された領域が４つのブロックに亘って分布され前記斜線領域の一つ若しくは二つの画素が隣り合うブロックのコーナーポイントに位置する時、コーナーポイントは、図６（Ｂ）に示すように、ＤＣＴ係数の量子化により歪曲されうる。このように歪曲されたコーナーポイントをコーナー異常値と呼ぶ。前記コーナー異常値はデブロッキングフィルター及びフィルターでは除去できない。前記コーナー異常値を減らすために、まずコーナー異常値を検出し、次に、前記検出されたコーナー異常値を補償する。また、図６（Ｂ）はコーナー異常値の検出のための簡単な座標値を記している。ここで、Ａ，Ｂ，Ｃ及びＤは８×８ブロックのコーナーポイントの画素値である。

【００８２】まず、前記コーナー異常値の検出のためのアルゴリズムは次のように表現できる。

【００８３】

【数６】

```
value[0]=A;  value[1]=B;
value[2]=C;  value[3]=D;
Average=(A+B+C+D+2)/4;
Count=0;
for(m=0;m<4;m++)
        if(|value[m]-Average|>QP)
                Count++;        /*候補ポイントの個数*/
```

【００８４】ここで、ＱＰはＨ．２６３の量子化要素（quantization factor）である。

【００８５】前記’Ｃｏｕｎｔ’は、コーナー異常値候補画素の数を記憶する変数である。もし、前記Ｃｏｕｎｔが‘０’であれば、コーナー異常値はない。もしＡのみが図６（Ｂ）において候補ポイントであり、｜Ａ－Ａ$_3$｜が３ＱＰ／２より小さければ、コーナー異常値補償はＡ，Ａ$_1$及びＡ$_2$上において次のように行われる。ここで、Ａ$_1$，Ａ$_2$はＡと隣り合う画素を、Ａ$_3$はＡと対角線に位置する画素を示す。Ａに対して補償された値をＡ’，Ａ$_1$に対して補償された値をＡ’$_1$，Ａ$_2$に対して補償された値をＡ’$_2$とすれば、前記Ａ’，Ａ’$_1$及びＡ’$_2$は以下の数７のように決定される。

【００８６】

$$A' = (4A+B+C+2D+4)/8$$
$$A'_1 = (A'+3A_1+2)/4$$
$$A'_2 = (A'+3A_2+2)/4$$

【００８７】候補ポイントの個数が二つ以上であれば、（Ａ$_3$＋Ｂ$_3$＋Ｃ$_3$＋Ｄ$_3$＋２）／４から最大の差を有する候補が選ばれ、コーナー異常値補償は前記一つの候補の場合でのような方法でそのポイント上において行われる。

【００８８】２．３　リンギングノイズの低減のためのデリンギングフィルター

まず、第１実施形態について説明すれば、次のようである。各ブロックに対しデリンギングフィルターを適用す[illegible]

ロックに適用される。映像の微細部がフィルタリングにより歪曲されることを防止するために、フィルタリング前に簡単なエッジ検出が行われる。図７（Ａ）及び図７（Ｂ）に示すように、エッジ検出及び２次元信号適応フィルタリング（２－Ｄ ＳＡＦ）は‘０’でないリンギングフラグを有する８×８ブロックに適用される。というのは、境界画素はデブロッキングフィルターによりスムーズになるためである。

【００８９】次に、第２実施形態におけるリンギングノイズの低減のためのデリンギングフィルターを説明すれば、次のようである。各ブロックに対しデリンギングフィルターを適用する前に、リンギングフラグ、即ちＲＦ０及びＲＦ１を調べる。まず、リンギングノイズを減少させるデリンギングフィルタリングの遂行成否を判断するアルゴリズムを表現すれば、次のようである。

【００９０】

【数８】

```
if (BLOCK_I==NOT coded)      No deringing filtering;
if (INTRA frame)    {
    if (RF0 of BLOCK_I==1)     deringing filtering;
    else                       No deringing filtering;
}
if (P or PB-frame) {
   if (BLOCK_I==INTRA4V_BLOCK)     deringing filtering;
   else  {
        if(BLOCK_I==INTER4V_BLOCK) deringing filtering;
        else   {
           if(RF1 of BLOCK_I==1)       deringing filtering;
           else                        No deringing filtering;
        }
    }
}
```

【００９１】前記リンギングノイズを低減させるデリンギングフィルタリングの遂行成否アルゴリズムを説明すれば、次のようである。

【００９２】ブロックＩに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下で、前記ブロックＪに関し、現ブロックと逆量子化された前ブロックとの差が所定の値以下であれば、デリンギングフィルタリングを行わない。

【００９３】イントラフレームの場合、リンギングノイズを減少させるフィルタリングの遂行成否はブロックＩのリンギングフラグがデリンギングフィルタリングの必要有りを示しているかを検査して、デリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、そうでなければデリンギングフィルタリングを行わない。

【００９４】次にインターフレームの場合、リンギングノイズを減少させるフィルタリングの遂行成否は以下のように決定される。即ち、ブロックＩがイントラブロックであればデリンギングフィルタリングを行う。前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックであればフィルタリングを行う。前記ブロックＩがイントラブロックでなく、８×８予測モードを使用したブロックでなく、ブロックＩのＲＦＩがデリンギングフィルタリングが必要有りを示せばデリンギングフィルタリングを行い、ブロックＩのＲＦＩがデリンギングフィルタリングが必要無しを示せば（Ａ１＞２ＱＰ）ａｎｄ（Ａ２＞２ＱＰ）を満

【００９５】デリンギングフィルタリングは、エッジ検出と２次元信号適応フィルタリング（２－Ｄ ＳＡＦ）により行われる。映像の微細部がフィルタリングにより歪曲されることを防止するために、フィルタリング前に簡単なエッジ検出が行われる。図７（Ａ）及び図７（Ｂ）に示すように、リンギングノイズを減少させるために、エッジ検出及び２次元信号適応フィルタリング（２－Ｄ ＳＡＦ）は上記した条件が満足される場合、８×８ブロックに適用される。

【００９６】一方、前記デリンギングフィルタリングに対する第１実施形態及び第２実施形態におけるエッジ検出について説明する。映像エッジを見出すために、１次元水平及び垂直傾斜演算子が再構成されたブロックに適用される。エッジ画素を決定するためのしきい値は、Ｈ．２６３の量子化ファクターＱＰから選ばれる。２次元ＳＡＦが８×８画素に適用されるために、エッジ情報は、図７（Ｂ）に示すように、現ブロック内の１０×１０ブロックに対して得られなければならない。

【００９７】水平エッジ検出は、現画素を画素［ｍ］［ｎ］、前記画素［ｍ］［ｎ］の右側の画素を画素［ｍ］［ｎ＋１］、左側の画素を画素［ｍ］［ｎ－１］、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ＋１］との差をＡ１、前記画素［ｍ］［ｎ］と画素［ｍ］［ｎ－１］との差をＡ２、Ｈ．２６３の量子化要素をＱＰとするとき、条件式（（Ａ１＞ＱＰ）ａｎｄ（Ａ２＞Ｑ

＝１となる。また垂直エッジ検出は、現画素を画素［m］［n］、前記画素［m］［n］の上方の画素を画素［m＋1］［n］、下方の画素を画素［m－1］［n］、前記画素［m］［n］と画素［m＋1］［n］との差をA’１、前記画素［m］［n］と画素［m－1］［n］との差をA’２、H．２６３の量子化要素をＱＰとするとき、条件式（（A’１＞ＱＰ）ａｎｄ（A’２＞ＱＰ））ｏｒ（A’１＞２ＱＰ）ｏｒ（A’＊２＞２ＱＰ）を満足すれば、エッジとして検出され、エッジ［m］［n］＝‘１’となる。

```
/*水平エッジ検出*/
A1=|pixel[m][n]-pixel[m][n+1]|;
A2=|pixel[m][n]-pixel[m][n-1]|;
if ( ( (A1>QP) and (A2>QP) ) or (A1>2QP) or (A2>2QP) )
    Edge[m][n]=1;
else{      /*垂直エッジ検出*/
    A1=|pixel[m][n]-pixel[m+1][n]|;
    A2=|pixel[m][n]-pixel[m-1][n]|;
    if ( ( (A1>QP) and (A2>QP) ) or (A1>2QP) or (A2>2QP) ) )
        Edge[m][n]=1;
    }
```

【００９８】以上のエッジマップＥｄｇｅ［m］［n］を画素値ｐｉｘｅｌ［m］［n］から生成するアルゴリズムで表現すれば、次のようである。

【００９９】

【数９】

【０１００】次に、２次元信号適応フィルターＳＡＦを使用したデリンギングフィルタリングについて説明する。前記フィルタリングは映像の微細部の深刻な損失なしにリンギングノイズをスムーズにするためのものである。本発明に係るデリンギングフィルタリングは、エッジマップ（edge map）に従いコンボルーション（convolution）に対する加重ファクター（weighting factor）が可変する簡単なコンボルーション演算である。前記ＳＡＦは、Ｅｄｇｅ［m］［n］を使用することにより復号化されたブロックに適用される。図７（A）は、２次元ＳＡＦに対するカーネル（kernel）を示している。図７（B）におけるフィルターウィンドウの中心点Ａがエッジ画素であれば、２次元フィルタリング演算は行われない（図７（B）の例１）。４－コネクティッドフィルターウィンドウにおいてエッジポイントが含まれていなければ、ローパスフィルタリングが行われる（図７（B）の例２）。もし中心点上に存在しないあるエッジポイントが４－コネクティッドフィルタウィンドウにあれば、エッジ画素を除いた加重フィルタリングが行われる（図７（B）の例３）。加重ファクターが計算の複雑性を考慮して定義され、これによりＳＡＦフィルタリングが、以下の表１に示すように、簡単なシフト及び加算演算によって行われる。

【０１０１】

【表１】

41 42

A	B	C	D	E	ＳＡＦ
0	0	0	0	0	A=(4A+B+C+D+E+4)/8
0	0	0	0	1	A=(4A+B+2C+D+4)/8
0	0	0	1	0	A=(4A+2B+C+D+4)/8
0	0	0	1	1	A=(2A+B+C+2)/4
0	0	1	0	0	A=(4A+B+D+2E+4)/8
0	0	1	0	1	A=(2A+B+D+2)/4
0	0	1	1	0	A=(2A+B+E+2)/4
0	0	1	1	1	A=(A+B+1)/2
0	1	0	0	0	A=(4A+C+2D+E+4)/8
0	1	0	0	1	A=(2A+C+D+2)/4
0	1	0	1	0	A=(2A+C+E+2)/4
0	1	0	1	1	A=(A+C+1)/2
0	1	1	0	0	A=(2A+D+E+2)/4
0	1	1	0	1	A=(A+D+1)/2
0	1	1	1	0	A=(A+E+1)/2
0	1	1	1	1	A=A

但し、‘０’はエッジでないことを示し、‘１’はエッジを示す。

【０１０２】３．ブロッキングフラグのパッディング
第２実施形態ではブロッキングフラグのパッディングを行う。ＱＣＩＦの場合、Ｙのためのブロッキングフラグ Ｂｆ＿Ｙは２２×１８アレイで構成され、Ｃｂのためのブロッキングフラグ Ｂｆ＿Ｃｂ及びＣｒのためのブロッキングフラグ Ｂｆ＿Ｃｒは１１×９アレイで構成される。ここで、各エレメントは各ブロックのノイズ情報を有している。しかし乍ら、非制限動きベクトルモード（Unrestricted Motion Vector mode）が使用されれば、動きベクトルはピクチャーの外側を示すことが認められる。従って、動きベクトルがピクチャーの外側を示すことを認めるために、Ｂｆ＿Ｙ，Ｂｆ＿Ｃｂ及びＢｆ＿Ｃｒパッディングがなされる。Ｂｆ＿Ｙの場合、Ｂｆ＿Ｙを拡張するために、Ｂｆ＿Ｙの最上位行及び最下位行のエレメントは垂直的に複写される。また垂直繰返しパッディングがなされてからは、水平的な繰返しパッディングが最左側及び最右側のカラムのエレメント上において行われる。

【０１０３】最終に、元のＢｆ＿Ｙサイズを Ｍ×Ｎとするとき、パッディングがなされてからはサイズは（Ｍ＋８）×（Ｎ＋８）となる。同じく、Ｂｆ＿Ｃｂ及びＢｆ＿Ｃｒの元のサイズがＭ／２×Ｎ／２であるとすれば、パッディングがなされてからは（Ｍ／２＋４）×（Ｎ／２＋４）となる。

【０１０４】図８は、Ｂｆ＿Ｙパッディングの特徴ブ

るが、その一例として基準フレームのブロッキングフラグを複写することにより行われうる。また前記パッディングはループフィルタリングしようとする新たなフレームが入れば先になされた後、動きベクトルを用いブロッキングフラグを抽出する時に、前記パッディングされたブロッキングフラグを用い該当マクロブロックのブロッキングフラグを求める。

【０１０５】一方、上記した本発明の実施形態はコンピュータにて実行できるプログラムにより作成可能である。そして、コンピュータにおいて用いられる媒体から前記プログラムを動作させる汎用ディジタルコンピューターにおいて具現できる。前記媒体はマグネチック貯蔵媒体（例：ロム、フロッピーディスク、ハードディスク等）、光学的な読み込み媒体（例：ＣＤ－ＲＯＭ，ＤＶＤ等）及びキャリアウェーブ（例：インターネットを介して転送）などの貯蔵媒体を含む。

【０１０６】例えば、前記記録媒体は、映像データのエンコーディング及びデコーディング時に発生する量子化効果の低減のためのループフィルタリング方法において、逆量子化された映像データの逆量子化係数の分布及び前フレームと現フレームとの差を示す動きベクトルを用いて前記映像データのループフィルタリング必要性の可否を示すフラグを抽出するフラグ抽出段階がコンピュータにより行われるコード手段と、前記抽出されたフラ

リングするフィルタリング段階がコンピュータにより行われるプログラムコード手段とを含むことを特徴とする。

【０１０７】そして本発明を具現するための機能的なプログラム、コード及びコードセグメントは本発明の属する技術分野のプログラマーにより容易に推論できる。

【０１０８】

【発明の効果】高圧縮された映像データの復元に際して、ブロッキングアーチファクト、コーナー異常値及びリンギングノイズなどの量子化効果がもたらされる。本発明に係るループフィルタリング方法は、フラグ及び適応フィルターを使用することにより量子化効果の低減を図るものである。各ブロックのブロッキング及びリンギングフラグはループフィルタリングの計算量を減らす上で大きな手助けとなる。現ブロックに対するブロッキング及びリンギングフラグを抽出するには、インターフレームの動きベクトルが使用される。

【０１０９】ビデオコーディングにおいて、高品質の映像及びハードウェア並びにソフトウェアへの具現の容易性のためには、計算の複雑性及びＰＳＮＲが考慮されなければならない。ハードウェアの複雑性の側面から、本発明に係る方法は乗算及び割り算なしに並列処理によって遂行できる。

【０１１０】本発明に係るループフィルタリング方法は、映像の微細部を維持しながら主観的な画質を格段に向上させることから、広範に使用できる。

【図面の簡単な説明】

【図１】　ブロックに基づき映像データをループフィルタリングする時、量子化効果の低減のための映像データループフィルタリング装置の構成を示すブロック図である。

＊【図２】　Ｈ．２６３＋に対する復号化器のブロック図及び前記復号化器の逆量子化部において逆量子化された８×８　ＤＣＴ係数ブロックを示す図である。

【図３】　インターフレームの８×８ブロックＡｃと基準フレームにおける隣接ブロックの関係を示す図である。

【図４】　インターＶＯＰの水平ブロッキングフラグＨＢＦ、垂直ブロッキングフラグＶＢＦ及びリンギングフラグＲＦ抽出を説明するための一例を示す図である。

【図５】　ブロッキングアーチファクトの減少を目的とするデブロッキングフィルターの動作の説明のために、ブロック境界とブロック境界の画素位置とを示す図である。

【図６】　クロスポイントとコーナー異常値とを示す図であって、（Ａ）は、量子化によってコーナー異常値を生成する映像エッジの例を示し、（Ｂ）は、量子化によって発生されたコーナー異常値と、コーナー異常値補償を行うためのコーナーポイントの座標値とを示す。

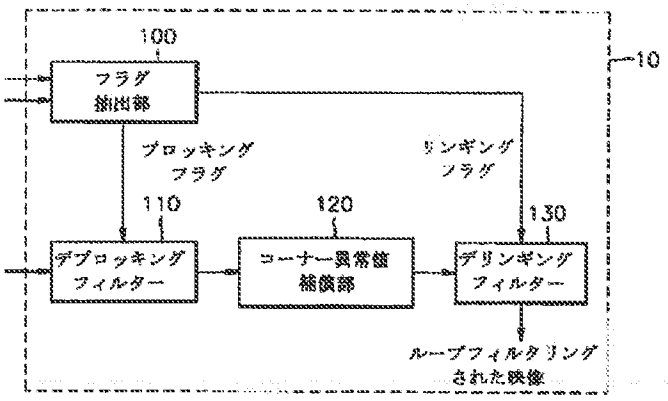
【図７】　（Ａ）は、２次元信号適応フィルターＳＡＦカーネルを示す図であり、（Ｂ）は、エッジ検出のための１０×１０ブロック及びＳＡＦの例を示す図である。

【図８】　Ｂｆ＿Ｙパッディングの結果を示す図である。

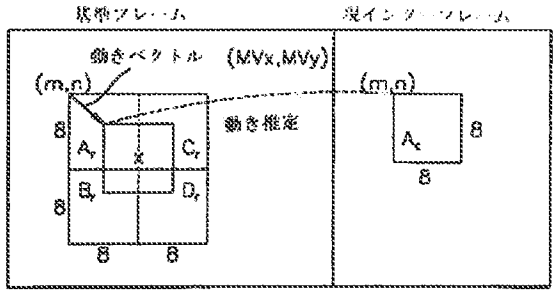
【符号の説明】

１０　映像データ後処理装置
１００　フラグ抽出部
１１０　デブロッキングフィルター
１２０　コーナー異常値補償部
１３０　デリンギングフィルター

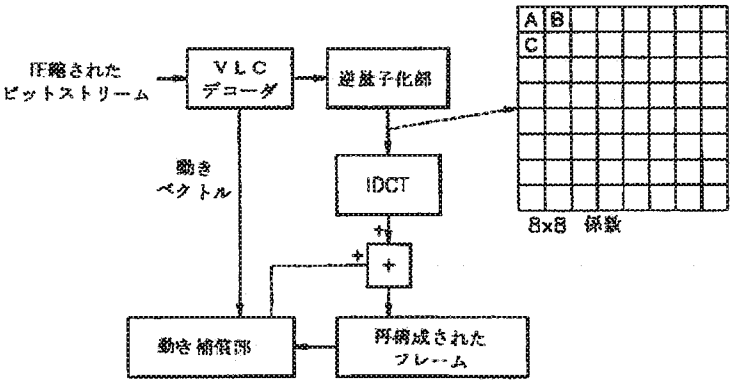
【図１】



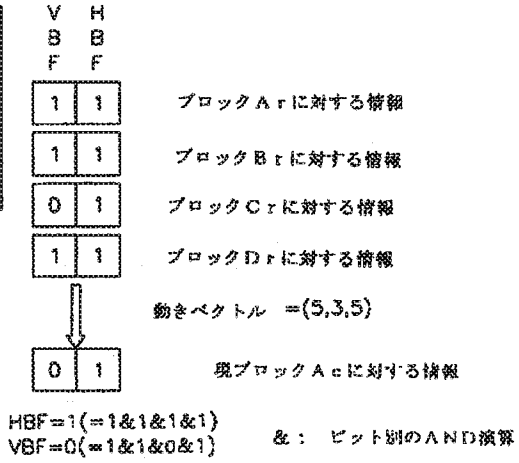
【図３】



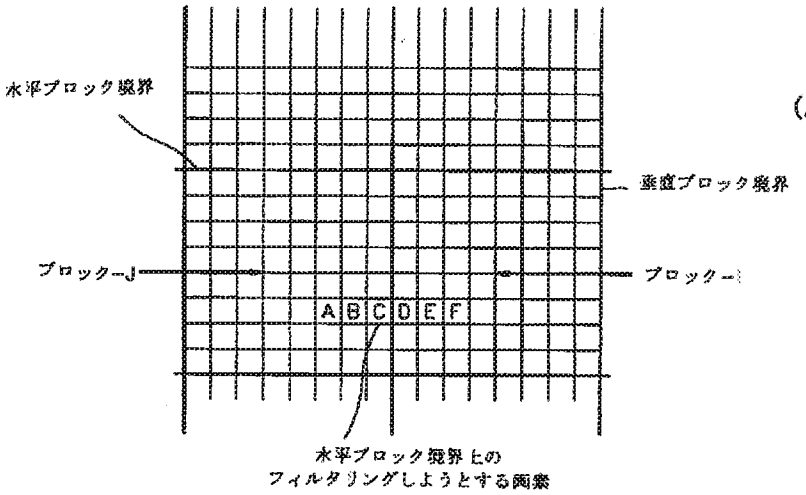
【図2】


圧縮された
ビットストリーム
VLC
デコーダ
逆量子化部
IDCT
動き
ベクトル
動き補償部
再構成された
フレーム
A B
C
8x8 係数

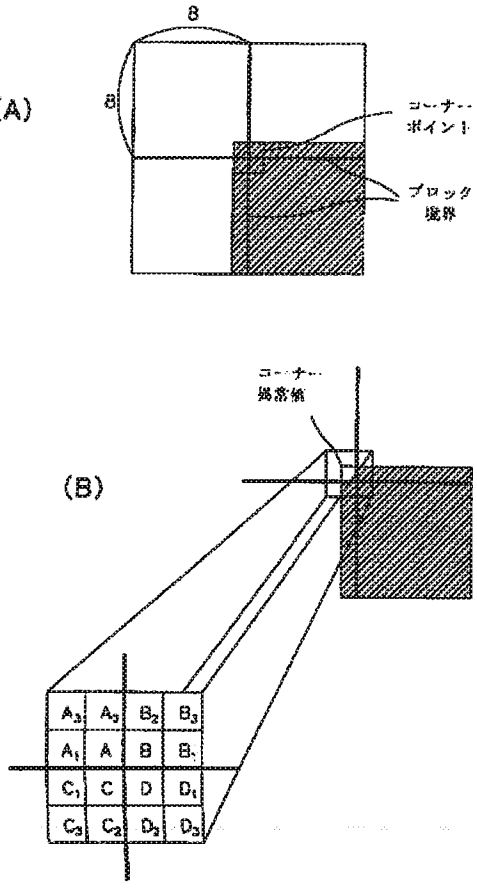
【図4】


V B F
H B F
1 1
ブロックArに対する情報
1 1
ブロックBrに対する情報
0 1
ブロックCrに対する情報
1 1
ブロックDrに対する情報
動きベクトル =(5,3,5)
0 1
現ブロックAcに対する情報
HBF=1(=1&1&1&1)
VBF=0(=1&1&0&1)
&: ビット別のAND演算

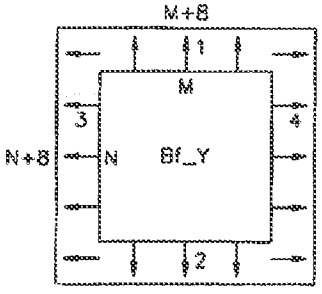
【図5】


水平ブロック境界
垂直ブロック境界
ブロック-J
ブロック-I
A B C D E F
水平ブロック境界上の
フィルタリングしようとする画素

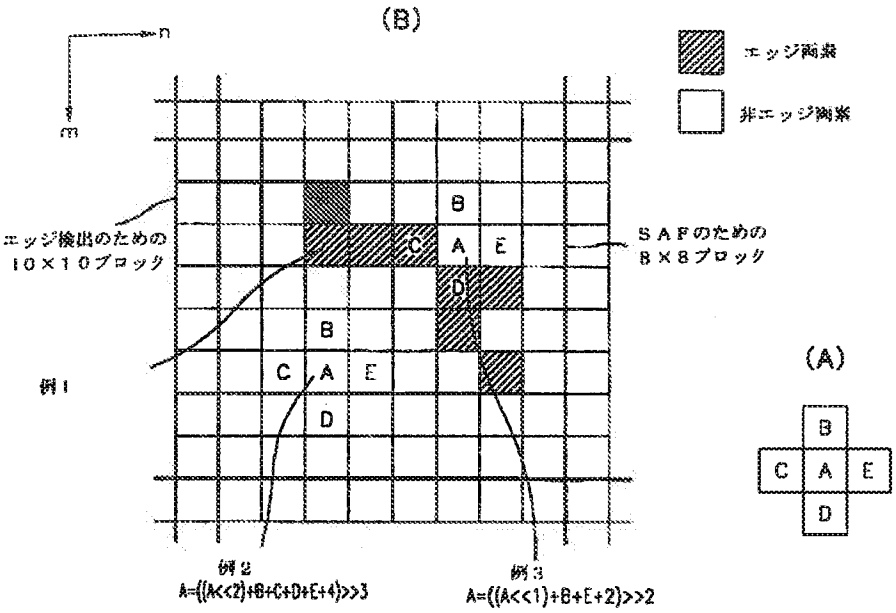
【図6】


(A)
8
8
コーナー
ポイント
ブロック
境界
(B)
コーナー
異常値
A3 A2 B2 B3
A1 A B B1
C1 C D D1
C3 C2 D3 D3

【図8】


M+8
1
M
3
4
N+8
N
Bf_Y
2

【図７】



フロントページの続き

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EXAMINER	
AHMED, SAMIR ANWAR	
ART UNIT	PAPER NUMBER
2665	

NOTIFICATION DATE	DELIVERY MODE
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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):

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Office Action Summary	Application No. 12/312,386	Applicant(s) KAO ET AL.	
	Examiner SAMIR AHMED	Art Unit 2665	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 *10/10/2012*.

☐ 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) _____ 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) *1-30* is/are rejected.

8)☐ Claim(s) _____ 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: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

Drawings

2. Figures 1 and 2 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 101

3. 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.

Claims 1-5, and 11-15 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. Claims 1-5, and 11-15 defines a "an apparatus", that is ineligible because:

the claimed "apparatus is not necessarily hardware,

the specification discloses a "software" embodiment (see page 26, lines 26-28),

the claimed "apparatus" is only directed to and covers only the software embodiment.

Claim Rejections - 35 USC § 112

4. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-5, and 11-15 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 1 is directed to an apparatus with no structure that is implemented by a pure "software" embodiment (see page 26, lines 26-28), the metes and bounds of the claim are not defined.

As to claims 2-5 and 11-15 refer to claim 1 rejection.

6. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

7. Claim 25 is rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 25 recites “wherein enablement information and/or disablement information". For such claims the specification should disclose three independent embodiments. An embodiment disclosing how "enablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element”. A second embodiment disclosing how "disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element”. A third embodiment disclosing how “enablement information and disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element”. There is no three independent embodiments in the specification.

For art rejection “and/or” is interpreted as “or”.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claims 1-24, 26-30 rejected under pre-AIA 35 U.S.C. 102 (b)as being anticipated by Lee et al. (US 2003/0219073).

As to claim 1, Lee discloses, an apparatus, comprising: an encoder encoding an image region, the encoder having at least two filters for successively performing in-loop filtering to respectively reduce at least a first and a second type of quantization artifact (Fig. 1, Abstract, paragraphs [0009], [0031]) , wherein said encoder renders a decision to selectively enable or disable each of the at least two filters at a given level [the in-loop filtering determines whether deblocking filtering is needed and no need for ringing noise filtering (paragraph [0020]) or there is a need for performing ringing filtering (paragraph [0024]), using a blocking flag and a ringing flag (paragraph [0031])], the given level being selected from among each of a macroblock level, a slice level, a picture level, and a sequence level [the in-loop filtering is performed in macroblock level (paragraph [0055])].

As to claim 2, Lee further discloses, wherein at least one of the at least two filters is used to enforce at least one compression constraint [the filters reducing the noise in the blocks according to H.236 quantization factor QP and it is performed when encoding and therefore it is a compression constraint (Fig. 1, Abstract, paragraphs [0009], [0031]), and [0020])].

As to claim 3, Lee further discloses, wherein at least one of the two or more filters is adaptively enabled or disabled depending upon at least one of data characteristics and data statistics corresponding to the image region (Abstract , paragraph [0024], [0028], [0048] and [0118], Figs 7A and 7B).

As to claim 4, Lee further discloses, wherein the two or more filters are comprised in a two-pass filter, the two-pass filter having a deblocking filter for performing a first pass to reduce blocking artifacts as the first type of quantization artifact and a sparse de- noising filter for performing a second pass to reduce noise as the second type of quantization artifact (Abstract , paragraph [0024], [0028], [0048] and [0118], Figs 7A and 7B).

As to claim 5, Lee further discloses, wherein said at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters (Fig.1, Abstract, paragraph [0118]).

Claims 6-10 are the corresponding method claims of claims 1-5. Lee et al teach a method inherent in the apparatus of claims 1-5. Thus Lee et al teach claims 6-10 as evidently explained in the above-cited passages.

Claims 11-15 are the corresponding decoding apparatus claims of claims 1-5. Lee et al teach a decoding apparatus (Fig. 2) and teach the filtering can be applied when decoding (paragraphs [0010], [0029], [0031], [0033]). Thus Lee et al teach claims 11-15 as evidently explained in the above-cited passages.

Claims 16-20 are the corresponding method claims of claims 11-15. Lee et al teach a method inherent in the apparatus of claims 11-15. Thus Lee et al teach claims 16-20 as evidently explained in the above-cited passages.

Claim 21 is a storage media analogous to apparatus claim 1, grounds of rejection analogous to those applied to claim 1 are applicable to claim 21. Lee further discloses storage media (paragraph [0116]).

As to claim 22 refer to claim 2 rejection.

As to claim 23, Lee further discloses, wherein at least one of the at least two filters is used to enforce at least one compression constraint [the filters reducing the noise in the blocks according to H.236 quantization factor QP (Fig. 1, Abstract, paragraphs [0009], [0031]), and [0020])].

As to claim 24 refer to claim 3 rejection.

As to claim 26, Lee further discloses, wherein a total number, a type, and an order of implementation of the at least two filters is dynamically selected [a blocking flag and ringing flag (type of filters) (paragraph [0012]), based on image data analysis it is determined to perform a first filtering to remove blocking artifacts and a second filtering to remove the ringing noise after performing the first filtering (total number and order of implementation) (paragraphs [0020] and [0021]).

As to claim 27-30 refer to claim 26 rejection.

Claim Rejections - 35 USC § 103

10. The following is a quotation of pre-AIA 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.

11. Claim 25 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Lee et al. (US 2003/0219073) as applied to claim 21 above, and further in view of Francois et al (US 2010/0150229).

As to claim 25, Lee discloses enable or disabling the filters at macroblock level (paragraph [0055]). Lee does not specifically disclose wherein enablement information and/or disablement information for at least one of the two filters is signaled using at least one of a high level syntax element and a block level syntax element.

Francois discloses that it is well known to configure the data stream sent by coders to decoders according to a particular syntax comprises fields for example the sequence (high level syntax element) or slice (according to the MPEG standard) level that including filter information (paragraph [0043]). Also, in a coder, the calculation of the filters and the integration of the data of the filters into the stream being made at the level of a layer (paragraph [0044]). The parameters and fields added to the syntax of the bitstream are at sequence level, picture level and slice level that is a continues series of macroblocks (paragraphs [0066]-[0073]. The method standardizing a set of predefined filters at the decoder. Moreover, the filters can be signaled in the syntax as described and stored by the decoder. Hence the decoder at any moment has a set of potential filters, stored in memory and indexed by number. The indices of the filters to use can then be sent to the decoder, specifying what filters it must use, without needing to explicitly send the coefficients of these filters. If at a given moment new filters must be used, they are coded into the syntax with their associated index (paragraph [0083].

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the teachings of Francois to modify the method of Lee by configuring the data stream sent by coders to signal decoders according to a particular syntax comprises fields for example the sequence (high level syntax element) or slice (according to the MPEG standard) level that including filter information in order to standard a set of predefined filters at the decoder. Moreover, the filters can be signaled in the syntax as described and stored by the decoder. Hence the decoder at any moment has a set of potential filters, stored in memory and indexed by number. The indices of the filters to use can then be sent to the decoder, specifying what filters it must use, without needing to explicitly send the coefficients of these filters. If at a given moment new filters must be used, they are coded into the syntax with their associated index (paragraph [0083].

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMIR AHMED whose telephone number is (571)272-7413. The examiner can normally be reached on Mon-Fri 8:30am-6:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bhavesh Mehta can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/SAMIR AHMED/
Primary Examiner, Art Unit 2665

Notice of References Cited	Application/Control No. 12/312,386	Applicant(s)/Patent Under Reexamination KAO ET AL.	
	Examiner SAMIR AHMED	Art Unit 2665	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2010/0150229	06-2010	Francois et al.	375/240.12
*	B	US-2005/0190843	09-2005	Lee, Sung-Kyu	375/240.16
*	C	US-2011/0116549	05-2011	SUN, Shijun	375/240.16
*	D	US-5,541,852	07-1996	Eyuboglu et al.	709/232
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	29	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:19
L2	18	L1 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:20
L3	19	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:20
L4	5	L2 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:20
L5	7	L1 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:20
L6	28	L1 and level	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:20
L7	28	L1 and level	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:21
L8	18	L2 and level	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:21
L9	18	L8 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:21
L10	15761	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2013/12/20 15:21

			IBM_TDB			
L11	6	L10 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:21
L12	6	L10 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:22
L13	6	L10 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:22
L14	2	L13 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:22
L15	7154	L10 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:24
L16	623	L15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:24
L17	28	L6 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:24
L18	7	L17 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:25
L19	11487	quantization with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:26
L20	8468	L19 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:27
L21	19	L20 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2013/12/20 15:27

			DERWENT; IBM_TDB			
L22	6	L21 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:28
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L24	6	L23 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:29
L25	4842	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:30
L26	109	L25 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:33
L27	12	L26 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:34
L28	56775	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 15:57
L29	18	L28 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 15:59
L30	6117	375/240.12.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:17
L31	4	L30 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:18
L32	4	L30 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:19
L33	128	L30 and l28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2013/12/20 16:19

			DERWENT; IBM_TDB			
L34	15	L33 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:20
L35	1534	375/240.27.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:26
L36	1	L35 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:26
L37	19	L35 and l28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:28
L38	0	L37 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:28
L39	4399	G06T5/001.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:29
L40	0	L39 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:29
L41	275	L39 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:30
L42	2	L41 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:31
L43	1286	G06T5/002.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:31
L44	0	L43 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:32
L45	105	L43 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:32
L46	0	L45 and ((macroblock adj1 level) (slice	US-PGPUB;	OR	ON	2013/12/20

		adj1 level) (picture adj1 level) (sequence adj1 level))	USPAT; USOCR			16:32
L47	1485	H04N7/50.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:33
L48	0	L47 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:33
L49	12	L47 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:33
L50	2	L49 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:34
L51	195	H04N7/64.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:35
L52	0	L51 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:35
L53	3	L51 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:35
L54	24	L51 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:37
L55	415	H04N7/26888.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:38
L56	0	L55 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:38
L57	43	L55 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:39
L58	2	L57 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:39
L59	699	H04N7/26244.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:40
L60	0	L59 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2013/12/20 16:40

			IBM_TDB			
L61	28	L59 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:40
L62	3	L61 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:41
L63	214	H04N7/26276.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:41
L64	0	L63 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/20 16:42
L65	3	L63 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:42
L66	10	L63 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2013/12/20 16:43
S1	22	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:14
S2	13	S1 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:17
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S4	1	S2 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:24
S5	2	S1 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:26
S6	22	S1 and level	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:27
S7	13	S2 and level	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:27
S8	13	S7 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT;	OR	ON	2012/07/02 17:28

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S9	11319	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:40
S10	4	S9 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:41
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S12	9	S9 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) and ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:42
S13	1	S10 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:43
S14	1	S12 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:44
S15	5453	S9 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:45
S16	414	S15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2012/07/02 17:45
S17	22	S6 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/07/02 17:46

12/20/2013 4:44:43 PM
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2624

✓	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	02/14/2012	07/02/2012	12/20/2013						
	1	✓	=	✓						
	2	✓	=	✓						
	3	✓	=	✓						
	4	✓	=	✓						
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	26		=	✓						
	27		=	✓						
	28		=	✓						
	29		=	✓						
	30		=	✓						

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12312386
Filing Date	2009-05-07
First Named Inventor	Meng-Ping Kao
Art Unit	2624
Examiner Name	Samir Anwar Ahmed
Attorney Docket Number	PU060222; Customer #24498

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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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
/SA/	1	20030219073	A1	2003-11-27	Y. Lee et al.	(equivalent of JP2000-059769 listed below)

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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]
/SA/	1	2000-059769	JP		2000-02-25	Samsung Electronics Co., Ltd.Korean Advanced Inst.	(equivalent of US 2003/0219073 listed above)	☐

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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]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /SA/

Receipt date: 10/10/2012		
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	12312386 12312386 - GAU: 2665
	Filing Date	2009-05-07
	First Named Inventor	Meng-Ping Kao
	Art Unit	2624
	Examiner Name	Samir Anwar Ahmed
	Attorney Docket Number	PU060222; Customer #24498

/SA/	1	PARK, S.H. ET AL., "Theory of Projection onto the Narrow Quantization Constraint Set and Its Application", IEEE Transactions on Image Processing, October 1999, Vol. 8, No. 10, pp. 1361-1373	☐

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EXAMINER SIGNATURE

Examiner Signature	/Samir Ahmed/	Date Considered	12/28/2013

*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.

Receipt date: 10/10/2012		
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	12312386 12312386 - GAU: 2665
	Filing Date	2009-05-07
	First Named Inventor	Meng-Ping Kao
	Art Unit	2624
	Examiner Name	Samir Anwar Ahmed
	Attorney Docket Number	PU060222; Customer #24498

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	/GUY H. ERIKSEN/	Date (YYYY-MM-DD)	2012-10-10
Name/Print	GUY H. ERIKSEN 609-734-6807	Registration Number	41,736

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:

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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.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /SA/

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2665

CPC- SEARCHED		
Symbol	Date	Examiner
G06T 5/001	12/20/2013	/SA/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
382	232,236,238,251	7/02/2012	/SA/
375	240.02, 240.03, 240.13	7/02/2012	/SA/
382	232, 236, 238, 251	12/20/2013	/SA/
375	240.02; 240.03; 240.12; 240.13	12/20/2013	/SA/

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)- See search history printout	2/14/2012	YG
Updated East search history, see search history printout	7/02/2012	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	12/20/2013	SA
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	12/20/2013	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
382	232	7/02/2012	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
	EAST PGPUB text search see interference search printout	7/02/2012	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

CERTIFICATE OF TRANSMISSION UNDER 37 CFR § 1.8

I hereby certify that this document is being electronically transmitted via the United States Patent and Trademark Office via EFS-Web on June 2, 2014.

Signature: /Gregory S. Weaver, #53,751/
Gregory S. Weaver, Reg. No. 53,751

PU060222-US-PCT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Meng-Ping Kao et al. Serial No.: 12/312,386 Filed: May 7, 2009 For: METHOD AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING	Examiner: Yuzhen Ge Group Art: 2624 Conf. No.: 8783

AMENDMENT

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

Madam:

This is in response to the Office Action dated January 2, 2014, for which a response was due on April 2, 2014. Filed herewith is a Petition with fee for two-month extension, thereby extending the period for reply to June 2, 2014. Accordingly, this response is timely filed.

- **Amendments to the Claims** are listed beginning on page **2** of this paper;
- **Amendments to the Drawings** are listed on page **3** of this paper; and
- **Remarks** begin on page **9** of this paper.

Amendments to the Drawings

FIGS. 1 and 2 have each been amended to include the label "Prior Art". Replacements sheets including the amendments for FIGS. 1 and 2 are being submitted herewith.

Amendments to the Claims

1. (Currently Amended) An apparatus [[,]] comprising:

an encoder that encodes ~~encoding~~ an image region, the encoder including ~~having~~ at least two filters for successively performing in-loop filtering to ~~respectively~~ reduce at least a first and a second type of quantization artifact, respectively, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and a sparse de-noising filter for performing a second pass to reduce noise, wherein the [[said]] encoder renders a decision to selectively enable or disable the sparse de-noising filter ~~each of the at least two filters~~ at a given level, the given level being at least ~~selected from among each of~~ a macroblock level, a slice level, a picture level, or [[and]] a sequence level.

2. (Original) The apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

3. (Currently Amended) The apparatus of claim 1, wherein at least one of the at least two ~~or more~~ filters is adaptively enabled or disabled depending upon at least ~~one of~~ data characteristics corresponding to the image region or [[and]] data statistics corresponding to the image region.

4. (Canceled)

5. (Currently Amended) The apparatus of claim 1, wherein the [[said]] at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

6. (Currently Amended) A method [[,]] comprising:

encoding an image region, wherein the encoding [[step]] includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact ~~respectively~~ using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and a sparse de-noising filter for performing a second pass to reduce noise, wherein the [[said]] encoding includes ~~step comprises~~ rendering a decision to selectively enable or disable the sparse de-noising filter ~~each of the at least two filters~~ at a given level, the given level being at least ~~selected from among each of~~ a macroblock level, a slice level, a picture level, or [[and]] a sequence level.

7. (Previously Presented) The method of claim 6, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

8. (Currently Amended) The method of claim 6, wherein at least one of the at least two ~~or more~~ filters is adaptively enabled or disabled depending upon at least ~~one of~~ data characteristics corresponding to the image region or [[and]] data statistics corresponding to the image region.

9. (Canceled)

10. (Currently Amended) The method of claim 6, wherein the [[said]] at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

11. (Currently Amended) An apparatus [[,]] comprising:

a decoder that decodes ~~decoding~~ an image region, the decoder including ~~having~~ at least two filters for successively performing in-loop filtering to ~~respectively~~ reduce at least a first and a second type of quantization artifact, respectively, the at least two filters including a deblocking

filter for performing a first pass to reduce blocking artifacts and a sparse de-noising filter for performing a second pass to reduce noise, wherein the [[said]] decoder renders a decision to selectively enable or disable the sparse de-noising filter ~~each of the at least two filters~~ at a given level, the given level being at least ~~selected from among each of~~ a macroblock level, a slice level, a picture level, or [[and]] a sequence level.

12. (Previously Presented) The apparatus of claim 11, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

13. (Currently Amended) The apparatus of claim 11, wherein at least one of the at least two ~~or more~~ filters is adaptively enabled or disabled depending upon at least ~~one of~~ data characteristics corresponding to the image region or [[and]] data statistics corresponding to the image region.

14. (Canceled)

15. (Currently Amended) The apparatus of claim 11, wherein the [[said]] at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

16. (Currently Amended) A method [[,]] comprising:

decoding an image region, wherein the decoding [[step]] includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact ~~respectively~~ using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and a sparse de-noising filter for performing a second pass to reduce noise, wherein the [[said]] encoding includes ~~step comprises~~ rendering a decision to selectively enable or disable the sparse de-noising filter ~~each of the at least two filters~~ at a

given level, the given level being at least ~~selected from among each of~~ a macroblock level, a slice level, a picture level, or [[and]] a sequence level.

17. (Previously Presented) The method of claim 16, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

18. (Currently Amended) The method of claim 16, wherein at least one of the at least two ~~or more~~ filters is adaptively enabled or disabled depending upon at least ~~one of~~ data characteristics corresponding to the image region or [[and]] data statistics corresponding to the image region.

19. (Canceled)

20. (Currently Amended) The method of claim 16, wherein the [[said]] at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

21. (Currently Amended) A non-transitory storage media having a computer readable program stored thereon that when executed on a computer causes the computer to perform a method [[steps]] embodied by the program, the method [[steps]] comprising:

encoding an image region field, wherein the encoding [[step]] includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact ~~respectively~~ using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and a sparse de-noising filter for performing a second pass to reduce noise, wherein the [[said]] encoding includes ~~step comprises~~ rendering a decision to selectively enable or disable the sparse de-noising filter ~~each of the at least two filters~~ at a given level, the given level being at least ~~selected from among each of~~ a macroblock level, a slice level, a picture level, or [[and]] a sequence level.

22. (Original) The storage media of claim 21, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

23. (Previously Presented) The storage media of claim 22, wherein the at least one compression constraint involves a quantization constraint set.

24. (Currently Amended) The storage media of claim 21, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least ~~one of~~ data characteristics corresponding to the image region or [[and]] data statistics corresponding to the image region.

25. (Currently Amended) The storage media of claim 21, wherein at least enablement information for the sparse de-noising filter or ~~and/or~~ disablement information for the sparse de-noising filter ~~at least one of the two filters~~ is signaled using at least one of a high level syntax element and a block level syntax element.

26. (Currently Amended) The apparatus of claim 1, wherein a total number, a type, and an order of implementation of the at least two filters are [[is]] dynamically selected.

27. (Currently Amended) The method of claim 6, wherein a total number, a type, and an order of implementation of the at least two filters are [[is]] dynamically selected.

28. (Currently Amended) The apparatus of claim 11, wherein a total number, a type, and an order of implementation of the at least two filters are [[is]] dynamically selected.

29. (Currently Amended) The method of claim 16, wherein a total number, a type, and an order of implementation of the at least two filters are [[is]] dynamically selected.

30. (Currently Amended) The ~~non-transitory~~ storage media of claim 21, wherein a total number, a type, and an order of implementation of the at least two filters are [[is]] dynamically selected.

REMARKS

Claims 1-3, 5-8, 10-13, 15-18, and 20-30 are pending in the application, with claims 4, 7, 9, 14, and 19 having been canceled herein. Reconsideration and further examination are respectfully requested.

The Office Action entered an objection to FIGS. 1 and 2. FIGS. 1 and 2 have each been amended to include the label "Prior Art". Withdrawal of the objections is respectfully requested.

Claims 1-5 and 11-15 were rejected under 35 U.S.C. § 101. The Office Action fails to establish a *prima facie* case for a rejection under § 101 because the rejections provide *only conclusions* without providing the reasoning behind the conclusions. As MPEP § 2106(III) explains, "After USPTO personnel identify and explain in the record the reasons why a claim is for an abstract idea, physical phenomenon, or law of nature with no practical application, then the burden shifts to the applicant to either amend the claim or make a showing of why the claim is eligible for patent protection." (emphasis added)

According to page 2 of the Office Action, claims 1-5 and 11-15 are not statutory because:

1) "the claimed 'apparatus is not necessarily hardware",

2) "the specification discloses a "software" embodiment (see page 26, lines 26-28)", and

3) "the claimed "apparatus" is only directed to and covers only the software embodiment".

Each of 1, 2, and 3 above are merely conclusions. The Office Action does not explain how or why it was concluded that the claimed apparatus is not necessarily hardware. The Office Action does not explain how or why it is relevant that there is a software embodiment disclosed in the specification (the specification also discloses hardware embodiments). The Office Action does not explain how or why it was concluded that the claimed apparatus is only directed to the software embodiment.

To be clear, there is no explanation or rational in the Office Action for why the claimed apparatus is interpreted to cover only the software embodiment.

Accordingly, the rejections are untenable. For at least this reason, Applicants traverse the rejections.

Claims 1-5 and 11-15 were rejected under 35 U.S.C. §112, second paragraph. The rejections are traversed for at least the reason that, like the § 101 rejections, the Office Action

fails to provide any rational for interpreting the claims as "pure software." The rejections state only conclusions. Accordingly, for at least this reason, Applicants traverse the rejections.

Claim 25 was rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to meet the enablement requirement. The rejection is traversed. The rejecion does not provide any proper analysis for enablement. (*See*, MPEP § 2164.01 Test of Enablement) For at least this reason, the rejection fails to provide a valid reason for lack of enablement. The rejection is traversed.

Claims 1-24 and 26-30 were rejected under 35 U.S.C. § 102(b) over U.S. Patent Publication No. 2003/0219073 (Lee). Claim 25 was rejected under 35 U.S.C. § 103(a) over Lee in view of U.S. Patent Publication No. 2010/0150229 (Francois). Reconsideration and withdrawal of the rejections are respectfully requested.

The Office Action asserts that Lee's Abstract, paragraph [0024], [0028], [0048] and [0118], and Figs 7A and 7B anticipate a deblocking filter for performing a first pass to reduce blocking artifacts and *a sparse de-noising filter for performing a second pass* to reduce noise. (*See*, page 8 of the Office Action (rejecting claim 4 under 35 U.S.C. § 102(b))) Applicants disagree. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." (MPEP §2131 (emphasis added)) The cited portions of Lee do not expressly or inherently disclose at least *a sparse de-noising filter for performing a second pass* to reduce noise. While the cited portions of Lee may disclose deringing filtering, Lee does not disclose or suggest *a sparse de-noising filter for performing a second pass* to reduce noise.

Claim 1 has been amended to incorporate subject matter from dependent claim 4, and in particular, amended claim 1 specifies the at least two filters include a deblocking filter for performing a first pass to reduce blocking artifacts and *a sparse de-noising filter for performing a second pass* to reduce noise. Claim 4 has been canceled. This should be viewed as a traversal of the rejection of claim 4 under 35 U.S.C. § 102(b).

Lee's deringing filtering does not disclose or suggest *a sparse de-noising filter for performing a second pass* to reduce noise. The remaining cited reference, namely Francois, fails to cure the deficiency of Lee. Accordingly, for at least this reason, claim 1 is believed to be allowable.

Likewise, claims 6, 11, 16, and 21 have been amended to specify the at least two filters include a deblocking filter for performing a first pass to reduce blocking artifacts and *a sparse de-noising filter for performing a second pass* to reduce noise. Accordingly, for at least this reason, claims 6, 11, 16, and 21 are believed to be allowable.

The remaining claims depend from the independent claims and are believed to be allowable for at least the corresponding reasons above.

In view of the foregoing, it is respectfully submitted that all the claims pending in this patent application are in condition for allowance. Entry of this amendment, reconsideration of the application, and allowance of all the claims are respectfully requested. If the Examiner believes a phone call would advance prosecution, the Examiner is invited to contact Applicants' undersigned representative at the phone number below.

In the event there are any errors with respect to the fees for this response or any other papers related to this response, the Director is hereby given permission to charge any shortages and credit any overcharges of any fees required for this submission to Deposit Account No. 07-0832.

Respectfully submitted,

By: /Gregory S. Weaver, #53,751/
Gregory S. Weaver
Attorney for Applicants
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(818) 480-5064

Patent Operations
Thomson Licensing LLC
P.O. Box 5312
Princeton, New Jersey 08540

June 2, 2014

Replacement Sheet

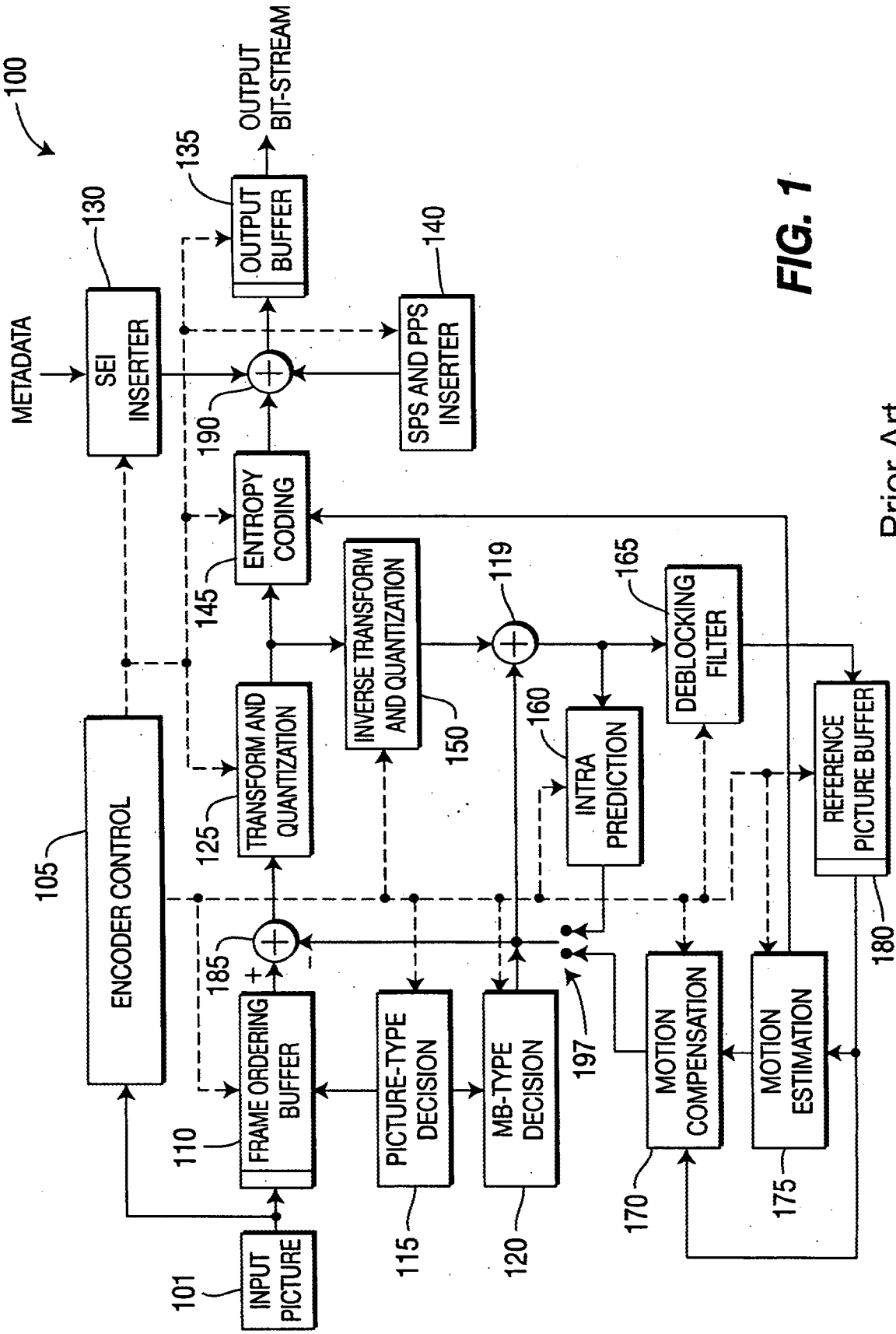


FIG. 1

Prior Art

Replacement Sheet

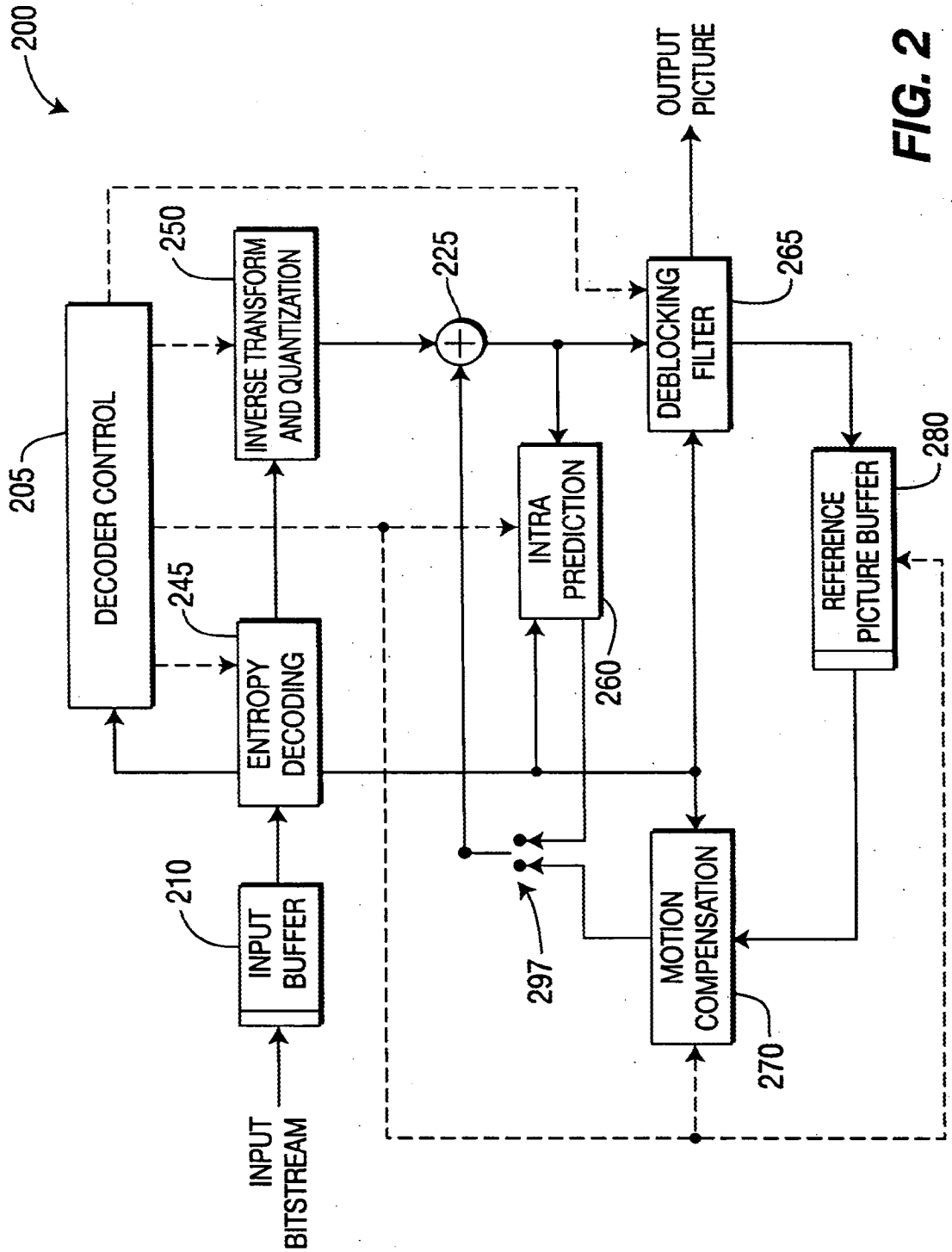


FIG. 2

Prior Art

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Gregory Scott Weaver
Attorney Docket Number:	PU060222

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:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 2 months with $0 paid	1252	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**600**

Electronic Acknowledgement Receipt

EFS ID:	19182341
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Gregory Scott Weaver
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	03-JUN-2014
Filing Date:	07-MAY-2009
Time Stamp:	00:00:47
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	$600
RAM confirmation Number	9317
Deposit Account	070832
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	PU060222_EOT_02JUNE2014.pdf	186920 751b35e9e8ddf79293efacffb7013122d6213afb	no	2
Warnings:					
Information:					
2		PU060222-US-PCT_amendment.pdf	153000 5d376fbf94a40cd24e4709e74afbf54ec3eaa72e	yes	11

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Drawings-only black and white line drawings	2	2
Claims	3	8
Applicant Arguments/Remarks Made in an Amendment	9	11

Warnings:					
Information:					
3	Drawings-only black and white line drawings	figsfile.pdf	307144 61a01c9edd37236038302668af994536caabe2e2	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30566 621ccce6de9ed479ba866b632de0d7f82d45650f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	677630		

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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/22 (03-13)
Approved for use through 3/31/2013. 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.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): PU060222-US-PCT

Application Number: 12/312,386

Filed: May 7, 2009

For: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Art Unit: 2665

Examiner: Samir Anwar Ahmed

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1400
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

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

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 070832.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 53751.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Gregory S. Weaver, #53,751/ — Signature

June 2, 2014 — Date

Gregory S. Weaver — Typed or printed name

818.480.5064 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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/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 12/312,386	Filing Date 05/07/2009	☒ 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 **06/03/2014**

	(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))	* 26	Minus	** 30	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 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
/NICHELE PETERSON/

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.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 07/15/2014

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
2 Independence Way
Suite 200
Princeton, NJ 08540-6620

EXAMINER	
AHMED, SAMIR ANWAR	
ART UNIT	PAPER NUMBER
2665	

NOTIFICATION DATE	DELIVERY MODE
07/15/2014	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):

uspto@technicolor.com
pat.verlangieri@technicolor.com
russell.smith@technicolor.com

Office Action Summary	Application No. 12/312,386	Applicant(s) KAO ET AL.	
	Examiner SAMIR AHMED	Art Unit 2665	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 *06/03/2014*.

☐ 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) _____ 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) *1-3,5-8,10-13,15-18 and 20-30* is/are rejected.

8)☐ Claim(s) _____ 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

1. The present application is being examined under the pre-AIA first to invent provisions.

2. The amendment filed on 06/03/2014 is entered and made of record.

3. The drawings (Fig.1 and Fig.2) filed on 06/03/2014 are accepted by the Examiner.

4. In response to Applicant's amendment filed on 06/03/2014, the rejection of claim 25 under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the enablement requirement is withdrawn.

Response to Arguments

5. Applicant's arguments filed on 06/03/2014 have been fully considered but they are not persuasive for the following reasons:

Applicant alleges, "The Office Action fails to establish a *prima facie* case for a rejection under 35 U.S.C. 101 because……." (Page 9, lines 7-23). The Examiner disagrees. The Examiner has explained the rational for concluding that the claims are patent in-eligible. The specification discloses "It is to be understood that the teachings of the present principles may be implemented in various forms of hardware, software, firmware, special purpose processors, or combinations thereof" (page 26, lines 26-28), which encompasses hardware, software, firmware or combinations thereof embodiments. An apparatus implemented by a pure software embodiment has no structure and is nonstatutory under 35 U.S.C. 101.

Applicant alleges, "Claims 1-5 and 11-15 were rejected under 35 U.S.C. 112, second paragraph……) (page 9, line 28- page10, line 7). The Examiner disagrees. The Examiner has explained the rational for rejecting the claims as being indefinite. The specification as shown above discloses a software embodiment. An apparatus implemented by a pure software embodiment has no structure and has no antecedent basis in the specification simply because the specification does not show how a pure software apparatus has a structure. Hence, the metes and bounds of the claims are not defined and the claims are indefinite.

Claim Rejections - 35 USC § 101

6. 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.

7. Claims 1-3, 5, 11-13 and 15 are rejected under 35 U.S.C. 101 the rejection stated in paragraph 3 of the Office Action mailed on 01/02/2014 is incorporated by reference herein.

Claim Rejections - 35 USC § 112

8. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

9. Claims 1-3, 5, 11-13 and 15 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out

and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. The rejections stated in paragraph 5 of the Office Action mailed on 01/02/2014 are incorporated by reference herein.

Claim Rejections - 35 USC § 103

10. The following is a quotation of pre-AIA 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.

11. Claims 1-3, 5-8, 10-13, 15-18, and 20-30 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 2003/0219073) and Applicant's Admitted prior art (Background Page 3, lines 17-20).

As to claim 1, Lee discloses, an apparatus comprising:

an encoder that encodes an image region, the encoder including at least two filters for successively performing in-loop filtering to reduce at least a first and a second type of quantization artifact, respectively, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and a de-noising filter for performing a second pass to reduce noise [a deblocking filter to reduce blocking artifacts (first pass) and a deranging filter (de-noising filer, second pass) to reduce noise (Fig. 1, Abstract, paragraphs [0009], [0031], [0044])], wherein the encoder renders a decision to selectively enable or disable the de-noising filter at a given level [the in- loop filtering determines whether deblocking filtering is needed and no need for ringing noise

filtering (paragraph [0020]) or there is a need for performing ringing filtering (de-nosing) (paragraph [0024]), using a blocking flag and a ringing flag (paragraphs [0024], [0028],[0031], [0048] and [0118], Figs 7A and 7B)], the given level being at least a macroblock level, a slice level, a picture level, or a sequence level [the in-loop filtering is performed in macroblock level (paragraph [0055])].

Lee discloses an adaptive deringing filter (de-noising filter) (paragraph [0049]) but does not disclose that the de-noising filter is a sparse filter. Applicant's Admitted prior art (Background Page 3, lines 3-5 and 17-20) discloses that at present, it has been observed that sparsity based de-noising techniques, present a higher distortion reduction in terms of objective measures (e.g., mean squared error (MSE)) than other techniques and that sparsity based de-noising tools could reduce quantization noise over video frames that include locally uniform regions (smooth, high frequency, texture, and so forth) separated by singularities. It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the teachings of Applicant's Admitted prior art to modify the apparatus of Lee by using a sparsity based de-noising filter in order to achieve a higher distortion reduction in terms of objective measures (e.g., mean squared error (MSE)) than other filters.

As to claim 2, Lee further discloses, wherein at least one of the at least two filters is used to enforce at least one compression constraint [the filters reducing the noise in the blocks according to H.236 quantization factor QP and it is performed when encoding and therefore it is a compression constraint (Fig. 1, Abstract, paragraphs [0009], [0031]), and [0020])].

As to claim 3, Lee further discloses, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region (Abstract, paragraph [0024], [0028], [0048] and [0118], Figs 7A and 7B).

As to claim 5, Lee further discloses, wherein the at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters (Fig.1, Abstract, paragraph [0118]).

Claims 6-8 and 10 are the corresponding method claims of apparatus claims 1-3 and 5. Lee et al teach a method inherent in the apparatus of claims 1-3 and 5. Thus Lee et al teach claims 6-8 and 10 as evidently explained in the above-cited passages.

Claims 11-13 and 15 are the corresponding decoding apparatus claims of claims 1-3 and 5. Lee et al teaches a decoding apparatus (Fig. 2) and teaches the filtering can be applied when decoding (paragraphs [0010], [0029], [0031], [0033]). Thus Lee et al teach claims 11-13 and 15 as evidently explained in the above-cited passages.

Claims 16-18 and 20 are the corresponding method claims of apparatus claims 11-13 and 15. Lee et al teach a method inherent in the apparatus of claims 11-13 and 15. Thus Lee et al teach claims 16-20 as evidently explained in the above-cited passages.

Claim 21 is a storage media analogous to apparatus claim 1, grounds of rejection analogous to those applied to claim 1 are applicable to claim 21. Lee further discloses storage media (paragraph [0116]).

As to claim 22 refer to claim 2 rejection.

As to claim 23, Lee further discloses, wherein at least one of the at least two filters is used to enforce at least one compression constraint [the filters reducing the noise in the blocks according to H.236 quantization factor QP (Fig. 1, Abstract, paragraphs [0009], [0031]), and [0020])].

As to claim 24 refer to claim 3 rejection.

As to claim 26, Lee further discloses, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected [a blocking flag and ringing flag (type of filters) (paragraph [0012]), based on image data analysis it is determined to perform a first filtering to remove blocking artifacts and a second filtering to remove the ringing noise after performing the first filtering (total number and order of implementation) (paragraphs [0020] and [0021]).

As to claim 27-30 refer to claim 26 rejection.

12. Claim 25 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 2003/0219073) and Applicant's Admitted prior art (Background Page 3, lines 17-20) as applied to claim 21 above, and further in view of Francois et al (US 2010/0150229).

As to claim 25, Lee in view of Applicant's admitted prior art discloses enable or disabling the sparse de-noising filter at macroblock level (paragraph [0055]). Neither

Lee nor Applicant's admitted prior art specifically disclose wherein at least enablement information for the sparse de-noising filter or disablement information for the sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

Francois discloses that it is well known to configure the data stream sent by coders to decoders according to a particular syntax comprises fields for example the sequence (high level syntax element) or slice (according to the MPEG standard) level that including filter information (paragraph [0043]). Also, in a coder, the calculation of the filters and the integration of the data of the filters into the stream being made at the level of a layer (paragraph [0044]). The parameters and fields added to the syntax of the bitstream are at sequence level, picture level and slice level that is a continues series of macroblocks (paragraphs [0066]-[0073]. The method standardizing a set of predefined filters at the decoder. Moreover, the filters can be signaled in the syntax as described and stored by the decoder. Hence the decoder at any moment has a set of potential filters, stored in memory and indexed by number. The indices of the filters to use can then be sent to the decoder, specifying what filters it must use, without needing to explicitly send the coefficients of these filters. If at a given moment new filters must be used, they are coded into the syntax with their associated index (paragraph [0083].

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the teachings of Francois to modify the method of Lee in view of Applicant's admitted prior art by configuring the data stream sent by coders to signal decoders according to a particular syntax comprises fields for example the

sequence (high level syntax element) or slice (according to the MPEG standard) level that including filter information in order to standard a set of predefined filters at the decoder. Moreover, the filters can be signaled in the syntax as described and stored by the decoder. Hence the decoder at any moment has a set of potential filters, stored in memory and indexed by number. The indices of the filters to use can then be sent to the decoder, specifying what filters it must use, without needing to explicitly send the coefficients of these filters. If at a given moment new filters must be used, they are coded into the syntax with their associated index (paragraph [0083].

Conclusion

13. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMIR AHMED whose telephone number is (571)272-7413. The examiner can normally be reached on Mon-Fri 8:30am-6:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bhavesh Mehta can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/SAMIR AHMED/
Primary Examiner, Art Unit 2665

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2624

✓	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	02/14/2012	07/02/2012	12/20/2013	07/10/2014					
	1	✓	=	✓	✓					
	2	✓	=	✓	✓					
	3	✓	=	✓	✓					
	4	✓	=	✓	-					
	5	✓	=	✓	✓					
	6	✓	=	✓	✓					
	7	✓	=	✓	✓					
	8	✓	=	✓	✓					
	9	✓	=	✓	-					
	10	✓	=	✓	✓					
	11	✓	=	✓	✓					
	12	✓	=	✓	✓					
	13	✓	=	✓	✓					
	14	✓	=	✓	-					
	15	✓	=	✓	✓					
	16	✓	=	✓	✓					
	17	✓	=	✓	✓					
	18	✓	=	✓	✓					
	19	✓	=	✓	-					
	20	✓	=	✓	✓					
	21	✓	=	✓	✓					
	22	✓	=	✓	✓					
	23	✓	=	✓	✓					
	24	✓	=	✓	✓					
	25	✓	=	✓	✓					
	26		=	✓	✓					
	27		=	✓	✓					
	28		=	✓	✓					
	29		=	✓	✓					
	30		=	✓	✓					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	31	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:34
L2	19	L1 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:34
L3	20	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:34
L4	5	L2 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:34
L5	8	L1 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:35
L6	30	L1 and level	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:35
L7	19	L2 and level	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:35
L8	19	L7 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:35
L9	17431	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:35
L10	6	L9 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3)	US-PGPUB; USPAT;	OR	ON	2014/07/10 18:35

		same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L11	6	L9 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:36
L12	14	L9 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) and ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:36
L13	2	L10 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:36
L14	2	L12 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:36
L15	7845	L9 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:37
L16	694	L15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:37
L17	30	L6 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:37
L18	31	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:37
L19	19	L18 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:38
L20	20	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" |	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:38

		"5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.				
L21	5	L19 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:39
L22	8	L18 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:39
L23	30	L18 and level	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:40
L24	30	L18 and level	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:41
L25	19	L19 and level	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:41
L26	19	L25 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:41
L27	12231	quantization with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:44
L28	9044	L27 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:45
L29	20	L28 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/07/10 18:45
L30	6	L29 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:46
L31	5058	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:46
L32	115	L31 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:46
L33	13	L32 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2014/07/10 18:47

7/ 10/ 2014 6:48:15 PM
C:\ Users\ sahmed1\ Documents\ EAST\ Workspaces\ 12312386.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2665

CPC- SEARCHED		
Symbol	Date	Examiner
G06T 5/001	12/20/2013	/SA/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
382	232,236,238,251	7/02/2012	/SA/
375	240.02, 240.03, 240.13	7/02/2012	/SA/
382	232, 236, 238, 251	12/20/2013	/SA/
375	240.02; 240.03; 240.12; 240.13	12/20/2013	/SA/

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)- See search history printout	2/14/2012	YG
Updated East search history, see search history printout	7/02/2012	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	12/20/2013	SA
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	12/20/2013	SA
Updated previous East search history, see search history printout	7/10/2014	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
382	232	7/02/2012	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
	EAST PGPUB text search see interference search printout	7/02/2012	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

PTO/SB/31 (07-09)
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NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Docket Number (Optional): PU060222-US-PCT

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)]
on _____

Signature _____

Typed or printed name _____

In re Application of: Meng-Ping Kao, et al.

Application Number	Filed
12/312,386	May 7, 2009

For METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Art Unit	Examiner
2665	Samir Anwar Ahmed

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800

☐ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ _____

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 070832 .

☑ A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest.
See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed.
(Form PTO/SB/96)

☑ attorney or agent of record.
Registration number 53751.

☐ attorney or agent acting under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34. _____

/Gregory S. Weaver, #53,751/
Signature

Gregory S. Weaver
Typed or printed name

818.480.5064
Telephone number

January 15, 2015
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required.
Submit multiple forms if more than one signature is required, see below*.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 41.31. 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, 1.14 and 41.6. 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.**

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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:

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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.

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Applicants request a pre-appeal brief review of the present application under the Pre-Appeal Brief Conference Pilot Program. A Notice of Appeal is filed herewith in response to the final Office Action dated July 15, 2014 ("the final Office Action"), for which a response was due on October 15, 2014. Filed herewith is a Petition with fee for three-month extension, thereby extending the period for reply to January 15, 2015. Accordingly, this response is timely filed.

Applicants contend the rejections in the final Office Action contain clear factual errors. For at least the following reasons, the rejections are improper and should be withdrawn.

Rejections under 35 U.S.C. § 101

Claims 1-3, 5, 11-13, and 15 were rejected under 35 U.S.C. § 101. The rejected claims are directed to apparatuses.

Independent claim 1 recites an apparatus that includes an encoder that encodes an image region. FIG. 3 and corresponding text on pages 11-13 of the specification describe an example apparatus according to claim 1. The example of FIG. 3 clearly describes a real-world apparatus, i.e., tangible structure.[1] Independent claim 11 recites an apparatus that includes a decoder that decodes an image region. FIG. 4 and corresponding text on pages 13-14 of the specification describe an example apparatus according to claim 11. The example of FIG. 4 clearly describes a real-world apparatus, i.e., tangible structure.[2]

Despite the detailed embodiments disclosed in FIGS. 3 and 4, for example, the final Office Action rejects the claims by relying solely on a single sentence at p. 26, lns. 26-28 of the specification, which reads: "It is to be understood that the teachings of the present principles may be implemented in various forms of hardware, software, firmware, special purpose processors, or

[1] *See, e.g.*, p. 11, ln. 13 to p. 13, ln. 8 ("The video encoder 300 includes a frame ordering buffer 310 having an output in signal communication with a non-inverting input of a combiner 385. An output of the combiner 385 is connected in signal communication with a first input of a transformer and quantizer 325. An output of the transformer and quantizer 325 is connected in signal communication with …")(emphasis added).

[2] *See, e.g.*, p. 13, ln. 12 to p. 14, ln. 22 ("The video decoder 400 includes an input buffer 410 having an output connected in signal communication with a first input of the entropy decoder 445. A first output of the entropy decoder 445 is connected in signal communication with a first input of an inverse transformer and inverse quantizer 450. An output of the inverse transformer and inverse quantizer 450 is connected in signal communication with …")(emphasis added).

combinations thereof."[3] (emphasis added) The final Office Action interprets this sentence to include a disclosure of "a pure software embodiment", which "has no structure", and therefore asserts that the claimed apparatuses are pure software with no structure.[4] However, the final Office Action's interpretation of this sentence is clearly erroneous because the interpretation ignores the plain meaning of the word "implemented."

The Merriam-Webster Online Dictionary defines "implement" as:

> "carry out, accomplish; *especially*: to give practical effect to and ensure of actual fulfillment by concrete measures"[5]

Similarly, the Oxford English Online Dictionary defines "implement" as:

> "Put (a decision, plan, agreement, etc.) into effect"[6]

It should be clear from the plain meaning of "implement" that the teachings, disclosed embodiments, etc. of the specification cannot possibly be implemented by an imaginary apparatus, i.e., an apparatus with no structure, such as a pure software embodiment. In fact, an imaginary apparatus cannot implement anything, i.e., cannot give practical effect to and ensure actual fulfillment by concrete measures or put into effect. Therefore, the sentence on page 26 of the specification cannot reasonably be interpreted to disclose a pure software embodiment, much less an "apparatus implemented by a pure software embodiment", as asserted by the final Office Action. The interpretation of this sentence, the resulting interpretation of the claims, and the rejections are based on clear error.

Rejections under 35 U.S.C. § 112, second paragraph

Claims 1-3, 5, 11-13, and 15 were rejected under 35 U.S.C. § 112, second paragraph. The rationale for the rejections is based on the same erroneous interpretation of the sentence on

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[3] *See*, p. 2 of the final Office Action; *see also*, p. 3 of the final Office Action (citing the rejection stated in the Office Action dated January 2, 2014).
[4] Final Office Action, p. 3.
[5] avail. at http://www.merriam-webster.com/dictionary/implement, accessed January 14, 2015 (emphasis in original and added).
[6] avail. at http://www.oxforddictionaries.com/us/definition/american_english/implement?searchDictCode=all, accessed January 14, 2015 (emphasis added).

page 26 of the specification as in the rejections under § 101. For similar reasons as described above, the rejections under § 112, second paragraph are clearly erroneous.

Rejections under 35 U.S.C. § 103(a)

The final Office Action enters new grounds for rejection of claims 1-3, 5-8, 10-13, 15-18, and 20-30 under 35 U.S.C. § 103(a) over a proposed combination of U.S. Patent Publication No. 2003/0219073 (Lee) and alleged admitted prior art (AAPA) in the Background section of the specification at page 3, lines 17-20.[7] The new rejections are clearly erroneous because the AAPA relied on by the rejection specifically teaches away from very combination proposed by the rejection. In fact, the primary point of the AAPA is to explain why one skilled in the art would not consider making such a combination.

The final Office Action acknowledges that "Lee discloses an adaptive deringing filter (de-noising filter) (paragraph [0049]) but does not disclose that the de-noising filter is a sparse filter." To make up for this deficiency in Lee, the final Office Action picks a few lines from the Background section of Applicants' specification and takes the lines out of context. Specifically, the final Office Action describes page 3, lines 17-20 of the specification as disclosing that "it has been observed that sparsity based de-noising techniques, present a higher distortion reduction in terms of objective measures (e.g., mean squared error (MSE)) than other techniques". However, that sentence in the Background section actually reads:

> "At present, it has been observed that sparsity based de-noising techniques, even though they present a higher distortion reduction in terms of objective measures (e.g., mean squared error (MSE)) than other techniques, they may present important visual artifacts that need to be addressed."

In other words, this sentence relied on by the final Office Action is actually pointing out an important problem that teaches away from the proposed combination.

Likewise, the final Office Action describes page 3, lines 3-5 of the specification as disclosing "sparsity based de-noising tools could reduce quantization noise over video frames that include locally uniform regions (smooth, high frequency, texture, and so forth) separated by singularities." However, the final Office Action fails to mention the remainder of the paragraph:

[7] The rejection of claim 25 under 35 U.S.C. § 103(a) also relies on the new, erroneous grounds of rejection.

> "However, the de-noising tool was designed for additive, independent and identically distributed (i.i.d.) noise removal, while quantization noise has significantly different properties, which can present significant issues in terms of proper distortion reduction and visual de-artifacting. This implies that these techniques may get confused by true edges or false blocky edges. … A possible consequence of inadequate threshold selection is that sparse denoising might result into over-smoothed reconstructed pictures, or a blocky artifact(s) may still be present despite the filtering procedure. In particular, for the smooth picture regions, the signal as well as the blocky artifact added to the signal would probably have sparse representation at the filtering stage if the same transform is used for compression and denoising. So a thresholding operation would probably still keep the artifact."

In other words, while the AAPA does mention sparsity-based denoising, it does so for the very purpose of pointing out why one skilled in the art would not consider using sparsity-based denoising as proposed by the combination asserted in the rejections. Ignoring this fundamental teaching-away is clear error in the rejections under § 103(a).

The Finality of the Rejections is Premature, the next Office Action should be Non-Final

Although premature finality is not a basis for appeal, Applicants wish to point out that the finality of the rejections was clearly premature. Applicants believe this is an appropriate issue for consideration because if prosecution is re-opened and a new Office Action is issued, the new Office Action should be non-final.

Finality of the rejections is premature because the final Office Action enters new grounds of rejection not necessitated by Applicants' amendments. Specifically, the Office Action dated January 2, 2014 (the previous Office Action) rejected claim 4 under 35 U.S.C. § 102(a) over Lee. The Office Action took the position that "Lee … discloses … a sparse de-noising filter for performing a second pass to reduce noise … (Abstract , paragraph [0024], [0028], [0048] and [0118], Figs 7A and 78)."[8] Applicants traversed this assertion in the amendment dated June 2, 2014, and amended claim 1 to incorporate this disputed subject matter from dependent claim 4. Applicants specifically pointed out "This should be viewed as a traversal of the rejection of

[8] Office Action dated January 2, 2014, page 6 (emphasis added).

claim 4 under 35 U.S.C. § 102(b). Lee's deringing filtering does not disclose or suggest *a sparse de-noising filter for performing a second pass* to reduce noise."[9]

The final Office Action does not address Applicants' traversal in the Response to Arguments. Rather, in apparent agreement with Applicants' traversal, the final Office Action changes its position and acknowledges "Lee discloses an adaptive deringing filter (de-noising filter) (paragraph [0049]) but does not disclose that the de-noising filter is a sparse filter."[10] Consequently, the final Office Action finds rejection on new grounds, relying on a new reference, the AAPA, and changing the basis of rejection to obviousness under 35 U.S.C. § 103(a) over a combination of Lee and the AAPA. The new grounds of rejection were clearly not necessitated by Applicants' amendment incorporating the disputed subject matter of dependent claim 4 into independent claim 1. Accordingly, finality of the § 103(a) rejections is premature.

If a next Office Action maintains the grounds of rejection or enters other new grounds, the next Office Action should be non-final.

Respectfully submitted,

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Patent Operations
Thomson Licensing LLC
P.O. Box 5312
Princeton, New Jersey 08540

January 15, 2015

[9] Amendment dated June 2, 2014, pages 8-9 (emphasis in original and added).
[10] Final Office Action, page 5 (emphasis added).

Doc Code: AP.PRE.REQ

PTO/SB/33 (07-09)
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PRE-APPEAL BRIEF REQUEST FOR REVIEW

Docket Number (Optional): PU060222-US-PCT

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)]

on January 15, 2015

Signature Gregory S. Weaver, #53,751/

Typed or printed name Gregory S. Weaver

Application Number	Filed
12/312,386	May 7, 2009

First Named Inventor: Meng-Ping Kao

Art Unit	Examiner
2665	Samir Anwar Ahmed

Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request.

This request is being filed with a notice of appeal.

The review is requested for the reason(s) stated on the attached sheet(s).
Note: No more than five (5) pages may be provided.

I am the

- ☐ applicant/inventor.
- ☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)
- ☑ attorney or agent of record. Registration number 53,751.
- ☐ attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 _____

/Gregory S. Weaver, #53,751/
Signature

Gregory S. Weaver
Typed or printed name

818-480-5064
Telephone number

January 15, 2015
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☑ *Total of 1 forms are submitted.

This collection of information is required by 35 U.S.C. 132. 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, 1.14 and 41.6. 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: Mail Stop AF, 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.

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Gregory Scott Weaver
Attorney Docket Number:	PU060222

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:				
Notice of Appeal	1401	1	800	800
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
			Total in USD ($)	**2200**

Electronic Acknowledgement Receipt

EFS ID:	21224743
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Gregory Scott Weaver
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	15-JAN-2015
Filing Date:	07-MAY-2009
Time Stamp:	18:29:34
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	$2200
RAM confirmation Number	4973
Deposit Account	070832
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	PU060222-US-PCT_ExtofTime_15Jan2015.pdf	187218 fa3bb3a35b38c4abe1fac22082580596f0da63fd	no	2
Warnings:					
Information:					
2	Notice of Appeal Filed	PU060222-US-PCT_NoticeofAppeal_15Jan2015.pdf	245479 74e4cb4d8757c94d20e71a3cf5a35180fd803b5f	no	2
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	PU060222-US-PCT_Pre-AppealBriefRequestforReview_15Jan2015.pdf	38577 5ee681ad921820f3fcaf38049773e22a075fcb6c	no	5
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	PU060222-US-PCT_PTOsb0033_Pre-AppealBriefRequestforReview_15Jan2015.pdf	193297 6acb7fd35a1e2976a65157d335cfeedbb5470d2b	no	2
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	32491 112d3632433f6cc93be02495fc715ba2fb1d1470	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	697062		

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/22 (03-13)
Approved for use through 3/31/2013. 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.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): PU060222-US-PCT

Application Number: 12312386

Filed: May 7, 2009

For: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Art Unit: 2665

Examiner: Samir Anwar Ahmed

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1400
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

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

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 070832.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 53751.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Gregory S. Weaver, #53,751/ — Signature

January 15, 2015 — Date

Gregory S. Weaver — Typed or printed name

818.480.5064 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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.**

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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)).
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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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 02/06/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER
AHMED, SAMIR ANWAR

ART UNIT	PAPER NUMBER
2665	

NOTIFICATION DATE	DELIVERY MODE
02/06/2015	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):

uspto@technicolor.com
pat.verlangieri@technicolor.com
russell.smith@technicolor.com

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	12/312,386	KAO ET AL.	
	Examiner	Art Unit	
	SAMIR AHMED	2665	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAMIR AHMED*. (3)_____.

(2) *Gregory Weaver (Reg. #53,751)*. (4)_____.

Date of Interview: *28 January 2015*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☒101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant's representative agreed to amend the claims overcome the rejections outlined in the final rejection..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAMIR AHMED/ Primary Examiner, Art Unit 2665	

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
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 02/09/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER	
AHMED, SAMIR ANWAR	

ART UNIT	PAPER NUMBER
2665	

MAIL DATE	DELIVERY MODE
02/09/2015	PAPER

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 Panel Decision from Pre-Appeal Brief Review	Application No. 12/312,386	Applicant(s) KAO ET AL.
	Examiner SAMIR AHMED	Art Unit 2665

This is in response to the Pre-Appeal Brief Request for Review filed 15 January, 2015.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
☐ The request does not include reasons why a review is appropriate.
☐ A proposed amendment is included with the Pre-Appeal Brief request.
☐ Other: .

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☒ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

☐ The panel has determined the status of the claim(s) is as follows:
Claim(s) allowed: _____.
Claim(s) objected to: _____.
Claim(s) rejected: *1-3,5-8, 10-13, 15-18 and 20-30.* .
Claim(s) withdrawn from consideration: _____.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) *SAMIR AHMED*.	(3) *Stephen R. Koziol* .
(2) *Bhavesh Mehta*.	(4)_____.

/SAMIR AHMED/ Primary Examiner, Art Unit 2665	/BHAVESH MEHTA/ Supervisory Patent Examiner, Art Unit 2665	/Stephen R Koziol/ Supervisory Patent Examiner, Art Unit 2665

PTO/SB/30EFS (07-09)
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.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	12312386	Filing Date	2009-05-07	Docket Number (if applicable)	PU060222	Art Unit	2665
First Named Inventor	Meng-Ping Kao			Examiner Name	Samir Anwar Ahmed		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☒ Other 2-month extension of time

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 070832

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (07-09)
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.

Signature of Registered U.S. Patent Practitioner			
Signature	/Gregory S. Weaver, #53,751/	Date (YYYY-MM-DD)	2015-05-15
Name	Gregory S. Weaver	Registration Number	53751

This collection of information is required by 37 CFR 1.114. 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.

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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 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.

PTO/SB/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): PU060222

Application Number: 12/312,386

Filed: May 7, 2009

For: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

Art Unit: 2665

Examiner: Samir Anwar Ahmed

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 600
☐ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

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

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 07-0832.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 53,751.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Gregory S. Weaver, #53,751/ — Signature

May 15, 2015 — Date

Gregory S. Weaver — Typed or printed name

818.480.5064 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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.

CERTIFICATE OF TRANSMISSION UNDER 37 CFR § 1.8

I hereby certify that this document is being electronically transmitted via the United States Patent and Trademark Office via EFS-Web on May 15, 2015.

Signature: /Gregory S. Weaver, #53,751/
Gregory S. Weaver, Reg. No. 53,751

PU060222-US-PCT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Meng-Ping Kao et al. Serial No.: 12/312,386 Filed: May 7, 2009 For: METHOD AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING	Examiner: Samir Anwar Ahmed Group Art: 2665 Conf. No.: 8783

AMENDMENT
AND
STATEMENT OF SUBSTANCE OF INTERVIEW

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

Madam:

This is in response to the final Office Action dated July 15, 2014, for which a response was due on October 15, 2014. Applicants timely filed a Notice of Appeal with three-month extension on January 15, 2015, which set a due date of March 15, 2015 for filing an appeal brief. Filed herewith is a Petition with fee for two-month extension, thereby extending the period for reply to May 15, 2015. Accordingly, this response is timely filed. A Request for Continued Examination (RCE) is also filed herewith. Further examination based on the amended claims herein is respectfully requested.

- **Amendments to the Claims** are listed beginning on page **2** of this paper;
- **Remarks** begin on page **10** of this paper.

Amendments to the Claims

1. (Currently Amended) An apparatus comprising:

a hardware [[an]] encoder that encodes an image region, the encoder including at least two filters for successively performing in-loop filtering to reduce at least a first and a second type of quantization artifact, respectively, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and [[a]] an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the encoder renders a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

2. (Original) The apparatus of claim 1, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

3. (Previously Presented) The apparatus of claim 1, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

4. (Canceled)

5. (Previously Presented) The apparatus of claim 1, wherein the at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

6. (Currently Amended) A method comprising:

encoding an image region, wherein the encoding includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to

reduce blocking artifacts and [[a]] an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the encoding includes rendering a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

7. (Previously Presented) The method of claim 6, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

8. (Previously Presented) The method of claim 6, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

9. (Canceled)

10. (Previously Presented) The method of claim 6, wherein the at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

11. (Currently Amended) An apparatus comprising:

a hardware decoder that decodes an image region, the decoder including at least two filters for successively performing in-loop filtering to reduce at least a first and a second type of quantization artifact, respectively, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and [[a]] an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the decoder renders a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

12. (Previously Presented) The apparatus of claim 11, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

13. (Previously Presented) The apparatus of claim 11, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

14. (Canceled)

15. (Previously Presented) The apparatus of claim 11, wherein the at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

16. (Currently Amended) A method comprising:

decoding an image region, wherein the decoding includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and [[a]] an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the encoding includes rendering a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

17. (Previously Presented) The method of claim 16, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

18. (Previously Presented) The method of claim 16, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

19. (Canceled)

20. (Previously Presented) The method of claim 16, wherein the at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

21. (Currently Amended) A non-transitory storage media having a computer readable program stored thereon that when executed on a computer causes the computer to perform a method embodied by the program, the method comprising:

encoding an image region field, wherein the encoding includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and [[a]] an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the encoding includes rendering a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

22. (Original) The storage media of claim 21, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

23. (Previously Presented) The storage media of claim 22, wherein the at least one compression constraint involves a quantization constraint set.

24. (Previously Presented) The storage media of claim 21, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

25. (Currently Amended) The storage media of claim 21, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

26. (Previously Presented) The apparatus of claim 1, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

27. (Previously Presented) The method of claim 6, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

28. (Previously Presented) The apparatus of claim 11, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

29. (Previously Presented) The method of claim 16, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

30. (Previously Presented) The storage media of claim 21, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

31. (New) The apparatus of claim 2, wherein the at least one compression constraint involves a quantization constraint set.

32. (New) The apparatus of claim 1, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

33. (New) The method of claim 7, wherein the at least one compression constraint involves a quantization constraint set.

34. (New) The method of claim 6, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

35. (New) The apparatus of claim 12, wherein the at least one compression constraint involves a quantization constraint set.

36. (New) The apparatus of claim 11, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

37. (New) The method of claim 17, wherein the at least one compression constraint involves a quantization constraint set.

38. (New) The method of claim 16, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

39. (New) The storage medium of claim 21, wherein the at least two filters are in-loop filters corresponding to encoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

40. (New) A non-transitory storage media having a computer readable program stored thereon that when executed on a computer causes the computer to perform a method embodied by the program, the method comprising:

decoding an image region, wherein the decoding includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the encoding includes rendering a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least a macroblock level, a slice level, a picture level, or a sequence level.

41. (New) The storage media of claim 40, wherein at least one of the at least two filters is used to enforce at least one compression constraint.

42. (New) The storage media of claim 40, wherein at least one of the at least two filters is adaptively enabled or disabled depending upon at least data characteristics corresponding to the image region or data statistics corresponding to the image region.

43. (New) The storage media of claim 40, wherein the at least two filters are in-loop filters corresponding to decoding the image region, and wherein a version of the image region that is displayed is different from at least one of an output signal corresponding to the image region after the at least two in-loop filters and the initial input signal corresponding to the image region before the at least two in-loop filters.

44. (New) The storage media of claim 40, wherein a total number, a type, and an order of implementation of the at least two filters are dynamically selected.

45. (New) The storage media of claim 41, wherein the at least one compression constraint involves a quantization constraint set.

46. (New) The storage media of claim 40, wherein at least enablement information for the adaptive sparse de-noising filter or disablement information for the adaptive sparse de-noising filter is signaled using at least one of a high level syntax element and a block level syntax element.

REMARKS

Claims 1-3, 5-8, 10-13, 15-18, and 20-46 are pending in the application, with claims 31-46 having been newly added herein. Reconsideration and further examination are respectfully requested.

Statement of substance of interview

Applicants wish to thank the Examiner for contacting Applicants' undersigned representative on January 28, 2015 to discuss possible amendments. During the interview, the Examiner tentatively agreed that amendments along the lines presented above would overcome the rejections.

The rejections

Claims 1-3, 5, 11-13, and 15 were rejected under 35 U.S.C. § 101 and under 35 U.S.C. §112, second paragraph. Claims 1-3, 5-8, 10-13, 15-18, and 20-30 were rejected under 35 U.S.C. § 103(a) over U.S. Patent Publication No. 2003/0219073 (Lee) in view of allegedly admitted prior art. Claim 25 was rejected under 35 U.S.C. § 103(a) over Lee in view of U.S. Patent Publication No. 2010/0150229 (Francois) and allegedly admitted prior art. As discussed above, the amendments to the claims are believed to obviate the rejections. Reconsideration and withdrawal of the rejections are respectfully requested.

New claims

The foregoing amendments include new claims 31-46. Each of the new claims includes features that correspond to the features of an amended claim or a previously presented claim. The following is a list of the new claims and the amended claim or previously presented claims with corresponding features, for the Examiner's convenience:

- new apparatus claims 31 and 32 -- previously presented storage media claim 23 and amended storage media claim 25

- new method claims 33 and 34 -- previously presented storage media claim 23 and amended storage media claim 25

- new apparatus claims 35 and 36 -- previously presented storage media claim 23 and amended storage media claim 25

- new method claims 37 and 38 -- previously presented storage media claim 23 and amended storage media claim 25

- new storage media claim 39 -- previously presented method claim 10

- new storage media claims 40 and 44 -- amended method claim 16 and previously presented method claims 17, 18, 20, and 29

- new storage media claims 45 and 46 -- previously presented storage media claim 23 and amended storage media claim 25

The new claims are believed to be allowable for at least the same reasons as the amended and previously presented claims.

Conclusion

In view of the foregoing, it is respectfully submitted that all the claims pending in this patent application are in condition for allowance. Entry of this amendment, reconsideration of the application, and allowance of all the claims are respectfully requested. If the Examiner believes a phone call would advance prosecution, the Examiner is invited to contact Applicants' undersigned representative at the phone number below.

In the event there are any errors with respect to the fees for this response or any other papers related to this response, the Director is hereby given permission to charge any shortages and credit any overcharges of any fees required for this submission to Deposit Account No. 07-0832.

Respectfully submitted,

By: /Gregory S. Weaver, #53,751/
Gregory S. Weaver
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Reg. No. 53,751
(818) 480-5064

Patent Operations
Thomson Licensing LLC
P.O. Box 5312
Princeton, New Jersey 08540

May 15, 2015

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Gregory Scott Weaver
Attorney Docket Number:	PU060222

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:				
Claims in excess of 20	1615	12	80	960
Independent claims in excess of 3	1614	1	420	420
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 2 months with $0 paid	1252	1	600	600
Miscellaneous:				
RCE- 2nd and Subsequent Request	1820	1	1700	1700
		Total in USD ($)		**3680**

Electronic Acknowledgement Receipt

EFS ID:	22364999
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Gregory Scott Weaver
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	15-MAY-2015
Filing Date:	07-MAY-2009
Time Stamp:	18:36:04
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	$3680
RAM confirmation Number	5050
Deposit Account	070832
Authorized User	WEAVER, GREG

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	PU060222_RCE_15MAY2015.pdf	697638 9c3c1b5e0c8617c1238d49700bbb5c32e4dc8e14	no	3
Warnings:					
Information:					
2	Extension of Time	PU060222_ExtofTime_15MAY2015.pdf	187197 6fb72191f6167688c49be56b37a6ab480a654077	no	2
Warnings:					
Information:					
3		PU060222-US-PCT_Amendment_15MAY2015.pdf	57708 1df42de78f6a29884b25927f5c1c1166135b8dfa	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment Submitted/Entered with Filing of CPA/RCE	1	1
	Claims	2	9
	Applicant Arguments/Remarks Made in an Amendment	10	12

Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	35954 68648d734bb38450888ef97ca199b069fdff6e23	no	2
Warnings:					
Information:					
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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/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/312,386	Filing Date 05/07/2009	☐ 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 **05/15/2015**

	(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))	* 42	Minus	** 30	= 12	X $80 =	960
Independent (37 CFR 1.16(h))	* 6	Minus	***5	= 1	X $420 =	420
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	1380

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
/KIMBERLY PANNELL/

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.

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

24498 7590 05/22/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER
AHMED, SAMIR ANWAR

ART UNIT	PAPER NUMBER
2665	

DATE MAILED: 05/22/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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	08/24/2015

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)

24498 7590 05/22/2015
Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

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.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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	08/24/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
AHMED, SAMIR ANWAR	2665	382-232000

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
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 05/22/2015

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4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER	
AHMED, SAMIR ANWAR	

ART UNIT	PAPER NUMBER
2665	

DATE MAILED: 05/22/2015

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. 12/312,386	Applicant(s) KAO ET AL.	
	Examiner SAMIR AHMED	Art Unit 2665	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 *RCE filed 5/15/2015*.
   ☐ 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 *1-3,5-8,10-13,15-18 and 20-46 (now renumbered 1-42 for issue)*. 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 _____
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 _____.

/SAMIR AHMED/
Primary Examiner, Art Unit 2665

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

CPC

Symbol				Type	Version
H04N		19	/ 86	F	2014-11-01
H04N		19	/ 159	I	2014-11-01
H04N		19	/ 176	I	2014-11-01
H04N		19	/ 70	I	2014-11-01
H04N		19	/ 46	I	2014-11-01
H04N		19	/ 61	I	2014-11-01
H04N		19	/ 117	I	2014-11-01
H04N		19	/ 126	I	2014-11-01
H04N		19	/ 154	I	2014-11-01
H04N		19	/ 174	I	2014-11-01
H04N		19	/ 44	I	2014-11-01
H04N		19	/ 82	I	2014-11-01
			/		
			/		
			/		

CPC Combination Sets

Symbol				Type	Set	Ranking	Version
			/				
			/				

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 42	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665 (Primary Examiner)	05/18/2015 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 6

U.S. Patent and Trademark Office

Part of Paper No. 20150518

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
382	232	G 0 6 K 9 / 36 (2006.01.01)	

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
382	251				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	42	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665	05/18/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

☐ 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	1	14	17	29	33										
2	2	15	18	30	34										
3	3	----	19	31	35										
----	4	16	20	32	36										
4	5	17	21	33	37										
5	6	18	22	34	38										
6	7	19	23	35	39										
7	8	20	24	36	40										
----	9	21	25	37	41										
8	10	22	26	38	42										
9	11	23	27	39	43										
10	12	24	28	40	44										
11	13	25	29	41	45										
----	14	26	30	42	46										
12	15	27	31												
13	16	28	32												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 42	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665 (Primary Examiner)	05/18/2015 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 6

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2624

✓	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	02/14/2012	07/02/2012	12/20/2013	07/10/2014	05/18/2015				
1	1	✓	=	✓	✓	=				
2	2	✓	=	✓	✓	=				
3	3	✓	=	✓	✓	=				
----	4	✓	=	✓	-	-				
4	5	✓	=	✓	✓	=				
5	6	✓	=	✓	✓	=				
6	7	✓	=	✓	✓	=				
7	8	✓	=	✓	✓	=				
----	9	✓	=	✓	-	-				
8	10	✓	=	✓	✓	=				
9	11	✓	=	✓	✓	=				
10	12	✓	=	✓	✓	=				
11	13	✓	=	✓	✓	=				
----	14	✓	=	✓	-	-				
12	15	✓	=	✓	✓	=				
13	16	✓	=	✓	✓	=				
14	17	✓	=	✓	✓	=				
15	18	✓	=	✓	✓	=				
----	19	✓	=	✓	-	-				
16	20	✓	=	✓	✓	=				
17	21	✓	=	✓	✓	=				
18	22	✓	=	✓	✓	=				
19	23	✓	=	✓	✓	=				
20	24	✓	=	✓	✓	=				
21	25	✓	=	✓	✓	=				
22	26		=	✓	✓	=				
23	27		=	✓	✓	=				
24	28		=	✓	✓	=				
25	29		=	✓	✓	=				
26	30		=	✓	✓	=				
27	31					=				
28	32					=				
29	33					=				
30	34					=				
31	35					=				
32	36					=				

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2624

✓	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	02/14/2012	07/02/2012	12/20/2013	07/10/2014	05/18/2015				
33	37					=				
34	38					=				
35	39					=				
36	40					=				
37	41					=				
38	42					=				
39	43					=				
40	44					=				
41	45					=				
42	46					=				

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	(encod$3 and image and region and two and filters and successiv$3 and in-loop and filtering and reduce and quantization and artifacts and deblocking and filter and blocking and artifacts and adaptive and sparse and de-noising and filter and level and macroblock and slice and picture and sequence).CLM.	USPAT; UPAD	OR	ON	2015/05/18 17:42

5/18/2015 5:43:10 PM

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2665

CPC- SEARCHED		
Symbol	Date	Examiner
G06T 5/001	12/20/2013	/SA/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
382	232,236,238,251	7/02/2012	/SA/
375	240.02, 240.03, 240.13	7/02/2012	/SA/
382	232, 236, 238, 251	12/20/2013	/SA/
375	240.02; 240.03; 240.12; 240.13	12/20/2013	/SA/
382	232, 236, 238, 251	5/18/2015	/SA/
375	240.02; 240.03, 240.13	5/18/2015	/SA/

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)-See search history printout	2/14/2012	YG
Updated East search history, see search history printout	7/02/2012	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	12/20/2013	SA
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	12/20/2013	SA
Updated previous East search history, see search history printout	7/10/2014	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	5/18/2015	SA
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	5/18/2015	SA
Updated previous East search history, see search history printout	5/18/2015	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
382	232	7/02/2012	SA
	EAST PGPUB text search see interference search printout	7/02/2012	SA
	EAST PGPUB text search see interference search printout	5/18/2015	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	5348	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:11
L2	137	L1 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:12
L3	137	L1 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:13
L4	16	L3 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:13
L5	92700	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:14
L6	63947	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:15
L7	28	L6 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:15
L8	8164	375/240.12.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:17
L9	5	L8 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2015/05/18 17:18

			IBM_TDB			
L10	2034	375/240.27.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:18
L11	21	L10 and L6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:18
L12	1952	G06T5/001.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:20
L13	611	G06T5/001.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:21
L14	0	L13 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:21
L15	44	L13 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:21
L16	0	L15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:21
L17	0	L15 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:22
L18	4261	G06T5/002.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:22
L19	378	L18 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:22
L20	0	L19 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:23
L21	306	H04N7/50.cpc.	US-PGPUB; USPAT;	OR	ON	2015/05/18 17:23

			USOCR			
L22	3	L21 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:24
L23	129	H04N7/64.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:24
L24	5	H04N7/64.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:25
L25	0	L24 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:25
L26	1	L24 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:25
L27	320	H04N7/26888.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:26
L28	19	H04N7/26888.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:26
L29	0	L28 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:26
L30	0	L29 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:27
L32	973	H04N7/26244.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:27
L33	3	L31 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:28
L34	3	L31 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT;	OR	ON	2015/05/18 17:28

			USOCR			
L35	0	L34 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:28
L36	209	H04N7/26276.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:29
L37	6	H04N7/26276.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:29
L38	0	L37 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:29
L39	0	L37 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:29
L40	39	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:30
L41	27	L40 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:31
L42	20	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:31
L43	11	L41 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:31
L44	14	L40 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:32
L45	39	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2015/05/18 17:32

			JPO; DERWENT; IBM_TDB			
L46	38	L45 and level	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:32
L47	27	L45 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:33
L48	27	L47 and level	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:33
L49	20086	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:33
L50	12	L49 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:33
L51	13430	quantization with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:34
L52	9976	L51 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:34
L53	27	L52 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/05/18 17:34
L54	12	L53 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:34
L55	5348	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:35
L56	137	L55 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:35
L57	16	L56 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/05/18 17:35

5/ 18/ 2015 5:36:32 PM
C:\ Users\ sahmed1\ Documents\ EAST\ Workspaces\ 12312386.wsp

PTO/SB/30EFS (07-09)
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	12312386	Filing Date	2006-11-08	Docket Number (if applicable)	PU060222	Art Unit	2665
First Named Inventor	Meng-Ping KAO			Examiner Name	Ahmed, Samir Anwar		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 070832

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (07-09)
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Signature of Registered U.S. Patent Practitioner			
Signature	/Gregory S. Weaver, #53,751/	Date (YYYY-MM-DD)	2015-08-24
Name	Gregory S. Weaver	Registration Number	53751

This collection of information is required by 37 CFR 1.114. 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.

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 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.

PTO/SB/08a (01-10)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12312386
Filing Date	2006-11-08
First Named Inventor	Meng-Ping KAO
Art Unit	2665
Examiner Name	AHMED, SAMIR ANWAR
Attorney Docket Number	PU060222-US-PCT

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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
	1					

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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
	1	20130077693		2013-03-28	DOLBY LABS LICENSING CORP.	EQCN1663258
	2	20120213276		2012-08-23	HAGAI ET AL.	EQJP2003179933

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
	1	CN1663258	CN		2005-08-30	DOLBY LABS LICENSING CORP.	US20130077693	☐
	2	JP2003179933	JP		2003-06-27	MATSUSHITA ELECTRIC IND CO LTD.	US20120213276	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12312386
	Filing Date	2006-11-08
	First Named Inventor	Meng-Ping KAO
	Art Unit	2665
	Examiner Name	AHMED, SAMIR ANWAR
	Attorney Docket Number	PU060222-US-PCT

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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]
	1		☐
If you wish to add additional non-patent literature document citation information please click the Add button			Add

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	12312386
	Filing Date	2006-11-08
	First Named Inventor	Meng-Ping KAO
	Art Unit	2665
	Examiner Name	AHMED, SAMIR ANWAR
	Attorney Docket Number	PU060222-US-PCT

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	/Gregory S. Weaver, #53,751/	Date (YYYY-MM-DD)	2015-08-24
Name/Print	Gregory S. Weaver	Registration Number	53,751

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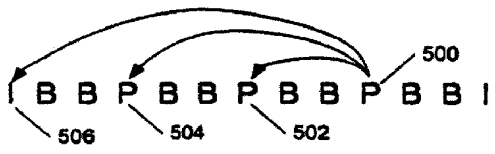
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权利要求书 3 页 说明书 35 页 附图 15 页

[54] 发明名称 改进的视频压缩帧插值

[57] 摘要

一种用于在视频图像压缩系统中改进一个或多个预测帧的图像质量的方法、系统和计算机程序，其中每个帧包括多个像素。 某些类型的帧的宏块图像区域在某些情况下可以参考一个或多个可参考帧来编码，而在其他情况下可以参考两个或多个可参考帧来编码。 这种编码可能包括插值，例如不相等加权的插值。 图像区域的 DC 值或 AC 像素值也可以在加权或未加权的情况下进行插值。 具有可变数量的双向预测帧的这类帧的编码模式可以动态地确定。 可以以不同于显示顺序的传送顺序把帧从编码器传送到解码器。 在运动向量补偿预测的过程中，可以把锐化和/或柔化滤波器应用于某些帧的图像区域。



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1. 一种用于视频图像压缩的方法，所述方法包括：

提供一个包括图像区域的帧序列，所述帧包括预测帧和可参考帧；和

通过参考所述序列中的两个或多个前面的可参考帧对至少一个预测帧的一个图像区域进行编码。

2. 根据权利要求 1 所述的方法，其中所述的至少一个预测帧包括一个可参考帧。

3. 根据权利要求 1 所述的方法，其中所述可参考帧包括预测帧和内部帧。

4. 根据权利要求 1 所述的方法，其中所述预测帧包括可参考预测帧和双向预测帧。

5. 根据权利要求 4 所述的方法，其中所述至少一个预测帧包括一个双向预测帧。

6. 根据权利要求 5 所述的方法，进一步包括：

通过参考所述序列中的两个或多个后续的可参考帧对一个双向预测帧的一个图像区域进行编码。

7. 根据权利要求 1 所述的方法，进一步包括：

识别所述两个或多个前面的可参考帧中的至少一个。

8. 根据权利要求 1 所述的方法，其中所述编码包括使用来自所述两个或多个前面的可参考帧的选定图像区域的不相等加权来编码。

9. 根据权利要求 8 所述的方法，进一步包括：

识别所述的不相等加权。

10. 根据权利要求 8 所述的方法，其中所述的不相等加权包括大于

1 或小于 0 的权重。

11. 根据权利要求 8 所述的方法，其中所述帧包括排列在图像区域中的帧，和

其中所述编码包括使用对应于所述两个或多个可参考帧的不相等像素值来编码。

12. 根据权利要求 1 所述的方法，其中所述的帧序列包括可参考帧和双向预测帧，每个所述帧包括排列在宏块中的像素值。

13. 根据权利要求 12 所述的方法，进一步包括：

按显示顺序基于来自一个或多个预测帧的运动向量使用直接模式预测来确定一个双向预测帧中的至少一个宏块。

14. 根据权利要求 13 所述的方法，其中所述编码包括使用来自所述两个或多个前面的可参考帧的选定图像区域的一个不相等加权来编码。

15. 根据权利要求 14 所述的方法，其中用小于 0 或大于 1 的帧比例分数对至少一个这样的运动向量进行换算。

16. 一种用于视频图像压缩的方法，所述方法包括：

提供一个包括图像区域的帧序列，所述帧包括双向预测（B）帧和可参考帧，所述可参考帧包括预测（P）帧和内部（I）帧；和

通过参考所述序列中的一个前面的可参考帧对至少一个 P 帧的一个图像区域进行编码，其中所述的前面的可参考帧被至少一个居间的可参考帧从所述 P 帧中隔开。

17. 根据权利要求 16 所述的方法，进一步包括：

识别所述的前面的可参考帧；和

用所述识别通知解码器。

18. 一种用于在具有可参考帧和双向预测帧序列的视频图像压缩系统中动态地确定具有可变数量的双向预测帧的这类帧的编码模式的

方法，所述方法包括：

选择一个初始序列，其开始于一个可参考帧，具有至少一个紧接着的后续双向预测帧，并以一个可参考帧结束；

增加一个可参考帧到所述初始序列的结尾以创建一个测试序列；

对照一个选定的评估标准对所述测试序列进行评估；

对于评估所述测试序列的每个满足步骤，在所述的所增加的可参考帧之前插入一个双向帧并重复所述的评估步骤；和

如果所述评估测试序列的步骤是不满足的，那么接受所述的前面的测试序列作为当前的编码模式。

19. 根据权利要求 18 所述的方法，进一步包括：

为一个选定的测试序列的帧的至少一个图像区域确定一个插值混合比例。

改进的视频压缩帧插值

相关申请的交叉参考

本申请是2001年7月11日提交的美国申请序列号09/904203的部分延续申请，并要求2002年6月28日提交的美国C.I.P.申请序列号10/187395的优先权。

技术领域

本发明涉及视频压缩，更特别地是涉及在MPEG类的编码和解码系统中改进的视频压缩帧插值。

背景技术

MPEG视频压缩

MPEG-2和MPEG-4是国际视频压缩标准，它们定义的各自的视频语法，提供了高效的方法来以更紧凑的编码数据表示图像序列。编码比特的语言就是所谓的“语法”。例如，几个标记可以表示整个样本块（例如对于MPEG-2是64个样本）。两种MPEG标准都描述了解码（重构）过程，即把编码的比特从紧凑的表示变换成图像序列的原始格式的一个近似。例如，在编码比特流中的一个标志可以表示在利用离散余弦变换（DCT）算法对随后的比特解码之前，是否使用预测算法先处理这些比特。包括解码过程的算法由这些MPEG标准所定义的语义来规定。这个语法可以被用于开发普通的视频特征，例如空间冗余、时间冗余、匀速运动、空间屏蔽等等。MPEG解码器必须能够解析和解码输入的数据流，但是只要数据流符合相应的MPEG语法，就可以使用各种各样的可能的数据结构和压缩技术（虽然在技术上这背离了标准，因为语义不一致）。在某种替换语法内携带所需的语义也是可能的。

这些MPEG标准使用各种压缩方法，包括帧内方法和帧间方法。在大多数视频场景中，背景保持相对稳定而动作在前景中发生。背景

可能移动，但是通常许多场景是冗余的。这些 MPEG 标准通过创建称为“内”帧或“I 帧”的参考帧开始压缩。在不参考其他帧的情况下来压缩 I 帧，因此 I 帧包含了视频信息的一个完整的帧。I 帧提供用于随机访问的数据比特流的入口点，但只能被适度地压缩。典型地，表示 I 帧的数据在比特流中每隔 12 到 15 帧放置(虽然在某些情况下在 I 帧之间使用更宽的间隔也是有用的)。据此，由于落入参考 I 帧之间的帧中只有一小部分不同于包围的（bracketing）I 帧，所以只有图像差别被捕获、压缩和存储。两种类型的帧被用于这种差别——预测帧（P 帧）和双向预测的（或插值的）帧（B 帧）。

P 帧一般根据过去的帧（I 帧或者前面 P 帧）来编码，而且通常被用作后续 P 帧的参考。P 帧受到相当大的压缩量。B 帧提供最高的压缩量，但是为了被编码既需要过去的参考帧也需要未来的参考帧。P 帧和 I 帧是“可参考帧”，因为它们可以被 P 帧或 B 帧参考。

宏块（macroblock）是图像像素区域。对于 MPEG-2，宏块是 4 个 8x8 DCT 块的 16x16 像素组，对于 P 帧加上一个运动向量，对于 B 帧加上一个或两个运动向量。可以使用帧内或帧间（预测的）编码对 P 帧内的宏块单独编码。可以使用帧内编码、前向预测编码、后向预测编码或同时使用前向和后向（即双向插值）预测编码对 B 帧内的宏块单独编码。在 MPEG-4 视频编码中所用的结构与此稍有不同，但是是类似的。

在编码之后，MPEG 数据比特流包括 I 帧、P 帧和 B 帧的序列。序列可以由 I 帧、P 帧和 B 帧的几乎任何模式组成(关于它们的位置有几个次要的语义限制)。但是，在业界实践中常见的是具有固定的帧模式（例如，IBBPBBPBBPBBPBB）。

运动向量预测

在 MPEG-2 和 MPEG-4 中（以及类似的标准，例如 H.263），B 型（双向预测的）帧的使用被证明是有益于压缩效率的。这种帧的每个宏块的运动向量可以由以下三种方法中的任何一种来预测：

模式 1：根据前面的 I 帧或 P 帧进行的前向预测（即非双向预测的帧）。

模式 2：根据后续的 I 帧或 P 帧进行的后向预测。

模式 3：根据后续和前面的 I 帧或 P 帧进行的双向预测。

模式 1 和用于 P 帧的前向预测方法相同。模式 2 除了向后根据后续帧来工作外，是相同的概念。模式 3 是插值模式，其结合了来自前面的和后续的帧的信息。

除了这三种模式，MPEG-4 还支持用于 B 帧的另一种插值运动向量预测模式：直接模式预测，其使用来自后续 P 帧的运动向量，加上一个增量（δ）值（如果来自共处的 P 宏块的运动向量被分成 8x8 的模式——对于 16x16 宏块产生 4 个运动向量——那么该增量被应用于 B 帧中的所有 4 个独立的运动向量）。后续 P 帧的运动向量指向前面 P 帧或 I 帧。一个比例被用于对后续 P 帧的运动向量进行加权。该比例是当前的 B 帧相对于后续的 P 帧和前面的 P（或 I）帧的相对时间位置。

图 1 是根据现有技术的帧的时间线和 MPEG-4 直接模式运动向量。MPEG-4 直接模式（模式 4）的概念是指在每个居间的 B 帧中的宏块的运动可能接近被用于编码在随后 P 帧中的相同位置的运动。增量被用于对从后续 P 帧的相应运动向量（MV）103 导出的比例运动向量进行小的校正。图 1 显示的是给予每个中间 B 帧 104a、104b 的运动向量 101 和 102 的比例加权，其作为前面 P 帧或 I 帧 105 和下一个 P 帧 106 之间的“时间距离”的函数。分配给相应的中间 B 帧 104a、104b 的运动向量 101 和 102 等于分配的权重值（分别是 1/3 和 2/3）乘以下一个 P 帧的运动向量 103，加上增量值。

关于 MPEG-2，B 帧的所有预测模式在编码中被测试，并且被比较以找到每个宏块的最佳预测。如果没有好的预测，那么宏块被单独编码成“I”（“内部”）宏块。编码模式被选为前向（模式 1）、后向（模式 2）和双向（模式 3）编码中的最佳模式，或者选为内部编码。关于 MPEG-4，不允许选择内部编码。相反，直接模式成为第四种选择。同样，基于某种最佳匹配准则选择最优的编码模式。在基于 MPEG-2 和 MPEG-4 的软件编码器中，使用 DC 匹配（绝对差值的和，或“SAD”）来确定最佳匹配。

在编码的数据比特流中连续 B 帧的数量是由 MPEG 中的参数值“M”确定的。M 减 1 是每个 P 帧和下一个 P 帧（或 I 帧）之间的 B

帧的数量。因此，如果 M = 3，则每个 P 帧（或 I 帧）之间就有 2 个 B 帧，如图 1 所示。在 M 值的限定方面（因而也限定了连续 B 帧的数量），主要的限制在于 P 帧（或 I 帧）之间的运动变化量变大。更多的 B 帧意味着 P 帧（或 I 帧）之间的时间更长。因此，运动向量的效率和编码范围限制构成了中间 B 帧数量的极限。

还很重要的是要注意到 P 帧携带“变化能量”和移动的图像流一起前进，因为每个解码 P 帧被用作预测下一个后续 P 帧的起始点。但是，B 帧在使用之后被丢弃。因此，任何用于创建 B 帧的比特仅被用于那个帧，而且与 P 帧不同，它们不提供帮助后续帧解码的校正。

发明内容

本发明涉及一种用于在视频图像压缩系统中提高一个或多个预测帧图像质量的方法、系统和计算机程序，其中每个帧包括多个像素。

一个方面，本发明包括确定双向预测帧的每个像素的值作为一个将一双向预测帧序列包围起来的非双向预测帧中的对应像素值的加权比例。在一个实施例中，该加权比例是进行包围的非双向预测帧之间的距离的函数。在另一个实施例中，加权比例是进行包围的非双向预测帧之间的距离和进行包围的非双向预测帧的等平均值的混合函数。

本发明的另一个方面，像素值的插值表示表示在线性空间中，或者在其他不同于原始非线性表示的优化的非线性空间中。

本发明的其他方面包括系统、计算机程序和方法，其包含：

- 具有包括图像区域的可参考帧序列的视频图像压缩系统，其中至少一个预测帧的至少一个图像区域参考两个或多个可参考帧被编码。
- 具有包括图像区域的可参考帧序列的视频图像压缩系统，其中至少一个预测帧的至少一个图像区域以显示顺序参考一个或多个可参考帧被编码，其中至少一个这样的可参考帧不是在显示顺序中最靠近至少一个预测帧的前面的可参考帧。
- 具有包括宏块的可参考帧序列的视频图像压缩系统，其中在至少一个预测帧内的至少一个宏块通过来自两个或多个可参考帧的插值而被编码。

- 具有包括图像区域的可参考帧和双向预测帧序列的视频图像压缩系统，其中至少一个双向预测帧的至少一个图像区域被编码以包括至少两个以上的运动向量，每个这样的运动向量参考在至少一个可参考帧中的对应的图像区域。
- 具有包括图像区域的可参考帧序列的视频图像压缩系统，其中至少一个预测帧的至少一个图像区域被编码以包括至少两个运动向量，每个这样的运动向量参考在可参考帧中的对应的图像区域，其中这样的至少一个预测帧的每个这样的图像区域通过来自两个或多个可参考帧的插值而被编码。
- 具有包括图像区域的可参考帧和双向预测帧序列的视频图像压缩系统，其中至少一个双向预测帧的至少一个图像区域被编码作为来自两个或多个可参考帧的选定图像区域的不相等加权。
- 具有包括图像区域的可参考帧和双向预测帧序列的视频图像压缩系统，其中至少一个双向预测帧的至少一个图像区域通过来自两个或多个可参考帧的插值而被编码，其中两个或多个可参考帧中的至少一个在显示顺序中被至少一个居间的可参考帧与双向预测帧隔开，且其中这样的至少一个图像区域被编码作为这样的至少两个或多个可参考帧的选定图像区域的不相等加权。
- 具有包括图像区域的可参考帧和双向预测帧序列的视频图像压缩系统，其中至少一个双向预测帧的至少一个图像区域通过来自两个或多个可参考帧的插值而被编码，其中两个或多个可参考帧中的至少一个在显示顺序中被至少一个居间的后续可参考帧与双向预测帧隔开。
- 具有包括图像区域的可参考帧和双向预测帧序列的视频图像压缩系统，其中至少一个双向预测帧的至少一个图像区域被编码作为来自两个或多个可参考帧的选定图像区域的不相等加权。
- 具有预测帧和双向预测帧序列的视频图像压缩系统，每个帧包括排列在宏块中的像素值，其中双向预测帧中的至少一个宏块

是使用基于来自两个或多个预测帧的运动向量的直接模式预测确定的。

- 具有可参考帧和双向预测帧序列的视频图像压缩系统，每个帧包括排列在宏块中的像素值，其中双向预测帧中的至少一个宏块是使用基于来自显示顺序中的一个或多个预测帧的运动向量的直接模式预测确定的，其中这样的一个或多个预测帧中的至少一个在显示顺序中是在双向预测帧前面。
- 具有可参考帧和双向预测帧序列的视频图像压缩系统，每个帧包括排列在宏块中的像素值，其中双向预测帧中的至少一个宏块是使用基于来自一个或多个预测帧的运动向量的直接模式预测确定的，其中这样的一个或多个预测帧的至少一个在显示顺序中是在双向预测帧之后而且被至少一个居间的可参考帧与双向预测帧隔开。
- 具有帧序列的视频图像压缩系统，每个帧包括具有 DC 值的多个图像区域，每个这样的图像区域包括的每个像素具有 AC 像素值，其中至少一个帧的至少一个图像区域的 DC 值和 AC 像素值中的至少一个被确定为来自至少一个其他帧的对应的各自的 DC 值和 AC 像素值的加权插值。
- 具有可参考帧序列的视频图像压缩系统，每个帧包括具有 DC 值的多个图像区域，每个这样的图像区域包括的每个像素具有 AC 像素值，其中至少一个预测帧的至少一个图像区域的 DC 值和 AC 像素值中的至少一个是从两个或多个可参考帧的对应的各自的 DC 值和 AC 像素值插值得到的。
- 改进视频图像压缩系统中的两个或多个双向预测中间帧的序列的图像质量，每个帧包括具有 DC 值的多个图像区域，每个这样的图像区域包括的每个像素具有 AC 像素值，包括下列中的至少一个：确定双向预测中间帧的每个图像区域的 AC 像素值为包围双向预测中间帧序列的可参考帧中的对应 AC 像素值的第一加权比例；和确定这种双向预测中间帧的每个图像区域的 DC 值为包围双向预测中间帧序列的可参考帧中的对应 DC 值的第二加权比例。具有帧序列的视频图像压缩系统，所述帧

包括具有初始表示的多个像素，其中至少一个帧的像素是从至少两个其他帧的对应像素插值得到的，其中该至少两个其他帧的这种对应的像素在变换到不同的表示时被插值，并导致插值的像素变换回初始的表示。

- 在具有可参考帧和双向预测帧序列的视频图像压缩系统中，动态地确定具有可变数量的双向预测帧的这种帧的编码模式，包括：选择一个初始序列，其始于可参考帧，具有至少一个紧跟的后续双向预测帧，并以可参考帧结束；把可参考帧加到该初始序列的结尾以创建一个测试序列；对照选定的评估标准评估该测试序列；对于评估该测试序列的每个满足步骤，在加入的可参考帧前面插入双向帧并且重复评估步骤；且如果评估该测试序列不满足，那么接受前面的测试序列作为当前的编码模式。
- 具有可参考帧序列的视频图像压缩系统，可参考帧被至少一个双向预测帧隔开，其中这种双向预测帧的数量在这种序列中是变化的，且其中至少一个这种双向预测帧的至少一个图像区域是使用对应于至少两个可参考帧的像素值的不相等加权确定的。
- 具有帧序列的视频图像压缩系统，所述帧由编码器编码且由解码器解码，其中至少一个帧的至少一个图像区域是基于两个或多个其他帧的加权插值，这种加权插值基于编码器和解码器可用的至少一组权值，其中对选定的这种至少一组权值之一的指定从编码器传送到解码器以选择一个或多个当前有效的权值。
- 具有帧序列的视频图像压缩系统，所述帧由编码器编码且由解码器解码，其中至少一个帧的至少一个图像区域是基于两个或多个其他帧的加权插值，这种加权插值基于至少一组权值，其中至少一组权值被下载到解码器，且此后对选定的这种至少一组权值之一的指定从编码器传送到解码器以选择一个或多个当前有效的权值。
- 具有可参考帧序列的视频图像压缩系统，可参考帧由编码器编码且由解码器解码，其中在可参考帧序列中的预测帧从编码器

传送到解码器，其传送顺序不同于这种预测帧在解码之后的显示顺序。

- 具有可参考帧序列的视频图像压缩系统，可参考帧包括排列在图像区域中的像素，其中至少一个预测帧的至少一个图像区域是参考两个或多个可参考帧被编码的，其中每个这样的图像区域是使用对应于这样的两个或多个可参考帧的像素值的不相等加权确定的。
- 具有预测帧、双向预测帧和内部帧序列的视频图像压缩系统，每个帧包括图像区域，其中从锐化和柔化滤波器组中选择的至少一个滤波器在预测帧或双向预测帧的运动向量补偿预测的过程中被用于这种预测帧或双向预测帧的至少一个图像区域。

附图和下面的描述阐明了本发明的一个或多个实施例的细节。根据说明书、附图和权利要求，本发明的其他特征、目标和优点是明显的。

附图说明

图 1 是根据现有技术的帧的时间线和 MPEG-4 直接模式运动向量。

图 2 是根据本发明的这个方面的帧的时间线和比例像素加权值。

图 3 是根据本发明的这个方面的帧的时间线和混合的、比例的和相等的像素加权值。

图 4 是一个流程图，显示了作为可以被计算机实现的方法的本发明的一个说明性实施例。

图 5 显示当前 P 帧参考前两个 P 帧和一个前面 I 帧的多个先前参考的例子的图。

图 6A 是典型的现有技术 MPEG-2 编码模式图，显示了进行包围的 I 帧和/或 P 帧之间的恒定数量的 B 帧。

图 6B 是理论上可能的现有技术 MPEG-4 视频编码模式图，显示了进行包围的 I 帧和/或 P 帧之间的变化数量的 B 帧，以及 I 帧之间的变化的距离。

图 7 是一个编码模式图。

图 8 是一个流程图，显示了插值方法的一个实施例，DC 插值不同

于 AC 插值。

图 9 是一个流程图，显示了使用替换表示的亮度像素的插值方法的一个实施例。

图 10 是一个流程图，显示了使用替换表示的色度像素的插值方法的一个实施例。

图 11 是显示两个 P 帧中的每个帧的独特运动向量区域尺寸的图。

图 12 是显示 P 帧和 B 帧序列的图，带有 B 帧的插值权重，其被确定为与一个 2 远离（2-away）后续 P 帧的距离的函数，该 P 帧参考一个 1 远离（1-away）后续 P 帧。

图 13 是显示 P 帧和 B 帧序列的图，带有 B 帧的插值权重，其被确定为与一个 1 远离后续 P 帧的距离的函数，该 P 帧参考一个 1 远离前面 P 帧。

图 14 是显示 P 帧和 B 帧序列的图，其中后续 P 帧具有参考前面 P 帧的多个运动向量。

图 15 是显示 P 帧和 B 帧序列的图，其中最近的后续 P 帧具有一个参考前面的一个 P 帧的运动向量，且下一个最近的后续 P 帧具有多个参考前面 P 帧的运动向量。

图 16 是显示 P 帧和 B 帧序列的图，其中最近的前面 P 帧具有一个参考前面的一个 P 帧的运动向量。

图 17 是显示 P 帧和 B 帧序列的图，其中最近的前面 P 帧具有两个参考前面 P 帧的运动向量。

图 18 是显示 P 帧和 B 帧序列的图，其中最近的前面 P 帧具有一个参考前面 P 帧的运动向量。

图 19 是显示三个 P 帧 P1、P2、P3 的帧序列，其中 P3 使用有两个运动向量的插值参考，P1 和 P2 各一个运动向量。

图 20 显示四个 P 帧 P1、P2、P3 和 P4 的帧序列，其中 P4 使用有三个运动向量的插值参考，P1、P2 和 P3 各一个运动向量。

图 21 是显示 P 帧和 B 帧序列的图，其中不同的 P 帧具有参考前面不同的 P 帧的一个或多个的运动向量，并显示分配给特定 B 帧的各个前向和后向参考的不同权重。

图 22 是显示 P 帧和 B 帧序列的图，其中 P 帧的比特流顺序不同于

显示顺序。

图 23 是显示具有分配的权重的 P 帧和 B 帧序列的图。

图 24 是在帧内的物体的位置时间图。

在不同附图中的相同参考符号表示相同的元素。

具体实施方式

概述

本发明的一个方面是基于这样的认识：常见的做法是使用 M 值为 3，其在每个 P(或 I)帧之间提供了两个 B 帧。但是 M=2 和 M=4 或更高都是有用的。特别重要的是要注意到 M 的值（B 帧的数量加 1）也具有和帧速率的自然关系。在每秒 24 帧（fps），即电影的播放率，帧之间 1/24 秒的时间距离可以导致帧到帧的实质图像变化。但是在 60 fps、72 fps 或更高的帧速率，相邻帧之间的时间距离相应地减少。结果是随着帧速率的增加，越大的 B 帧数量（即 M 值越大）在压缩效率中变得有用和有益。

本发明的另一个方面是基于这样的认识：MPEG-2 和 MPEG-4 视频压缩都利用过于简单的插值方法。例如，对于模式 3，帧的每个宏块的双向预测是后续和前面的帧宏块的等平均，其被两个对应的运动向量取代。这个等平均适合 M=2（即单个的中间 B 帧），因为该 B 帧到前面 P(或 I)帧和后续 P(或 I)帧的时间相等。但是，对于更大的 M 值，使用等加权只能对中央对称的 B 帧（即如果 M=4，6，8 等等的中间帧）进行最佳预测。类似地，在 MPEG-4 直接模式 4，即使运动向量是比例加权的，每个中间 B 帧的预测像素值是前面 P(或 I)帧和后续 P 帧的对应像素的等比例。

因此，对于 M>2，把合适的比例权重应用于每个 B 帧的预测像素值是一个进步。当前 B 帧的每个像素的比例权重对应于当前 B 帧相对于前面和后续 P(或 I)帧的相对位置。因此，如果 M=3，第一个 B 帧就使用前面帧的对应像素值（调整的运动向量）的 2/3，和后续帧的对应像素值（调整的运动向量）的 1/3。

图 2 是根据本发明的这个方面的帧的时间线和比例像素加权值。每个中间 B 帧 201a、201b 的每个宏块内的像素值被加权成前面的 P 或

I 帧 A 和下一个 P 或 I 帧 B 之间的“距离”的函数，离 P 或 I 帧越近，加权值越大。也就是，双向预测 B 帧的每个像素值是进行包围的非双向预测帧 A 和 B 的对应像素值的加权组合。在这个例子中，对于 M=3，第一个 B 帧 201a 的加权等于 2/3A＋1/3B，第二个 B 帧 201b 的加权等于 1/3A＋2/3B。还显示的是，在常规的 MPEG 系统下被分配的等平均加权；每个 B 帧 201a、201b 的的 MPEG-1、2 和 MPEG-4 加权等于（A＋B）/2。

扩展动态范围和对比范围的应用

如果 M 大于 2，中间 B 帧中的像素值的比例加权将在许多情况下将会改进双向（模式 3）和直接（MPEG-4 模式 4 的有效性）编码。示例包括常见的电影和视频编辑效果，例如渐弱和交叉渐隐。这些类型的视频效果是 MPEG-2 和 MPEG-4 的有问题的编码示例，这是由于使用简单 DC 匹配算法，且通常使用的 M = 3（即两个中间 B 帧），导致 B 帧的相等比例。这些情况下的编码通过根据本发明使用比例 B 帧插值得以改进。

比例 B 帧插值对于扩展动态和对比范围的编码效率的提高也有直接的应用。在图像编码中的常见事件是亮度的变化，这在当物体逐渐移进（或移出）阴影（软阴影边界）时发生。如果对数的编码表示被用于亮度（例如，由对数亮度 Y 具体表示的亮度），那么采光亮度变化将是 DC 偏移量变化。如果采光亮度减半，那么像素值将减少相等的量。因此，为了编码这个变化，应该发现一个 AC 匹配，且编码的 DC 差值应该应用于该区域。这种被编码进 P 帧的 DC 差值也应该在每个居间的 B 帧中成比例地应用（参见共同待决的美国专利申请 09/905039 号，标题为“Method and System for Improving Compressed Image Chroma Information”，其被转让给本发明的受让人，因而在在此通过引用将其并入，用于关于对数编码表示的额外信息）。

除了亮度中的变化，比例 B 帧插值也有益于对比度的变化。例如，随着飞机移向观众，移出云或薄雾，其对比度逐渐增加。这个对比度增加将被表示成在对应 P 帧编码宏块中的 DCT 的 AC 系数中的增加的幅度。同样，在居间的 B 帧中的对比度变化将由比例插值最接近地近

似，因此提高了编码效率。

随着帧速率变大和随着 M 值的增加，使用比例 B 帧插值提高动态范围和对比度编码效率变得日渐重要。

把高M值应用于时间分层

利用本发明的实施例允许增加 M 的值，从而增加了在进行包围的 P 帧和/或 I 帧之间的 B 帧的数量，同时保持或增加了编码效率。这种用法有益于许多应用，包括时间分层。例如，在题为“Temporal and Resolution Layering for Advanced Television”的美国专利 5988863 号中（其被转让给本发明的受让人，在此通过引用并入），注意到 B 帧是用于分层的时间（帧）速率的合适机制。这种速率的灵活性与可用的连续 B 帧的数量有关。例如，单个 B 帧（M = 2）可以支持 72 fps 的流内的 36 fps 解码的时间层或 60 fps 的流内的 30 fps 解码的时间层。三个 B 帧（M=4）可以支持 72 fps 流内的 36 fps 和 18 fps 解码的时间层，以及 60 fps 流内的 30 fps 和 15 fps 解码的时间层。在 120 fps 流内使用 M=10 可以支持 12 fps 、24 fps 和 60 fps 解码的时间层。M = 4 也可以用于 144 fps 流，以提供在 72 fps 和 36 fps 解码的时间层。

作为对每个第 N 帧的改进，120 fps 或 72 fps 的多个帧可以被解码和按比例地混合，如在共同待决的美国专利申请 09/545233 号中描述的，该专利标题为“Enhancements to Temporal and Resolution Layering”（其被转让给本发明的受让人，在此通过引用并入），以改进 24 fps 结果的运动模糊特征。

即使更高的帧速率可以使用在共同待决的美国专利申请 09/435277 号中所描述的方法合成，该专利申请题为“System and Method for Motion Compensaion and Frame Rate Conversion”（其被转让给本发明的受让人，在此通过引用并入）。例如，通过运动补偿帧速率转换可以利用 72 fps 摄像底片（original）来创建 288 帧每秒的有效帧速率。使用 M = 12，可以得到 48 fps 和 24 fps 的帧速率以及其他有用的速率，例如 144 fps、96 fps 和 32 fps（当然，底片为 72 fps）。使用这种方法的帧速率转换不需要是整倍数的。例如，120 fps 的有效速率可以根据 72 fps 的源创建，然后作为 60 fps 和 24 fps 速率的源（使用

M = 10）。

因此，时间分层有益于优化 B 帧插值的性能。上面所述的比例 B 帧插值使更多数量的连续 B 帧功能更高效，因此能够实现这些好处。

混合的B帧插值比例

在传统的系统中使用等平均加权作为 B 帧像素值的运动补偿模式预测器的一个原因是特定 B 帧前面或者后面的 P(或 I)帧可能是有噪声的，因此表示不理想的匹配。等混合在插值运动补偿块中会优化噪声的减少。存在使用量化的 DCT 函数来编码的差分残差（difference residual）。当然，来自运动补偿比例的匹配越好，所需的差分残差比特越少，最后所得到的图像质量越高。

在有物体移近和移出阴影或者薄雾的情况下，M > 2 时的真正的比例提供更好的预测。但是，当光和对比度未发生变化时，等加权可被证明是更好的预测值，因为沿着运动向量向前移动宏块的误差将和来自后向位移块的误差平均，因此把每个误差减半。即使如此，更可能的是，较近的 P(或 I)帧的 B 帧宏块与较远的 P(或 I)帧相比与那个帧更相关。

因此，在某些情况下，例如区域的对比度或者亮度改变，理想做法是利用 B 帧宏块像素加权的真正比例（对于亮度和颜色），如上所述。在其他情况下，可能更优的做法是利用等比例，如在 MPEG-2 和 MPEG-4 中。

本发明的另一方面利用这两个比例技术的混合（等平均和帧一距离比例）用于 B 帧像素插值。例如，对于 M = 3 的情况，1/3 和 2/3 比例的 3/4 可以与等平均的 1/4 混合，导致两个比例是 3/8 和 5/8。这个技术可以使用“混合因子”F 来概括。

加权 = F•(帧距离比例权重) + (1 – F)•等平均权重

混合因子 F 的有用范围是从 1 到 0，1 表示完全比例插值，0 表示完全等平均（也可能使用相反的赋值）。

图 3 是根据本发明的这个方面的帧的时间线和混合的、比例的和相等的像素加权值。每个中间 B 帧 301a 和 301b 的每个宏块的像素值被加权为前面的 P 或者 I 帧 A 和下一个 P 或者 I 帧 B 之间的“时间距

离”的函数，以及 A 和 B 的等平均的函数。在这个例子中，对于 M=3 和混合因子 F=3/4，第一个 B 帧 301a 的混合加权等于 5/8A＋3/8B（也就是比例加权 2/3A＋1/3B 的 3/4 加上等平均加权（A＋B）/2 的 1/4）。类似地，第二个 B 帧 301b 的加权等于 3/8A＋5/8B。

混合因子 F 的值可以为全部的编码整体设定，或者为每个图像组（GOP）、一个范围的 B 帧、每个 B 帧或者 B 帧内的每个区域设定（包括，例如细化到每个宏块，或者对于以 8x8 模式使用 P 向量的 MPEG-4 直接模式，甚至是单个的 8x8 运动块）。

为了节省比特并反映这样的事实即混合比例通常没有重要到要和每个宏块一起传送，混合的优化使用应该与要压缩的图像类型有关。例如，对于正在淡出、渐隐的图像或者整体采光或对比度正在逐渐改变的图像，混合因子 F 接近或等于 1（即选择比例插值）一般是最优的。对于没有这种采光或对比度变化的连续图像，那么较低的混合因子值例如 2/3、1/2 或 1/3 可能形成最优的选择，从而保留比例插值的某些好处以及等平均插值的某些好处。所有在 0 到 1 范围内的混合因子值一般是有用的，因为对于任何给定的 B 帧，在这个范围内有一个特定值证明是优化的。

对于宽动态范围和宽对比度范围图像，混合因子可以依赖局部区域特征区域地确定。但是，通常宽范围的采光和对比度建议混合因子值支持完全比例插值，而不是等平均插值。

优化的混合因子通常是由经验确定的，虽然对于特定类型场景的经验可以被用于创建按场景类型的混合因子表格。例如，图像变化特征的确定可以被用于为帧或者区域选择混合比例。替换地，可以使用许多的候选混合因子（用于整个帧或者区域）编码 B 帧，评估每个混合因子以优化图像质量（例如，由最高的信噪比即 SNR 确定的）和最低的比特数。这些候选的评估然后可以被用于为混合比例选择最佳值。也可以使用图像变化特征和编码的质量/效率的组合。

靠近 B 帧序列中间的 B 帧或者来自低值 M 的 B 帧不会被比例插值过多影响，因为计算的比例已经接近等平均。但是，对于较高的 M 值，B 帧位置的极值可以被混合因子的选择显著影响。注意对于这些极限位置混合因子可以不同，这些极限位置比更中央的位置（其从偏

离平均获得很少好处或者没有获得好处）更多地利用该平均，因为它们已经具有邻近 P（或者 I）帧的高比例。例如，如果 M=5，第一个和第四个 B 帧可能使用的混合因子 F 混合了更多的等平均，但第二个和第三个 B 帧可能使用严格的 2/5 和 3/5 的等平均比例。如果比例到平均混合因子（propotion-to-average blend factor）作为序列中 B 帧位置的函数变化，那么混合因子的变化值可以在压缩的比特流中传送或者作为辅助信息传给解码器。

如果要求静态的一般混合因子（由于缺少传送值的方法），那么值 2/3 通常接近最优的，且可以在编码器和解码器中被选择作为 B 帧插值的静态值。例如，使用 F=2/3 的混合因子，对于 M=3 的连续帧，比例将是 7/18（7/18＝2/3*1/3＋1/3*1/2）和 11/18（11/18=2/3*2/3+1/3*1/2）。

线性插值

视频帧像素值一般存储在特定表示中，特定表示把原始的图像信息映射到数字值。这种映射可能导致线性的或者非线性的表示。例如，在压缩中使用的亮度值是非线性的。各种形式的非线性表示的使用包括对数、指数（各种幂）以及黑色校正的指数（通常用于视频信号）。

在狭窄的动态范围上或者对于邻近区域的插值，非线性表示是可接受的，因为这些邻近的插值表示分段的线性插值。因此，亮度的小变化可以由线性插值合理地近似。但是，对于亮度的广泛变化，例如发生在宽动态范围和宽对比度范围图像中的，把非线性信号处理为线性的将是不准确的。即使对于正常的对比度范围图像，线性淡出和交叉渐隐可以被线性插值降低效果。有些淡出和交叉渐隐利用非线性的淡出和渐隐率，增加了进一步的复杂性。

对于使用比例混合，或者甚至是简单的比例或等平均插值的额外改进是在线性空间里表示的像素值上进行这种插值，或者在不同于原始非线性亮度表示的其他优化的非线性空间中进行这种插值。

这可以被完成，例如通过首先把两个非线性亮度信号（来自前面和后续 P（或者 I）帧）转换成线性表示，或者不同的非线性表示。然后应用比例混合，在应用逆变换之后，在图像的原始非线性亮度表示中产生混合的结果。但是，比例函数已经在亮度信号的更优表示上执

行。

当颜色正在褪色或者变得更加饱和时，如与在薄雾和阴天中的变化关联的对比度变化中发生的，除了亮度之外，把这个线性或非线性变换有利地应用于颜色（色度）值也是有用的。

示例性实施例

图 4 是一个流程图，显示了本发明的一个示例性实施例，其作为可以被计算机实现的一个方法：

步骤 400：在视频图像压缩系统中，对于计算 B 帧的直接和插值模式，使用（1）帧距离比例，或者（2）等权重和帧距离比例的混合来确定插值值以应用于两个或多个双向预测中间帧的输入序列的每个像素，插值值来源于括起这种从源（例如视频图像流）输入的序列的至少两个非双向预测的帧。

步骤 401：相对于图像单元（例如图像组（GOP）、帧序列、场景、帧、帧内的区域、宏块、DCT 块或者类似有用的分组或像素的选择）优化插值值。插值值可以为整个编码期间静态地设定，或者为每个图像单元动态地设定。

步骤 402：进一步相对于场景类型或编码简单性优化插值值。例如，插值值可以被设定：静态地（例如 2/3 比例和 1/3 等平均）；比例地，为接近等平均的帧，但在邻近 P（或 I）帧附近要混合等平均；动态地，基于整体场景特征，例如淡出和交叉渐隐；动态地（和局部地），基于局部图像区域特征，例如局部的对比度和局部的动态范围；或者动态地（和局部地），基于编码性能（例如最高编码 SNR）和生成的最少编码比特。

步骤 403：传送合适的比例量给解码器，如果不是静态确定的。

步骤 404：可选地，为每个帧转换亮度信息为线性的或者替换的非线性表示，并把这个替换传送给解码器，如果不是静态确定的。

步骤 405：使用确定的插值值确定比例像素值。

步骤 406：如果有必要（由于步骤 404），再转换成原始的表示。

扩展的P帧参考

如上所述，在现有技术 MPEG-1、2 和 4 压缩方法中，P 帧参考前

面的 P 或者 I 帧，且 B 帧参考最近的前面或后续的 P 和/或 I 帧。同样的技术被用于 H.261 和 H.263 运动补偿的 DCT 压缩标准，其包含了低比特率压缩技术。

正在开发的 H.263++和 H.26L 标准中，B 帧参考被扩展到指向没有直接包围当前帧的 P 或者 I 帧。也就是说，B 帧内的宏块可以指向前面 P 帧之前的一个 P 或者 I 帧，或者指向后续 P 帧之后的一个 P 或者 I 帧。由于每个宏块有一个或多个比特，跳过前面或后续 P 帧可以简单地表示。概念上，使用前面 P 帧用于 B 中的参考只要求存储空间。对于 H.263++或 H.26L 的低比特率编码使用，这是少量的额外存储。对于后续的 P 帧参考，必须相对于 B 帧编码修改该 P 帧编码顺序，以致于必须在居间的 B 帧之前解码未来的 P 帧（或者可能是 I 帧）。因此，编码顺序对于后续的 P 帧参考也是个问题。

P 帧和 B 帧类型之间的主要差别是：（1）B 帧可以被双向参考（最多每个宏块两个运动向量）；（2）在使用之后 B 帧被丢弃（这也意味着在解码过程中可以跳过它们以提供时间分层）；和（3）P 帧被用作“跳板”，一个到下一个，因为每个 P 帧必须被解码以用作每个后续 P 帧的参考。

作为本发明的另一个方面，根据一个或多个的前面的 P 或者 I 帧（不包括每个 P 帧只参考最近的前面 P 帧或者 I 帧的情况）解码 P 帧（与 B 帧相对）。因此，例如，每个宏块的两个或者多个运动向量可以被用于当前的 P 帧，所有运动向量在时间上指向后面（也就是指向一个或多个先前解码的帧）。这样的 P 帧仍然保持“跳板”特点。图 5 是一个显示多个先前参考的例子，由当前 P 帧 500 参考两个前面 P 帧 502、504 和前面 I 帧 506。

此外，在这样的 P 帧参考中可以应用宏块插值的概念，如上所述。因此，除了表示对一个以上的前面 P 或 I 帧的单个参考之外，也可以为每个这样的帧参考使用一个运动向量，以混合多个前面 P 或 I 帧的比例。例如，可以应用上面所述的使用具有两个帧参考的 B 帧插值模式的技术以允许 P 帧中的任何宏块利用两个运动向量来参考前面两个 P 帧或者一个前面的 P 帧和一个前面的 I 帧。这个技术在两个运动向量之间插值，但在时间上不是双向的（和 B 帧插值情况一样），因为两个

运动向量时间上都指向后面。存储开销减少到一个点，在这点，为这种并发参考在存储器中保存前面的多个 P 或 I 帧是相当实用的。

在应用这种 P 帧插值时，肯定需要选择前面两个或多个 P 帧（以及可选地，一个前面的 I 帧）的各种有用比例并通知解码器。特别是帧的等混合是有用的混合比例之一。例如，有前两个 P 帧作为参考，可以混合每个 P 帧的相等的 1/2。对于前三个 P 帧，可以使用 1/3 的相等混合。

两个 P 帧的另一个有用混合是 2/3 的最近的前面帧和 1/3 的最远的前面帧。对于前 3 个 P 帧，另一个有用混合是 1/2 的最近的前面帧，1/3 中间的前面帧和 1/6 的最远的前面帧。

在任何情况下，可以利用多个前面 P 帧（和可选地，一个 I 帧）的一组简单的有用混合，并将它们简单地从编码器通知到解码器。每当对优化图像单元的编码效率有用时，可以选择使用的特定混合比例。可以使用少量的比特选择许多的混合比例，只要适合想要的图像单元，这些比特可以被传送给解码器。

作为本发明的另一个方面，转变选择单个 P 帧参考从最近的前面 P（或 I）帧到更“远”的前面 P（或 I）帧也是有用的。在这个方式中，P 帧会利用每个宏块（或者可选地，在 MPEG-4 模式编码中的每个 8x8 块）的单个运动向量，但是会利用一个或多个的比特表示该参考参考单个特定的前面帧。在这个模式中的 P 帧宏块不是插值的，但是会参考选定的前面帧，该帧从可能的两个、三个或者更多的前面 P（或 I）帧中选择用于参考。例如，2 比特编码可指定多至 4 个的前面帧中的一个作为单个选择帧。这个 2 比特编码可以在任何方便的图像单元被改变。

自适应的B帧数量

在 MPEG 编码中典型地使用 I、P、B 帧类型的固定模式。在 P 帧之间的 B 帧数量典型地是常数。例如，在 MPEG 编码中在 P（或 I）帧之间使用两个 B 帧是典型的。图 6A 是典型的现有技术 MPEG-2 编码模式图，显示了在进行包围的 I 帧 600 和/或 P 帧 602 之间的固定数量的 B 帧（即两个）。

MPEG-4 视频编码标准概念地允许在进行包围的 I 帧和/或 P 帧之间是变数量的 B 帧，以及 I 帧之间变化的距离。图 6B 是理论上可能的现有技术 MPEG-4 视频编码模式图，显示了在进行包围的 I 帧 600 和/或 P 帧 602 之间的变数量的 B 帧，以及 I 帧 600 之间的变距离。

这个灵活的编码结构理论上可被用于通过将最有效的 B 帧和 P 帧编码类型匹配到运动图像帧来提高编码效率。虽然这个灵活性已经被特别地允许，但是人们很少研究它，而且在这种灵活的结构中实际确定 B 帧和 P 帧位置的机制也是未知的。

本发明的另一个方面在普通使用中把这里描述的概念应用于这个灵活的编码结构以及简单的固定编码模式。因此能够使用上面所述的方法来插值 B 帧，而 P 帧可以参考一个以上的前面 P 帧或 I 帧并根据本说明书被插值。

特别地，B 帧内的宏块可以利用与固定结构一样有效的适于灵活编码结构的比例混合。当 B 帧参考与最靠近的进行包围的 P 帧或 I 帧相比更远的 P 帧或 I 帧时，也可以利用比例混合。

类似地，在这个灵活编码结构中，P 帧可以参考一个以上的前面的 P 帧或 I 帧，与固定模式结构一样有效。此外，当这些 P 帧参考一个以上的前面的 P 帧（可选地，加上一个 I 帧）时，混合比例可以被应用于这种 P 帧中的宏块。

（A）在灵活的编码模式中确定位置

以下方法允许编码器优化帧编码模式以及利用混合比例的效率。对于选定范围的帧，可以尝试许多候选的编码模式以确定最优的或者接近最优的（相对于指定标准）模式。图 7 是一个可以被检验的编码模式图。以 P 或者 I 帧结束的初始序列 700 是任意选定的，并被用作增加的附加 P 帧和/或 B 帧的基础，然后评估附加 P 帧和/或 B 帧（如下所述）。在一个实施例中，一个 P 帧被加到初始序列 700 以创建用于评估的第一个测试序列 702。如果评估满足，那么插入一个居间的 B 帧以创建第二个测试序列 704。对于每个满足的评估，插入附加 B 帧以创建逐渐变长的测试序列 706～712，直到评估标准变得不满足。到那一点，前面的编码序列被接受。然后重复这个过程，使用先前接受

的编码序列的结尾 P 帧作为增加新 P 帧的起始点，然后插入新的 B 帧。

最优的或者接近最优的编码模式可以基于各种评估标准选择，通常涉及各种编码特征的权衡，例如编码的图像质量和所需的编码比特数量。常用的评估标准包括被使用的最少比特数量（在固定的量化参数测试中），或者最好的信噪比（在固定的比特率测试中），或者两者的组合。

最小化一个绝对差值和（SAD）也是常见的，SAD 形成 DC 匹配的测量。如在共同待决的题为“Motion Estimation for Video Compression System”的美国专利申请 09/904192 号（其被转让给本发明的受让人，因而通过引用并入）中描述的，AC 匹配标准也是特定候选匹配的质量的有用测量（本专利申请也描述其他有用的优化）。因此可以检验在所有宏块的最佳匹配上累积的 AC 和 DC 匹配标准，以确定每个候选编码模式的整体匹配质量。当这个 AC/DC 匹配技术和每个帧模式类型的编码比特数量的估计一起使用时，它可以增进或者取代信噪比（SNR）和使用最少比特的测试。典型的是，编码 B 帧宏块所使用的量化参数值（QP）比用于 P 帧的更高，其影响在各种候选编码模式内使用的比特数和质量（通常作为信噪比测量）。

（B）在灵活编码模式中的混合比例优化

可选地，对于根据上述方法确定的每个候选模式，可以测试混合比例相对一个或多个标准的适合性（例如最优的或者接近最优的混合比例）。这可以被完成，例如通过测试最好质量（最低 SNR）和/或效率（使用的最少比特）。为 P 帧中的每个宏块使用一个或多个前面的参考也可以用同样的方式确定，测试每个候选的参考模式和混合比例以确定一组或多组合适的参考。

一旦为下一步骤（图 7 中的步骤 700）选择了编码模式，就可以为各种候选编码模式测试后续步骤（步骤 702－712）。在这个方法中，可以确定运动图像序列的更高效的编码。因此，可以如上面的子节（A）描述的那样优化/提高效率；可以在每个测试的编码步骤应用混合优化。

DC对AC插值

在图像编码的许多情况中，例如当使用图像帧的对数表示时，帧

像素值的上述插值将最优地编码亮度中的变化。但是，在替换的视频“γ曲线”、线性和其他表示中，把不同的插值混合因子应用于像素的DC值而不是AC值，这通常被证明是有用的。图8是一个流程图，显示了一种与AC插值明显不同的具有DC插值的插值方法的一个实施例。对于来自第一和第二输入帧的选定图像区域（通常是DCT块或者宏块）802、802'，减去每个这种区域的平均像素值804、804'，因此在选定的区域中把DC值（即整个选定区域的平均值）806、806'和AC值（即保留的有符号像素值）808、808'分开。然后各自的DC值806、806'可以乘以插值权重810、810'，其不同于乘以AC（有符号的）像素值808、808'使用的814、814'。然后，最新插值的DC值812和最新插值的AC值816可以被合并成818，产生选定区域的新预测820。

和本发明中的其他插值值一样，可以将合适的权重通知每个图像单元的解码器。可以在许多编码值之间选择少量的比特，以及选择像素值的AC对DC方面的独立插值。

线性&非线性插值

插值是线性的加权平均。由于插值运算是线性的，且由于每个图像帧中的像素值通常是以非线性形式（例如视频伽马表示或者对数表示）表示的，插值过程的进一步优化成为可能的。例如，特定帧序列的像素的插值，以及从AC值分离的DC值的插值，有时用线性的像素表示将是最优的或者接近最优的。但是，对于其他的帧序列，如果像素是被表示成对数值或者其他的像素表示，那么这种插值将是最优的或者接近最优的。此外，用于插值U和V（色度）信号分量的最优表示或接近最优的表示可不同于Y（亮度）信号分量的最优表示或接近最优的表示。因此，本发明的一个有用方面是作为插值程序的一部分，把像素表示转换成替换的表示。

图9是一个流程图，显示了使用替换表示的亮度像素插值的方法的一个实施例。开始于初始表示（例如视频伽马或者对数）中的亮度（Y）像素的一个区域或者块（步骤900），像素数据被变换成不同于初始表示的替换表示（例如线性的、对数的、视频伽马）（步骤902）。然后如上所述，变换的像素区域或者块被插值（步骤906），并变换回

初始表示（步骤 906）。结果得到插值的像素亮度值（步骤 908）。

图 10 是一个流程图，显示了使用替换表示的色度像素插值的方法的一个实施例。开始于初始表示（例如视频伽马或者对数）中的色度（U, V）像素的一个区域或者块（步骤 1000），像素数据被变换成不同于初始表示的替换表示（例如线性的、对数的、视频伽马）（步骤 1002）。然后如上所述，变换的像素区域或者块被插值（步骤 1006），并变换回初始表示（步骤 1006）。结果得到插值的像素色度值（步骤 1008）。

各种表示之间的变换可以根据题为“Method and System for Improving Compressed Image Chroma Information”的美国专利申请 09/905039 号的讲解进行，其被转让给本发明的受让人，因此通过引用并入。注意，通常使用简单的查找表进行替换的表示变换及其逆变换。

作为本发明的这个方面的一个变化，用于 AC 插值的替换（线性或非线性）表示空间可不同于用于 DC 插值的替换表示空间。

和插值权重一样，选择哪种替换插值表示用于每个亮度（Y）和色度（U 和 V）像素表示，可以使用每个选定图像单元的少量比特通知解码器。

每个宏块的运动向量的数量

在 MPEG-2 中，P 帧中的每个 16x16 宏块允许一个运动向量。在 B 帧中，MPEG-2 允许每个 16x16 宏块最多两个运动向量，对应于双向的插值模式。在 MPEG-4 视频编码中，P 帧中的每个 16x16 宏块允许多至 4 个运动向量，对应于每个 8x8 DCT 块一个运动向量。在 MPEG-4 B 帧中，当使用插值模式时，每个 16x16 宏块允许最多两个运动向量。如果后续的对应 P 帧宏块被设置为具有 4 个运动向量的 8x8 模式，在 MPEG-4 直接模式中的单个运动向量增量可以导致 4 个独立的“隐式”运动向量。这是在换算时间距离（该 B 帧在时间上更靠近该 P 帧的前面 P 帧或 I 帧参考）之后，通过将 16x16 B 帧宏块中所携带的一个运动向量增量增加到来自随后 P 帧宏块中的对应的 4 个独立运动向量中的每一个来实现的。

本发明的一个方面包括增加每个图像区域（例如宏块）的运动向量数量的选择。例如，有时证明每个 B 帧宏块具有两个以上的运动向

量是有益的。这些可以通过参考附加的 P 帧或者 I 帧和在加权和中具有 3 个或更多的插值项被应用。也可以应用附加的运动向量以允许 B 帧宏块的 8x8 DCT 块的独立向量。而且，可以使用 4 个独立增量以通过把独立增量应用于后续 P 帧的 4 个 8x8 区域运动向量中的每一个来扩展直接模式的概念。

此外，可以使用 B 帧插值技术修改 P 帧以在插值模式中参考多于一个的前面帧，使用上面描述的 B 帧的两个插值项技术。这个技术可以容易地扩展到两个以上的前面 P 帧或者 I 帧，所得到的插值在加权和中具有 3 个或更多的项。

和本发明的其他方面(例如像素表示和 DC 对 AC 插值方法)一样，可以使用每个图像单元的少量比特把特定的加权和传递给解码器。

在应用本发明的这个方面时，8x8 像素 DCT 块和运动向量域之间的对应不需要像 MPEG-2 和 MPEG-4 中那样严格。例如，使用除了 16x16、16x8（只在 MPEG-4 中的隔行扫描中使用）、8x8 以外的替换区域尺寸用于运动向量可能是有用的。这种替换可能包括任何数量的有用区域尺寸，例如 4x8、8x12、8x16、6x12、2x8、4x8、24x8、32x32、24x24、24x16、8x24、32x8、32x4 等等。使用少量这种有用的尺寸，几个比特可以把运动向量区域尺寸和 DCT 块尺寸之间的对应通知解码器。在使用传统的 8x8 DCT 块的系统中，一组到运动向量域的简单对应对简化运动补偿中的处理是有用的。在 DCT 块尺寸不是 8x8 的系统中，那么可以在指定的运动向量域中实现更大的灵活性，如在题为“Enhanced Temporal and Resolution Layering in Advanced Television”的共同待决的美国专利申请 09/545233 号中所描述的，其被转让给本发明的受让人，因此通过引用将其并入。注意，运动向量区域边界不需要对应于 DCT 区域边界。实际上，以运动向量区域界限落入 DCT 块内（且不在其界限上）的方式定义运动向量区域经常是有用的。

扩展运动向量域的灵活性的概念也适用于本发明的插值方面。只要指定了每个像素和指向一个或多个参考帧的一个或多个运动向量之间的对应，就可以使用本发明的所有通用性把上述插值方法应用于有用运动向量的全部灵活性。甚至当使用 P 帧时，对于每个前面帧参考，对应于每个运动向量的区域的尺寸可以不同，而且当使用 B 帧时，对

于每个前面和未来的帧参考，对应于每个运动向量的区域尺寸可以不同。如果在应用本发明的改进插值方法时运动向量的区域尺寸不同，那么插值反映重叠的共同区域。运动向量参考的重叠共同区域可以被用作当分别插值 DC 和 AC 像素值时，在其上确定 DC 项的区域。

图 11 显示了两个 P 帧 1104、1106 各自的独特运动向量区域尺寸 1100 和 1102。在根据这个发明计算插值时，确定运动向量区域尺寸的联合 1108。联合 1108 定义了所有的被认为是具有分配的运动向量的区域。

因此，例如在将 B 帧 1112 的 4x4 DCT 区域向后插值到前面 P 帧 1104 时，联合 1108 内的 4x4 区域 1110 会使用对应于前面 P 帧中的 8x16 区域 1114 的运动向量。如果前向预测，那么联合 1108 内的 1110 区域会使用对应于下一 P 帧中的 4x16 区域 1115 的运动向量。类似地，联合 1108 内的区域 116 的向后插值会使用对应于 8x16 区域 1114 的运动向量，而前向预测相同的区域会使用对应于 12x16 区域 1117 的运动向量。

在本发明的一个实施例中，利用两个步骤来实现普遍（即非统一尺寸）运动向量的插值。第一步是确定运动向量共同区域，如关于图 11 所描述的。这为每个前面帧或者后续帧参考建立了像素和运动向量之间的对应（即每个指定像素区域尺寸的运动向量的数量）。第二步是利用合适的插值方法和对于像素的每个区域有效的插值因子。编码器的任务是确保最优的或接近最优的运动向量区域和插值方法被指定，且所有像素使它们的向量和插值方法完全被指定。对于运动向量的固定模式（例如为整个帧指定每个 32x8 块一个运动向量），具有单个指定的插值方法（例如为整个帧指定的到被参考帧的每个距离的固定比例混合）的情况，这非常简单。如果对运动向量区域尺寸做区域性的改变，且区域尺寸的不同依赖于参考的是哪个前面帧或者后续帧（例如对于最近的前面帧是 8x8 块，对于下一个最近的前面帧是 32x8 块），这个方法也能变得相当复杂。此外，可以在帧内区域性地指定插值方法。

编码时，编码器的工作是确定比特的最优或接近最优的用法以在运动向量区域形状和尺寸之间选择，和选择最优或接近最优的插值方

法。还需要一个决定以指定被参考帧的数量和距离。通过详尽地测试大量候选运动向量区域尺寸、要参考的候选帧和每个这样的运动向量区域的插值方法来确定这些指定，直到找到最优或接近最优的编码。最优（相对于选定的标准）可以通过在编码块之后找到最小的 SNR 或者在编码块之后找到固定量化参数（QP）的最少比特数，或者通过应用其他合适的测量来确定。

直接模式扩展

在 MPEG-4 中的 B 帧宏块中使用的传统直接模式，在运动向量编码中是高效的，利用简单共同增量提供了 8x8 块模式的好处。直接模式基于时间距离在对应的宏块位置处对后续 P 帧的每个对应的运动向量进行加权，该 P 帧参考前面 P 帧。例如，如果 M=3（即两个居间的 B 帧），用简单线性插值，第一个 B 帧使用-2/3 倍的后续 P 帧运动向量以确定相对于这种 P 帧的像素偏移，和 1/3 倍的后续 P 帧运动向量以确定相对于前面 P 帧的像素偏移。类似地，第二个 B 帧使用-1/3 倍的相同 P 帧运动向量以确定相对于这种 P 帧的像素偏移，和 2/3 倍的后续 P 帧运动向量以确定相对于前面 P 帧的像素偏移。在直接模式中，小的增量被加到每个对应的运动向量。作为这个发明的另一个方面，这个概念可以扩展至指向一个或多个 n 远离 P 帧的 B 帧参考，这些 P 帧又参考一个或多个前面或后续 P 帧或 I 帧，通过考虑帧距离来确定帧比例分数（frame scale fraction）。

图 12 是显示 P 帧和 B 帧序列的图，其中 B 帧的插值权重被确定为到 2 远离后续 P 帧的距离的函数，该 P 帧参考 1 远离后续 P 帧。在这个说明性的例子中，M=3，表示在进行包围的 P 帧 1204、1206 之间有两个连续 B 帧 1200、1202。在这个例子中，在下一个最近的后续 P 帧 1208 中的每个共存的宏块可指向该居间的（即最近的）P 帧 1204，且最初的两个 B 帧 1200、1202 可参考下一个最近的后续 P 帧 1208 而不是最近的后续 P 帧 1204，如在传统 MPEG 中的。因而，对于第一个 B 帧 1200，帧比例分数 5/3 乘以来自下一个最近的后续 P 帧 1208 的运动向量 mv 会被用作相对于 P 帧 1208 的像素偏移，且第二个 B 帧 1202 会使用 4/3 乘以那个相同的运动向量的偏移。

如果被 B 帧参考的最近的后续 P 帧指向下一个最近的前面 P 帧，那么再次使用简单的帧距离以获得应用于运动向量的合适的帧比例分数。图 13 是显示 P 帧和 B 帧序列的图，其中 B 帧的插值权重被确定为到 1 远离后续 P 帧的距离的函数，该 P 帧参考 2 远离前面 P 帧。在这个说明性的例子中，M=3，B 帧 1300、1302 参考最近的后续 P 帧 1304，该 P 帧 1304 又参考 2 远离 P 帧 1306。因而，对于第一个 B 帧 1300，像素偏移分数是帧比例分数 2/6 乘以来自最近后续 P 帧 1304 的运动向量 mv，且第二个 B 帧 1302 会具有 1/6 乘以那个相同的运动向量的像素偏移，因为最近的后续 P 帧 1304 的运动向量指向 2 远离前面 P 帧 1306，该帧相距 6 个帧。

通常，在直接模式中 B 帧参考单个 P 帧的情况下，帧距离方法设定帧比例分数的分子等于该 B 帧到其参考的或者“目标”P 帧的帧距离，并设定分母等于从目标 P 帧到另一个被目标 P 帧参考的 P 帧的距离。对于从 B 帧到后续 P 帧进行的测量，帧比例分数的符号是负号，而对于从 B 帧到前面 P 帧进行的测量，帧比例分数的符号是正号。这种把帧距离或者帧比例分数应用于 P 帧运动向量的简单方法能够实现有效的直接模式编码。

此外，这个发明的另一个方面是允许直接模式应用于一个 P 帧的多个插值的运动向量参考。例如，如果从最近的和下一个最近的前面 P 帧插值一个 P 帧，那么根据本发明的这个方面的直接模式参考允许插值混合用于每个多参考直接模式 B 帧宏块。通常，一个 P 帧的两个或多个运动向量可以应用一个合适的帧比例分数。然后，两个或多个帧距离修正的运动向量可以和参考或指向那个 P 帧的每个 B 帧的对应插值权重一起使用（如下所述），以生成插值 B 帧宏块运动补偿。

图 14 是显示 P 帧和 B 帧序列的图，其中一个后续 P 帧具有多个参考前面 P 帧的运动向量。在这个例子中，B 帧 1400 参考后续 P 帧 P3。这个 P3 帧又具有两个运动向量 mv1 和 mv2，其参考对应的前面 P 帧 P2 和 P1。在这个例子中，可以使用两个加权项中的任一个或者这种加权项的组合在直接模式中对 B 帧 1400 的每个宏块进行插值。

B 帧 1400 的每个宏块可根据下列项构造成混合形式：

- 由 mv1 的帧比例分数 1/3 取代的帧 P2 的对应像素（这些像素

然后可能乘以某个比例权值 i）加上由 mv1 的帧比例分数-2/3 取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 j）；以及

- 由 mv2 的帧比例分数 2/3（4/6）取代的帧 P1 的对应像素（这些像素然后可能乘以某个比例权值 k）加上由 mv2 的帧比例分数-1/3（-2/6）取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 *l*）。

和所有的直接模式一样，运动向量增量可以与 mv1 和 mv2 中的每一个一起使用。

根据本发明的这个方面，如同多个前面 P 帧的情况一样，使用相同的插值方法和运动向量帧比例分数应用，B 帧中的直接模式预测宏块也能够参考多个后续的 P 帧。图 15 是显示 P 帧和 B 帧序列的图，其中最近的后续 P 帧具有参考一个前面 P 帧的运动向量，且下一个最近的后续 P 帧具有参考前面多个 P 帧的多个运动向量。在这个例子中，B 帧 1500 参考两个后续 P 帧 P2 和 P3。帧 P3 具有两个运动向量 mv1 和 mv2，它们参考对应的前面 P 帧 P2 和 P1。帧 P2 有一个运动向量 mv3，其参考前面 P 帧 P1。在这个例子中，使用 3 个加权项在直接模式中对 B 帧 1500 的每个宏块进行插值。假如这样的话，运动向量帧比例分数可以大于 1 或小于-1。

这种形式的直接模式 B 帧宏块插值的加权可以利用这里描述的插值的全部通用性。特别是，为了获得各种图像单元的最佳性能（例如质量对比特数），可对每个权值或者权值的组合进行测试。用于这种改进直接模式的插值分数组可以每个图像单元用少量比特指定给解码器。

B 帧 1500 的每个宏块可根据下列项构造成混合形式：

- 由 mv1 的帧比例分数-5/3 取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 i）加上由 mv1 的帧比例分数-2/3 取代的帧 P2 的对应像素（这些像素然后可能乘以某个比例权值 j）；
- 由 mv2 的帧比例分数-5/6 取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 k）加上由 mv2 的帧比例分数 1/6

取代的帧 P1 的对应像素（这些像素然后可能乘以某个比例权值 *l*）；以及

- 由 mv3 的帧比例分数-2/3 取代的帧 P2 的对应像素（这些像素然后可能乘以某个比例权值 m）加上由 mv3 的帧比例分数 1/3 取代的帧 P1 的对应像素（这些像素然后可能乘以某个比例权值 n）。

和所有的直接模式一样，运动向量增量可以与 mv1、 mv2 和 mv3 中的每一个一起使用。

注意，当下一个最近的后续 P 帧参考了包围一候选 B 帧的最近的 P 帧时，经常出现特别有益的直接编码模式。

在 MPEG-4 中 B 帧的直接模式编码总是使用后续 P 帧的运动向量作为参考。根据本发明的另一个方面，B 帧参考前面 P 帧的共存宏块的运动向量也是可能的，这些运动向量有时将证明直接模式编码参考的有益选择。假如这样的话，当下一个最近的前面 P 帧被最近的前面 P 帧的运动向量参考时，运动向量帧比例分数将大于 1。图 16 显示了 P 帧和 B 帧序列，其中最近的前面 P 帧具有参考前面 P 帧的运动向量。在这个例子中，B 帧 1600 参考了 1 远离的前面 P 帧 P2。帧 P2 的运动向量 mv 参考下一个前面 P 帧 P1（相对于 B 帧 1600，2 远离）。图中显示了合适的帧比例分数。

如果根据多个向量和帧对最近的前面 P 帧进行插值，那么应用类似于结合图 14 所描述的那些方法以获得运动向量帧比例分数和插值权值。图 17 是显示 P 帧和 B 帧序列的图，其中最近的前面 P 帧具有两个参考前面 P 帧的运动向量。在这个例子中，B 帧 1700 参考前面 P 帧 P3。前面的帧 P3 的一个运动向量 mv1 参考下一个前面 P 帧 P2，而第二个运动向量 mv2 参考 2 远离的前面 P 帧 P1。图中显示了合适的帧比例分数。

B 帧 1700 的每个宏块可以根据下列项构造成混合形式：

- 由 mv1 的帧比例分数 1/3 取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 i）加上由 mv1 的帧比例分数 4/3 取代的帧 P2 的对应像素（这些像素然后可能乘以某个比例权值 j）；以及

- 由 mv2 的帧比例分数 1/6 取代的帧 P3 的对应像素（这些像素然后可能乘以某个比例权值 k）加上由 mv2 的帧比例分数 7/6 取代的帧 P1 的对应像素（这些像素然后可能乘以某个比例权值 *l*）。

当前面 P 帧（相对于 B 帧）的运动向量指向下一个最近的前面 P 帧时，没有必要只利用下一个最近的前面帧作为插值参考，如在图 16 中的。最近的前面 P 帧可以为运动补偿证明更好的选择。假如这样的话，最近的前面 P 帧的运动向量被缩短到从 B 帧到那个 P 帧的帧距离分数。图 18 是显示 P 帧和 B 帧序列的图，其中最近的前面 P 帧具有一个参考前面 P 帧的运动向量。在这个例子中，对于 M=3，第一个 B 帧 1800 会使用 1/3 和-2/3 帧距离分数乘以最近的前面 P 帧 P2 的运动向量 mv。第二个 B 帧 1802 会使用 2/3 和-1/3 帧距离分数（未示出）。将这种选择通知解码器以区分这个例子和图 16 中所示的例子。

和所有其他的编码模式一样，直接模式的使用最好包括根据其他可用的插值和单向量编码模式和参考帧对候选模式进行测试。对于直接模式测试，最近的后续 P 帧（可选地，和下一个最近的后续 P 帧或甚至更远的后续 P 帧，和/或一个或多个前面 P 帧）可被作为候选帧测试，并且少量的比特（典型地是一个或两个）可被用于指定由解码器使用的直接模式 P 参考帧距离。

扩展的插值值

在 MPEG-1、2、4 及 H.261 和 H.263 标准中指定了，B 帧使用前向参考帧和后向参考帧的像素值的等加权，如由运动向量所取代的。本发明的另一个方面包括各种有用的不相等加权的应用，这些不相等加权显著提高 B 帧编码效率，以及这种不相等加权到多于两个参考的扩展，这些参考包括两个或多个时间上向前或者向后的参考。本发明的这个方面还包括用于为 P 帧而被参考和插值的一个以上的帧的方法。此外，当两个或多个参考在时间上指向前，或者当两个或多个参考在时间上指向后时，那么有时使用负权重和超过 1.0 的权重是有用的。

例如，图 19 是显示三个 P 帧 P1、P2 和 P3 的帧序列，其中 P3 用两个运动向量使用插值参考，而 P1 和 P2 各一个。例如，如果连续的

变化正在 P1 和 P3 之间的帧范围发生，那么 P2-P1（即帧 P2 的像素值（被 P2 的运动向量所取代）减去帧 P1 的像素值（被 P1 的运动向量所取代））将等于 P3-P2。类似地，P3-P1 将是 P2-P1 和 P3-P2 大小的两倍。在这种情况下，可以通过公式从 P2 和 P1 差别地预测帧 P3 的像素值：

P3 = P1 + 2 x (P2 - P1) = (2 x P2) - P1

既然这样，P3 的插值权重对于 P2 是 2.0，对于 P1 是-1.0。

作为另一个例子，图 20 显示了四个 P 帧 P1、P2、P3 和 P4 的帧序列，其中 P4 使用具有三个运动向量的插值参考，而 P1、P2 和 P3 各一个。因此，由于 P4 是从 P3、P2 和 P1 预测的，所以应用三个运动向量和插值权重。在这种情况下，如果连续的变化正在这个帧范围上发生，那么 P2 - P1 将等于 P3 - P2 和 P4 - P3，而 P4-P1 将等于 3 x (P2 - P1)和 3 x (P3 - P2)。

因此，在这个例子中，基于 P2 和 P1 的 P4 预测为：

P4 = P1 + 3 x (P2 - P1) = (3 x P2) - (2 x P1)　　(权重为 3.0 和-2.0)

基于 P3 和 P1 的 P4 预测为：

P4 = P1 + 3/2 x (P3 - P1) =(3/2 x P3) - (1/2 x P1) (权重为 1.5 和-0.5)

基于 P3 和 P2 的 P4 预测为：

P4 = P2 + 2 x (P3-P2) = (2 x P3) - P2　　(权重为 2.0 和-1.0)

然而可能的是，最靠近 P4（包括 P3 和 P2）的变化，比包括 P1 的预测是更可靠的 P4 的预测值。因此，通过给上面包括 P1 的两个项各 1/4 权重，并给仅包括 P3 和 P2 的项 1/2 权重，将导致：

1/2(2 P3 - P2) + 1/4(3/2 P3 - 1/2 P1) + 1/4(3 P2 – 2 P1) =

1 3/8 P3+1/4 P2 - 5/8 P1　　（权重为 1.375, 0.25 和-0.625）

据此，有时既使用大于 1.0 的权重又使用小于 0 的权重是有用的。在其它时候，如果从一个帧到下一个帧存在类似噪音的变化，具有 0.0 和 1.0 之间的适度的系数的正加权平均可产生 P4 的宏块（或者其他的像素区域）的最佳预测。例如，图 20 中 P1、P2 和 P3 各 1/3 的等加权在某些情况下可能形成 P4 的最佳预测。

注意最佳匹配的运动向量被用来确定 P1、P2、P3 等的区域，在这个例子中，计算时使用了 P1、P2、P3。在某些情况下，这个匹配可能最好是 AC 匹配，其允许变化的 DC 项通过 AC 系数预测。或者，如果

使用 DC 匹配（例如绝对差的和），那么经常能够预测 AC 系数的变化。在其他情况下，各种形式的运动向量匹配将形成具有各种权重混合的最佳预测。通常，特定情况的最佳预测是使用这里所描述的方法经验地确定的。

这些技术也适用于具有两个或多个在时间上指向后或指向前的运动向量的 B 帧。当在时间上指向前时，以上描述的用于 P 帧的系数模式被颠倒过来以准确地向后预测当前的 P 帧。使用本发明的这个方面，在向前和向后两个方向上均具有两个或多个运动向量是可能的，因此同时在两个方向预测。这些各种预测的合适的加权混合可以通过选择混合的加权来优化，混合加权最佳地预测了当前 B 帧的宏块（或其他像素区域）。

图 21 是显示 P 帧和 B 帧序列的图，其中不同 P 帧具有一个或多个参考前面不同 P 帧的运动向量，图中也显示了分配给被特定 B 帧参考的各自向前和向后参考的不同权重 a-e。在这个例子中，B 帧 2100 参考三个前面 P 帧和两个后续 P 帧。

在图 21 所示的例子中，帧 P5 必须被解码以使这个例子工作。有时以解码所需的顺序（“发送顺序”）在比特流中给帧排序是有用的，发送顺序没有必要是显示的顺序（“显示顺序”）。例如，在显示循环运动（例如物体的旋转）的帧序列中，特定的 P 帧可能更类似远处的 P 帧而不是最近的后续 P 帧。图 22 是显示 P 帧和 B 帧序列的图，其中 P 帧的比特流发送顺序不同于显示顺序。在这个例子中，帧 P3 更类似于帧 P5 而不是帧 P4。因此在 P4 之前发送和解码 P5，但在 P5 之前显示 P4 是有用的。优选地，当这种 P 帧可以被丢弃时（例如在比特流顺序中 n 个帧的终止时间或者在显示顺序中的帧 X 之后），每个 P 帧应该通知解码器。

如果从一个小的选择集中选择权重，那么少量比特就能够通知解码器要使用哪个权重。和这里所描述的所有其他权重一样，这可以每一个图像单元通知解码器一次，或者在解码过程中权重变化是有用的任何其他点上。

下载新的权重集也是可能的。在这种方式中，少量的权重集可以在给定时间上有效。这允许少量的比特通知解码器在解码过程中在任

何给定点将使用哪个有效的权重集。为了确定合适的权重集，可以在编码过程中测试大量的权重。如果发现小的子集提供高效率，那么可以通知解码器使用那个子集。因此能够只用几个比特把该子集的特定元素通知解码器。例如 10 个比特可以选择 1024 个子集元素中的一个。此外，当改变特定的小子集以维持效率时，可以把新的子集通知解码器。因此，编码器可以对比更新权重集所需的比特数，动态地优化在权重集元素中选择所需的比特数。此外，少量的短编码能被用于表示常见的有用权重，例如 1/2、1/3、1/4 等等。在这种方式中，少量的比特能被用于表示权重集，例如用于 P 帧中的 K-前向-向量预测（其中 K=1, 2, 3 …），或者 B 帧中的 K-前向-向量和 L-后向-向量预测（其中 K 和 L 从 0, 1, 2, 3 …中选择），或者 P 帧中的 K-前向-向量和 L-后向-向量预测（其中 K 和 L 从 0, 1, 2, 3 …中选择），作为当前 M 值的函数（即 B 帧相对于邻近 P（或 I）帧的相对位置）。

图 23 是显示具有分配权重的 P 帧和 B 帧序列的图。B 帧 2300 具有权重 a-e，其值是从 B 帧权重集 2302 的表格分配的。P 帧 2304 具有权重 m 和 n，其值是从 P 帧权重集 2306 的表格分配的。某些权重可以是静态的（即不变地下载到解码器），并由编码器通知。其他权重可以被动态地下载然后通知。

这个相同的技术可被用于动态地更新权重集以对比于 AC 插值选择 DC 插值。此外，可以表示编码值，其对比于变换值（在替换的线性或非线性表示中）的线性插值选择一般的（线性）插值（通常以非线性表示表示的像素值的插值）。类似地，这种编码值可以表示哪些这样的插值应用于 AC 值或 DC 值或者是否分开预测的 AC 和 DC 部分。

有效的子集也可被用于最少化在目前使用的权重系数集之间选择所必需的比特数。例如，如果 1024 个下载的权重集被保存在解码器中，那么可能在帧的一个特定部分期间需要大概 16 个是有效的。因此，通过选择（从 1024 个中选出）16 个权重集的哪些子集是有效的，只需要使用 4 个比特选择这 16 个中的哪个权重集是有效的。可以为这些最常见子集使用短编码来表示这些子集，因而允许少量的比特在常用的子集中选择。

柔化和锐化

和通过减去平均值从 AC 信号中简单地分开 DC 分量一样，在运动向量补偿预测的过程中，其他的滤波运算也是可能的。例如，各种高通、带通和低通滤波器可被应用于像素区域（例如宏块）以提取各种频率带。然后，当进行运动补偿时，可以修改这些频率带。例如，在有噪音的移动图像上滤出最高的频率以柔化（使之不太清晰或者稍微地模糊）该图像通常可能是有用的。更加柔化的图像像素，与用于量化的更陡的斜矩阵（tilt matrix）结合（更陡的斜矩阵忽略当前块中的更高频率的噪音），通常形成更高效的编码方法。已经有可能在每个图像单元的量化斜矩阵中表示变化。还可能下载亮度和色度的定制斜矩阵。注意不管斜矩阵是否改变，都可以提高运动补偿的效率。然而，通常最有效的是既改变斜矩阵又改变在运动补偿过程中应用的滤波器参数。

常见做法是使用降低的色度编码分辨率和色度特定的斜矩阵。但是，在这个例子中，色度编码分辨率是静态的（例如 4:2:0 水平和垂直地编码半分辨率或者 4:2:2 只是水平地编码半分辨率）。可以根据本发明的这个方面通过在运动补偿过程中把一个动态滤波器处理应用于色度和亮度（独立地或合作地）来提高编码效率，每个图像单元选择一个。

题为“Enhanced Temporal and Resolution Layering in Advanced Television”的美国专利申请 09/545233 号（前文引用过）描述了改进的负半周（截断的正弦函数）位移滤波器的使用。这些滤波器具有的优点是当进行运动向量位移的碎片像素（fractional-pixel）部分时，它们保持清晰度。在整像素（integer pixel）位移点和碎片像素位移点，使用降低或提高其清晰度的滤波器可更优地移动某些宏块（或其他有用的图像区域）。例如，对于“变焦”（其中，帧中的某些物体随着时间移出焦点和帧的其他部分进入焦点）来说，转变是清晰度和柔度的变化之一。因此，能够在图像的某些区域提高清晰度而在其他区域降低清晰度的运动补偿滤波器能够提高编码效率。特别地，如果图像的区域正移出焦点，那么降低清晰度可能是有益的，这将柔化图像（因而可能产生更好的匹配）和减少颗粒和/或噪音（因而可能提高编码效

率）。如果图像的区域正进入焦点，那么保持最好的清晰度或者甚至使用更大的负半周正弦滤波器值提高清晰度可能是有益的。

在编码过程中，色度滤波也能够从提高和降低清晰度中受益。例如，4:2:0 编码（水平和垂直地编码半分辨率色度）的许多编码效率优点可以通过为色度使用更柔的运动补偿滤波器而在U和/或V通道中保持全分辨率来实现。仅仅当在 U 和 V 通道中的色彩细节是高时，才有必要选择最清晰的位移滤波器；在有高色彩噪音或者颗粒的地方较柔的滤波器将更有益。

除了焦点的变化之外，从一个帧到下一个帧的方向和运动模糊变化量也是普遍的。当运动图像胶片帧的速率为 24 fps 时，即使一个简单的对话场景从一个帧到下一个帧在运动模糊方面也有显著的变化。例如，在一个帧中上嘴唇可能是模糊的，且在下一个帧中清晰化，这完全是由于在照相机中打开快门期间的嘴唇运动。对于这样的运动模糊，不仅在运动补偿过程中具有锐化和柔化（模糊化）滤波器而且具有锐化和柔化的方向方面将是有益的。例如，如果可以确定运动的方向，那么沿那个方向的柔化或锐化可被用于对应图像特写的移动或停止。用于运动补偿的运动向量本身可以相对于任何周围的帧（或对应区域）为特定帧（或帧内的区域）提供关于运动量、运动量的变化（即运动模糊）的一些有用信息。特别是，运动向量是 P 帧之间的最佳运动匹配，而运动模糊来自帧中的在打开快门时间期间的运动。

图 24 是一个帧内的物体位置对时间的图。照相机的快门只在部分帧时间期间打开。当快门打开时，物体的任何运动导致模糊。运动模糊量是由在快门打开期间的位置变化量表示的。因此，当快门打开时位置曲线 2400 的斜率是运动模糊的度量。

运动模糊量和运动方向也可以从清晰度量度、周围的运动向量（图像区域匹配的地方）、特征拖影检测和帧区域的人为辅助指定的组合中确定。可以基于确定的运动模糊量和运动方向选择滤波器。例如，对比所确定的运动模糊量和运动方向，各种滤波器的映射可以经验地确定。

当结合本发明的其他方面时，这种智能应用的滤波器可以显著地提高压缩编码效率。可以选择少量的这种滤波器，用少量的比特通知

解码器。同样，这能够是以每个图像单元一次或者在解码过程中的其他有用点上实现。与权重集一样，可以使用一组动态装入的滤波器，以及有效的子集机制以最少化在最有益的滤波器参数集合之间选择所需的比特数。

实现

本发明可以在硬件或软件，或者两者的组合（例如可编程的逻辑阵列）中实现。除非另外指定，作为本发明的一部分而包括的算法本质上不与任何特定的计算机或者其他装置相关。特别地，各种通用目的的设备可以与根据本文所述编写的程序一起使用，或者可能更方便的是构造更特殊的装置（例如集成电路）以执行特定功能。因此，本发明可以在一个或多个可编程计算机系统上执行的一个或多个计算机程序中实现，每个可编程计算机系统包括至少一个处理器、至少一个数据存储系统（包括永久的和易失的存储器和/或存储单元），至少一个输入设备或端口，和至少一个输出设备或端口。程序代码被应用于输入数据以执行这里描述的功能并生成输出信息。输出信息以公知的方式被应用于一个或多个输出设备。

每个这样的程序可以用任何希望的计算机语言（包括机器的、汇编的、或高级过程化的、逻辑的、面向对像的编程语言）实现以与计算机系统通信。在任何情况下，语言可以是编译语言或解释语言。

每个这样的计算机程序优选存储在或者下载到存储介质或设备上（例如固态存储器或介质，或者磁介质或光介质），这些存储介质或设备是通用或专门目的的可编程计算机可读的，当存储介质或设备被计算机系统读取以执行这里描述的程序时，这样的计算机程序用于配置和操作计算机。也可以考虑将本发明系统实现成计算机可读存储介质，其被配置为具有一计算机程序，如此配置的存储介质使计算机系统以特定的和预定的方式运行以执行本文所描述的功能。

已经描述了本发明的多个实施例。但是，应该理解的是，在不脱离本发明的精神和范围的情况下可以进行各种修改。例如，上文所述的某些步骤可能是顺序无关的，因此可以以一种与所述不同的顺序执行。因此，其他的实施例均在所附权利要求的范围内。

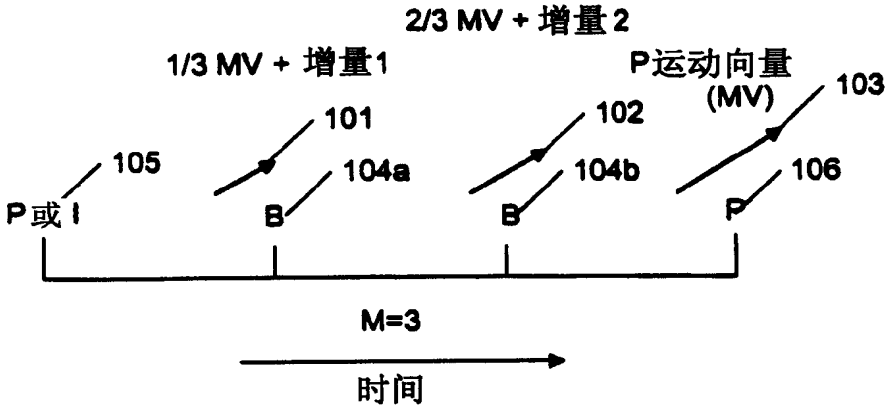


图1
比例运动向量加权
（现有技术）

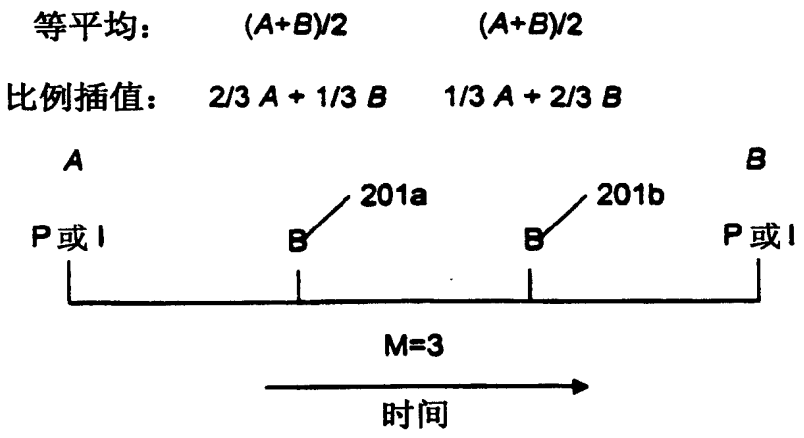


图2
像素值比例加权

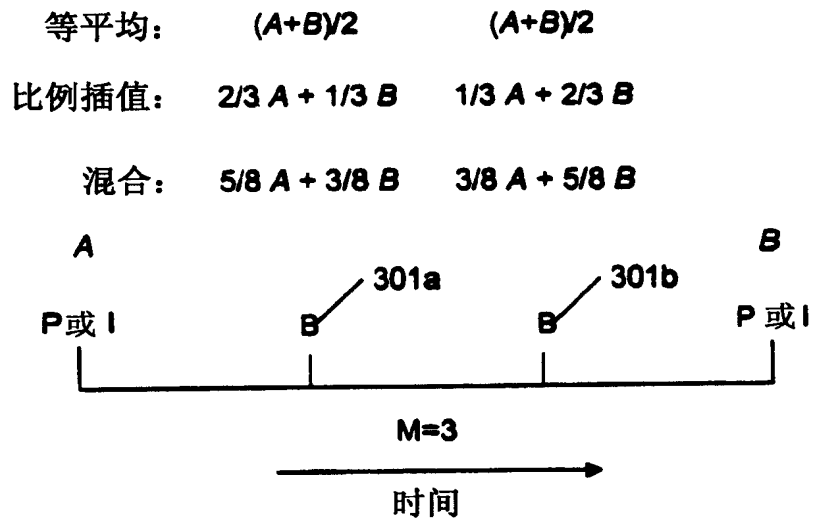


图3
混合像素值加权

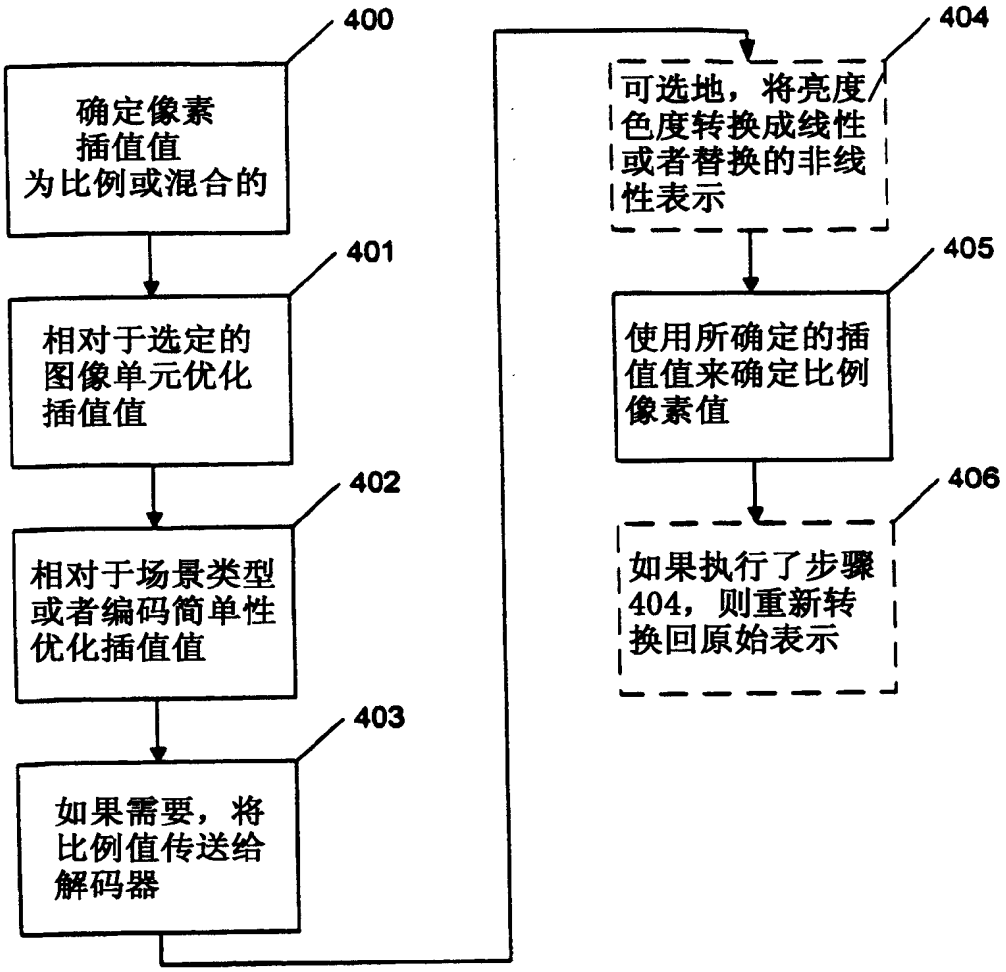

400
确定像素插值值为比例或混合的
401
相对于选定的图像单元优化插值值
402
相对于场景类型或者编码简单性优化插值值
403
如果需要，将比例值传送给解码器
404
可选地，将亮度/色度转换成线性或者替换的非线性表示
405
使用所确定的插值值来确定比例像素值
406
如果执行了步骤404，则重新转换回原始表示

图4

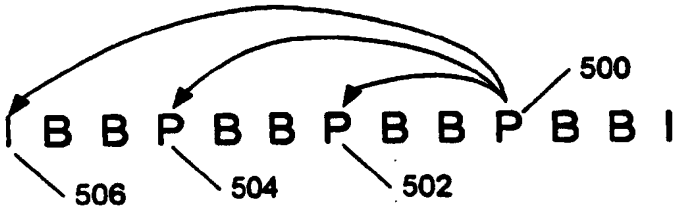


图5

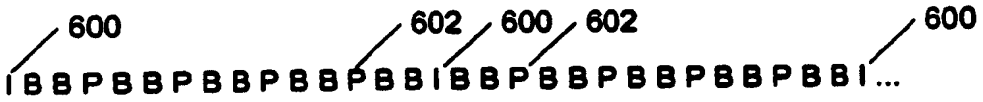


图6A
现有技术

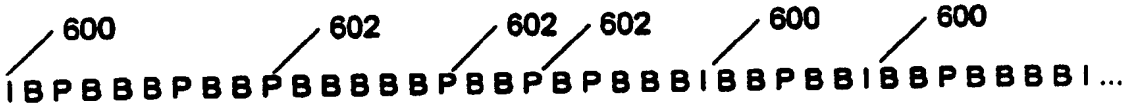


图6B
现有技术

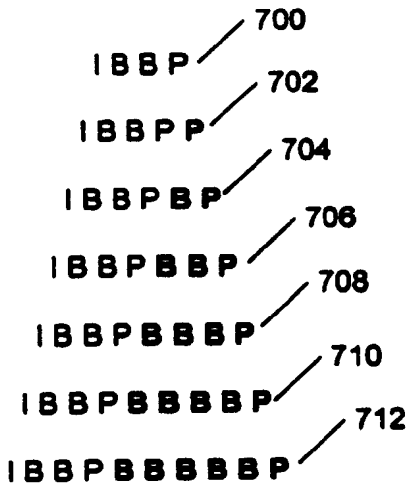

700
IBBP
702
IBBPP
704
IBBPBP
706
IBBPBBP
708
IBBPBBBP
710
IBBPBBBBP
712
IBBPBBBBBP

图7

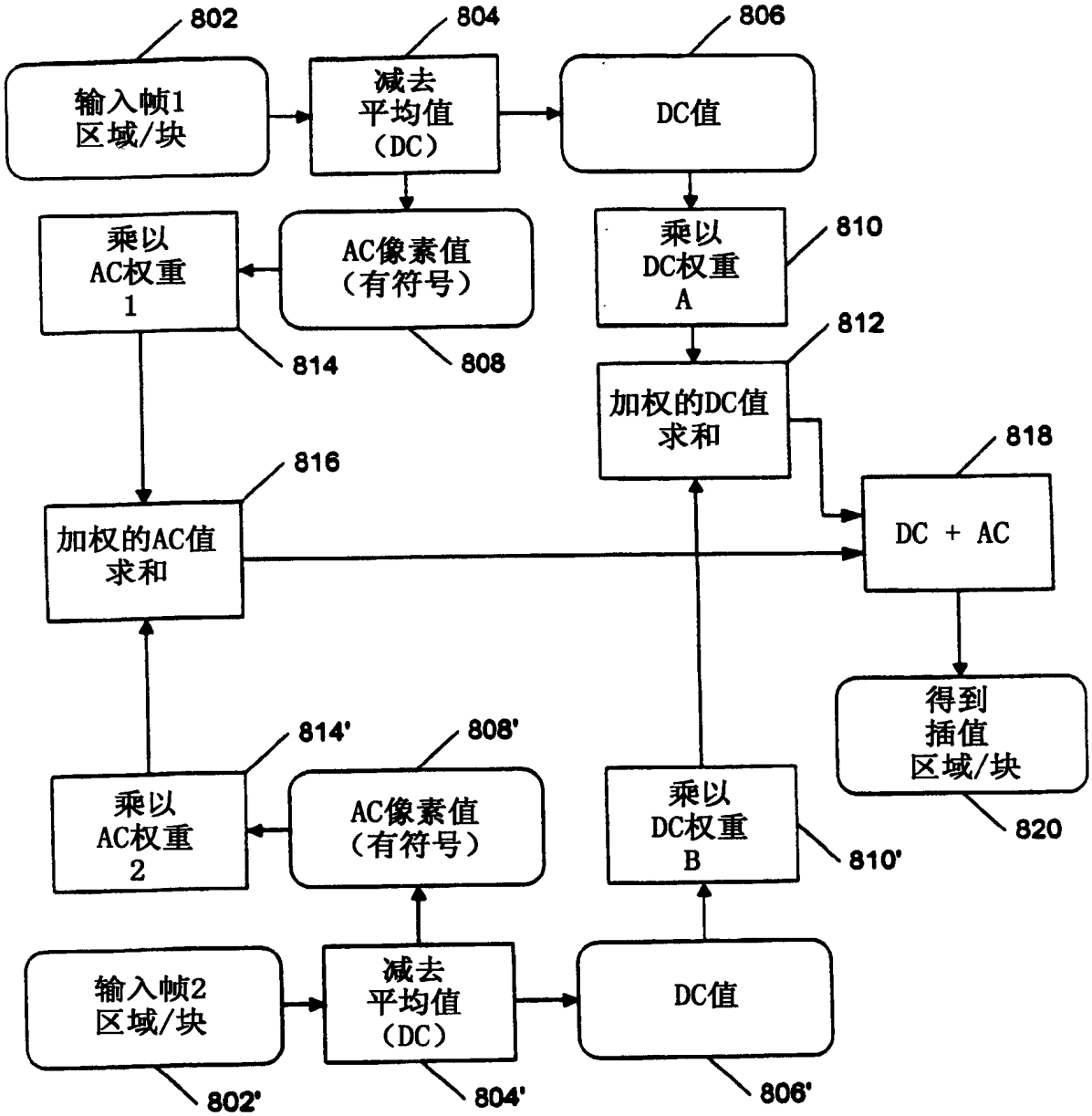

802
804
806
输入帧1
区域/块
减去
平均值
(DC)
DC值
乘以
AC权重
1
AC像素值
(有符号)
乘以
DC权重
A
810
814
808
812
加权的DC值
求和
818
816
加权的AC值
求和
DC + AC
得到
插值
区域/块
820
814'
808'
乘以
AC权重
2
AC像素值
(有符号)
乘以
DC权重
B
810'
输入帧2
区域/块
减去
平均值
(DC)
DC值
802'
804'
806'

图8

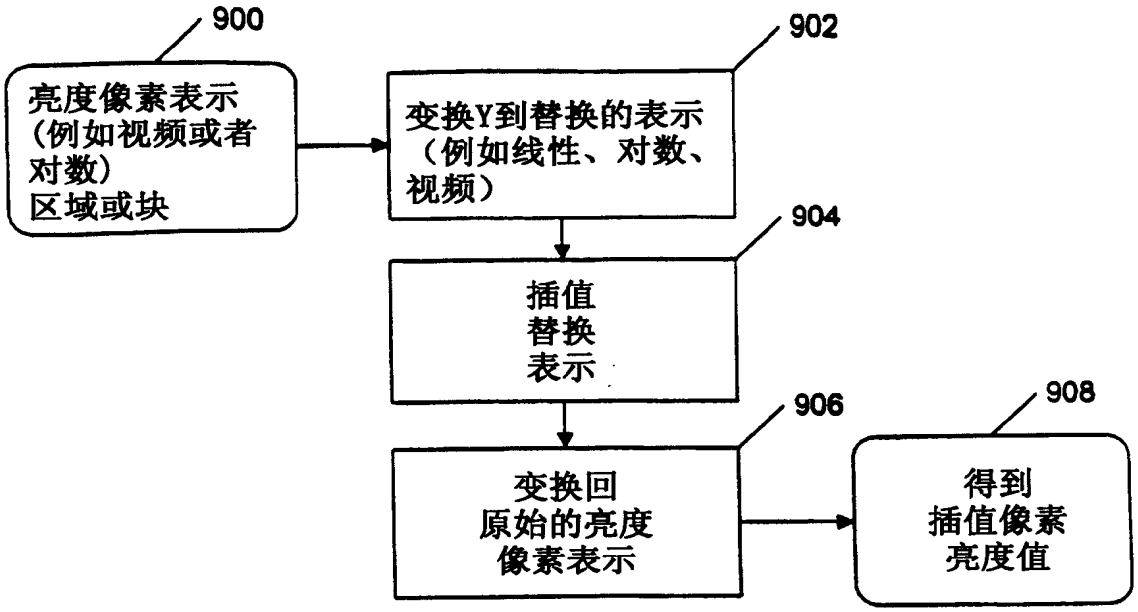

900
亮度像素表示（例如视频或者对数）区域或块
902
变换Y到替换的表示（例如线性、对数、视频）
904
插值替换表示
906
变换回原始的亮度像素表示
908
得到插值像素亮度值

图9

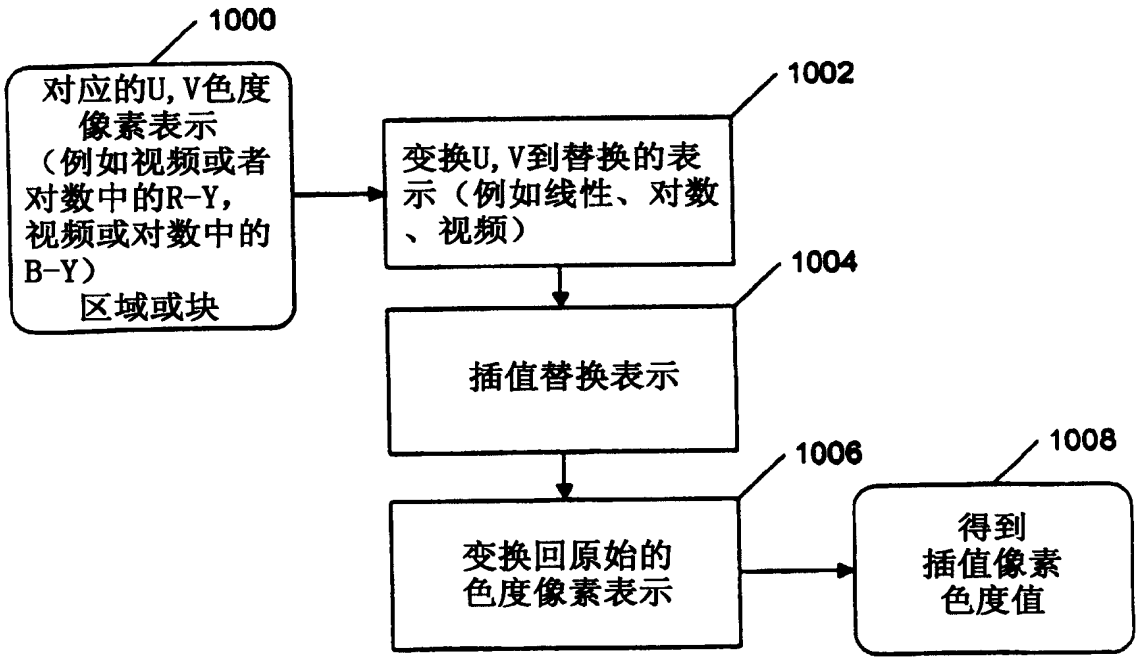

1000
对应的U,V色度像素表示（例如视频或者对数中的R-Y，视频或对数中的B-Y）区域或块
1002
变换U,V到替换的表示（例如线性、对数、视频）
1004
插值替换表示
1006
变换回原始的色度像素表示
1008
得到插值像素色度值

图10

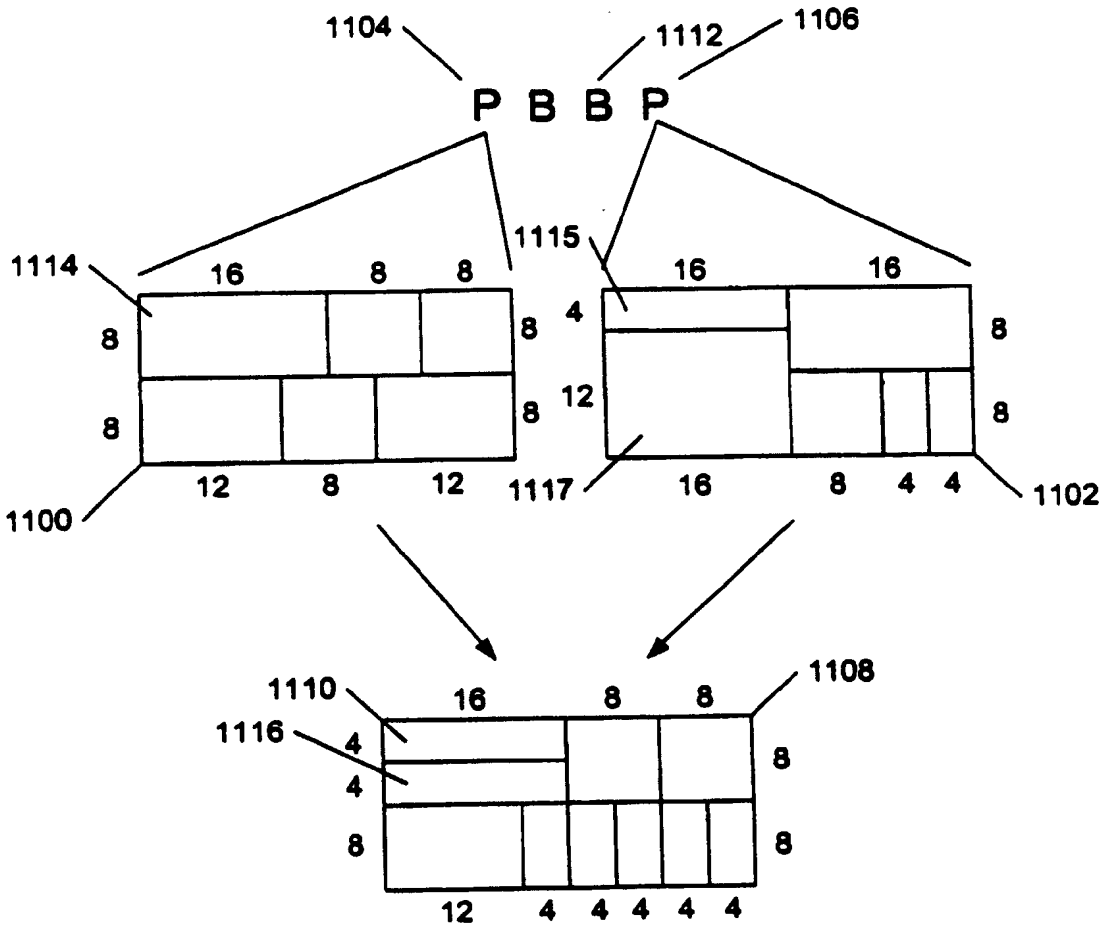

1104
1112
1106
P B B P
1114
1115
16
8
8
16
16
8
8
4
8
8
12
8
8
12
8
12
1117
16
8
4
4
1100
1102
1110
1108
16
8
8
1116
4
4
8
8
8
12
4
4
4
4
4

图11

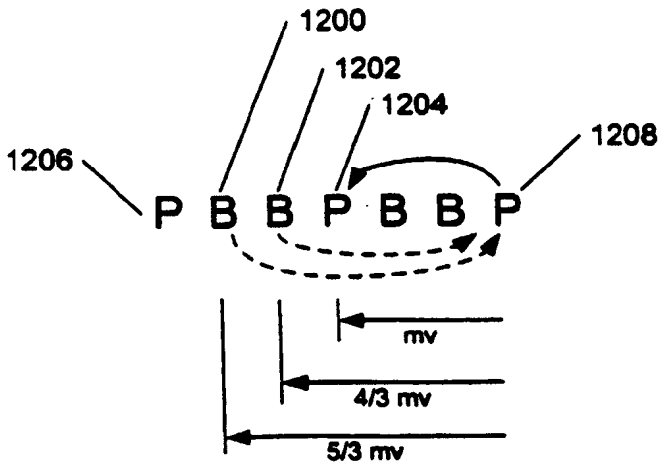

1200
1202
1204
1206
1208
P B B P B B P
mv
4/3 mv
5/3 mv

图12

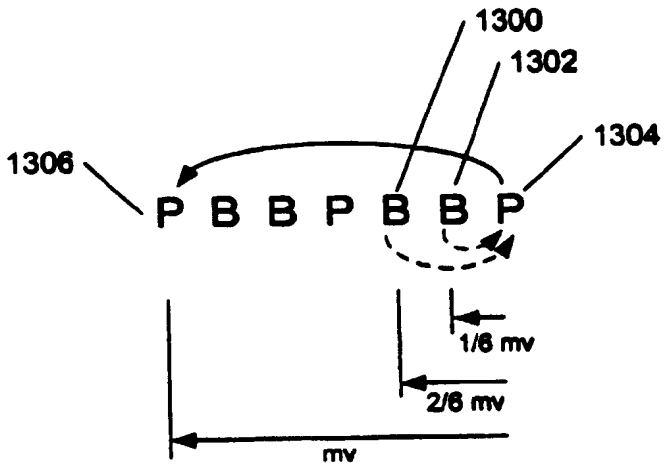

1300
1302
1304
1306
P B B P B B P
1/6 mv
2/6 mv
mv

图13

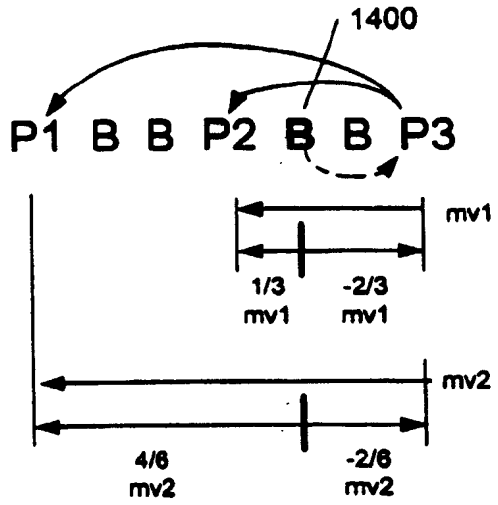

1400
P1 B B P2 B B P3
mv1
1/3
mv1
-2/3
mv1
mv2
4/6
mv2
-2/6
mv2

图14

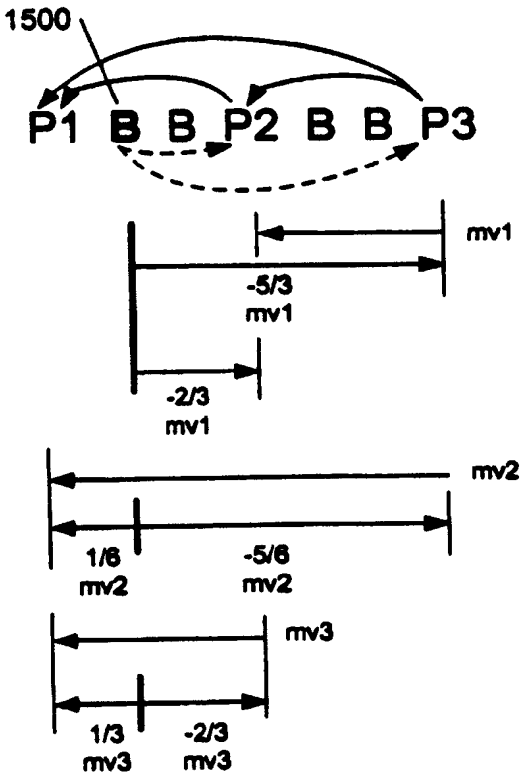

1500
P1 B B P2 B B P3
mv1
-5/3
mv1
-2/3
mv1
mv2
1/6
mv2
-5/6
mv2
mv3
1/3
mv3
-2/3
mv3

图15

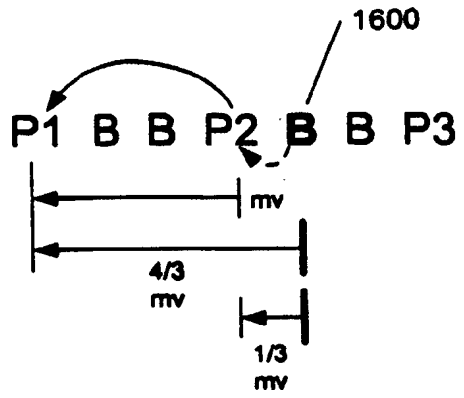

1600
P1 B B P2 B B P3
mv
4/3
mv
1/3
mv

图16

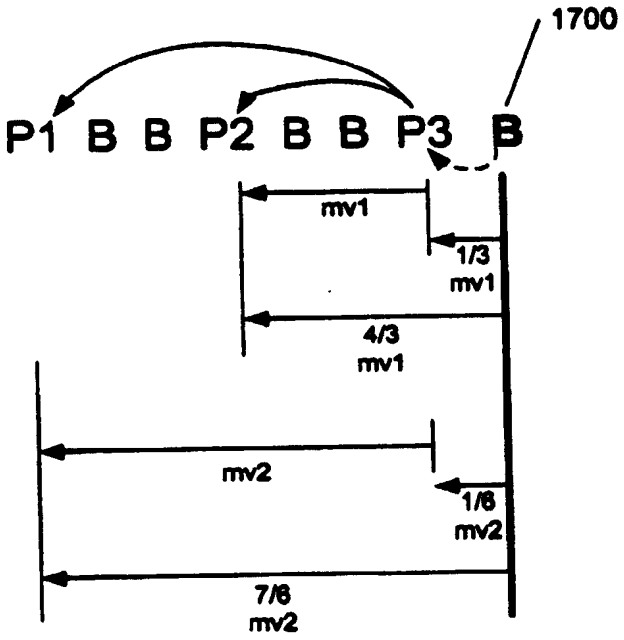

1700
P1 B B P2 B B P3 B
mv1
1/3
mv1
4/3
mv1
mv2
1/6
mv2
7/6
mv2

图17

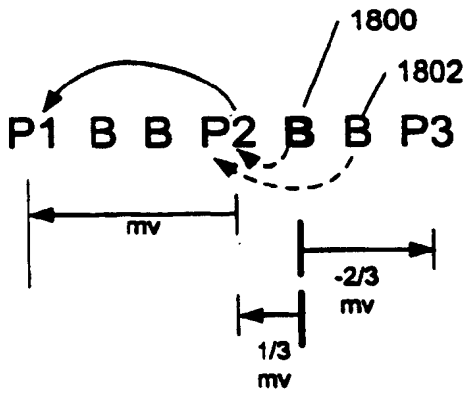

1800
1802
P1 B B P2 B B P3
mv
-2/3
mv
1/3
mv

图18

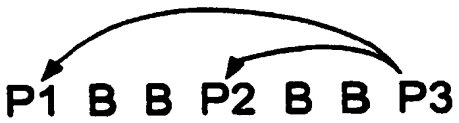

P1 B B P2 B B P3

图19


P1 B B P2 B B P3 B B P4

图20

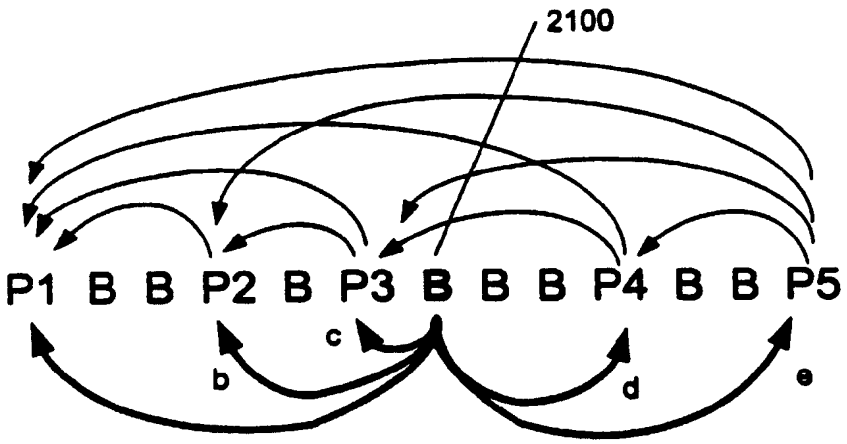


图21

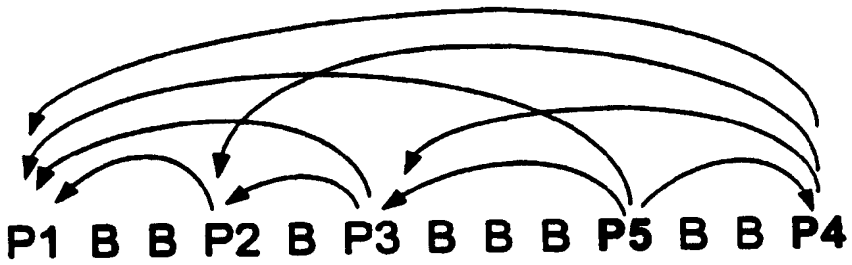


图22

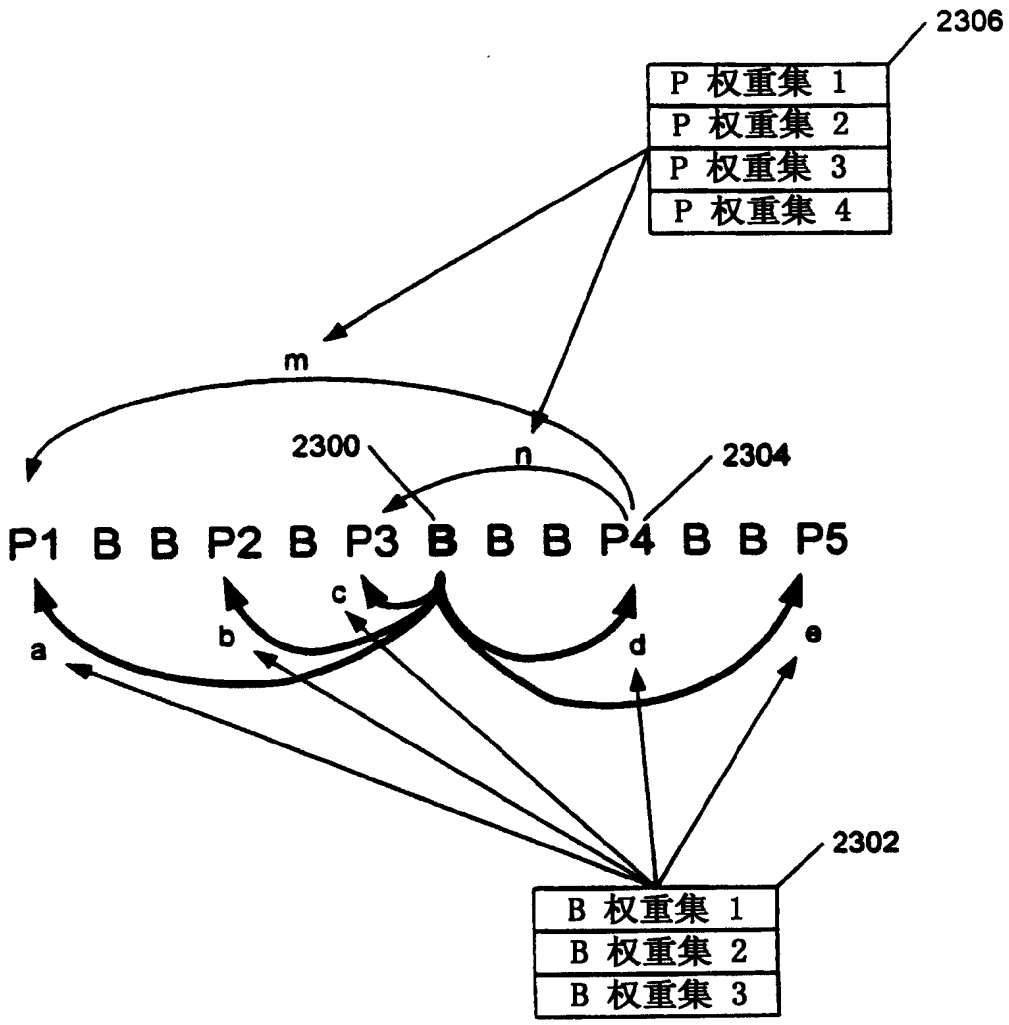

2306
P 权重集 1
P 权重集 2
P 权重集 3
P 权重集 4
m
n
2300
2304
P1 B B P2 B P3 B B B P4 B B P5
a
b
c
d
e
2302
B 权重集 1
B 权重集 2
B 权重集 3

图23

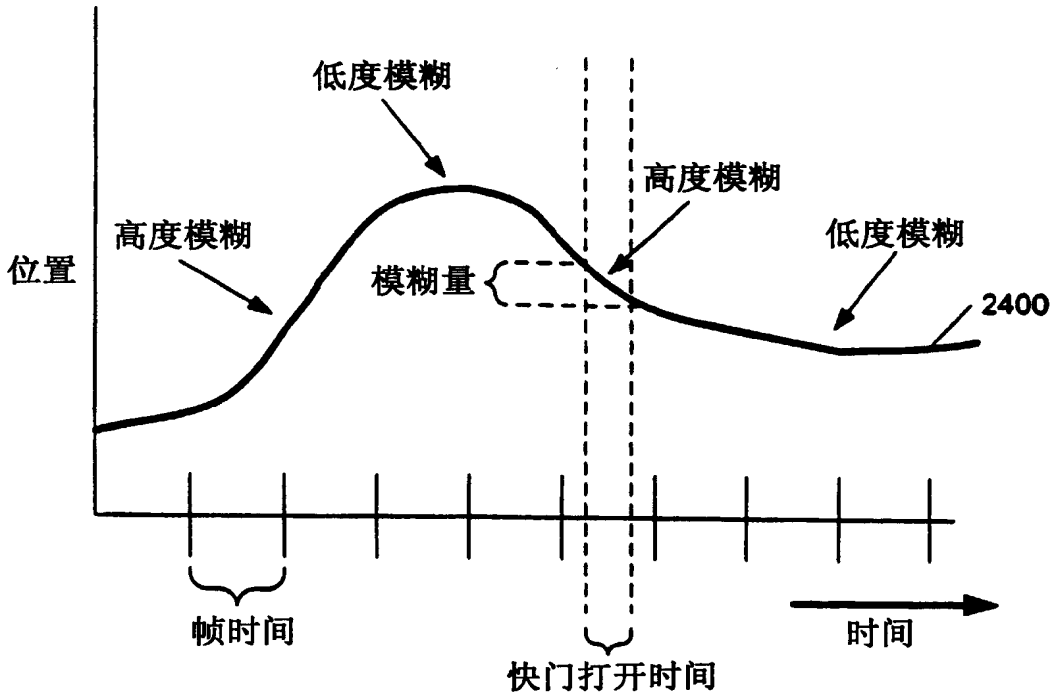


图24

CERTIFICATE OF TRANSMISSION UNDER 37 CFR § 1.8

I hereby certify that this document is being electronically transmitted via the United States Patent and Trademark Office via EFS-Web on August 24, 2015.

Signature: /Gregory S. Weaver, #53,751/
Gregory S. Weaver, Reg. No. 53,751

PU060222-US-PCT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Meng-Ping Kao et al. Serial No.: 12/312,386 Filed: May 7, 2009 For: METHOD AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING	Examiner: Samir Anwar Ahmed Group Art: 2665 Conf. No.: 8783

AMENDMENT
AND
STATEMENT OF SUBSTANCE OF INTERVIEW

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

Madam:

This is in response to the Notice of Allowance dated May 22, 2015, for which a response is due on Monday, August 24, 2015. Accordingly, this response is timely filed. A Request for Continued Examination (RCE) and Information Disclosure Statement (IDS) are also filed herewith. Further examination based on the amended claims herein is respectfully requested.

- **Amendments to the Claims** are listed beginning on page **2** of this paper;
- **Remarks** begin on page **3** of this paper.

Amendments to the Claims

1. to 15. (Canceled)

16. (Currently Amended) A method comprising:

decoding an image region, wherein the decoding includes performing in-loop filtering to reduce at least a first and a second type of quantization artifact using at least two filters in succession, the at least two filters including a deblocking filter for performing a first pass to reduce blocking artifacts and an adaptive sparse de-noising filter for performing a second pass to reduce noise, wherein the decoding ~~encoding~~ includes rendering a decision to selectively enable or disable the adaptive sparse de-noising filter at a given level, the given level being at least ~~a macroblock level, a slice level,~~ a picture level [[,]] or a sequence level.

17. to 46 (Canceled)

REMARKS

Claim 16 is pending in the application, with claims 1-3, 5-8, 10-13, 15, 17, 18, and 20-46 having been canceled herein. Reconsideration and further examination are respectfully requested.

Statement of substance of interview

Applicants wish to thank the Examiner for the August 21, 2015 interview with Applicants' undersigned representative. During the interview, the foregoing amendment was discussed. The Examiner tentatively agreed that amended claim would likely remain allowable.

Conclusion

In view of the foregoing, it is respectfully submitted that the pending claim in this patent application is in condition for allowance. Entry of this amendment, reconsideration of the application, and allowance of the claim are respectfully requested. If the Examiner believes a phone call would advance prosecution, the Examiner is invited to contact Applicants' undersigned representative at the phone number below.

In the event there are any errors with respect to the fees for this response or any other papers related to this response, the Director is hereby given permission to charge any shortages and credit any overcharges of any fees required for this submission to Deposit Account No. 07-0832.

Respectfully submitted,

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Gregory S. Weaver
Attorney for Applicants
Reg. No. 53,751
(818) 480-5064

Patent Operations
Thomson Licensing LLC
P.O. Box 5312
Princeton, New Jersey 08540

August 24, 2015

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特開2003－179933
（P2003－179933A）
(43)公開日　平成15年６月27日(2003.6.27)

(51)Int.Cl.'	識別記号	ＦＩ		テーマコード'（参考）
Ｈ０４Ｎ　7/32		Ｈ０３Ｍ　7/36		５Ｃ０５９
Ｈ０３Ｍ　7/36		Ｈ０４Ｎ　7/137	Ｚ	５Ｊ０６４

審査請求　未請求　請求項の数57　ＯＬ　（全 37 頁）

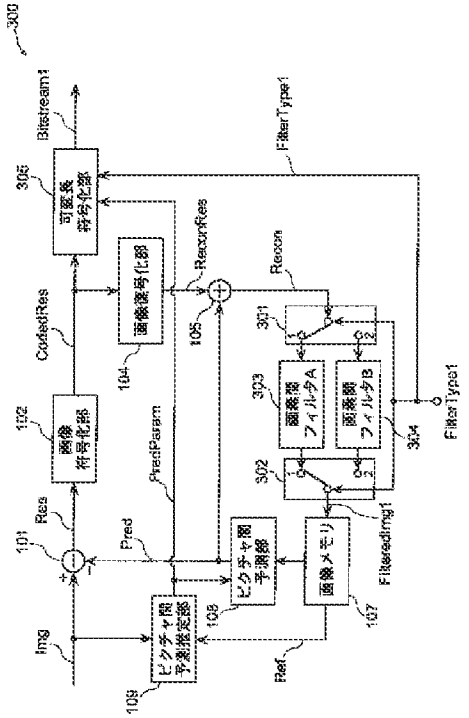
(21)出願番号　特願2002－265355(P2002－265355)
(22)出願日　平成14年９月11日(2002.9.11)
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(32)優先日　平成13年９月12日(2001.9.12)
(33)優先権主張国　日本（ＪＰ）

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最終頁に続く

(54)【発明の名称】　画像符号化方法および画像復号化方法

(57)【要約】　（修正有）
【課題】多様な状況に応じて画素間フィルタを選択的に使用し符号化データを生成する画像符号化装置および画像復号化装置を提供する。
【解決手段】画像符号化装置３００は、入力画像を表す画像データImgと、入力画像に対する予測画像を表す予測画像データPredとの差分を符号化して符号化画像データを生成する画像符号化装置で、画像データImgを符号化した後、復号化する画像復号化部１０４と、画像復号化部１０４で得られた復号化画像データReconに対して画素間フィルタ演算を施す画素間フィルタA３０３、B３０４と、画素間フィルタの１つを選択するスイッチ３０１、３０２と、選択された画素間フィルタで得られたフィルタ済復号化画像データFilteredImg1を参照画像データRefとして用い、入力画像データImgに対する予測画像データPredを生成するピクチャ間予測部１０８とを備える。



【特許請求の範囲】

【請求項１】　入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化方法であって、
前記差分画像データを符号化した後、前記符号化した差分データを復号化して前記予測画像データと加算する復号化ステップと、
複数の画素間フィルタのうちから、１つを選択する選択ステップと、
選択された前記画素間フィルタを用いて、前記復号化ステップで得られた復号化画像データに対する画素間フィルタ演算を施す演算ステップと、
前記演算ステップで得られたフィルタ済み復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成ステップとを含むことを特徴とする画像符号化方法。

【請求項２】　前記画像符号化方法は、さらに、
前記符号化画像データと、当該符号化画像データに関連する関連データとにより、外部出力用の出力符号化画像データを生成する出力データ生成ステップを含み、
前記出力データ生成ステップでは、前記選択ステップで選択された前記画素間フィルタを特定する選択情報を、前記関連データ中に記述することを特徴とする請求項１記載の画像符号化方法。

【請求項３】　前記選択ステップでは、入力画像データが他の画像に参照される画像であれば、より平滑度の高い前記画素間フィルタを選択することを特徴とする請求項１記載の画像符号化方法。

【請求項４】　入力画像データが他の画像に参照される画像であるかどうかは、前記入力画像データのピクチャタイプに応じて判断することを特徴とする請求項３記載の画像符号化方法。

【請求項５】　入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化方法であって、
前記差分画像データを符号化した後、前記符号化した差分画像データを復号化して前記予測画像データと加算する復号化ステップと、
画素間フィルタによる演算を行うまたは行わないを選択する選択ステップと、
前記演算を行うと選択された場合には前記画素間フィルタを用いて、前記復号化ステップで得られた復号化画像データに対する前記演算を施し、前記演算を行わないと選択された場合には前記演算を行わない演算ステップと、
前記演算ステップで得られた復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成ステップとを含むことを特徴とする画像符号化方法。

【請求項６】　前記画像符号化方法は、さらに、
前記符号化画像データと、当該符号化画像データに関連する関連データとにより、外部出力用の出力符号化画像データを生成する出力データ生成ステップを含み、
前記出力データ生成ステップでは、前記選択ステップで選択された前記画素間フィルタを特定する選択情報を、前記関連データ中に記述することを特徴とする請求項５記載の画像符号化方法。

【請求項７】　前記選択ステップでは、入力画像データが他の画像に参照される画像であれば、より平滑度の高い前記画素間フィルタを選択することを特徴とする請求項５記載の画像符号化方法。

【請求項８】　前記選択ステップでは、前記入力画像データのピクチャタイプに応じてフィルタを選択することを特徴とする請求項５記載の画像符号化方法。

【請求項９】　前記選択ステップでは、入力画像データがＢピクチャであれば、前記演算を行わないことを選択することを特徴とする請求項５記載の画像符号化方法。

【請求項１０】　前記画素間フィルタは、入力されるパラメータの値に応じて可変動作する数式演算フィルタであることを特徴とする請求項５記載の画像符号化方法。

【請求項１１】　前記選択ステップでは、入力画像データの所定のデータ単位ごとに前記画素間フィルタを切り替えて選択することを特徴とする請求項５記載の画像符号化方法。

【請求項１２】　符号化画像データを復号化する画像復号化方法であって、
前記符号化画像データを差分画像データに復号化し、予測画像データと前記差分画像データとを加算して、元の画像を表す画像データに復号化する復号化ステップと、
複数の画素間フィルタの１つを選択する選択ステップと、
選択された前記画素間フィルタを用いて、前記復号化ステップで元の画像に復号化した前記画像データに画素間フィルタ演算を施す演算ステップと、
前記演算が施された前記画像データから、予測画像データを生成する予測画像生成ステップとを含むことを特徴とする画像復号化方法。

【請求項１３】　前記画像復号化方法は、さらに、
前記符号化画像データのピクチャタイプに応じて、当該符号化画像データの参照の有無を判定する判定ステップを有し、
前記符号化画像データが他の画像に参照される画像であれば、前記選択ステップにおいて、より平滑度の高い前記画素間フィルタを選択することを特徴とする請求項１２記載の画像復号化方法。

【請求項１４】　前記復号化ステップでは、さらに、前記符号化画像データに関連する関連情報を復号化し、
前記選択ステップでは、復号化された前記関連情報に従

って、前記画素間フィルタを選択することを特徴とする請求項１２記載の画像復号化方法。

【請求項１５】　前記選択ステップでは、復号化された前記関連情報に示される前記画素間フィルタが画像復号化装置に備えられていないときには当該画像復号化装置に備えられている画素間フィルタのうち、前記関連情報に示される前記画素間フィルタと平滑度が近似する画素間フィルタを選択するを備えることを特徴とする請求項１４記載の画像復号化方法。

【請求項１６】前記選択ステップでは、前記複数の画素間フィルタの１つとして、前記画素間フィルタをバイパスするバイパス線を含み、

前記予測画像生成ステップでは、前記バイパス線が選択された場合には、前記演算が施されていない前記復号化された画像データから、予測画像データを生成することを特徴とする請求項１４記載の画像復号化方法。

【請求項１７】　前記画像復号化方法は、さらに、

前記演算ステップにおいて前記バイパス線が選択された場合には、前記演算が施されていない前記復号化された画像データに対して、第２の画素間フィルタ演算を施す第２の演算ステップと、

前記第２の画素間フィルタ演算が施された前記復号化された画像データを出力画像データとして外部に出力する出力ステップとを含むことを特徴とする請求項１６記載の画像復号化方法。

【請求項１８】　前記選択ステップでは、前記符号化画像データの所定のデータ単位ごとに前記画素間フィルタを切り替えて選択することを特徴とする請求項１６記載の画像復号化方法。

【請求項１９】前記画素間フィルタは、パラメータの値に応じて可変動作する数式演算フィルタであることを特徴とする請求項１６記載の画像復号化方法。

【請求項２０】　入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化装置であって、

前記差分画像データを符号化した後、前記符号化した差分画像データを復号化して前記予測画像データと加算する復号化手段と、

前記復号化手段で得られた復号化画像データに対して画素間フィルタ演算を施す複数の画素間フィルタと、

前記画素間フィルタのうちから、１つを選択する選択手段と、

選択された前記画素間フィルタで得られたフィルタ済み復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成手段とを備えることを特徴とする画像符号化装置。

【請求項２１】　前記画像符号化装置は、さらに、

前記複数の画素間フィルタをバイパスするバイパス線を備え、

前記選択手段は、前記画素間フィルタのいずれか、または前記バイパス線を選択することを特徴とする請求項２０記載の画像符号化装置。

【請求項２２】　前記画像符号化装置は、さらに、

前記符号化画像データと、当該符号化画像データに関連する関連データとにより、外部出力用の出力符号化画像データを生成する出力データ生成手段を備え、

前記出力データ生成手段は、前記選択手段によって選択された前記画素間フィルタのいずれか、またはバイパス線を特定する選択情報を、前記関連データ中に記述することを特徴とする請求項２１記載の画像符号化装置。

【請求項２３】　前記選択手段は、入力画像データが他の画像に参照される画像であれば、より平滑度の高い前記画素間フィルタを選択することを特徴とする請求項２１記載の画像符号化装置。

【請求項２４】　前記選択手段は、入力画像データが他の画像に参照されない画像であれば、あるいは入力画像データがＢピクチャであれば、より処理量の少ない前記画素間フィルタまたは前記バイパス線を選択することを特徴とする請求項２１記載の画像符号化装置。

【請求項２５】　前記選択手段は、入力画像データがＢピクチャであれば、より処理量の少ない前記画素間フィルタまたは前記バイパス線を選択することを特徴とする請求項２４記載の画像符号化装置。

【請求項２６】　前記画素間フィルタは、画素間フィルタはパラメータに応じて可変動作する数式演算フィルタであることを特徴とする請求項２０記載の画像符号化装置。

【請求項２７】　前記選択手段は、入力画像データの所定のデータ単位ごとに前記画素間フィルタを切り替えて選択することを特徴とする請求項２０記載の画像符号化装置。

【請求項２８】　動画像中のピクチャを表す画像データと動画中の他のピクチャを表す予測画像データとの差分を符号化して得られた符号化画像データから、元の動画像を表す複数の画像データを復号化する画像復号化装置であって、

前記符号化画像データの復号化結果と、当該符号化画像データに対応する、すでに復号化された予測画像データとを加算して、元のピクチャを表す画像データを復号化する復号手段と、

復号化された前記画像データに対して画素間フィルタ演算を施す複数の画素間フィルタのうちから１つを選択する選択手段と、

選択された前記画素間フィルタによる前記演算が施された画像データから、別の符号化画像データに対応する予測画像データを生成する予測画像生成手段とを備えることを特徴とする画像復号化装置。

【請求項２９】　前記画像復号化装置は、さらに、

前記符号化画像データのピクチャタイプに応じて、当該

符号化画像データの参照の有無を判定する判定手段を備え、
前記選択手段は、前記符号化画像データが他の画像に参照される画像であれば、より平滑度の高い前記画素間フィルタを選択することを特徴とする請求項２８記載の画像復号化装置。

【請求項３０】　前記復号化手段は、さらに、前記符号化画像データの関連情報を復号化し、
前記選択手段は、復号化された前記関連情報に従って、前記画素間フィルタを選択することを特徴とする請求項２８記載の画像復号化装置。

【請求項３１】　前記選択手段は、復号化された前記関連情報に示される前記画素間フィルタが当該画像復号化装置に備えられていないときには当該画像復号化装置に備えられている画素間フィルタのうち、前記関連情報に示される前記画素間フィルタと平滑度が近似する画素間フィルタを選択することを特徴とする請求項３０記載の画像復号化装置。

【請求項３２】　前記画像復号化装置は、さらに、
前記複数の画素間フィルタの１つとして、前記複数の画素間フィルタをバイパスするバイパス線を備え、
前記予測画像生成手段は、前記バイパス線が選択された場合には、前記演算が施されていない前記復号化された画像データから、予測画像データを生成することを特徴とする請求項３０記載の画像復号化装置。

【請求項３３】　前記画像復号化装置は、さらに、
前記バイパス線が選択された場合には、前記演算が施されていない前記復号化された画像データに対して、第２の画素間フィルタ演算を施す第２の画素間フィルタと、
前記第２の画素間フィルタ演算が施された前記復号化された画像データを出力画像データとして外部に出力する出力手段とを備えることを特徴とする請求項３２記載の画像復号化装置。

【請求項３４】　入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化装置のためのプログラムであって、
前記差分画像データを符号化した後、前記符号化した差分画像データを復号化して前記予測画像データと加算する復号化手段と、
前記復号化手段で得られた復号化画像データに対して画素間フィルタ演算を施す複数の画素間フィルタと、
前記画素間フィルタのうちから、１つを選択する選択手段と、
選択された前記画素間フィルタで得られたフィルタ済み復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成手段としてコンピュータを機能させるためのプログラム。

【請求項３５】　動画像中のピクチャを表す画像データと動画中の他のピクチャを表す予測画像データとの差分を符号化して得られた符号化画像データから、元の動画像を表す複数の画像データを復号化する画像復号化装置のためのプログラムであって、
前記符号化画像データの復号化結果と、当該符号化画像データに対応する、すでに復号化された予測画像データとを加算して、元のピクチャを表す画像データを復号化する復号手段と、
復号化された前記画像データに対して画素間フィルタ演算を施す複数の画素間フィルタのうちから１つを選択する選択手段と、
選択された前記画素間フィルタによる前記演算が施された画像データから、別の符号化画像データに対応する予測画像データを生成する予測画像生成手段としてコンピュータを機能させるためのプログラム。

【請求項３６】　前記符号化画像データと当該符号化画像データの関連データとが記録されたコンピュータ読み取り可能な記録媒体であって、
前記符号化画像データの一定単位ごとに、当該符号化画像データを復号化して参照画像とする際に復号化後の画像データに対して施すべき画素間フィルタ演算を複数の画素間フィルタ演算の中から特定する情報が記録されていることを特徴とする記録媒体。

【請求項３７】　前記符号化画像データと当該符号化画像データの関連データとが記録されたコンピュータ読み取り可能な記録媒体であって、
前記符号化画像データの一定単位ごとに、当該符号化画像データを復号化して参照画像とする際に復号化後の画像データに対して画素間フィルタ演算を施すべきか否かを示す情報が記録されていることを特徴とする記録媒体。

【請求項３８】　繰り返し入力されるフレーム画像を符号化する画像符号化装置であって、
フレーム画像に所定の変換処理を施すことによって符号化を行う符号化手段と、
前記符号化手段によって符号化されたフレーム画像に前記変換処理の逆の変換処理を施す逆変換手段と、
フレーム画像にフィルタ処理を施すフィルタ手段と、
フレーム画像を記憶するための記憶手段と、
前記逆変換手段による逆変換処理で得られたフレーム画像に対して、前記フィルタ手段によるフィルタ処理を施した後に当該フレーム画像を前記記憶手段に格納するか、又は、前記フィルタ手段によるフィルタ処理を施さずに当該フレーム画像を前記記憶手段に格納するように制御する制御手段とを備え、
前記符号化手段は、前記記憶手段に格納された過去のフレーム画像を参照しながら前記フレーム画像を符号化することを特徴とする画像符号化装置。

【請求項３９】　前記制御手段は、前記フレーム画像の

重要度が高い場合に、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像の重要度が低い場合に、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項３８記載の画像符号化装置。

【請求項４０】　前記符号化手段は、前記フレーム画像に対して、画面内符号化及び画面間符号化を含む符号化を行い、

前記制御手段は、前記フレーム画像が前記符号化手段によって画面内符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって画面間符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項３９記載の画像符号化装置。

【請求項４１】　前記符号化手段は、前記フレーム画像に対して、前方向予測符号化及び双方向予測符号化を含む符号化を行い、

前記制御手段は、前記フレーム画像が前記符号化手段によって前方向予測符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって双方向予測符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項３９記載の画像符号化装置。

【請求項４２】　前記符号化手段は、前記フレーム画像に対して、ベース・レイヤ符号化及びエンハンスメント・レイヤ符号化を含む符号化を行い、

前記制御手段は、前記フレーム画像が前記符号化手段によってベース・レイヤ符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によってエンハンスメント・レイヤ符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項３９記載の画像符号化装置。

【請求項４３】　前記制御手段は、当該画像符号化装置の処理能力についての余裕を監視し、余裕がある場合には、より重要度の低いフレーム画像までフィルタ処理を施し、余裕がない場合には、より重要度の高いフレーム画像までフィルタ処理を施さないように制御することを特徴とする請求項３９記載の画像符号化装置。

【請求項４４】　前記フレーム画像には、前記重要度に対応する優先順位が対応付けられ、

前記制御手段は、当該画像符号化装置が備えるＣＰＵの稼働率を監視することによって前記余裕を監視し、前記稼働率が高い場合には、優先度の高いフレーム画像だけフィルタ処理を施し、前記稼働率が低い場合には、優先度の低いフレーム画像までフィルタ処理を施すように制御することを特徴とする請求項４３記載の画像符号化装置。

【請求項４５】　前記フレーム画像は、複数のタイプのいずれかに属し、

前記制御手段は、

フレーム画像のタイプと前記優先度とを対応付けた第１情報テーブルと、

前記フィルタ処理を施す場合の前記優先度と前記稼働率との組み合わせを示す第２情報テーブルとを有し、

対象となるフレーム画像のタイプに基づいて、前記第１情報テーブルを参照することによって、当該フレーム画像の優先度を決定し、

決定した優先度と前記稼働率との組み合わせに基づいて、前記第２情報テーブルを参照することによって、当該フレーム画像に前記フィルタ処理を施すか否かを決定することを特徴とする請求項４４記載の画像符号化装置。

【請求項４６】　前記制御手段は、

複数の前記第１情報テーブルと、複数の前記第２情報テーブルを有し、

複数の前記第１情報テーブルの中から選択した１つの第１情報テーブルを参照することによって、前記フレーム画像の優先度を決定し、

複数の前記第２情報テーブルの中から選択した１つの第２情報テーブルを参照することによって、前記フレーム画像に前記フィルタ処理を施すか否かを決定することを特徴とする請求項４５記載の画像符号化装置。

【請求項４７】　繰り返し入力されるフレーム画像を復号化する画像復号化装置であって、

フレーム画像に所定の変換処理を施すことによって復号化を行う復号化手段と、

フレーム画像にフィルタ処理を施すフィルタ手段と、

フレーム画像を記憶するための記憶手段と、

前記復号化手段による復号化で得られたフレーム画像に対して、前記フィルタ手段によるフィルタ処理を施した後に当該フレーム画像を前記記憶手段に格納するか、又は、前記フィルタ手段によるフィルタ処理を施さずに当該フレーム画像を前記記憶手段に格納するように制御する制御手段とを備え、

前記復号化手段は、前記記憶手段に格納された過去のフレーム画像を参照しながら前記フレーム画像を復号化することを特徴とする画像復号化装置。

【請求項４８】　前記制御手段は、前記フレーム画像の重要度が高い場合に、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像の重要度が低い場合に、当該フレーム画像に対して前記フィルタ処理を施

さないように制御することを特徴とする請求項４７記載の画像復号化装置。

【請求項４９】　前記復号化手段は、前記フレーム画像に対して、面内復号化及び面間復号化を含む復号化を行い、

前記制御手段は、前記フレーム画像が前記復号化手段によって面内復号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記復号化手段によって面間復号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項４８記載の画像復号化装置。

【請求項５０】　前記復号化手段は、前記フレーム画像に対して、前方向予測復号化及び双方向予測復号化を含む復号化を行い、

前記制御手段は、前記フレーム画像が前記復号化手段によって前方向予測復号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記復号化手段によって後方予測復号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項４８記載の画像復号化装置。

【請求項５１】　前記復号化手段は、前記フレーム画像に対して、基本レイヤ復号化及び補強レイヤ復号化を含む復号化を行い、

前記制御手段は、前記フレーム画像が前記復号化手段によって基本レイヤ復号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記復号化手段によって補強レイヤ復号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御することを特徴とする請求項４８記載の画像復号化装置。

【請求項５２】　前記制御手段は、当該画像復号化装置の処理能力についての余裕を監視し、余裕がある場合には、より重要度の低いフレーム画像までフィルタ処理を施し、余裕がない場合には、より重要度の高いフレーム画像までフィルタ処理を施さないように制御することを特徴とする請求項４８記載の画像復号化装置。

【請求項５３】　前記フレーム画像には、前記重要度に対応する優先順位が対応付けられ、

前記制御手段は、当該画像復号化装置が備えるＣＰＵの稼働率を監視することによって前記余裕を監視し、前記稼働率が高い場合には、優先度の高いフレーム画像だけフィルタ処理を施し、前記稼働率が低い場合には、優先度の低いフレーム画像までフィルタ処理を施すように制御することを特徴とする請求項５２記載の画像復号化装置。

【請求項５４】　前記フレーム画像は、複数のタイプのいずれかに属し、

前記制御手段は、

フレーム画像のタイプと前記優先度とを対応付けた第１情報テーブルと、

前記フィルタ処理を施す場合の前記優先度と前記稼働率との組み合わせを示す第２情報テーブルとを有し、

対象となるフレーム画像のタイプに基づいて、前記第１情報テーブルを参照することによって、当該フレーム画像の優先度を決定し、

決定した優先度と前記稼働率との組み合わせに基づいて、前記第２情報テーブルを参照することによって、当該フレーム画像に前記フィルタ処理を施すか否かを決定することを特徴とする請求項５３記載の画像復号化装置。

【請求項５５】　前記制御手段は、

複数の前記第１情報テーブルと、複数の前記第２情報テーブルを有し、

複数の前記第１情報テーブルの中から選択した１つの第１情報テーブルを参照することによって、前記フレーム画像の優先度を決定し、

複数の前記第２情報テーブルの中から選択した１つの第２情報テーブルを参照することによって、前記フレーム画像に前記フィルタ処理を施すか否かを決定することを特徴とする請求項５４記載の画像復号化装置。

【請求項５６】　符号化済み画像にフィルタ処理を施した画像を参照して符号化する画像符号化方法であって、

被符号化フレームの重要度が高い場合には当該フレームの符号化済み画像にフィルタ処理を施し、

被符号化フレームの重要度が低い場合には当該フレームの符号化済み画像にフィルタ処理を施さないことを特徴とする画像符号化方法。

【請求項５７】　復号化済み画像にフィルタ処理を施した画像を参照して符号化画像を復号化する画像復号化方法であって、

被復号化フレームの重要度が高い場合には当該フレームの復号化済み画像にフィルタ処理を施し、

被復号化フレームの重要度が低い場合には当該フレームの復号化済み画像にフィルタ処理を施さないことを特徴とする画像復号化方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、画像符号化方法、画像復号化方法、画像符号化装置、画像復号化装置、それをソフトウェアで実施するためのプログラムおよび当該プログラムが記録された記録媒体に関する。

【０００２】

【従来の技術】近年、マルチメディアアプリケーションの発展に伴い、画像・音声・テキストなど、あらゆるメディアの情報を統一的に扱うことが一般的になってきた。このとき、全てのメディアをディジタル化することにより統一的にメディアを扱うことが可能になる。しかしながら、ディジタル化された画像は膨大なデータ量を持つため、蓄積・伝送のためには、画像の情報圧縮技術が不可欠である。一方で、圧縮した画像データを相互運用するためには、圧縮技術の標準化も重要である。画像圧縮技術の標準規格としては、ＩＴＵ-Ｔ勧告（国際電気通信連合　電気通信標準化部門）のＨ.２６１、Ｈ.２６３、ＩＳＯ（国際標準化機構）のＭＰＥＧ（Moving Picture Experts Group）-1、ＭＰＥＧ-2、ＭＰＥＧ-4などがある。

【０００３】図２３は、従来の画像符号化装置１００の構成を示すブロック図である。なお、本発明では、1枚の画像を構成する単位をピクチャと呼ぶ。インタレース画像信号ではピクチャはフィールドもしくはフレームを意味し、プログレッシブ画像信号ではピクチャはフレームのことを意味する。

【０００４】画像符号化装置１００は、差分器１０１、画像符号化部１０２、可変長符号化部１０３、画像復号化部１０４、加算器１０５、画素間フィルタ１０６、画像メモリ１０７、ピクチャ間予測部１０８およびピクチャ間予測推定部１０９を備える。差分器１０１は、正入力端子に入力される入力画像から、負入力端子に入力される予測画像を減算して、その差分画像を出力する。画像符号化部１０２は、入力される差分画像を符号化する。例えば、入力されるデータをＤＣＴ変換などを用いて周波数変換し、変換結果の周波数データを量子化することによって符号化する。可変長符号化部１０３は、符号化された差分画像とピクチャ間予測推定部１０９からの予測パラメータとを可変長符号化し、その結果得られた符号化データに、その符号化データに関連する情報を記述したヘッダなどの関連データを付加した上、出力符号化ビットストリームのフォーマットに整えて画像符号化装置１００の外部に出力する。画像復号化部１０４は、画像符号化部１０２によって符号化された差分画像に対し、画像符号化部１０２による符号化の逆処理を施すことによって符号化された差分画像を復号化し、復号化する。例えば、符号化された差分画像に対し、逆量子化処理を施した後、例えば逆ＤＣＴ変換などの逆周波数変換を施し、入力画像と予測画像との差分を復号化する。加算器１０５は、復号化された差分画像と予測画像とを加算し、入力画像を復号化する。画素間フィルタ１０６は、例えば、復号化された入力画像の高周波成分の符号化ノイズを抑圧するなどのフィルタリングを行う(例えば、特許文献１参照)。画像メモリ１０７は、加算器１０５において復号化された画像の少なくとも１ピクチャ分の画像データを参照画像として保持する。ピクチャ間予測部１０８は、ピクチャ間予測推定部１０９による予測結果に基づいて、画像メモリ１０７内の参照画像から予測画像を読み出す。ピクチャ間予測推定部１０９は、参照画像に対する入力画像の動きの変化量である予測パラメータPredParamを導出する。

【０００５】より具体的には、画像符号化装置１００には、外部から画像データImgが入力される。画像データImgは差分器１０１の正入力端子に入力される。差分器１０１は、この画像データImgと、負入力端子に入力された予測画像データPredとの画素値の差分を求め、差分画像データResとして出力する。この予測画像データPredは以下のようにして得られる。まず、既に符号化されたピクチャの画像であって、一旦符号化された後復号化され、１ピクチャ分の画像に復号化された参照画像データRefが画像メモリ１０７に格納される。次に、この参照画像データRefから、予測パラメータPredParamに基づいて、入力された画像データImgのブロックごとに、対応してブロックの画像を表すデータが切り出される。このブロックの画像をあらわすデータが予測画像データPredである。画像符号化装置１００は、符号化済みのピクチャの何枚かを予測用の参照画像データRefとして画像メモリ１０７に格納しており、ピクチャ間予測部１０８は画像メモリ１０７に格納された参照画像データRefから予測画像データPredを生成する。ピクチャ間予測推定部１０９は、入力画像データImgと参照画像データRefから予測に使用する予測パラメータデータPredParam（例えば、MPEGの画像符号化方式で使用される動きベクトル情報など）を求める。なお、画面内符号化の場合には予測画像の画素値は"０"とする。

【０００６】画像符号化部１０２は、差分画像データResを符号化し、差分画像符号化データCodedResとして出力する。画像復号化部１０４は、符号化された差分画像符号化データCodedResから元の画像を復号化して、ピクチャ間予測の参照画像として使用するために、差分画像符号化データCodedResを復号化し、復号化差分画像データReconResとして出力する。この復号化差分画像データReconResが示す画素値と、予測画像データPredが示す画素値とが加算器１０５において加算され、復号化画像データReconとして出力される。画素間フィルタ１０６は、復号化画像データReconをフィルタ演算処理し、フィルタ済復号化画像データFilteredImgとして画像メモリ１０７に格納する。

【０００７】画素間フィルタ１０６には、復号化画像データReconの符号化ノイズを低減し、その画像を参照画像として使用した場合に予測効率を向上させる効果がある。画素間フィルタ１０６の例としては、ＩＴＵ-Ｔ勧告のＨ・２６１のループ・フィルタがある。画素間フィルタ１０６により画素間フィルタ演算が行われたフィルタ済復号化画像データFilteredImgは、画像メモリ１０７に格納され、以降のピクチャを符号化する際に参照画

像として使用される。可変長符号化部１０３は、差分画像符号化データCodedResと予測パラメータデータPredParamとを可変長符号化して、１つの符号化データBitstreamにまとめて画像符号化装置１００の外部へ出力する。

【０００８】図２４は、従来の画像復号化装置２００の構成を示すブロック図である。画像復号化装置２００は、可変長復号化部２０１、画像復号化部２０２、加算器２０３、画素間フィルタ２０４、画像メモリ２０５およびピクチャ間予測部２０６を備える。画像復号化装置２００には、外部から符号化データBitstreamが入力される。可変長復号化部２０１は、入力された符号化データBitstreamを可変長復号化し、差分画像符号化データCodedResと予測パラメータデータPredParamに分離する。画像復号化部２０２は、差分画像符号化データCodedResを復号化し、復号化差分画像データReconResとして出力する。なお、復号化差分画像データReconResとして出力されるピクチャに参照された、すなわち、画像符号化装置１００において参照画像データRefに相当するピクチャは、既に復号化され画像メモリ１０７に格納されている。そこで、ピクチャ間予測部２０６は、予測パラメータデータPredParamに基づいて参照画像データRefから、予測画像データPredを生成する。加算器２０３は予測画像データPredと復号化差分画像データReconResとを加算し、復号化画像データReconとして出力する。画素間フィルタ２０４は、復号化画像データReconに画素間フィルタ演算を施し、フィルタ済復号化画像データFilteredImgとして画像復号化装置２００の外部に出力する。画像復号化装置２００の外部とは、例えば、テレビなどの表示装置である。また、フィルタ済復号化画像データFilteredImgは、画像メモリ２０５に格納され、以降のピクチャの参照画像データRefとして参照される。

【特許文献】特開平８－６５６６７号広報

【０００９】

【発明が解決しようとする課題】しかしながら、例えば、携帯電話機などを用いて動画像を伝送する場合などを考慮すると、携帯機器では１回の充電で長時間使用できるように機器全体での消費電力を抑えることが望まれるため、画像処理のために大きな電力が必要な高性能な処理能力を備えることは好ましくない。従って、画像処理のために処理能力が低い演算器しか使用できない携帯機器を対象とすると、要求される処理量が小さい画素間フィルタしか使用できない場合がある。一方、高画質な動画像の伝送および高い符号化効率に対する要求が強いアプリケーションでは、演算器に要求される処理量が大きいが、性能が高い画素間フィルタを使用したい場合もある。符号化方式がこれらの要求に柔軟に対応できれば、当該符号化方式、当該復号化方式に従う画像符号化装置および画像復号化装置などの運用範囲が広がり有益である。

【００１０】本発明は、このような従来の問題点に鑑みてなされたものであって、多様な状況に応じて画素間フィルタを選択的に使用し符号化データを生成する画像符号化装置、およびその符号化データを復号化する画像復号化装置を提供することを目的とする。

【００１１】

【課題を解決するための手段】本発明に係る画像符号化装置は、入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化装置であって、前記差分画像データを符号化した後、前記符号化した差分画像データを復号化して前記予測画像データと加算する復号化手段と、前記復号化手段で得られた復号化画像データに対して画素間フィルタ演算を施す複数の画素間フィルタと、前記画素間フィルタのうちから、１つを選択する選択手段と、選択された前記画素間フィルタで得られたフィルタ済み復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成手段とを備えることを特徴とする。

【００１２】また、本発明に係る画像復号化装置は、動画像中のピクチャを表す画像データと動画中の他のピクチャを表す予測画像データとの差分を符号化して得られた符号化画像データから、元の動画像を表す複数の画像データを復号化する画像復号化装置であって、前記符号化画像データの復号化結果と、当該符号化画像データに対応する、すでに復号化された予測画像データとを加算して、元のピクチャを表す画像データを復号化する復号手段と、復号化された前記画像データに対して画素間フィルタ演算を施す複数の画素間フィルタのうちから１つを選択する選択手段と、選択された前記画素間フィルタによる前記演算が施された画像データから、別の符号化画像データに対応する予測画像データを生成する予測画像生成手段とを備えることを特徴とする。

【００１３】さらに、本発明に係る画像符号化装置（及び画像復号化装置）は、繰り返し入力されるフレーム画像を符号化する画像符号化装置等であって、フレーム画像に所定の変換処理を施すことによって符号化を行う符号化手段と、前記符号化手段によって符号化されたフレーム画像に前記変換処理の逆の変換処理を施す逆変換手段と、フレーム画像にフィルタ処理を施すフィルタ手段と、フレーム画像を記憶するための記憶手段と、前記逆変換手段による逆変換処理で得られたフレーム画像に対して、前記フィルタ手段によるフィルタ処理を施した後に当該フレーム画像を前記記憶手段に格納するか、又は、前記フィルタ手段によるフィルタ処理を施さずに当該フレーム画像を前記記憶手段に格納するように制御する制御手段とを備え、前記符号化手段は、前記記憶手段に格納された過去のフレーム画像を参照しながら前記フレーム画像を符号化することを特徴とする。

【００１４】ここで、前記制御手段は、前記フレーム画

像の重要度が高い場合に、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像の重要度が低い場合に、当該フレーム画像に対して前記フィルタ処理を施さないように制御してもよい。例えば、前記制御手段は、前記フレーム画像が前記符号化手段によって面内符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって面間符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御したり、前記フレーム画像が前記符号化手段によって前方向予測符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって双方向予測符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御したり、前記フレーム画像が前記符号化手段によってベース・レイヤ符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によってエンハンスメント・レイヤ符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御してもよい。

【００１５】また、前記制御手段は、当該画像符号化装置（画像復号化装置）の処理能力についての余裕を監視し、余裕がある場合には、より重要度の低いフレーム画像までフィルタ処理を施し、余裕がない場合には、より重要度の高いフレーム画像までフィルタ処理を施さないように制御してもよい。例えば、前記フレーム画像には、前記重要度に対応する優先順位が対応付けられ、前記制御手段は、当該画像符号化装置が備えるＣＰＵの稼働率を監視することによって前記余裕を監視し、前記稼働率が高い場合には、優先度の高いフレーム画像だけフィルタ処理を施し、前記稼働率が低い場合には、優先度の低いフレーム画像までフィルタ処理を施すように制御してもよい。

【００１６】

【発明の実施の形態】（実施の形態１）以下、本発明の具体的な実施の形態について、図面を参照しながら説明する。図１は、本発明の実施の形態１に係る画像符号化装置３００の構成を示すブロック図である。同図において、図２３に示した従来の画像符号化装置１００と同様の構成要素およびデータについてはすでに説明しているので、同一の符号を付し、説明を省略する。以降の図においても同様に、すでに説明した既出の構成要素およびデータについては、同一の符号を付し、説明を省略する。画像符号化装置３００は、差分器１０１、画像符号化部１０２、可変長符号化部３０５、画像復号化部１０４、加算器１０５、画像メモリ１０７、ピクチャ間予測部１０８、ピクチャ間予測推定部１０９、スイッチ３０１、スイッチ３０２、画素間フィルタＡ３０３および画素間フィルタＢ３０４を備える。スイッチ３０１とスイッチ３０２とは、それぞれ、フィルタ種別データFilterTypelの値に応じて、端子１と端子２とのいずれかを選択的に接続するスイッチである。スイッチ３０１は、加算器１０５の出力端子と、画素間フィルタＡ３０３および画素間フィルタＢ３０４の入力端子との間に設けられる。また、スイッチ３０２は、画像メモリ１０７の入力端子と、画素間フィルタＡ３０３および画素間フィルタＢ３０４の出力端子との間に設けられている。画素間フィルタＡ３０３と画素間フィルタＢ３０４とは、例えば、ブロック間の境界付近における高周波ノイズを平滑化し、ブロックひずみを除去するデブロック・フィルタで、それぞれ平滑化の度合いが異なる。また、平滑化の度合いに対応して、平滑化のための演算処理量が異なる。なお、スイッチ３０１やスイッチ３０２等、図示する構成はハードウェアとして実装しても、ソフトウェアとして実装してもどちらでもよい。また、他の図面でも同様である。

【００１７】可変長符号化部３０５は、入力されるフィルタ種別データFilterTypelと差分画像符号化データCodedResと予測パラメータデータPredParamとを、それぞれ可変長符号化、例えば、ハフマン符号化して、１つの符号化データBitstreamlにまとめて画像符号化装置３００の外部へ出力する。

【００１８】以上のように構成される画像符号化装置３００の動作を、従来の画像符号化装置１００と比較して新たに構成された部分についてより具体的に説明する。まず、画像符号化装置３００には、外部からフィルタ種別データFilterTypelが入力される。ここで、外部からの入力とは、例えば、画像符号化装置の外部からのユーザによるキーボード等のユーザインターフェースを用いた入力であったり、あるいは、装置で固定のデータであって、装置でビットレート（圧縮率）や画像サイズに応じて決定される値である。このフィルタ種別データFilterTypelは、スイッチ３０１とスイッチ３０２とに入力される。当該スイッチ３０１とスイッチ３０２とは、このフィルタ種別データFilterTypelの値に応じて端子"１"と端子"２"とのいずれかに接続を切り替える。例えば、フィルタ種別データFilterTypelの値が"１"の場合には、スイッチ３０１とスイッチ３０２とはいずれも端子"１"を接続する。このとき加算器１０５から出力される復号化画像データReconに対しては、画素間フィルタＡ３０３によるフィルタリングが適用される。フィルタ種別データFilterTypelの値が"２"の場合には、スイッチ３０１とスイッチ３０２とは端子"２"側に切り替わり、加算器１０５から出力される復号化画像データReco

nに対して、画素間フィルタＢ３０４によるフィルタリングが適用される。このように画素間フィルタＡ３０３または画素間フィルタＢ３０４のフィルタリングが施されたフィルタ済復号化画像データFilteredImglは画像メモリ１０７に格納され、以降のピクチャの予測符号化における参照画像として使用される。また、画素間フィルタを特定するフィルタ種別データFilterTypelは、同一ピクチャの差分画像符号化データCodedResおよび予測パラメータデータPredParamとともに可変長符号化部３０５に入力され、それぞれ可変長符号化される。フィルタ種別データFilterTypelの可変長符号化結果は、当該差分画像符号化データCodedResと予測パラメータデータPredParamとの可変長符号化結果に対応付けて、符号化データBitstreamlに格納され、記録媒体に記録されたり、画像復号化装置に伝送されたりする。すなわち、各ピクチャの復号化画像データReconに対して適用された画素間フィルタの種別が、符号化データBitstreamlに格納されたフィルタ種別データFilterTypelによって画像復号化装置に通知される。これにより、符号化データBitstreamlを復号化する画像復号化装置では、画像符号化装置３００において各ピクチャの復号化画像データReconに適用された画素間フィルタを特定することができるので、各ピクチャの復号化画像に対してそれと同一のフィルタを使用することができる。なお、上記説明においてフィルタ種別データFilterTypelの値を"１"、"２"としたが、これは説明の便宜上定義した値であって、複数のフィルタを区別できる値であればどのような値でもよい。

【００１９】以上のように画像符号化装置３００では、画素間フィルタとして異なる予測性能・処理量の画素間フィルタを複数個備え、それらを外部から入力されるフィルタ種別データFilterTypelに応じて切り替えて使用することができる。このように異なる予測性能・処理量の画素間フィルタを切り替えて使用することには次の利点がある。まず、説明のため、画素間フィルタＡ３０３は画素間フィルタＢ３０４に比べて処理量は少なく、一方、画素間フィルタＢ３０４は画素間フィルタＡ３０３に比べてノイズ抑圧効果が高く予測符号化効率が向上するとする。本発明の画像符号化装置３００が出力する符号化データを復号化する画像復号化装置として、画素間フィルタＡ３０３のみを備えた画像復号化装置Ａと、画素間フィルタＡ３０３および画素間フィルタＢ３０４の双方を備えた画像復号化装置Ｂとの２種類の画像復号化装置を考える。前者の画像復号化装置Ａは要求される処理量が小さく、処理能力が低い機器に適している。後者の画像復号化装置Ｂは処理量が大きい機器に適している。後者の画像復号化装置Ｂは、画素間フィルタＡ３０３と画素間フィルタＢ３０４とのいずれの画素間フィルタを使用した符号化データも復号化可能であり、前者の画像復号化装置Ａに対して上位互換性を持つ。このような場合に、画像符号化装置３００は、上記２種類のいずれの画像復号化装置にも対応する画像符号化装置として機能することができる。つまり、上記の説明のように画像符号化装置３００において、対象とする画像復号化装置の処理能力に応じて適切な予測性能・処理量の画素間フィルタを選択できるようにしておくことにより、幅広い種類の機器に対して、画像符号化装置３００において適用されたものと同じ画素間フィルタを使用した符号化方式を適用する（符号化データBitstreamlを復号化させる）ことができる。

【００２０】また、画像復号化装置の処理能力に応じた符号化データの生成という用途以外にも、画像符号化装置３００の処理能力に応じて画素間フィルタを切り替えることができる。例えば、符号化する画像サイズやピクチャレートが大きい場合には、符号化処理全体に要する処理量が大きくなる。従って、符号化する画像サイズやピクチャレートが一定値以下の場合には要求される処理能力が高い画素間フィルタＢ３０４を使用し、符号化する画像サイズやピクチャレートが一定値以上の場合には、要求される処理能力が低い画素間フィルタＡ３０３を使用して、符号化処理全体に要する処理量が高くならないようにすることができる。また、複数の処理を1台の装置で時分割して実行するタイムシェアリングシステム上で画像符号化を実現する場合には、他の処理の影響で画像符号化に費やせる処理量が動的に変化する可能性がある。そこで、画像符号化に費やせる処理量が一定以上の場合には処理量が高い画素間フィルタＢ３０４を使用し、画像符号化に費やせる処理量が一定以下の場合には処理量が画素間フィルタＢ３０４より少ない画素間フィルタＡ３０３を使用することができる。

【００２１】画素間フィルタの切り替えのタイミングは、特定の性質の画像に適した画素間フィルタを複数備えて、各画像の性質に応じてピクチャ単位に画素間フィルタを切り替えるようにしてもよい。例えば、文字などエッジ情報が重要な場合にはエッジの保存性に優れた画素間フィルタを使用する。この切り替えは、エッジ検出や文字検出等の画像処理技術によって自動的に判断して行うことや、ユーザが明示的に自然画像に適した画素間フィルタ、文字に適した画素間フィルタ、エッジに適した画素間フィルタから選択してもよい。このように複数の画素間フィルタの切り替えが可能になれば、画像の性質に適切なフィルタを選択できるため、予測効率をより向上することができる。すなわち、処理量に応じて切り替えるのではなく、画質を向上するようにフィルタを切り替えることも有効である。従って、本実施の形態では処理量に応じて切り替える説明を行ったが、画質がよくなるようにフィルタを切り替えてもよい。

【００２２】また、画素間フィルタを切り替える単位は、ピクチャ単位とは限らず、画像内の部分によっても画像の性質が異なる可能性があるため、例えば、ＭＰＥ

Ｇのスライス、マクロブロックおよびブロックなどのピクチャより小さい画像領域を単位としてもよく、少なくとも１画素以上が集合した領域を単位として画素間フィルタを切り替えるようにしてもよい。

【００２３】図２は、入力画像のスライスごとに画素間フィルタを切り替える画像符号化装置４００の構成を示すブロック図である。画像符号化装置４００は、ＭＰＥＧのスライス単位で画素間フィルタを切り替えて復号化画像のフィルタリングを行う画像符号化装置であって、差分器１０１、画像符号化部１０２、画像復号化部１０４、加算器１０５、画像メモリ１０７、ピクチャ間予測部１０８、ピクチャ間予測推定部１０９、スイッチ４０３、スイッチ４０４、画素間フィルタＡ３０３、画素間フィルタＢ３０４、可変長符号化部３０５、フィルタ切り替え位置判定部４０１およびスイッチ４０２を備える。フィルタ切り替え位置判定部４０１は、外部から入力される画像データImgから入力画像のスライスを検出し、検出されたスライスが切り替わるごとに、例えば、１個のパルスを出力するようなフィルタ切り替え制御データSetFTypeをスイッチ４０２に出力する。スイッチ４０２は、フィルタ切り替え制御データSetFTypeが出力されていない間は端子間の接続が遮断されているスイッチであって、フィルタ切り替え制御データSetFTypeが出力されている瞬間、ごくわずかの時間だけ、外部から入力されるフィルタ種別データFilterType１をスイッチ４０３とスイッチ４０４とに導通する。スイッチ４０３とスイッチ４０４とは、いずれも入力画像データImgのスライスが切り替わるごとに瞬間的に入力されるフィルタ種別データFilterType１の値に応じて、端子"１"または端子"２"のいずれかを接続し、その状態を保持する。すなわち、スイッチ４０２の接続が遮断されている間には、画素間フィルタは切り替わらない。その結果、入力画像データImgのスライスの切り替わりごとに、フィルタ種別データFilterTypeによって新たな画素間フィルタが選択され、スライスの途中で画素間フィルタが切り替えられることを防止することができる。

【００２４】以上説明したように、本発明の画像符号化装置により、本発明の画像符号化装置が出力する符号化データを再生する画像復号化装置の処理能力に応じた画素間フィルタを用いた符号化データを作成することが可能になる。また、画像符号化装置の処理能力に応じて画素間フィルタを選択することができる。

【００２５】なお、本実施の形態の画像符号化装置の備える画素間フィルタは２つであるが、３つ以上の画素間フィルタを備えてもよい。本実施の形態と同様に、３つ以上の画素間フィルタのいずれかを選択して使用し、使用した画素間フィルタの種別を示すフィルタ種別データを符号化データに含めればよい。また、処理量に応じて切り替えるのではなく、画質を向上するようにフィルタを切り替えてもよい。

【００２６】なお、画像符号化装置４００では、フィルタ切り替え制御データSetFTypeを、検出されるスライスの切り替わりごとに値"１"を示し、それ以外の間は値"０"を示すパルス波形としたが、本発明はこれに限定されず、例えば、スライスの切り替わりごとに反転する矩形波などであってもよいし、その他の波形であってもよい。また、スイッチ４０２をフィルタ切り替え制御データSetFTypeが同位相の間は端子間の接続が遮断されているスイッチとしたが、本発明はこれに限定されず、フィルタ切り替え位置でない場合には、フィルタ切り替え位置判定部４０１は、スイッチ４０２を遮断するための値を示すフィルタ切り替え制御データSetFTypeを出力するとしてもよい。また、画像符号化装置４００では、画像データImgのスライス単位で画素間フィルタを切り替えるとしたが、ピクチャ単位に画素間フィルタを切り替えるとしてもよく、また、ブロック、マクロブロックまたは一定複数画素ずつを単位に画素間フィルタを切り替えるとしてもよい。

【００２７】図３（ａ）は、本発明の画像符号化装置が出力する符号化データBitstreamのストリーム構成を示す図である。図３（ｂ）は、本発明の画像符号化装置が画素間フィルタをスライスを単位として切り替えた場合に出力される符号化データBitstreamのストリーム構成を示す図である。本発明の符号化データの特徴は、複数の画素間フィルタの１つを特定するフィルタ種別データFilterTypeを符号化データBitstreamに含むことである。このストリーム構成により、本発明の符号化データBitstreamを復号化する画像復号化装置では、符号化データBitstreamに含まれているフィルタ種別データFilterTypeを調べることにより、符号化の際に使用された画素間フィルタと同一の画素間フィルタを使用することができる。

【００２８】図３（ａ）に示した符号化データBitstreamでは、符号化データBitstream全体に付されるヘッダ９０１の中（例えば、斜線部）に、各ピクチャのフィルタリングに用いられた画素間フィルタを示すフィルタ種別データFilterTypeの値が記述されている。この符号化データBitstreamは、図１に示した画像符号化装置３００から出力される符号化データBitstream1に対応している。また、図３（ｂ）に示した符号化データBitstreamでは、スライスごとに設けられるスライスヘッダ９０２の中（例えば、斜線部）に、当該スライスのフィルタリングに用いられた画素間フィルタを示すフィルタ種別データFilterTypeの値が記述される。この符号化データBitstreamは、図２に示した画像符号化装置４００から出力される符号化データBitstream1に対応している。このように、フィルタ種別データFilterTypeを符号化データBitstreamの先頭部分であるヘッダ９０１や、データの記録・伝送の基本単位であり誤り訂正・修整の単位でもあるスライスの先頭となるスライスヘッダ９０２などに

格納することによって、画像復号化装置では、ヘッダ９０１もしくはスライスから符号化データBitstreamを入力することにより、当該スライスの復号化前にそのスライスのフィルタリング種別を特定することができる。

【００２９】なお、ここではスライス単位で画素間フィルタを切り替えると説明したが、スライス単位だけでなく、スライスより小さい画像領域単位（１画素以上が集合した領域であればよい、例えば、ＭＰＥＧのマクロブロック・ブロックなど）で画素間フィルタを切り替えてもよい。また、スライスより大きい画像領域の単位であるピクチャで切り替えてもよい。この場合、図３（ａ）に示したヘッダ９０１の中（例えば、斜線部）に記述する以外に、例えば、ピクチャ符号化データごとに設けられるピクチャヘッダの中に、各ピクチャに対応するフィルタ種別データFilterTypeIの値を記述してもよい。また、マクロブロックまたはブロックをフィルタリング方法の切り替え単位とする場合には、各マクロブロックまたは各ブロックのフィルタ種別データFilterTypeIの値をスライスごとにまとめて、スライスヘッダに記述しておけばよい。

【００３０】更に、パケット等で伝送する場合はヘッダ部とデータ部を分離して別に伝送してもよい。その場合は、図３のようにヘッダ部とデータ部が１つのビットストリームとなることはない。しかしながら、パケットの場合は、伝送する順序が多少前後することがあっても、対応するデータ部に対応するヘッダ部が別のパケットで伝送されるだけであり、１つのビットストリームとなっていなくても、概念は図３で説明したビットストリームの場合と同じである。

【００３１】以上説明したように、本発明の画像符号化装置に入力されるフィルタ種別データFilterTypeIの値を、画像復号化装置の処理能力に応じた画素間フィルタを選択するよう設定しておくことにより、本発明の画像符号化装置が出力する符号化データを再生する画像復号化装置の処理能力に応じた符号化データを作成することが可能になる。また、画像符号化装置の処理能力に応じて画素間フィルタを選択することができる。また、処理量に応じて切り替えるのではなく、画質を向上するようにフィルタを切り替えてもよい。

【００３２】図４は、本実施の形態１に係る画像符号化装置によって生成された符号化データBitstreamIを復号化する画像復号化装置１０００の構成を示すブロック図である。画像復号化装置１０００は、入力される符号化データBitstreamIのヘッダに記述されているフィルタ種別データFilterTypeIに従ってピクチャごとまたはスライスごとに画素間フィルタを切り替え、符号化データBitstreamIの符号化データを復号化する画像復号化装置であって、可変長復号化部２０１、画像復号化部２０２、加算器２０３、画像メモリ２０５、ピクチャ間予測部２０６、スイッチ１００１、スイッチ１００２、画素間フィルタＡ１００３および画素間フィルタＢ１００４を備える。

【００３３】画像復号化装置１０００には、外部から符号化データBitstreamIが入力される。この符号化データBitstreamIは、例えば実施の形態１における画像符号化装置３００または画像符号化装置４００によって符号化されたものである。可変長復号化部２０１は、入力された符号化データBitstreamIを可変長復号化し、差分画像符号化データCodedResと予測パラメータデータPredParamとフィルタ種別データFilterTypeIとに分離し、差分画像符号化データCodedResを画像復号化部２０２に、予測パラメータデータPredParamをピクチャ間予測部２０６に、フィルタ種別データFilterTypeIをスイッチ１００１とスイッチ１００２とにそれぞれ出力する。スイッチ１００１およびスイッチ１００２は、フィルタ種別データFilterTypeIとして値"１"が入力された場合には、端子"１"側に切り替わり、復号化画像データReconに画素間フィルタＡ１００３によるフィルタリングを適用する。フィルタ種別データFilterTypeIとして値"２"が入力された場合には、スイッチ１００１およびスイッチ１００２は、端子"２"側に切り替わり、復号化画像データReconに画素間フィルタＢ１００４によるフィルタリングを適用する。いずれの画素間フィルタにより画素間フィルタ演算が施された場合にも、フィルタ済復号化画像データFilteredImgIは画像メモリ２０５に格納されるとともに、画像復号化装置１０００の外部、例えば、表示装置などに出力される。

【００３４】以上説明したように、本発明の画像復号化装置１０００によれば、ヘッダ部に画素間フィルタの種別を特定するフィルタ種別データFilterTypeＩを含んだ符号化データBitstreamIを復号化することが可能になる。

【００３５】なお、本実施の形態の画像復号化装置の備える画素間フィルタは２つであるが、３つ以上の画素間フィルタを備えてもよい。この場合、本実施の形態と同様に、符号化データBitstream内のフィルタ種別データに従い３つ以上の画素間フィルタのいずれかを選択し、使用すればよい。

【００３６】なお、実施の形態１で示したように、フィルタ種別がピクチャ単位、或いは、ピクチャより小さい画像領域の単位で切り替わる場合には、フィルタ種別が変更された時点で画素間フィルタを切り替える。

【００３７】図５は、指定された画素間フィルタが内部に備えられていない場合には、備えられている画素間フィルタを代用する画像復号化装置１１００の構成を示すブロック図である。画像復号化装置１１００は、符号化データ中に含まれるフィルタ種別データで選択された画素間フィルタが画像復号化装置１１００内に備えられていない場合には、画像符号化装置１１００に備えられているいずれかの画素間フィルタを代わりに用いることを

特徴とする。この画像復号化装置１１００は、可変長復号化部２０１、画像復号化部２０２、加算器２０３、画像メモリ２０５、ピクチャ間予測部２０６、スイッチ１００１、スイッチ１００２、画素間フィルタＡ１００３、画素間フィルタＢ１００４およびフィルタ種別データ変換部１１０１を備える。

【００３８】例えば、画像復号化装置１１００には、フィルタ種別データFilterTypeIの値"１"と値"２"とが示す２種類の画素間フィルタＡ１００３と、画素間フィルタＢ１００４としか備えられていないとする。画像復号化装置１１００には、外部から符号化データBitstream3が入力される。可変長復号化部２０１は、入力される符号化データBitstream3を可変長復号化し、差分画像符号化データCodedResと予測パラメータデータPredParamとフィルタ種別データFilterType3とに分離し、差分画像符号化データCodedResを画像復号化部２０２に、予測パラメータデータPredParamをピクチャ間予測部２０６に、フィルタ種別データFilterType3をフィルタ種別データ変換部１１０１にそれぞれ出力する。フィルタ種別データ変換部１１０１は、フィルタ種別データFilterType3の値が画像復号化装置１１００に備えられていない画素間フィルタを示す値"３"をとる場合には、フィルタ種別データFilterType3の値"３"を、例えば画像復号化装置１１００に備えられている画素間フィルタのうち、指定された画素間フィルタと平滑度が最も近似する画素間フィルタを示す"２"の値に変換して、フィルタ種別データFilterType4として出力する。

【００３９】この変換処理を行うことにより、画像復号化装置１１００において、符号化時とは異なる画素間フィルタを用いるため多少の画質劣化は生じるが本来の復号化画像に近い復号化処理が可能であるため、簡易的な画像復号機能としては十分有効性がある。フィルタ種別データFilterType4として値"１"が入力された場合には、スイッチ１００１とスイッチ１００２とは、いずれも端子"１"側に切り替わり、復号化画像データReconに対して画素間フィルタＡ１００３によるフィルタリングを適用する。フィルタ種別データFilterType4として値"２"が入力された場合には、スイッチ１００１とスイッチ１００２とは、いずれも端子"２"側に切り替わり、復号化画像データReconに対して画素間フィルタＢ１００４によるフィルタリングを適用する。画素間フィルタによる処理結果であるフィルタ済復号化画像データFilteredImg3は、画像復号化装置１１００外の表示装置などに出力される。

【００４０】以上説明したように、画像復号化装置１１００によれば、画像復号化装置１１００に備えられていない画素間フィルタを指定したフィルタ種別データFilterType3が、入力符号化データBitstream3に含まれている場合でも、内部に備えられている画素間フィルタを代用して復号化を行うことができる。したがって、大幅な画質の劣化を招くことなく、符号化データBitstreamを復号化することができる。

【００４１】なお、画像復号化装置１１００が備えている画素間フィルタ（画素間フィルタ演算なしも含む）が１つの場合には強制的にその画素間フィルタを使用することで復号化を行うことができる。

【００４２】なお、本実施の形態の画像復号化装置では、２個の画素間フィルタ（画素間フィルタ演算なしも１つのフィルタとして数える）を備えているが３個以上の画素間フィルタがあっても同様の処理が可能である。すなわち、画素間フィルタの１つとして、画素間フィルタ演算を行わず復号化画像データReconをそのまま画像メモリ２０５に格納する処理を含めてもよい。

【００４３】なお、実施の形態１で示したように、フィルタ種別がピクチャ単位、或いは、ピクチャより小さい画像領域の単位で切り替わる場合には、フィルタ種別が変更された時点で画素間フィルタを切り替える。

【００４４】画素間フィルタ３０３、３０４、１００３、１００４の動作について図７および図８を用いてより詳細に説明する。図７は、画素間フィルタの一例であるデブロック・フィルタの演算内容を示す図である。図７（ａ）は、フィルタリング前におけるブロック境界付近の画素値を示す図である。図７（ｂ）は、フィルタリング後におけるブロック境界付近の画素値を示す図である。図８は、画素間フィルタのフィルタリング処理の流れを示すフローチャートである。図７（ａ）は、同一水平走査線上の画素６０１～画素６０８におけるそれぞれの画素値を示している。画素６０１～画素６０４はいずれもブロック６１０内の画素であるが、画素６０５～画素６０８はブロック６１０に隣接するブロック６１１内の画素である。画素６０１～画素６０４の画素値は、それぞれｐ３、ｐ２、ｐ１およびｐ０であり、画素６０５～画素６０８の画素値は、それぞれｑ０、ｑ１、ｑ２およびｑ３である。画像符号化装置において、ピクチャ間予測、画像符号化、可変長符号化および画像復号化などの処理は一般に、ブロック（またはマクロブロック）などを単位として行われる。このため、隣接ブロック（またはマクロブロック）間の境界、例えばブロック６１０とブロック６１１との境界をまたぐ画素間、例えば画素６０４と画素６０５とで高周波数に符号化ノイズが生じやすい。例えば、図７（ａ）に示す画素６０４の画素値ｐ０と画素６０５の画素値ｑ０とでは符号化ノイズの影響によって画素値の差が大きくなり易いという傾向がある。このため、画素間フィルタは、複数のパラメータを用いてフィルタを決定することができ、例えばフィルタを決定するパラメータα、βに対応したフィルタであり、この画素間フィルタによりブロック境界をまたぐ画素群の画素値をフィルタリングする。

【００４５】図８に示すように、画素間フィルタは、まず、ブロック境界をまたぐ画素６０４と画素６０５との

画素値の差（ｐ０－ｑ０）の絶対値を求め、求められた絶対値がパラメータαの値未満であるか否かを判定する（Ｓ７０１）。判定の結果、画素値の差（ｐ０－ｑ０）の絶対値がパラメータαの値以上であれば、画素間フィルタは、復号化画像データReconで表される画素値に対してデブロック・フィルタ処理を行わない（Ｓ７０４）。一方、ステップＳ７０１における判定の結果、ブロック境界をまたぐ隣接画素間の画素値の差（ｐ０－ｑ０）の絶対値がパラメータαの値未満であれば、画素間フィルタはさらに、画素６０４と画素６０３との画素値の差（ｐ１－ｐ０）の絶対値を求め、求められた絶対値が、パラメータβの値未満であるか否かを判定する（Ｓ７０２）。ここで、画素６０４と画素６０３とは、同一ブロック６１０内の隣接画素である。判定の結果、画素値の差（ｐ１－ｐ０）の絶対値がパラメータβの値以上であれば、画素間フィルタ５０３は、復号化画像データReconで表される画素値に対してデブロック・フィルタ処理を行わない（Ｓ７０４）。また、判定の結果、画素値の差（ｐ１－ｐ０）の絶対値がパラメータβの値未満であれば、さらに、画素６０５と画素６０６との画素値の差（ｑ１－ｑ０）の絶対値を求め、求められた絶対値が、パラメータβの値未満であるか否かを判定する（Ｓ７０３）。ここで、画素６０５と画素６０６とは、同一ブロック６１１内の隣接画素である。判定の結果、画素値の差（ｑ１－ｑ０）の絶対値がパラメータβの値以上であれば、画素間フィルタは復号化画像データReconで表される画素値に対してデブロック・フィルタ処理を行わない（Ｓ７０４）。一方、画素値の差（ｑ１－ｑ０）の絶対値がパラメータβの値未満であれば、画素間フィルタ５０３は、復号化画像データReconに対してフィルタリングを行って符号化ノイズを除去し、処理を終了する。画素間フィルタは、以上の処理をブロック境界をまたぐ水平走査線方向および垂直走査線方向の各画素列について繰り返す。このように、３組の隣接画素の画素値の差のいずれかが一定値未満の場合にデブロック・フィルタ処理を施すことでブロック歪みを除去する。

【００４６】なお、上記ステップＳ７０４におけるデブロック・フィルタ処理では、境界近傍の画素に平滑化フィルタ（高域周波数成分抑圧フィルタ）を行う。例えば、平滑化による画素６０４の新たな画素値Ｐ０は、画素６０４の画素値ｐ０、画素６０５の画素値ｑ０、画素６０３の画素値ｐ１および画素６０６の画素値ｑ１に高域周波数成分を抑圧する低域通過フィルタ（Low Pass Filter）を用いて生成することができる。

【００４７】（実施の形態２）図６は、第２の実施の形態に係る画像符号化装置５００の構成を示すブロック図である。画像符号化装置５００が画像符号化装置３００と異なるのは、画素間フィルタ処理として、復号化画像データReconをそのまま参照画像データRefとして画像メモリ１０７に格納することを選択できることである。画像符号化装置５００は、差分器１０１、画像符号化部１０２、画像復号化部１０４、加算器１０５、画像メモリ１０７、ピクチャ間予測部１０８、ピクチャ間予測推定部１０９、スイッチ５０１、スイッチ５０２、画素間フィルタ５０３、テーブル保持部５０４および可変長符号化部５０５を備える。

【００４８】スイッチ５０１とスイッチ５０２とは、フィルタ種別データFilterType2の値が"０"のとき、いずれも端子"０"側に切り替わり、加算器１０５から出力される復号化画像データReconをそのまま画像メモリ１０７に格納する。スイッチ５０１とスイッチ５０２とは、フィルタ種別データFilterType2の値が"１"のとき、いずれも端子"１"側に切り替わり、加算器１０５から出力された復号化画像データReconを画素間フィルタ５０３に導通する。画素間フィルタ５０３は、画素値のフィルタリングに用いられるフィルタで、例えば、ブロック境界における高周波成分の符号化ノイズを抑圧するデブロック・フィルタである。画素間フィルタ５０３により画素間フィルタ演算されたフィルタ済復号化画像データFilteredImg2は画像メモリ１０７に格納される。可変長符号化部５０５は、このフィルタ種別データFilterType2と差分画像符号化データCodedResと予測パラメータデータPredParamとを可変長符号化して図３（ａ）に示したような１つの符号化データBitstream2にまとめ、画像符号化装置５００の外部へ出力する。

【００４９】なお、画像符号化装置５００の備える画素間フィルタは１つであるが、２つ以上の画素間フィルタを備えてもよい。２つ以上の画素間フィルタのいずれか、もしくは、画素間フィルタ演算なしを選択して使用し、使用した画素間フィルタの種別（画素間フィルタ演算なしを含む）を示すフィルタ種別データを符号化データに含めればよい。また、画像符号化装置５００では、テーブル保持部５０４を省略し、テーブル保持部５０４の機能を画素間フィルタ５０３の内部に備えるようにしてもよい。

【００５０】以上説明したように、本発明の画像符号化装置５００では、当該画像符号化装置５００から出力された符号化データBitstream2を再生する画像復号化装置の処理能力に応じた画素間フィルタを用いて符号化データを作成することが可能になる。また、画像符号化装置５００の処理能力に応じて画素間フィルタを選択することもできる。また、フィルタ種別をピクチャ単位またはピクチャより小さい画像領域の単位で切り替えるとしてもよい。

【００５１】図９は、画素間フィルタ処理を行うか行わないかを選択できる実施の形態２に係る画像復号化装置１２００の構成を示すブロック図である。画像復号化装置１２００が図４の画像復号化装置１０００と異なる点は、画素間フィルタ処理として画素間フィルタ演算を行わず、復号化画像データReconをそのまま参照画像デー

タRefとして画像メモリ２０５に格納することが選択できることである。画像復号化装置１２００は、可変長復号化部２０１、画像復号化部２０２、加算器２０３、画像メモリ２０５、ピクチャ間予測部２０６、スイッチ１２０１、スイッチ１２０２および画素間フィルタ１２０３を備える。

【００５２】画像復号化装置１２００には、例えば、図６の画像符号化装置５００によって符号化された図７（ａ）の符号化データのように、ヘッダ内に符号化の際に適用された画素間フィルタを示すフィルタ種別データFilterType2が含まれている符号化データBitstream2が入力される。フィルタ種別データFilterType2には、フィルタ種別として"画素間フィルタ演算なし"を示す値が含まれている。可変長復号化部２０１は、入力された符号化データBitstream2を可変長復号化し、差分画像符号化データCodedResと予測パラメータデータPredParamとフィルタ種別データFilterType2とに分離する。分離された差分画像符号化データCodedResと予測パラメータデータPredParamとフィルタ種別データFilterType2とは、それぞれ、画像復号化部２０２とピクチャ間予測部２０６とスイッチ１２０１およびスイッチ１２０２とに出力される。

【００５３】スイッチ１２０１およびスイッチ１２０２は、いずれも、フィルタ種別データFilterType2として値"０"が入力された場合には、端子"０"側に切り替わり、加算器２０３から出力された復号化画像データReconは、そのまま画像メモリ２０５に格納される。スイッチ１２０１とスイッチ１２０２とは、フィルタ種別データFilterType2として値"１"が入力された場合には、いずれも端子"１"側に切り替わり、復号化画像データReconに対して画素間フィルタ１２０３によるフィルタリングを適用する。

【００５４】また、フィルタ種別データから、参照画像となる復号化画像に画素間フィルタを使用しないと判断される場合には、その復号化画像を参照画像として画像メモリに格納するときには画素間フィルタによるフィルタリングを行わず、画像復号化装置の外部に出力するときのみ画素間フィルタを使用するとしてもよい。図１０は、さらに画像出力部に選択可能な画素間フィルタを備えた画像復号化装置１３００の構成を示すブロック図である。すでに説明したように、画像復号化装置１３００は、加算器２０３から出力される復号化画像に対して、画素間フィルタによるフィルタリングを行わないことをフィルタ種別データFilterType2が示している場合には、画像メモリに格納される復号化画像にはフィルタリングせず、外部に出力される復号化画像には出力側に設けた画素間フィルタによってフィルタリングを行う画像復号化装置であって、可変長復号化部２０１、画像復号化部２０２、加算器２０３、画像メモリ２０５、ピクチャ間予測部２０６、スイッチ１２０１、スイッチ１２０２、画素間フィルタ１２０３、スイッチ１３０１、スイッチ１３０２および画素間フィルタ１３０３を備える。

【００５５】スイッチ１２０１、スイッチ１２０２、スイッチ１３０１、スイッチ１３０２は、フィルタ種別データFilterType2の値が"１"の場合には全て端子"１"側に切り替わる。この場合には、スイッチ１２０１とスイッチ１２０２とは、加算器２０３の出力と、画素間フィルタ１２０３と、画像メモリ２０５とを導通し、スイッチ１３０２は、スイッチ１２０２の出力と画素間フィルタ１３０３との導通を遮断してスイッチ１３０１と短絡する。したがって、画素間フィルタ１２０３が復号化画像データReconに対してフィルタ演算を行い、フィルタ済復号化画像データFilterdImg3を出力する。フィルタ済復号化画像データFilteredImg3は、そのまま、すなわち、重ねて画素間フィルタ１３０３でフィルタリングされることなく、出力画像OutImgとして画像復号化装置外の表示装置などに出力される。フィルタ種別データFilterType2の値が"０"の場合には、スイッチ１２０１、スイッチ１２０２、スイッチ１３０１およびスイッチ１３０２は全て端子"０"側に切り替わる。この場合には、スイッチ１２０１は、加算器２０３の出力と、画素間フィルタ１２０３との導通を遮断し、スイッチ１２０２と短絡する。一方、スイッチ１３０２は、スイッチ１２０２の出力と画素間フィルタ１３０３とスイッチ１３０１の外部出力端子とを導通する。したがって、加算器２０３から出力された復号化画像データReconは、画素間フィルタ１２０３では画素間フィルタ演算されず、そのまま、画像メモリ２０５に参照画像として格納される。スイッチ１２０２の出力側から取り出された復号化画像データRecon、すなわち、実際にはフィルタリングされていないフィルタ済復号化画像データFilteredImg3は、画素間フィルタ１３０３によって画素間フィルタ演算が施され、出力画像OutImgとして画像復号化装置１３００外の表示装置などに出力される。

【００５６】なお、ここでは説明のために、画素間フィルタ１２０３と画素間フィルタ１３０３とは異なる構成要素として記載したが、実装上は同じ画素間フィルタを使用してもよい（２つの画素間フィルタは同時に動作することがないため、同じ画素間フィルタを用いても問題はない）。また、画素間フィルタ１２０３と画素間フィルタ１３０３とは従来の画素間フィルタ１０６であってもよいし、図６に示したテーブル保持部５０４を内蔵する画素間フィルタ５０３であってもよい。またさらに、複数のパラメータ表６２０を保持するテーブル保持部５０４を内蔵した画素間フィルタ５０３であってもよい。ただし、この場合には、画素間フィルタ５０３にもフィルタ種別データFilterType2'が入力される必要がある。

【００５７】以上説明したように、画像復号化装置１３００によれば、参照画像となる復号化画像に対してフィルタリングを施さない場合であっても、その復号化画像

に対して画素間フィルタによるフィルタリングを施すことができるので、画像復号化装置１３００から出力される出力画像OutImgを表示する表示装置では、より高画質の動画像を表示することができる。これは、参照画像となる復号化画像に対してフィルタリングを施さない場合には処理能力に余裕がある機器の場合に特に有効である。

【００５８】なお、実施の形態１で示したように、フィルタ種別データFilterType2で示される画素間フィルタの種別がピクチャ単位、或いは、ピクチャより小さい画像領域の単位で切り替わる場合には、フィルタ種別が変更された時点で画素間フィルタを切り替える。

【００５９】図１１は、各ピクチャのピクチャタイプに応じて画素間フィルタ１２０３を選択することができる画像復号化装置１４００の構成を示すブロック図である。画像復号化装置１４００は、復号化済みのピクチャが参照画像として使用されるか否かの情報、例えば、各ピクチャのピクチャタイプなどを含む符号化データを復号化する画像復号化装置であって、画像復号化部２０２、加算器２０３、画像メモリ２０５、ピクチャ間予測部２０６、画素間フィルタ１２０３、可変長復号化部１４０１、スイッチ１４０２、スイッチ１４０３およびピクチャ種別データ変換部１４０４を備える。

【００６０】可変長復号化部１４０１は、外部から入力される符号化データBitstream4を可変長復号化し、ピクチャ種別データPTypeと差分画像符号化データCodedResと予測パラメータデータPredParamとに分離する。分離されたピクチャ種別データPTypeはピクチャ種別データ変換部１４０４に、差分画像符号化データCodedResは画像復号化部２０２に、予測パラメータデータPredParamはピクチャ間予測部２０６に、それぞれ、出力される。ピクチャ種別データPTypeは、当該ピクチャが参照画像として使用されるか否かを示す情報である。例えば、国際標準規格であるＭＰＥＧ-1、2では、フレーム毎にピクチャタイプと呼ばれる情報が符号化データに含まれており、Ｂピクチャと呼ばれるフレームは参照画像として使用されることはない。従って、符号化データに含まれているこのピクチャタイプを本実施の形態のピクチャ種別データPTypeとして用いてもよい。参照画像として使用されないピクチャには、画素間フィルタによるフィルタリングを行わなくとも、他のピクチャの復号化にはあまり悪影響を与えない。

【００６１】ここで、画像復号化装置１４００は、当該ピクチャが参照画像として使用されない場合には画素間フィルタを行わない。例えば、画像復号化装置１４００の処理能力が低く、再生時刻に間に合った復号化を実行できない場合には、参照画像として使用されないピクチャに画素間フィルタによるフィルタリングを行わないことによって画像復号化装置１４００の処理量を軽減することができる。図１１のブロック図を用いて説明すると、まず、ピクチャ種別データ変換部１４０４は、入力されるピクチャタイプデータPTypeがＢピクチャ以外のピクチャを示していれば、すなわち、当該ピクチャが参照画像として使用されることを示していれば、スイッチ１４０２とスイッチ１４０３とは、いずれも端子"1"に切り替わる。これにより画像復号化装置１４００は、画素間フィルタ１２０３を使用して復号化画像データReconに画素間フィルタ演算を行い、演算結果を、フィルタ済復号化画像データFilteredImg5として画像メモリ２０５に格納するとともに、画像復号化装置１４００外の表示装置などに出力する。一方、ピクチャタイプデータPTypeが、当該ピクチャがＢピクチャであることを示していれば、すなわち、当該ピクチャが参照画像として使用されないことを示していれば、スイッチ１４０２とスイッチ１４０３とは端子"0"に切り替わり、画素間フィルタ１２０３は使用されず、加算器１０５から出力された復号化画像データReconは、そのまま外部に出力される。

【００６２】以上のように、画像復号化装置１４００によれば、あまり他のピクチャに参照されることがないＢピクチャに対して画素間フィルタ１２０３によるフィルタリングを省略するので、他のピクチャの復号化に大きな影響を与えることなく、符号化データBitstreamの復号化に要求される処理量を軽減することができる。また、このように画像復号化装置１４００は、符号化データのピクチャタイプに応じて画素間フィルタを選択するので、ピクチャヘッダなどのヘッダ情報の中に画素間フィルタの選択情報が入っていない、従来の画像符号化装置から出力される符号化データに対しても、参照されない画像に対してフィルタリング処理を省略して、フィルタリング処理の負荷を軽減することができる。

【００６３】なお、参照されないピクチャはフィルタリング処理をするしないに関わらず、例えば図１１で示せば画像メモリ２０５には保存する必要がない。よって、参照されるピクチャのみ、画像メモリ２０５にフィルタリング処理をしたデータを保存すればよい。

【００６４】なお、厳密にはBピクチャは参照されない画像を意味するのではなく、Bピクチャを参照するような画像符号化方法も考えられる。従って、ピクチャタイプによって単純に画素間フィルタを選択するのではなく、実際に参照されるピクチャであるかどうかを判断すれば、Bピクチャを参照する場合でもより適切な処理が可能である。ただし、Bピクチャを参照する場合でも、実装を簡単化するために、単純にピクチャタイプで切り替えてもよい。

【００６５】また、画素間フィルタを行うかどうかを切り替えるのでなく、図４または図５に示すように、画素間フィルタ１００３、画素間フィルタ１００４と２つのフィルタをピクチャタイプ、もしくは参照されるピクチャかどうかによって切り替えてもよい。

【００６６】更に、ピクチャタイプ、およびピクチャが参照されるかどうかによって画素間フィルタを切り替える画像復号化装置の例を説明したが、この切り替えを画像符号化装置でも同様に行うことができる。

【００６７】（実施の形態３）図１２は、本発明の実施の形態３に係る画像符号化装置１５００の機能構成を示すブロック図である。画像符号化装置１５００は、ＣＰＵ、メモリ、画像符号化のためのプログラムをインストールしたハードディスク（ＨＤ）等を備えるコンピュータ装置により実現され、その機能として、操作受付部１５０５、前処理部１５１０、減算部１５１２、直交変換部１５１３、量子化部１５１４、可変長符号化部１５１７、後処理部１５２０、逆量子化部１５２１、逆直交変換部１５２２、加算部１５２４、スイッチ部１５３０、画素間フィルタ１５４０、画像メモリ１５４１、動き検出部１５４２、動き補償部１５４３、優先順位決定部１５５０およびフィルタ処理制御部１５６０を備える。

【００６８】操作受付部１５０５は、操作者の入力操作を受け付ける。前処理部１５１０は、入力された画像信号を操作受付部１５０５の操作で指定され空間解像度にフォーマット変換するフォーマット変換部、およびピクチャタイプに合わせてピクチャを並べ替えるピクチャ並べ替え部等を備え、ピクチャタイプおよびフレームごとのフレーム画像等を順次出力する。

【００６９】なお、ピクチャタイプには、画面内符号化モード時に作成される、参照画像のないＩピクチャ（Ｉｎｔｒａ　Ｐｉｃｔｕｒｅ：面内符号化画像）と、画面間符号化モード時に作成され１つのピクチャのみを参照するＰピクチャ（Ｐｒｅｄｉｃｔｉｖｅ　Ｐｉｃｔｕｒｅ：予測符号化画像）及び後方画像も参照できるＢピクチャ（Ｂｉ Ｐｒｅｄｉｃｔｉｖｅ Ｐｉｃｔｕｒｅ：複数予測画像）とがあり、画面間符号化モード時における動き検出の際に、画像メモリ１５４１に格納された、動き検出部１５４２によって同時に参照可能な復号化画像の枚数が制限される。

【００７０】また、フレーム画像を符号化する場合、３つのピクチャタイプを使用して符号化する場合のモード（このモードを以下、「ＩＰＢ符号化モード」とも記す。）と、Ｉピクチャ及びＰピクチャの２つだけを使用して符号化する場合のモードとがある。このＩピクチャ及びＰピクチャの２つだけを使用して符号化する場合のモードには、参照の可能性があるＰピクチャ及び可能性のないＰピクチャについて符号化するモード（このモードを以下、「第1ＩＰ符号化モード」とも記す。）と、階層符号化における基本レイアのＰピクチャ、補強レイアで参照の可能性があるＰピクチャ及び可能性のないＰピクチャについて符号化するモード（このモードを以下、「第2ＩＰ符号化モード」とも記す。）とがある。階層符号化とは、ピクチャを基本レイアと補強レイアの２つに分類し、基本レイアは基本レイアのピクチャ群のみで単独で再生できるまとまりであり、補強レイアは符号化・復号化のためにベースラインのピクチャ群が必要となるピクチャ群である。基本レイアのみだとビット数が少なく、基本レイアと補強レイアを合わせるとビット数が多いがピクチャ数が多くなることから、ベースラインは全ての場合に記録・伝送し、補強レイアは高画質が必要な場合のみ記録・伝送することで、2通りの用途が容易に実現できるのが階層符号化の特徴である。

【００７１】第1ＩＰ符号化モードの場合には、フレーム画像に「可能性あり」あるいは「可能性なし」の情報が付加されると共に、ピクチャタイプに「可能性あり」あるいは「可能性なし」の情報が付加される。また、第2符号化モードの場合には、フレーム画像に「基本」、「可能性あり」あるいは「可能性なし」の情報が付加されると共に、ピクチャタイプに「基本」、「可能性あり」あるいは「可能性なし」の情報が付加される。

【００７２】減算部１５１２は、画面内符号化モード時には前処理部１５１０から出力されたフレーム画像をそのまま出力し、画面間符号化モード時にはフレーム画像と、動き補償部１５４３から出力された動き補償画像との差分値である動き補償誤差（残差画像）を計算する。

【００７３】直交変換部１５１３は、減算部１５１２から出力された画面内符号化モード時のフレーム画像及び画面間符号化モード時の動き補償誤差に対してそれぞれ離散コサイン変換等の直交変換を行うことにより、周波数領域に変換した周波数成分を出力する。量子化部１５１４は、直交変換部１５１３から出力された周波数成分を量子化することにより、量子化値を出力する。可変長符号化部１５１７は、量子化部１５１４から出力された量子化値に対してその発生頻度に応じた符号長を割り当てる可変長符号（ハフマン符号）を用いることで、さらなる情報圧縮を施した符号化信号を出力する。後処理部１５２０は、符号化信号等を一時的に記憶するバッファや、量子化部１５１４における量子化幅を制御するためのレート制御部等を備え、上記動きベクトル、ピクチャタイプ等や、可変長符号化部１５１７から出力された符号化信号をビットストリームの符号化信号に変換して出力する。

【００７４】逆量子化部１５２１は、量子化部１５１４によって生成された量子化値を逆量子化することにより周波数成分を復号化する。逆直交変換部１５２２は、逆量子化部１５２１によって復号化された周波数成分を逆直交変換することにより、画面内符号化モード時にはフレーム画像を、画面間符号化モード時には画素の差分値である動き補償誤差（残差画像）を復号化する。加算部１５２４は、画面内符号化モード時には逆直交変換部１５２２によって復号化されたフレーム画像（復号化画像）をそのまま出力し、画面間符号化モード時には逆直交変換部１５２２によって復号化された残差画像と、動き補償部１５４３によって生成された動き補償画像とを

加算することによりフレーム画像を復号化する。

【００７５】スイッチ部１５３０は、フィルタ処理制御部１５６０によるピクチャごとのスイッチＯＮ／ＯＦＦ制御によりスイッチング態様を同期して切り替える一対のスイッチ１５３１，１５３２からなり、画素間フィルタ１５４０をループ内に組み入れたり、ループから外したり、すなわち、画素間フィルタ１５４０による処理をスキップさせたりする。画素間フィルタ１５４０は、スイッチ１５３１，１５３２のＯＮ時に、加算部１５２４から出力された復号化画像に対してブロック単位で空間的な低域通過フィルタ処理を行い、ブロック歪み等のない復号化画像を生成する。例えば、ある画素とその周囲の画素と平均値を算出し、ある画素と周囲の画素との差が所定の範囲内であれば、そのある画素を算出した平均値に置き換える処理をブロック境界付近の画素に対して１つずつ実行する。

【００７６】画像メモリ１５４１は、スイッチ部１５３０から出力された復号化画像を複数フレーム分、記憶する。これにより、後処理部１５２０から出力される符号化信号を復号化する画像復号化装置と同じ状態で復号化画像をモニタしたり、復号化画像を画面間符号化モード時における参照画像として用いることが可能になる。なお、第１ＩＰ符号化モード及び第２ＩＰ符号化モードにおいて、参照の可能性ありの情報が付加されたＰピクチャの復号化画像は画像メモリ１５４１に必ず格納され、参照の可能性なしの情報が付加されたＰピクチャの復号化画像は画像メモリ１５４１に格納される必要はない。このため、可能性あり／なしの情報は、復号化画像を画像メモリ１５４１に格納する／しないと同じ意味を表している。

【００７７】動き検出部１５４２は、画面間符号化モード時に画像メモリ１５４１に格納されている復号化画像の中から前処理部１５１０から出力されたフレーム画像と差分が最も小さい参照画像をサーチし、差分画素の動き量である動きベクトルを出力する。なお、動きベクトル出力の際に、参照する画像が前方画像であるか、後方画像であるか、両画像の平均値であるかをブロック予測タイプを出力する。動き補償部１５４３は、動きベクトル及びブロック予測タイプで示される演算を行い、動き補償画像を生成する。優先順位決定部１５５０は、ピクチャタイプや、基本レイヤ、補強レイヤに応じてそのピクチャの優先度を出力する。フィルタ処理制御部１５６０は、優先順位決定部１５５０から出力された優先度またはＣＰＵ稼働率に応じてスイッチ１５３１，１５３２をＯＮ／ＯＦＦ制御する。

【００７８】図１３は、図１２に示される優先順位決定部１５５０の詳細な機能構成を示すブロック図である。同図に示されるように、優先順位決定部１５５０は、ピクチャタイプ及び基本レイア、補強レイアに応じてそのピクチャの優先度を出力するものであり、図１３に示されるように、３つのテーブル１５５１～１５５３と、セレクタ１５５４と、決定処理部１５５５とからなる。なお、第２ＩＰ符号化モードにおけるＰピクチャの場合には、そのピクチャタイプに「基本」、「参照される可能性のあり」又は「なし」を示す情報も付加されている。

【００７９】テーブル１５５１は、操作受付部１５０５の操作によってＩＰＢ符号化モードが指定された場合に選択され、フレーム画像のピクチャタイプと優先度とを対応付けたテーブルであって、Ｉピクチャでは優先度が「０」，Ｐピクチャでは優先度が「１」，Ｂピクチャでは優先度が「２」に設定されている。なお、数値が大きくなるに従って、優先度が低くなるように定められている。

【００８０】テーブル１５５２は、操作受付部１５０５の操作によって第１ＩＰ符号化モードが指定された場合に選択され、フレーム画像のピクチャタイプと優先度とを対応付けたテーブルであって、Ｉピクチャでは優先度が「０」，Ｐ（参照される可能性あり）ピクチャでは優先度が「１」、Ｐ（参照される可能性なし）ピクチャでは優先度が「２」に設定されている。

【００８１】テーブル１５５３は、第２IP符号化モードＩ，Ｐ（基本、参照の可能性あり、参照の可能性なし）符号化モードが指定された場合に選択されるテーブルであって、Ｉピクチャでは優先度が「０」，Ｐ（基本）ピクチャでは優先度が「１」、Ｐ（参照される可能性あり）ピクチャでは優先度が「２」、Ｐ（参照される可能性なし）ピクチャでは優先度が「３」に設定されている。

【００８２】セレクタ１５５４は、操作受付部１５０５により指定された符号化モード（ＩＰＢ符号化モード、第１ＩＰ符号化モード）に基づいて、テーブル１５５１～１５５３のいずれか１つを選択する。決定処理部１５５５は、セレクタ１５５４によって選択されたテーブルを参照し、前処理部１５１０から出力されたピクチャタイプ及び基本レイヤ、補強レイヤに応じた優先度を決定し、決定した優先度を出力する。具体的には、ＩＰＢ符号化モードが指定されている場合、セレクタ１５５４はテーブル１５５１を選択しており、決定処理部１５５５は、前処理部１５１０からピクチャタイプが出力されるごとに、Ｉピクチャ、Ｐピクチャ、Ｂピクチャに対応付けられた優先度を出力する。また、第１ＩＰ符号化モードが指定されている場合、セレクタ１５５４はテーブル１５５２を選択しており、決定処理部１５５５は、ピクチャタイプと、Ｐピクチャに付加されているデータ（「可能性あり」、「可能性なし」）に基づいて、優先度を出力する。さらに、第２ＩＰ符号化モードが指定されている場合、セレクタ１５５４はテーブル１５５３を選択しており、決定処理部１５５５は、ピクチャタイプと、Ｐピクチャタイプに付加されているデータ（参照の「基本」、「可能性あり」、「可能性なし」）に基づい

て、優先度を出力する。

【００８３】図１４は、図１２に示されるフィルタ処理制御部１５６０の詳細な機能構成を示すブロック図である。同図に示されるように、フィルタ処理制御部１５６０は、優先順位決定部１５５０から出力された優先度及びＣＰＵ稼働率に応じてスイッチ１５３１，１５３２をＯＮ／ＯＦＦ制御するものであり、図１４に示されるように、３つのテーブル１５６１～１５６３と、セレクタ１５６４と、スイッチ切換処理部１５６５とからなる。テーブル１５６１は、ＩＰＢ符号化モードが指定される場合に選択され、フィルタ処理を施す場合の優先度とＣＰＵの稼働率との組み合わせを示すテーブルであって、ＣＰＵの稼働率が７０％未満では優先度が０～２の場合にスイッチＯＮし、ＣＰＵの稼働率が７０％以上８０％未満では優先度が０と１の場合にだけスイッチＯＮし、ＣＰＵの稼働率が８０％以上では優先度が０の場合にだけスイッチＯＮするように設定されている。

【００８４】テーブル１５６２は、第１ＩＰ符号化モードが指定される場合に選択され、フィルタ処理を施す場合の優先度とＣＰＵの稼働率との組み合わせを示すテーブルであって、ＣＰＵの稼働率が７０％未満では優先度が０～２の場合にスイッチＯＮし、ＣＰＵの稼働率が７０％以上８０％未満では優先度が０と１の場合にだけスイッチＯＮし、ＣＰＵの稼働率が８０％以上では優先度が０の場合にだけスイッチＯＮするように設定されている。

【００８５】テーブル１５６３は、第２ＩＰ符号化モードが指定される場合に選択され、フィルタ処理を施す場合の優先度とＣＰＵの稼働率との組み合わせを示すテーブルであって、ＣＰＵの稼働率が７０％未満では優先度が０～３の場合にスイッチＯＮし、ＣＰＵの稼働率が７０％以上８０％未満では優先度が０と１と２の場合にだけスイッチＯＮし、ＣＰＵの稼働率が８０％以上では優先度が０と１の場合にだけスイッチＯＮするように設定されている。

【００８６】セレクタ１５６４は、操作受付部１５０５により指定された符号化モード（ＩＰＢ符号化モード、新第１ＩＰ符号化モード）に基づいて、テーブル１５６１～１５６３のいずれか１つを選択する。スイッチ切換処理部１５６５は、セレクタ１５６４によって選択されたテーブルを参照し、優先順位決定部１５５０から出力された優先度及びピクチャごとに取得したＣＰＵ稼働率に基づいて、スイッチＯＮあるいはＯＦＦの信号を出力し、スイッチ部１５３０のスイッチ１５３１，１５３２をＯＮ／ＯＦＦ制御する。

【００８７】具体的には、ＩＰＢ符号化モードが指定されている場合、セレクタ１５６４はテーブル１５６１を選択しており、スイッチ切換処理部１５６５は、ＣＰＵ稼働率が７０％未満の場合、Ｉピクチャ、Ｐピクチャ、Ｂピクチャの全てについてスイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が７０％以上で８０％未満の場合、スイッチ切換処理部１５６５は、Ｉピクチャと、Ｐピクチャとの場合にだけ、スイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が８０％以上の場合、スイッチ切換処理部１５６５は、Ｉピクチャの場合にだけ、スイッチＯＮの信号を出力する。

【００８８】また、第１ＩＰ符号化モードが指定されている場合、セレクタ１５６４はテーブル１５６２を選択しており、スイッチ切換処理部１５６５は、ＣＰＵ稼働率が７０％未満の場合、Ｉピクチャ、Ｐピクチャ（可能性あり）、Ｐピクチャ（可能性なし）の全てについてスイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が７０％以上で８０％未満の場合、スイッチ切換処理部１５６５は、Ｉピクチャと、Ｐピクチャ（可能性あり）との場合にだけ、スイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が８０％以上の場合、スイッチ切換処理部１５６５は、Ｉピクチャの場合にだけ、スイッチＯＮの信号を出力する。

【００８９】さらに、第２ＩＰ符号化モードが指定されている場合、セレクタ１５６４はテーブル１５６３を選択しており、スイッチ切換処理部１５６５は、Ｉピクチャ、Ｐピクチャ（ベース）、Ｐピクチャ（可能性あり）、Ｐピクチャ（可能性なし）の全てについてスイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が７０％以上で８０％未満の場合、スイッチ切換処理部１５６５は、Ｉピクチャと、Ｐピクチャ（ベース）と、Ｐピクチャ（可能性あり）との場合にだけ、スイッチＯＮの信号を出力する。また、ＣＰＵ稼働率が８０％以上の場合、スイッチ切換処理部１５６５は、Ｉピクチャと、Ｐピクチャ（ベース）との場合にだけ、スイッチＯＮの信号を出力する。

【００９０】次いで、このように構成された画像符号化装置１５００の動作を説明する。フレーム画像をＩピクチャとして符号化する画面内符号化モード時には、前処理部１５１０から出力されたフレーム画像は、直交変換部１５１３による直交変換によって周波数成分に圧縮符号化され、量子化部１５１４による量子化によって量子化値に圧縮符号化される。この量子化値は、可変長符号化部１５１７による可変長符号化によって可変長に圧縮符号化され、後処理部１５２０によってＩピクチャのビットストリームの符号化信号に変換され、ハードディスク等の記憶媒体に格納される。

【００９１】一方、量子化部１５１４から出力された量子化値は、逆量子化部１５２１による逆直交変換によって周波数成分に復号化され、逆直交変換部１５２２による逆直交変換によってフレーム画像に復号化される。この復号化されたフレーム画像（復号化画像）は、フィルタ処理制御部１５６０の制御によりスイッチ１５３１，１５３２がＯＮされている場合には画素間フィルタ１５４０によってブロック歪みを除去するフィルタ処理が施

された後・画像メモリ１５４１に格納され、スイッチ１５３１・１５３２がＯＦＦされている場合にはフィルタ処理が施されることなく画像メモリ１５４１に格納される。

【００９２】また、フレーム画像をＰピクチャ及びＢピクチャとして符号化する画面間符号化モード時には、動き検出部１５４２によって動きベクトルが生成され、動き補償部１５４３によって動き補償画像（予測画像）が生成され、減算部１５１２によって動き補償誤差（差分画像）が生成される。なお・動き検出部１５４２は・画像メモリ１５４１に格納されている復号化画像の中から前処理部１５１０から出力されたフレーム画像と差分が最も小さい予測画像を、前方または後方の１つもしくは複数の参照画像から探索する。

【００９３】図１５は、画像メモリ１５４１に格納されているフレーム画像の参照関係を示す図である。特に、図１５（ａ）はＩＰＢ方式の場合の予測における参照画像を示す図であり、図１５（ｂ）は第１ＩＰ方式の場合の予測における参照画像を示す図であり、図１５（ｃ）は第２ＩＰ方式の場合の予測における参照画像を示す図である。なお、各方式の各ピクチャの下欄にそのピクチャに対応付けられた優先順位（優先度）が示されている。

【００９４】図１５（ａ）のＩＰＢ方式の場合におけるＰピクチャの予測では、前方のＩピクチャ及びＰピクチャを参照することができる。Ｂピクチャの予測では、前方のＩピクチャ又はＰピクチャを参照することができると共に、後方で時間的に最も近いＩピクチャ又はＰピクチャを１つ参照することができる。

【００９５】なお、Ｈ・２６ＬのＢピクチャの予測では、Ｉピクチャ、Ｐピクチャに加え、Ｂピクチャを前方画像として参照することもできるようになっている。このＢピクチャを参照画像として用いるモードの場合には、Ｂピクチャのフレーム画像に「可能性あり」あるいは「可能性なし」の情報が付加されると共に、ピクチャタイプに「可能性あり」あるいは「可能性なし」の情報が付加される。そして、このモードにおいて、参照の可能性ありの情報が付加されたＢピクチャの復号化画像は必ず画像メモリ１５４１に格納され、参照の可能性なしの情報が付加されたＢピクチャの復号化画像は画像メモリ１５４１に格納される必要はない。

【００９６】図１５（ｂ）の第１ＩＰ方式の場合におけるＰ（参照の可能性あり）ピクチャの予測では、前方のＩピクチャ及びＰ（参照の可能性あり）ピクチャを参照することができる。Ｐ（参照の可能性なし）ピクチャの予測では・前方のｉピクチャ又はＰ（参照の可能性あり）ピクチャを参照することができる。

【００９７】図１５（ｃ）の第２ＩＰ方式の場合におけるＰ（ベース）ピクチャの予測では、前方のＩピクチャ及びＰ（ベース）ピクチャを参照することができる。Ｐ（参照の可能性あり）ピクチャの予測では、前方のＩピクチャ及びＰ（ベース）ピクチャを参照することができる。Ｐ（参照の可能性なし）ピクチャの予測では、前方のＩピクチャ、Ｐ（ベース）ピクチャ又はＰ（参照の可能性あり）ピクチャを複数参照することができる。

【００９８】なお、説明の便宜上、ＩＰＢ符号化モードが指定されている場合について説明する。このような制限下、動き検出部１５４２は、サーチした参照画像と前処理部１５１０から出力されたフレーム画像との差分画素の動き量を動きベクトルとして出力すると共に、参照する画像が前方画像であるか、後方画像であるか、双方向画像の平均値であるかを示すブロック予測タイプを出力する。また、動き補償部１５４３は、動き検出部１５４２から出力された動きベクトルと、ブロック予測タイプとで示される演算を差分画素に対して行い、動き補償画像を生成する。そして、減算部１５１２は、前処理部１５１０から出力されたフレーム画像と動き補償部１５４３によって生成された動き補償画像とを減算することにより、動き補償誤差（差分画像）を生成する。

【００９９】減算部１５１２から出力された動き補償誤差（差分画像）は、直交変換部１５１３による直交変換によって周波数成分に圧縮符号化され、量子化部１５１４による量子化によって量子化値に圧縮符号化される。この量子化値は・可変長符号化部１５１７による可変長符号化によって可変長に圧縮符号化され、後処理部１５２０によって動きベクトル等と共にＰピクチャ又はＢピクチャのビットストリームの符号化信号に変換され、ハードディスク等の記憶媒体に格納される。

【０１００】一方、量子化部１５１４から出力された参照の可能性を有するＰピクチャ又はＢピクチャの量子化値は、逆量子化部１５２１による逆直交変換によって周波数成分に復号化され、逆直交変換部１５２２による逆直交変換によって動き補償誤差（差分画像）に復号化される。そして・加算部１５２４によって、動き補償誤差（差分画像）と動き補償画像とを加算することにより、フレーム画像に復号化される。この復号化されたフレーム画像（復号化画像）は、フィルタ処理制御部１５６０の制御によりスイッチ１５３１，１５３２がＯＮされている場合には画素間フィルタ１５４０によってブロック歪みを除去するフィルタ処理が施された後、画像メモリ１５４１に格納され、スイッチ１５３１・１５３２がＯＦＦされている場合にはフィルタ処理が施されることなく画像メモリ１５４１に格納される。

【０１０１】ここで、フィルタ処理制御部１５６０によるスイッチ１５３１・１５３２のＯＮ／ＯＦＦ制御をより詳細に説明する。図１６は、フィルタ処理制御部１５６０のスイッチ切換処理部１５６５が実行するスイッチ駆動処理を示すフローチャートである。

【０１０２】ところで、優先順位決定部１５５０の決定処理部１５５５は、セレクタ１５５４によって選択され

たテーブル１５５１を参照し、前処理部１５１０から出力されたピクチャごとにピクチャタイプに応じた優先度を決定し、決定した優先度を出力している。具体的には、ＩＰＢ符号化モードが指定されている場合、セレクタ１５５４はテーブル１５５１を選択しており、決定処理部１５５５は、前処理部１５１０からピクチャタイプが出力されるごとに、Ｉピクチャの場合には優先度「０」を、Ｐピクチャの場合には「１」を、Ｂピクチャの場合には優先度「２」を出力する。

【０１０３】フィルタ処理制御部１５６０のスイッチ切換処理部１５６５は、ピクチャの符号化ごとにそのピクチャの優先度と、この画像符号化装置１５００が備えるＣＰＵの稼働率とを取得し（Ｓ２１）、テーブル（図１４の例では、テーブル１５６１）の参照するエントリーを決定する（Ｓ２２）。

【０１０４】具体的には、ＣＰＵ稼働率が７０％未満であれば、参照するエントリーを１行目と決定し、ＣＰＵ稼働率が７０％以上で８０％未満であれば、参照するエントリーを２行目と決定し、ＣＰＵ稼働率が８０％以上であれば、参照するエントリーを３行目と決定する。

【０１０５】参照するエントリーを決定し終わると、スイッチ切換処理部１５６５は、そのエントリーの右欄を読み出し（Ｓ２３）、復号化画像のピクチャタイプに設定された優先度が右欄にあるかどうか判断する（Ｓ２４）。右欄にあれば（Ｓ２４でＹｅｓ）、スイッチ切換処理部１５６５は、スイッチオンの信号をスイッチ１５３１，１５３２に出力する（Ｓ２５）。これにより復号化画像にフィルタ処理が施され、フィルタ処理が施された復号化画像が画像メモリ１５４１に格納される。

【０１０６】これに対して、右欄になければ（Ｓ２４でＮｏ）、スイッチ切換処理部１５６５は、スイッチオフの信号をスイッチ１５３１，１５３２に出力する（Ｓ２６）。これにより復号化画像に対するフィルタ処理がスキップされ、フィルタ処理を施さずに復号化画像が画像メモリ１５４１に格納される。

【０１０７】このような制御がピクチャごとに行われ、フィルタ処理が施された復号化画像やフィルタ処理が施されない復号化画像が順次画像メモリ１５４１に格納される。従って、画像符号化において、常に、ノイズ除去等の画素間フィルタをかけるのではなく、必要に応じて、選択的に画素間フィルタをかけることができるので、例えば、画質に大きく影響するフレーム画像だけに対して画素間フィルタをかけることで、処理能力が小さい画像符号化装置であっても画像メモリに格納される重要なフレームの画質を維持し、画像メモリに格納された復号化画像にブロック歪みが蓄積されることが少なくなり、動き補償部による予測効率が向上され、ＭＰＥＧの技術よりも画質劣化を減少させることができ、低ビットレートで高い画質改善効果が得られる。

【０１０８】すなわち、他のフレーム画像に対して大きい影響度を持つフレーム画像、つまり、画面内符号化フレーム画像、前方向予測符号化フレーム画像、基本レイヤのフレーム画像等について優先的に画素間フィルタが施されるので、同じ処理負荷の増大に対して、より有効に画素間フィルタによるノイズ除去等の画質改善効果を得ることができる。

【０１０９】また、画像符号化装置の処理能力がフルに発揮されるように、フィルタ処理のＯＮ／ＯＦＦを制御することができるので、高い効率でＣＰＵが使用されることとなり、同じハードウェア資源であっても、高画質の符号化が実現される。

【０１１０】（実施の形態４）次いで、本発明の実施の形態に係る画像復号化装置について説明する。図１７は、本発明の実施の形態４に係る画像復号化装置１６００の機能構成を示すブロック図である。

【０１１１】この画像復号化装置１６００は、図１２に示される画像符号化装置１５００で符号化された符号化信号を復号化するものであって、ＣＰＵ、メモリ、画像復号化のためのプログラムをインストールしたハードディスク（ＨＤ）等を備えるコンピュータ装置により実現され、その機能として、前処理部１６１０と、可変長復号化部１６１７と、逆量子化部１６２１と、逆直交変換部１６２２と、加算部１６２４と、スイッチ部１６３０と、画素間フィルタ１６４０と、後処理部１６７０と、画像メモリ１６４１と、動き補償部１６４３と、優先順位決定部１６５０と、フィルタ処理制御部１６６０とからなる。

【０１１２】前処理部１６１０は、符号化信号を一時的に格納するバッファ等を備え、符号化信号に含まれるピクチャタイプ、動きベクトル、画像自体の符号化信号を分離して出力する。なお、画像の符号化信号が第１ＩＰ符号化モードの場合には、フレーム画像に「可能性あり」あるいは「可能性なし」の情報が付加されると共に、ピクチャタイプに「可能性あり」あるいは「可能性なし」の情報が付加される。また、第２ＩＰ符号化モードの場合には、フレーム画像に「基本」、「可能性あり」あるいは「可能性なし」の情報が付加されると共に、ピクチャタイプに「基本」、「可能性あり」あるいは「可能性なし」の情報が付加される。

【０１１３】可変長復号化部１６１７は、前処理部１６１０から出力された符号化信号に対して復号化（ハフマン復号化）することにより、固定長の量子化値を出力する。逆量子化部１６２１は、可変長復号化部１６１７から出力された量子化値を逆量子化することにより周波数成分を復号化する。逆直交変換部１６２２は、逆量子化部１６２１によって復号化された周波数成分を逆直交変換することにより、画面内符号化モード時にはフレーム画像を、画面間符号化モード時には画素の差分値である動き補償誤差（残差画像）を復号化する。

【０１１４】加算部１６２４は、画面内符号化モード時

には逆直交変換部１６２２によって復号化されたフレーム画像（復号化画像）をそのまま出力し、画面間符号化モード時には逆直交変換部１６２２によって復号化された動き補償誤差（残差画像）と動き補償部１６４３によって生成された動き補償画像とを加算することによりフレーム画像を復号化する。スイッチ部１６３０は、フィルタ処理制御部１６６０によるピクチャごとのスイッチＯＮ／ＯＦＦ制御によりスイッチング態様を同期して切り替える一対のスイッチ１６３１，１６３２からなり、画素間フィルタ１６４０をループ内に組み入れたり、ループから外したり、すなわち、画素間フィルタ１６４０による処理をスキップさせたりする。

【０１１５】画素間フィルタ１６４０は、スイッチ１６３１，１６３２のＯＮ時に、加算部１６２４から出力された復号化画像に対してブロック単位で空間的な低域通過フィルタ処理を行い、ブロック歪み等のない復号化画像を生成する。例えば、ある画素とその周囲の画素と平均値を算出し、ある画素と周囲の画素との差が所定の範囲内であれば、そのある画素を算出した平均値に置き換える処理をブロック境界付近の画素に対して１つずつ実行する。

【０１１６】後処理部１６７０は、所定の空間解像度にフォーマット変換するフォーマット変換部や、ピクチャタイプに合わせて並べ替えられた画面を元の順序に戻す画面順序戻し部等を備え、復号化画像をモニタ等に出力する。画像メモリ１６４１は、スイッチ部１６３０から出力された参照の可能性を有する復号化画像を複数フレーム分記憶する。動き補償部１６４３は、前処理部１６１０から出力された動きベクトル及びブロック予測タイプで示される演算を画像メモリ１６４１に格納されている復号化画像に対して行い、動き補償画像を生成する。優先順位決定部１６５０は、図１３に示される優先順位決定部１５５０と同構成であって、前処理部１６１０から出力されたピクチャタイプや、基本レイヤ、補強レイヤに応じてそのピクチャの優先度を出力する。フィルタ処理制御部１６６０は、図１４に示されるフィルタ処理制御部１５６０と同構成であって、優先順位決定部１６５０から出力された優先度及び監視によって得られたＣＰＵ稼働率に応じてスイッチ部１６３０のスイッチ１６３１，１６３２をＯＮ／ＯＦＦ制御する。

【０１１７】次いで、このように構成された画像復号化装置１６００の動作を説明する。なお、画像符号化装置１５００と合わせて説明する便宜上、ＩＰＢ符号化モードが指定されている場合について説明する。

【０１１８】Ｉピクチャの符号化信号をフレーム画像に復号化する画面内符号化モード時には、前処理部１６１０から出力された符号化信号は、可変長復号化部１６１７によって可変長復号化され量子化値に復号化され、逆量子化部１６２１による逆直交変換によって周波数成分に伸張復号化され、逆直交変換部１６２２による逆直交変換によってフレーム画像（復号化画像）に復号化される。この復号化されたフレーム画像（復号化画像）は、フィルタ処理制御部１６６０の制御によりスイッチ１６３１，１６３２がＯＮされている場合には画素間フィルタ１６４０によってブロック歪みを除去するフィルタ処理が施された後、画像メモリ１６４１に格納されると共に、後処理部１６７０において画像の順番が元に戻されたり、フォーマット変換され、モニタ等に出力される。これに対して、スイッチ１６３１，１６３２がＯＦＦされている場合には、復号化画像は、フィルタ処理が施されることなく画像メモリ１６４１に格納されると共に、後処理部１６７０において画像の順番が元に戻されたり、フォーマット変換され、モニタ等に出力される。

【０１１９】また、Ｐピクチャ及びＢピクチャの符号化信号をフレーム画像に復号化する画面間符号化モード時には、前処理部１６１０から出力された符号化信号は、可変長復号化部１６１７によって可変長復号化され量子化値に復号化され、逆量子化部１６２１による逆直交変換によって周波数成分に伸張復号化され、逆直交変換部１６２２による逆直交変換によって動き補償誤差（差分画像）に復号化される。

【０１２０】一方、動き補償部１６４３によって動き補償画像（予測画像）が生成される。なお、動き補償部１６４３は、前処理部１６１０から出力された動きベクトルと、ブロック予測タイプとで示される演算を画像メモリ１６４１から読み出した参照画像の差分画素に対して行い、動き補償画像を生成する。

【０１２１】そして、加算部１６２４によって、動き補償誤差（差分画像）と動き補償画像とを加算することにより、フレーム画像に復号化される。この復号化されたフレーム画像（復号化画像）は、フィルタ処理制御部１６６０の制御によりスイッチ１６３１，１６３２がＯＮされている場合には画素間フィルタ１６４０によってブロック歪みを除去するフィルタ処理が施された後、後処理部１６７０において画像の順番が元に戻されたり、フォーマット変換され、モニタ等に出力されると共に、参照鹿瀬委を有する復号化画像は画像メモリ１６４１に格納される。これに対してスイッチ１６３１，１６３２がＯＦＦされている場合にはフィルタ処理が施されることなく、後処理部１６７０において画像の順番が元に戻されたり、フォーマット変換され、モニタ等に出力されると共に、参照可能性を有する復号化画像は、画像メモリ１６４１に格納される。ここで、画像符号化装置１５００のスイッチ１５３１，１５３２の場合と同様に、スイッチ１６３１，１６３２は、フィルタ処理制御部１６６０によりＯＮ／ＯＦＦ制御されている。

【０１２２】すなわち、フィルタ処理制御部１６６０のスイッチ切換処理部は、ピクチャの符号化ごとにそのピクチャの優先度と、この画像復号化装置１６００が備えるＣＰＵの稼働率とを取得し、ＩＰＢ符号化モード用の

テーブルの参照するエントリーを決定し、そのエントリーの右欄を読み出し、復号化画像のピクチャタイプに設定された優先度が右欄にあるかどうか判断する。右欄にあれば、フィルタ処理制御部１６６０のスイッチ切換処理部は、スイッチオンの信号をスイッチ１６３１，１６３２に出力する。これにより復号化画像にフィルタ処理が施され、フィルタ処理が施された復号化画像が画像メモリ１６４１に格納される。これに対して、右欄になければ、フィルタ処理制御部１６６０のスイッチ切換処理部は、スイッチオフの信号をスイッチ１６３１，１６３２に出力する。これにより復号化画像に対するフィルタ処理がスキップされ、フィルタ処理を施さずに復号化画像が画像メモリ１６４１に格納される。このような制御がピクチャごとに行われ、フィルタ処理が施された復号化画像やフィルタ処理が施されない復号化画像が順次画像メモリ１６４１に格納される。

【０１２３】従って、画像復号化において、常に、ノイズ除去等の画素間フィルタをかけるのではなく、必要に応じて、選択的に画素間フィルタをかけることができるので、例えば、画質に大きく影響するフレーム画像だけに対して画素間フィルタをかけることで、処理能力が小さい画像復号化装置であっても画像メモリに格納される重要なフレームの画質を維持し、画像メモリに格納された復号化画像にブロック歪みが蓄積されることが少なくなり、動き補償部による予測効率が向上され、ＭＰＥＧの技術よりも画質劣化を減少させることができ、低ビットレートで高い画質改善効果が得られる。

【０１２４】すなわち、他のフレーム画像に対して大きい影響度を持つフレーム画像、つまり、画面内符号化フレーム画像、前方向予測符号化フレーム画像、ベース・レイヤフレーム画像等について優先的に画素間フィルタが施されるので、同じ処理負荷の増大に対して、より有効に画素間フィルタによるノイズ除去等の画質改善効果を得ることができる。

【０１２５】また、画像復号化装置の処理能力がフルに発揮されるように、フィルタ処理のＯＮ／ＯＦＦを制御することができるので、高い効率でＣＰＵが使用されることとなり、同じハードウェア資源であっても、高画質の復号化が実現される。

【０１２６】なお、本発明は、このような画像符号化装置や画像復号化装置として実現することができるだけでなく、これらの装置が備える特徴的な手段をステップとする画像符号化方法や画像復号化方法として実現したり、それらのステップをコンピュータに実行させるプログラムとして実現することもできる。そして、そのプログラムは、ＣＤ－ＲＯＭ等の記録媒体やインターネット等の伝送媒体を介して流通させることができるのは言うまでもない。

【０１２７】（実施の形態５）さらに、上記各実施の形態で示した画像符号化方法または画像復号化方法の構成を実現するためのプログラムを、フレキシブルディスク等の記憶媒体に記録するようにすることにより、上記各実施の形態で示した処理を、独立したコンピュータシステムにおいて簡単に実施することが可能となる。

【０１２８】図１８は、上記実施の形態１から実施の形態２の画像符号化方法または画像復号化方法を格納したフレキシブルディスクを用いて、コンピュータシステムにより実施する場合の説明図である。

【０１２９】図１８（ｂ）は、フレキシブルディスクの正面からみた外観、断面構造、及びフレキシブルディスクを示し、図１８（ａ）は、記録媒体本体であるフレキシブルディスクの物理フォーマットの例を示している。フレキシブルディスクＦＤはケースＦ内に内蔵され、該ディスクの表面には、同心円状に外周からは内周に向かって複数のトラックＴｒが形成され、各トラックは角度方向に１６のセクタＳｅに分割されている。従って、上記プログラムを格納したフレキシブルディスクでは、上記フレキシブルディスクＦＤ上に割り当てられた領域に、上記プログラムとしての画像符号化方法が記録されている。

【０１３０】また、図１８（ｃ）は、フレキシブルディスクＦＤに上記プログラムの記録再生を行うための構成を示す。上記プログラムをフレキシブルディスクＦＤに記録する場合は、コンピュータシステムＣｓから上記プログラムとしての画像符号化方法または画像復号化方法をフレキシブルディスクドライブを介して書き込む。また、フレキシブルディスク内のプログラムにより上記画像符号化方法をコンピュータシステム中に構築する場合は、フレキシブルディスクドライブによりプログラムをフレキシブルディスクから読み出し、コンピュータシステムに転送する。

【０１３１】なお、上記説明では、記録媒体としてフレキシブルディスクを用いて説明を行ったが、光ディスクを用いても同様に行うことができる。また、記録媒体はこれに限らず、ＩＣカード、ＲＯＭカセット等、プログラムを記録できるものであれば同様に実施することができる。

【０１３２】図１９から図２２は、上記実施の形態で示した符号化処理または復号化処理を行う機器、およびこの機器を用いたシステムを説明する図である。

【０１３３】図１９は、コンテンツ配信サービスを実現するコンテンツ供給システムex１００の全体構成を示すブロック図である。通信サービスの提供エリアを所望の大きさに分割し、各セル内にそれぞれ固定無線局である基地局ex１０７～ex１１０が設置されている。このコンテンツ供給システムex１００は、例えば、インターネットex１０１にインターネットサービスプロバイダex１０２および電話網ex１０４を介して、コンピュータex１１１、ＰＤＡ（personal digital assistant）ex１１２、カメラex１１３、携帯電話ex１１４が接続される。しか

し、コンテンツ供給システムex１００は図１９のような組み合わせに限定されず、いずれかを組み合わせて接続するようにしてもよい。また、固定無線局である基地局ex１０７～ex１１０を介さずに、電話網ex１０４に直接接続されてもよい。

【０１３４】カメラex１１３はデジタルビデオカメラ等の動画撮影が可能な機器である。また、携帯電話は、ＰＤＣ（Personal Digital Communications）方式、ＣＤＭＡ（Code Division Multiple Access）方式、Ｗ－ＣＤＭＡ（Wideband-Code Division Multiple Access）方式、若しくはＧＳＭ（Global System for Mobile Communications）方式の携帯電話機、またはＰＨＳ（Personal Handyphone System）等であり、いずれでも構わない。

【０１３５】また、ストリーミングサーバex１０３は、カメラex１１３から基地局ex１０９、電話網ex１０４を通じて接続されており、カメラex１１３を用いてユーザが送信する符号化処理されたデータに基づいたライブ配信等が可能になる。撮影したデータの符号化処理はカメラex１１３で行っても、データの送信処理をするサーバ等で行ってもよい。また、カメラ１１６で撮影した動画データはコンピュータex１１１を介してストリーミングサーバex１０３に送信されてもよい。カメラex１１６はデジタルカメラ等の静止画、動画が撮影可能な機器である。この場合、動画データの符号化はカメラex１１６で行ってもコンピュータex１１１で行ってもどちらでもよい。また、符号化処理はコンピュータex１１１やカメラex１１６が有するＬＳＩex１１７において処理することになる。なお、画像符号化・復号化用のソフトウェアをコンピュータex１１１等で読み取り可能な記録媒体である何らかの蓄積メディア（ＣＤ－ＲＯＭ、フレキシブルディスク、ハードディスクなど）に組み込んでもよい。さらに、カメラ付きの携帯電話ex１１５で動画データを送信してもよい。このときの動画データは携帯電話ex１１５が有するＬＳＩで符号化処理されたデータである。

【０１３６】図２０は、携帯電話ex１１５の一例を示す図である。携帯電話ex１１５は、基地局ex１１０との間で電波を送受信するためのアンテナex２０１、ＣＣＤカメラ等の映像、静止画を撮ることが可能なカメラ部ex２０３、カメラ部ex２０３で撮影した映像、アンテナex２０１で受信した映像等が復号化されたデータを表示する液晶ディスプレイ等の表示部ex２０２、操作キー群から構成される本体部ex２０４、音声出力をするためのスピーカ等の音声出力部ex２０８、音声入力をするためのマイク等の音声入力部ex２０５、撮影した動画もしくは静止画のデータ、受信したメールのデータ、動画のデータもしくは静止画のデータ等、符号化されたデータまたは復号化されたデータを保存するための記憶メディアex２０７、携帯電話ex１１５に記憶メディアex２０７を装着可能とするためのスロット部ex２０６を有している。記憶メディアex２０７はＳＤカード等のプラスチックケース内に電気的に書換えや消去が可能な不揮発性メモリであるＥＥＰＲＯＭ（Electrically Erasable and Programmable Read Only Memory）の一種であるフラッシュメモリ素子を格納したものである。

【０１３７】このコンテンツ供給システムex１００では、ユーザがカメラex１１３、カメラex１１６等で撮影しているコンテンツ（例えば、音楽ライブを撮影した映像等）を上記実施の形態同様に符号化処理してストリーミングサーバex１０３に送信する一方で、ストリーミングサーバex１０３は要求のあったクライアントに対して上記コンテンツデータをストリーム配信する。クライアントとしては、上記符号化処理されたデータを復号化することが可能な、コンピュータex１１１、ＰＤＡex１１２、カメラex１１３、携帯電話ex１１４等がある。このようにすることでコンテンツ供給システムex１００は、符号化されたデータをクライアントにおいて受信して再生することができ、さらにクライアントにおいてリアルタイムで受信して復号化し、再生することにより、個人放送をも実現可能になるシステムである。

【０１３８】さらに、携帯電話ex１１５について図２１を用いて説明する。携帯電話ex１１５は表示部ex２０２及び本体部ex２０４の各部を統括的に制御するようになされた主制御部ex３１１に対して、電源回路部ex３１０、操作入力制御部ex３０４、画像符号化部ex３１２、カメラインターフェース部ex３０３、ＬＣＤ（Liquid Crystal Display）制御部ex３０２、画像復号化部ex３０９、多重分離部ex３０８、記録再生部ex３０７、変復調回路部ex３０６及び音声処理部ex３０５が同期バスex３１３を介して互いに接続されている。電源回路部ex３１０は、ユーザの操作により終話及び電源キーがオン状態にされると、バッテリパックから各部に対して電力を供給することによりカメラ付ディジタル携帯電話ex１１５を動作可能な状態に起動する。携帯電話ex１１５は、ＣＰＵ、ＲＯＭ及びＲＡＭ等でなる主制御部ex３１１の制御に基づいて、音声通話モード時に音声入力部ex２０５で集音した音声データを音声処理部ex３０５によってディジタル音声データに変換し、これを変復調回路部ex３０６でスペクトラム拡散処理し、送受信回路部ex３０１でディジタルアナログ変換処理及び周波数変換処理を施した後にアンテナex２０１を介して送信する。また携帯電話機ex１１５は、音声通話モード時にアンテナex２０１で受信した受信データを増幅して周波数変換処理及びアナログディジタル変換処理を施し、変復調回路部ex３０６でスペクトラム逆拡散処理し、音声処理部ex３０５によってアナログ音声データに変換した後、これを音声出力部２０８を介して出力する。さらに、データ通信モード時に電子メールを送信する場合、本体部ex２０４の操作キーの操作によって入力された電子メールのテキストデータは操作入力制御部ex３０４を介して主制御部ex

３１１に送出される。主制御部ex３１１は、テキストデータを変復調回路部ex３０６でスペクトラム拡散処理し、送受信回路部ex３０１でディジタルアナログ変換処理及び周波数変換処理を施した後にアンテナex２０１を介して基地局ex１１０へ送信する。

【０１３９】データ通信モード時に画像データを送信する場合、カメラ部ex２０３で撮像された画像データをカメラインターフェース部ex３０３を介して画像符号化部ex３１２に供給する。また、画像データを送信しない場合には、カメラ部ex２０３で撮像した画像データをカメラインターフェース部ex３０３及びＬＣＤ制御部ex３０２を介して表示部ex２０２に直接表示することも可能である。

【０１４０】画像符号化部ex３１２は、カメラ部ex２０３から供給された画像データを上記実施の形態で示した符号化方法によって圧縮符号化することにより符号化画像データに変換し、これを多重分離部ex３０８に送出する。また、このとき同時に携帯電話機ex１１５は、カメラ部ex２０３で撮像中に音声入力部ex２０５で集音した音声を音声処理部ex３０５を介してディジタルの音声データとして多重分離部ex３０８に送出する。

【０１４１】多重分離部ex３０８は、画像符号化部ex３１２から供給された符号化画像データと音声処理部ex３０５から供給された音声データとを所定の方式で多重化し、その結果得られる多重化データを変復調回路部ex３０６でスペクトラム拡散処理し、送受信回路部ex３０１でディジタルアナログ変換処理及び周波数変換処理を施した後にアンテナex２０１を介して送信する。

【０１４２】データ通信モード時にホームページ等にリンクされた動画像ファイルのデータを受信する場合、アンテナex２０１を介して基地局ex１１０から受信した受信データを変復調回路部ex３０６でスペクトラム逆拡散処理し、その結果得られる多重化データを多重分離部ex３０８に送出する。

【０１４３】また、アンテナex２０１を介して受信された多重化データを復号化するには、多重分離部ex３０８は、多重化データを分離することにより符号化画像データと音声データとに分け、同期バスex３１３を介して当該符号化画像データを画像復号化部ex３０９に供給すると共に当該音声データを音声処理部ex３０５に供給する。

【０１４４】次に、画像復号化部ex３０９は、符号化画像データを上記実施の形態で示した符号化方法に対応した復号化方法で復号することにより再生動画像データを生成し、これをＬＣＤ制御部ex３０２を介して表示部ex２０２に供給し、これにより、例えばホームページにリンクされた動画像ファイルに含まれる動画データが表示される。このとき同時に音声処理部ex３０５は、音声データをアナログ音声データに変換した後、これを音声出力部ex２０８に供給し、これにより、例えばホームページにリンクされた動画像ファイルに含まる音声データが再生される。

【０１４５】なお、上記システムの例に限られず、最近は衛星、地上波によるディジタル放送が話題となっており、図２２に示すようにディジタル放送用システムにも上記実施の形態の少なくとも符号化方法または復号化方法いずれかを組み込むことができる。具体的には、放送局ex４０９では映像情報の符号化ビットストリームが電波を介して通信または放送衛星ex４１０に伝送される。これを受けた放送衛星ex４１０は、放送用の電波を発信し、この電波を衛星放送受信設備をもつ家庭のアンテナex４０６で受信し、テレビ（受信機）ex４０１またはセットトップボックス（ＳＴＢ）ex４０７などの装置により符号化ビットストリームを復号化してこれを再生する。また、記録媒体であるCDやDVD等の蓄積メディアex４０２に記録した符号化ビットストリームを読み取り、復号化する再生装置ex４０３にも上記実施の形態で示した画像復号化装置を実装することが可能である。この場合、再生された映像信号はモニタex４０４に表示される。また、ケーブルテレビ用のケーブルex４０５または衛星／地上波放送のアンテナex４０６に接続されたセットトップボックスex４０７内に画像復号化装置を実装し、これをテレビのモニタex４０８で再生する構成も考えられる。このときセットトップボックスではなく、テレビ内に画像復号化装置を組み込んでも良い。また、アンテナex４１１を有する車ex４１２で衛星ex４１０からまたは基地局ex１０７等から信号を受信し、車ex４１２が有するカーナビゲーションex４１３等の表示装置に動画を再生することも可能である。

【０１４６】更に、画像信号を上記実施の形態で示した画像符号化装置で符号化し、記録媒体に記録することもできる。具体例としては、DVDディスクｅｘ４２１に画像信号を記録するDVDレコーダや、ハードディスクに記録するディスクレコーダなどのレコーダex４２０がある。更にSDカードｅｘ４２２に記録することもできる。レコーダｅｘ４２０が上記実施の形態で示した画像復号化装置を備えていれば、DVDディスクｅｘ４２１やSDカードｅｘ４２２に記録した画像信号を再生し、モニタｅｘ４０８で表示することができる。

【０１４７】なお、カーナビゲーションex４１３の構成は例えば図２１に示す携帯電話機ex１１５と同様であるが、図２１に示した構成のうち、カメラ部ex２０３とカメラインターフェース部ex３０３、画像符号化部ｅｘ３１２を除いた構成が考えられる。同様なことがコンピュータex１１１やテレビ（受信機）ex４０１等でも考えられる。また、上記携帯電話ex１１４等の端末は、符号化器・復号化器を両方持つ送受信型の端末の他に、符号化器のみの送信端末、復号化器のみの受信端末の３通りの実装形式が考えられる。

【０１４８】このように、本明細書に示した符号化方

法、復号化方法を実装することにより本実施の形態で示したいずれの装置・システムに関しても実現可能になる。

【０１４９】

【発明の効果】本発明に係る画像符号化装置は、入力画像を表す入力画像データと、前記入力画像のピクチャに対する予測画像を表す予測画像データとの差分である差分画像データを符号化して符号化画像データを生成する画像符号化装置であって、前記差分画像データを符号化した後、前記符号化した差分画像データを復号化して前記予測画像データと加算する復号化手段と、前記復号化手段で得られた復号化画像データに対して画素間フィルタ演算を施す複数の画素間フィルタと、前記画素間フィルタのうちから、１つを選択する選択手段と、選択された前記画素間フィルタで得られたフィルタ済み復号化画像データを参照画像データとして用いて、入力画像データに対する予測画像データを生成する予測画像生成手段とを備えることを特徴とする。

【０１５０】したがって、本発明に係る画像符号化装置は、画像符号化装置側での処理能力や、符号化信号を受信する画像復号化装置側での処理能力、もしくは符号化対象の画像の性質や圧縮率等に応じて適切な画素間フィルタを切り替えて符号化信号を作成することができるという効果がある。

【０１５１】また、本発明に係る画像復号化装置は、動画像中のピクチャを表す画像データと動画中の他のピクチャを表す予測画像データとの差分を符号化して得られた符号化画像データから、元の動画像を表す複数の画像データを復号化する画像復号化装置であって、前記符号化画像データの復号化結果と、当該符号化画像データに対応する、すでに復号化された予測画像データとを加算して、元のピクチャを表す画像データを復号化する復号手段と、復号化された前記画像データに対して画素間フィルタ演算を施す複数の画素間フィルタのうちから１つを選択する選択手段と、選択された前記画素間フィルタによる前記演算が施された画像データから、別の符号化画像データに対応する予測画像データを生成する予測画像生成手段とを備えることを特徴とする。

【０１５２】従って、本発明に係る画像復号化装置では、画像復号化装置の処理能力や画像の参照の有無に応じて画素間フィルタを選択し、予測画像を生成することができるという効果がある。また、画像符号化装置で画素間フィルタを切り替えた場合は、画像復号化装置でも対応する画素間フィルタを用いて正しく復号化できる。

【０１５３】さらに、本発明に係る画像符号化装置（及び画像復号化装置）は、繰り返し入力されるフレーム画像を符号化する画像符号化装置等であって、フレーム画像に所定の変換処理を施すことによって符号化を行う符号化手段と、前記符号化手段によって符号化されたフレーム画像に前記変換処理の逆の変換処理を施す逆変換手段と、フレーム画像にフィルタ処理を施すフィルタ手段と、フレーム画像を記憶するための記憶手段と、前記逆変換手段による逆変換処理で得られたフレーム画像に対して、前記フィルタ手段によるフィルタ処理を施した後に当該フレーム画像を前記記憶手段に格納するか、又は、前記フィルタ手段によるフィルタ処理を施さずに当該フレーム画像を前記記憶手段に格納するように制御する制御手段とを備え、前記符号化手段は、前記記憶手段に格納された過去のフレーム画像を参照しながら前記フレーム画像を符号化することを特徴とする。

【０１５４】これによって、画像符号化（及び画像復号化）において、常に、ノイズ除去等の画素間フィルタをかけるのではなく、必要に応じて、選択的に画素間フィルタをかけることができるので、例えば、画質に大きく影響するフレーム画像だけに対して画素間フィルタをかけることで、処理能力が小さい画像符号化装置（画像復号化装置）であっても画素間フィルタを採用することが可能となり、低ビットレートで高い画質改善効果が得られる。

【０１５５】ここで、前記制御手段は、前記フレーム画像の重要度が高い場合に、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像の重要度が低い場合に、当該フレーム画像に対して前記フィルタ処理を施さないように制御してもよい。例えば、前記制御手段は、前記フレーム画像が前記符号化手段によって面内符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって面間符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御したり、前記フレーム画像が前記符号化手段によって前方向予測符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によって双方向予測符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御したり、前記フレーム画像が前記符号化手段によってベース・レイヤ符号化が行われたものである場合に、当該フレームの重要度が高いと判断し、当該フレーム画像に対して前記フィルタ処理を施し、前記フレーム画像が前記符号化手段によってエンハンスメント・レイヤ符号化が行われたものである場合に、当該フレームの重要度が低いと判断し、当該フレーム画像に対して前記フィルタ処理を施さないように制御してもよい。

【０１５６】これによって、他のフレーム画像に対して大きい影響度を持つフレーム画像、つまり、面内符号化フレーム画像、前方向予測符号化フレーム画像、ベース・レイヤフレーム画像等について優先的に画素間フィル

タが施されるので、同じ処理負荷の増大に対して、より有効に画素間フィルタによるノイズ除去等の画質改善効果を得ることができる。

【０１５７】また、前記制御手段は、当該画像符号化装置（画像復号化装置）の処理能力についての余裕を監視し、余裕がある場合には、より重要度の低いフレーム画像までフィルタ処理を施し、余裕がない場合には、より重要度の高いフレーム画像までフィルタ処理を施さないように制御してもよい。例えば、前記フレーム画像には、前記重要度に対応する優先順位が対応付けられ、前記制御手段は、当該画像符号化装置が備えるＣＰＵの稼働率を監視することによって前記余裕を監視し、前記稼働率が高い場合には、優先度の高いフレーム画像だけフィルタ処理を施し、前記稼働率が低い場合には、優先度の低いフレーム画像までフィルタ処理を施すように制御してもよい。

【０１５８】これによって、画像符号化装置（画像復号化装置）の処理能力がフルに発揮されるように、フィルタ処理のＯＮ／ＯＦＦを制御することができるので、高い効率でＣＰＵが使用されることとなり、同じハードウェア資源であっても、高画質の符号化（復号化）が実現される。

【０１５９】以上のように、本発明により、低ビットレート（高圧縮率）で高画質の画像符号化及び画像復号化が実現され、特に、限られたハードウェア資源下でのソフトウェアによる画像符号化処理及び画像復号化処理における高い画質改善効果が発揮され、情報通信技術とコンピュータが広く普及した今日における実用的価値は極めて高いと言える。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態に係る画像符号化装置の構成を示すブロック図である。

【図２】入力画像のスライスごとに画素間フィルタを切り替える画像符号化装置の構成を示すブロック図である。

【図３】（ａ）は、本発明の画像符号化装置が出力する符号化データBitstreamのストリーム構成を示す図である。（ｂ）は、本発明の画像符号化装置が画素間フィルタをスライスを単位として切り替えた場合に出力される符号化データBitstreamのストリーム構成を示す図である。

【図４】本実施の形態１に係る画像符号化装置によって生成された符号化データBitstreamlを復号化する画像復号化装置の構成を示すブロック図である。

【図５】指定された画素間フィルタが内部に備えられていない場合には、備えられている画素間フィルタを代用する画像復号化装置の構成を示すブロック図である。

【図６】本発明の第２の実施の形態に係る画像符号化装置の構成を示すブロック図である。

【図７】図６に示した画素間フィルタの一例であるデブロック・フィルタの演算内容を示す図である。（ａ）は、フィルタリング前におけるブロック境界付近の画素値を示す図である。（ｂ）は、フィルタリング後におけるブロック境界付近の画素値を示す図である。

【図８】画素間フィルタのフィルタリング処理の流れを示すフローチャートである。

【図９】画素間フィルタ処理を行うか行わないかを選択できる画像復号化装置の構成を示すブロック図である。

【図１０】さらに出力段に選択可能な画素間フィルタを備えた画像復号化装置の構成を示すブロック図である。

【図１１】各フレームのピクチャタイプに応じて画素間フィルタを選択することができる画像復号化装置の構成を示すブロック図である。

【図１２】本発明の実施の形態３に係る画像符号化装置の機能構成を示すブロック図である。

【図１３】図１２に示される優先順位決定部の詳細な機能構成を示すブロック図である。

【図１４】図１２に示されるフィルタ処理制御部の詳細な機能構成を示すブロック図である。

【図１５】図１２に示される画像メモリに格納されているフレーム画像の参照関係を示す図である。

【図１６】図１４に示されるスイッチ切換処理部が実行するスイッチ駆動処理を示すフローチャートである。

【図１７】本発明の実施の形態４に係る画像復号化装置の機能構成を示すブロック図である。

【図１８】上記実施の形態１から実施の形態３の画像符号化方法または画像復号化方法を格納したフレキシブルディスクを用いて、コンピュータシステムにより実施する場合の説明図である。（ａ）は、記録媒体本体であるフレキシブルディスクの物理フォーマットの例を示している。（ｂ）は、フレキシブルディスクの正面からみた外観、断面構造、及びフレキシブルディスクを示し、（ｃ）は、フレキシブルディスクＦＤに上記プログラムの記録再生を行うための構成を示す。

【図１９】コンテンツ配信サービスを実現するコンテンツ供給システムの全体構成を示すブロック図である。

【図２０】携帯電話の外観の一例を示す図である。

【図２１】携帯電話の構成を示すブロック図である。

【図２２】上記実施の形態で示した符号化処理または復号化処理を行う機器、およびこの機器を用いたシステムを説明する図である。

【図２３】従来の画像符号化装置の構成を示すブロック図である。

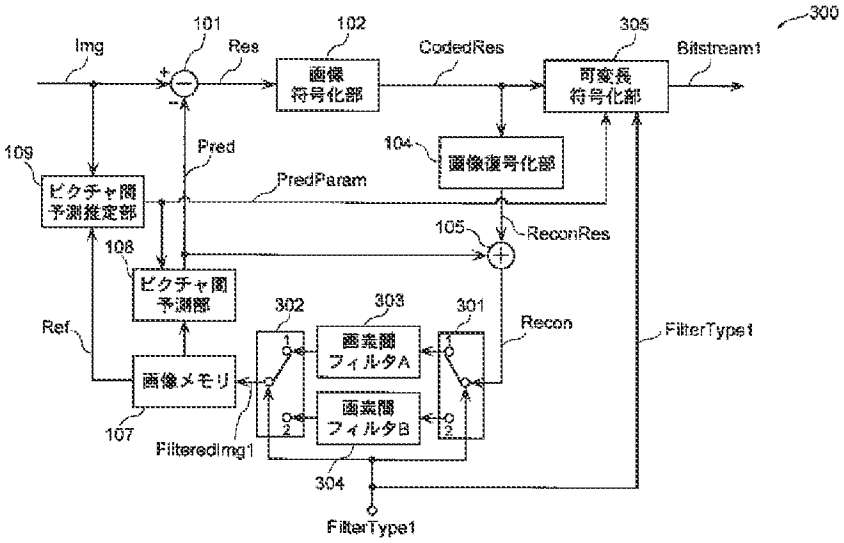
【図２４】従来の画像復号化装置の構成を示すブロック図である。

【符号の説明】

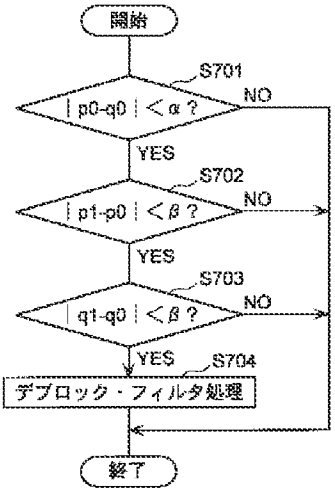
３００　画像符号化装置
１０１　差分器
１０２　画像符号化部
１０４　画像復号化部

１０５	加算器	＊Img	画像データ
１０７	画像メモリ	FilterType1	フィルタ種別データ
１０８	ピクチャ間予測部	Res	差分画像データ
１０９	ピクチャ間予測推定部	Bitstream1	符号化データ
３０１	スイッチ	PredParam	予測パラメータデータ
３０２	スイッチ	CodedRes	差分画像符号化データ
３０３	画素間フィルタＡ	FilteredImg1	フィルタ済復号化画像データ
３０４	画素間フィルタＢ	Ref	参照画像データ
３０５	可変長符号化部	＊ Recon	復号化画像データ

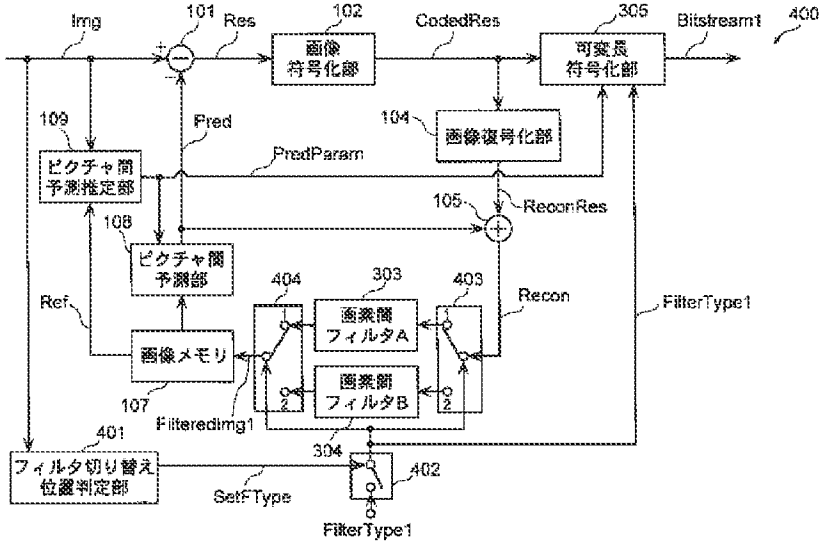
【図１】



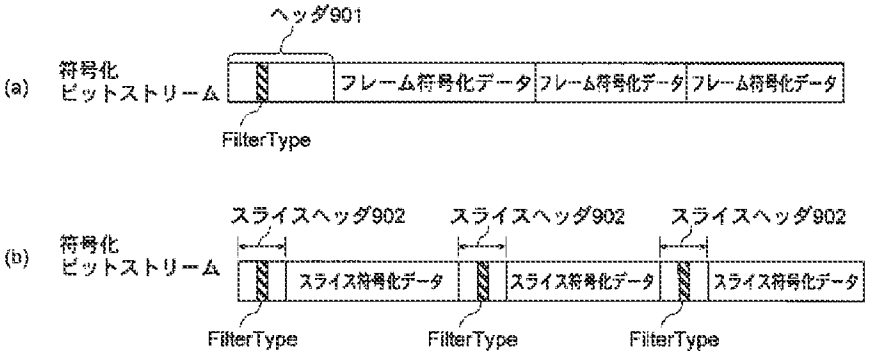
【図８】



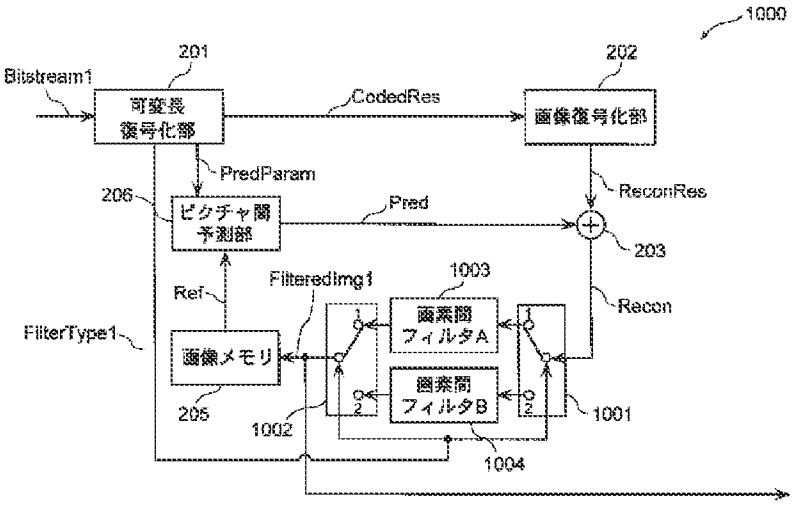
【図２】



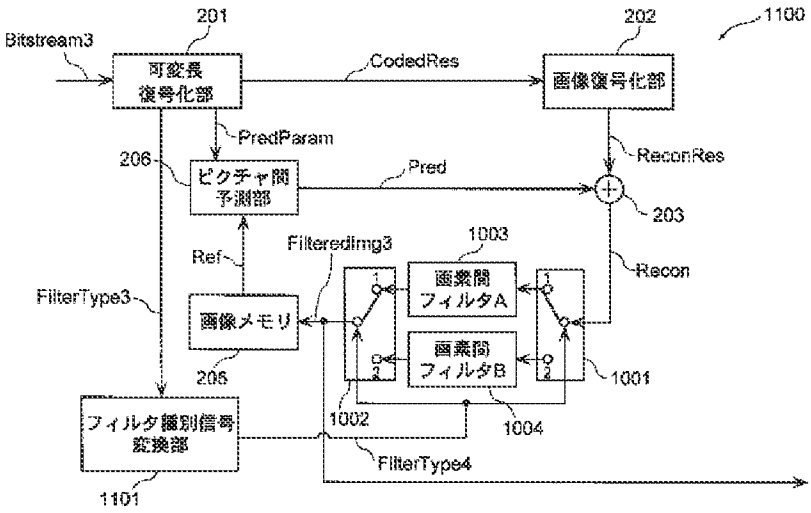
【図３】


ヘッダ901
(a)
符号化
ビットストリーム
フレーム符号化データ
フレーム符号化データ
フレーム符号化データ
FilterType
スライスヘッダ902
スライスヘッダ902
スライスヘッダ902
(b)
符号化
ビットストリーム
スライス符号化データ
スライス符号化データ
スライス符号化データ
FilterType
FilterType
FilterType

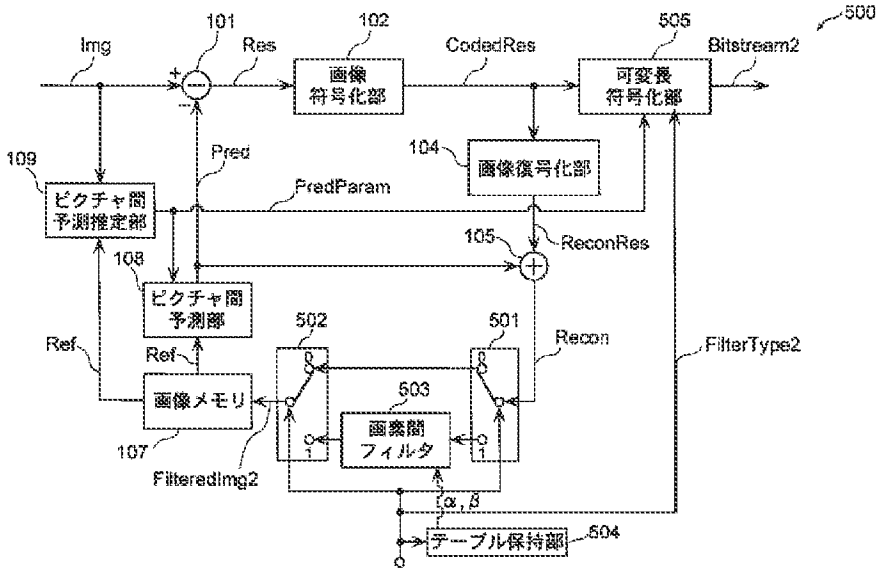
【図４】


1000
201
202
Bitstream1
可変長
復号化部
CodedRes
画像復号化部
PredParam
206
ピクチャ間
予測部
Pred
ReconRes
203
Ref
FilteredImg1
1003
Recon
FilterType1
画像メモリ
画素間
フィルタA
画素間
フィルタB
205
1002
1001
1004

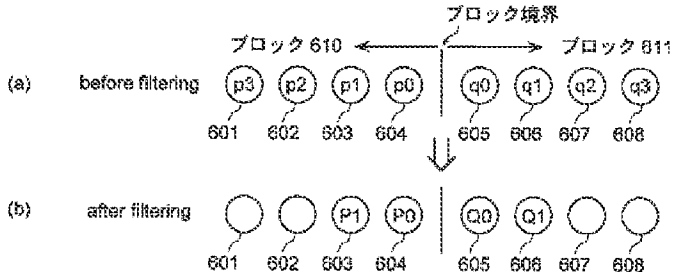
【図５】


1100
201
202
Bitstream3
可変長
復号化部
CodedRes
画像復号化部
PredParam
206
ピクチャ間
予測部
Pred
ReconRes
203
Ref
FilteredImg3
1003
Recon
FilterType3
画像メモリ
画素間
フィルタA
画素間
フィルタB
206
1001
1002
1004
フィルタ識別信号
変換部
FilterType4
1101

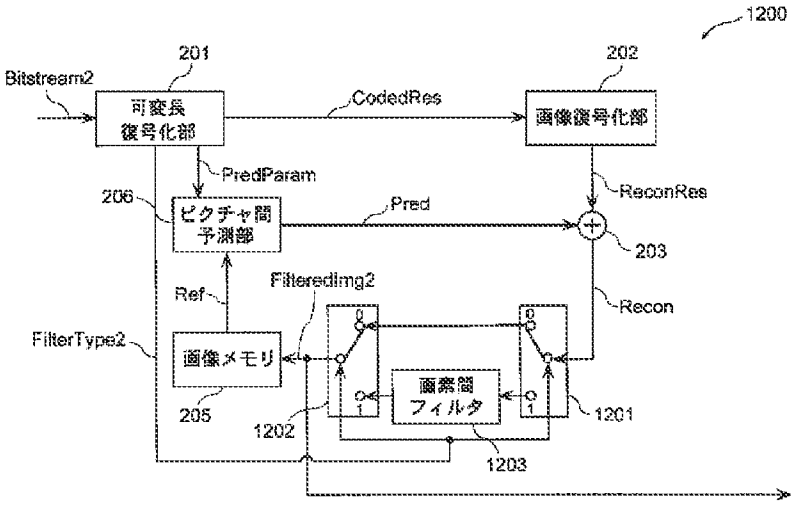
【図６】


500
101
102
505
Img
Res
CodedRes
Bitstream2
画像
符号化部
可変長
符号化部
109
Pred
104
画像復号化部
ピクチャ間
予測推定部
PredParam
105
ReconRes
108
ピクチャ間
予測部
502
501
Ref
Ref
Recon
FilterType2
画像メモリ
503
画素間
フィルタ
107
FilteredImg2
α, β
テーブル保持部
504

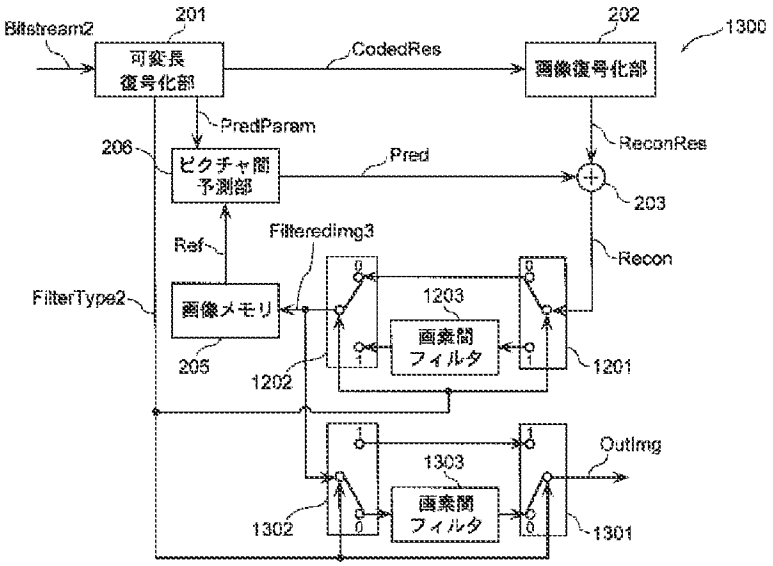
【図７】


ブロック境界
ブロック 610
ブロック 611
(a)
before filtering
p3
p2
p1
p0
q0
q1
q2
q3
601
602
603
604
605
606
607
608
(b)
after filtering
P1
P0
Q0
Q1

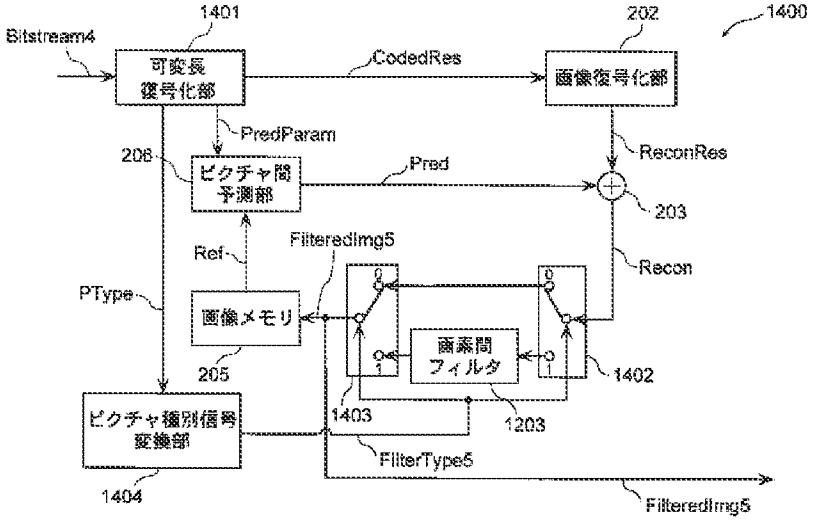
【図９】


1200
201
202
Bitstream2
可変長
復号化部
CodedRes
画像復号化部
PredParam
ReconRes
206
ピクチャ間
予測部
Pred
203
Ref
FilteredImg2
Recon
FilterType2
画像メモリ
画素間
フィルタ
205
1202
1201
1203

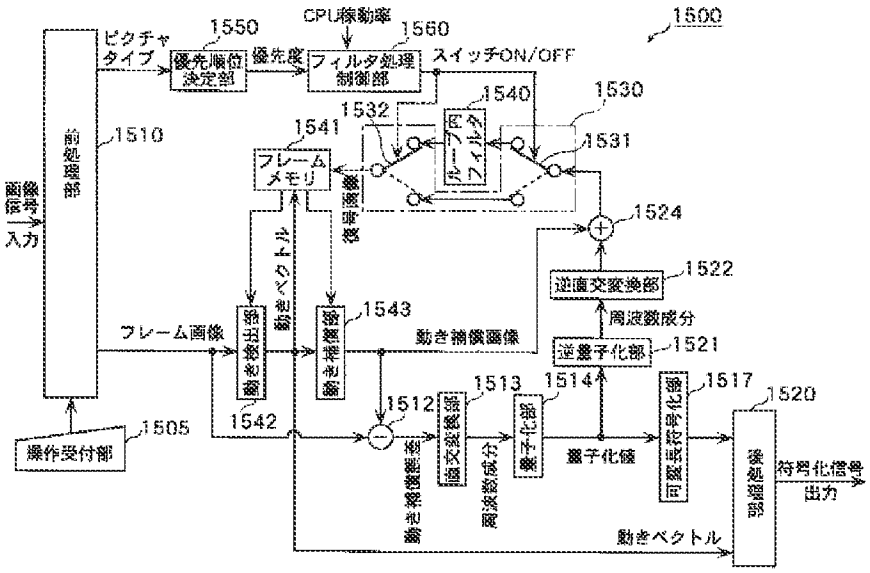
【図１０】


Bitstream2
201
可変長
復号化部
CodedRes
202
画像復号化部
1300
PredParam
ReconRes
206
ピクチャ間
予測部
Pred
203
Ref
FilteredImg3
Recon
FilterType2
画像メモリ
1203
画素間
フィルタ
205
1202
1201
OutImg
1303
画素間
フィルタ
1302
1301

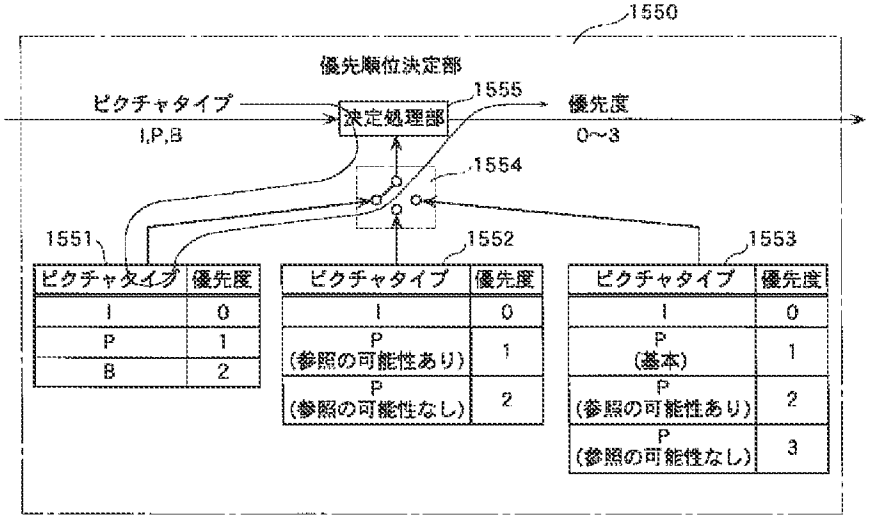
【図１１】


Bitstream4
1401
可変長
復号化部
CodedRes
202
画像復号化部
1400
PredParam
ReconRes
206
ピクチャ間
予測部
Pred
203
Ref
FilteredImg5
Recon
PType
画像メモリ
画素間
フィルタ
205
1402
ピクチャ種別信号
変換部
1403
1203
FilterType5
1404
FilteredImg5

【図１２】



【図１３】

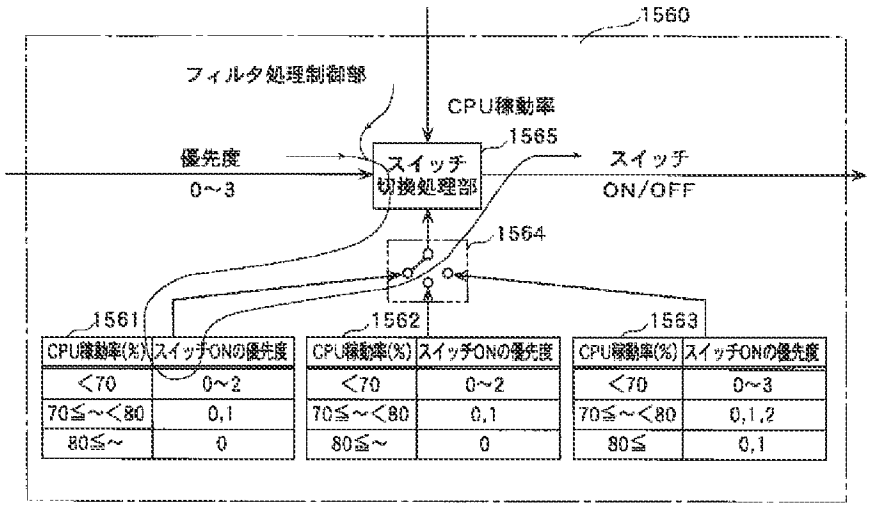


ピクチャタイプ	優先度
I	0
P	1
B	2

ピクチャタイプ	優先度
I	0
P (参照の可能性あり)	1
P (参照の可能性なし)	2

ピクチャタイプ	優先度
I	0
P (基本)	1
P (参照の可能性あり)	2
P (参照の可能性なし)	3

【図１４】

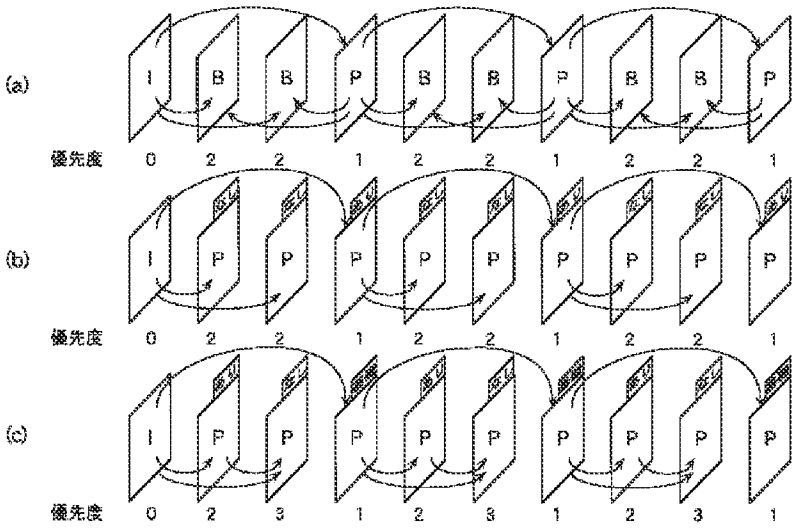


CPU稼動率(%)	スイッチONの優先度
<70	0～2
70≦～<80	0,1
80≦～	0

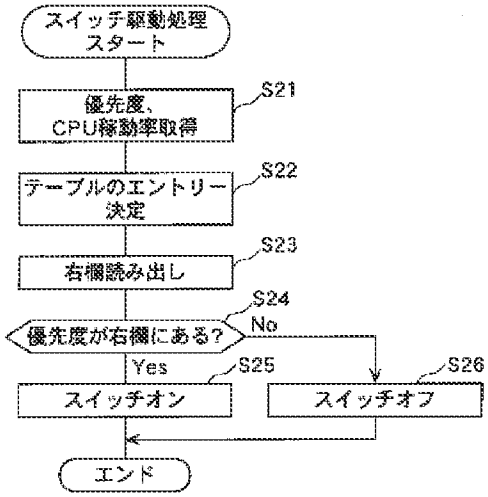
CPU稼動率(%)	スイッチONの優先度
<70	0～2
70≦～<80	0,1
80≦～	0

CPU稼動率(%)	スイッチONの優先度
<70	0～3
70≦～<80	0,1,2
80≦	0,1

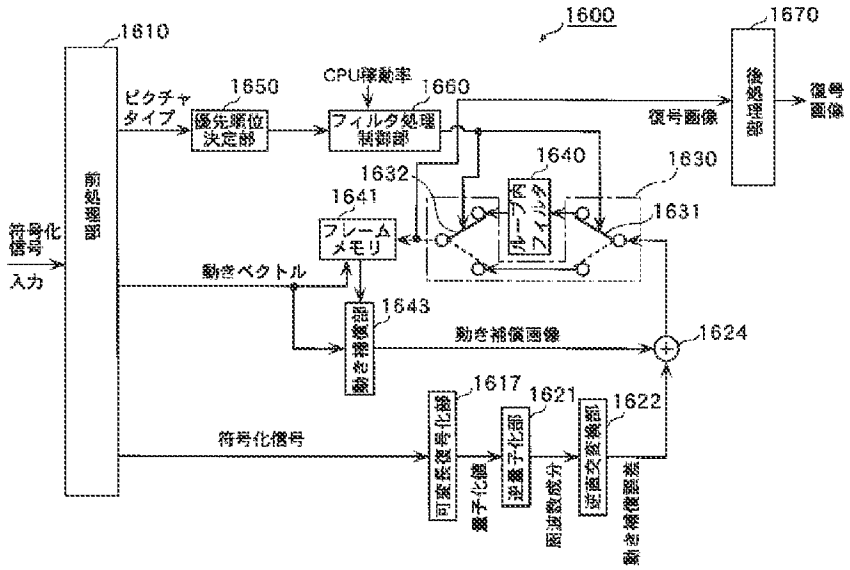
【図１５】



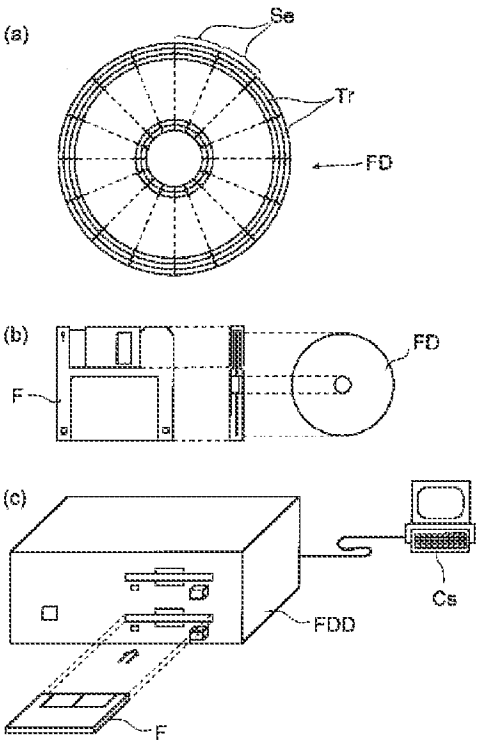
【図１６】


スイッチ駆動処理
スタート
優先度、
CPU稼動率取得
S21
テーブルのエントリー
決定
S22
右欄読み出し
S23
S24
優先度が右欄にある?
No
Yes
S25
S26
スイッチオン
スイッチオフ
エンド

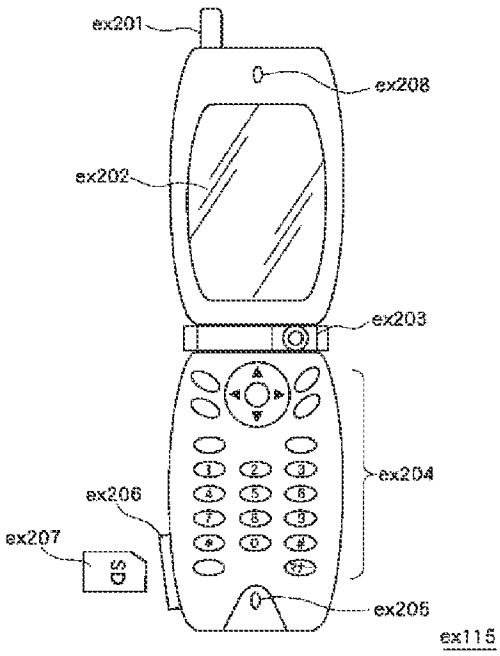
【図１７】


1600
1610
1670
ピクチャ
タイプ
1650
優先順位
決定部
CPU稼動率
1660
フィルタ処理
制御部
復号画像
後処理部
復号
画像
1640
1630
1632
1641
ループ内
フィルタ
1631
フレーム
メモリ
符号化
画像
入力
動きベクトル
1643
動き補償部
動き補償画像
1624
1617
1621
1622
符号化信号
可変長復号化部
逆量子化部
逆直交変換部
量子化値
周波数成分
動き補償画素

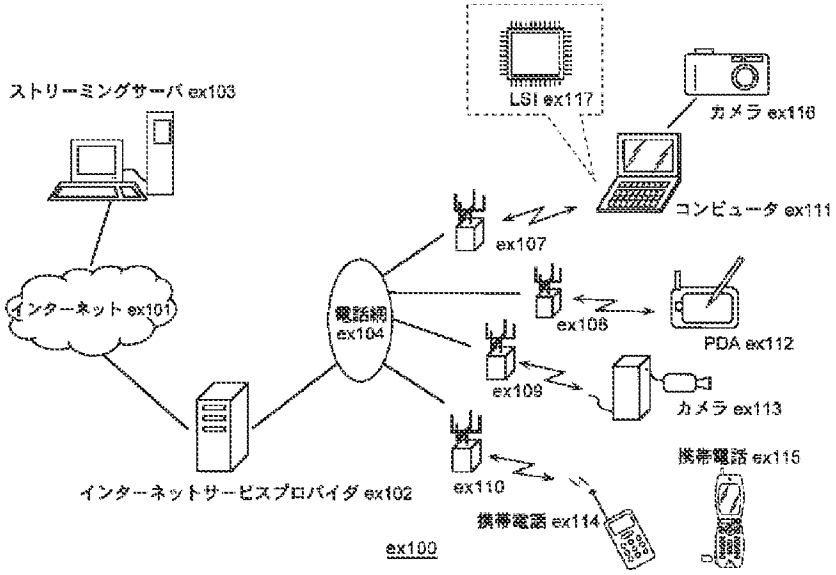
【図１８】


(a)
Se
Tr
FD
(b)
FD
F
(c)
Cs
FDD
F

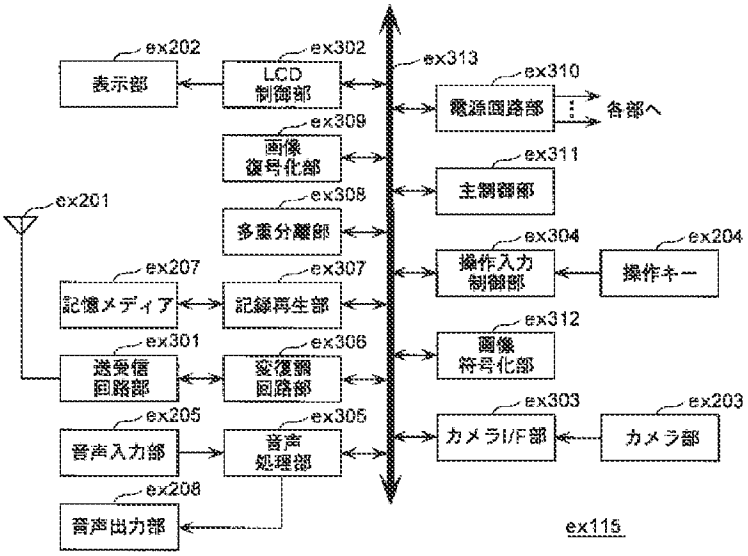
【図２０】


ex201
ex208
ex202
ex203
ex204
ex206
ex207
SD
ex205
ex115

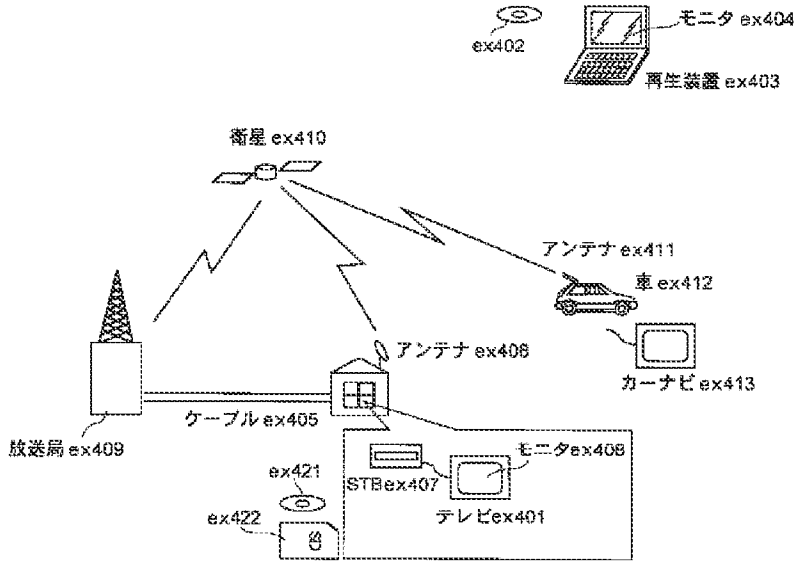
【図１９】


ストリーミングサーバ ex103
LSI ex117
カメラ ex116
コンピュータ ex111
ex107
インターネット ex101
電話網 ex104
ex108
PDA ex112
ex109
カメラ ex113
携帯電話 ex115
ex110
インターネットサービスプロバイダ ex102
携帯電話 ex114
ex100

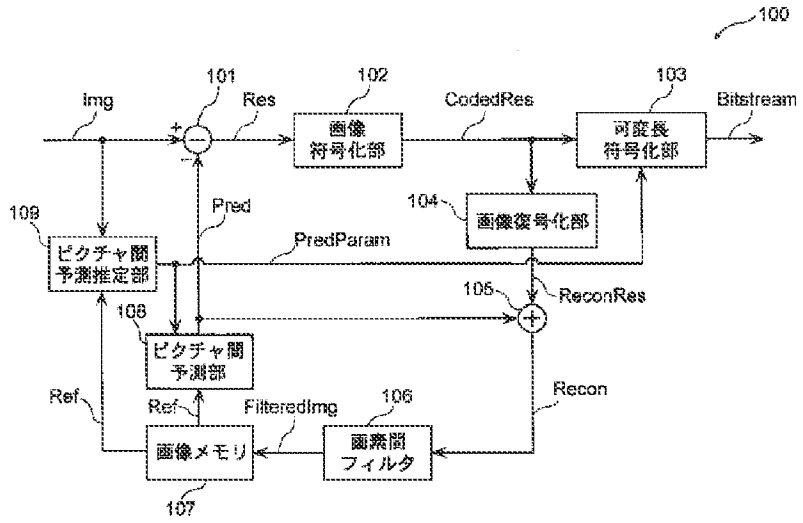
【図２１】


ex202
表示部
ex302
LCD
制御部
ex313
ex310
電源回路部
各部へ
ex309
画像
復号化部
ex311
主制御部
ex201
ex308
多重分離部
ex304
操作入力
制御部
ex204
操作キー
ex207
記憶メディア
ex307
記録再生部
ex312
画像
符号化部
ex301
送受信
回路部
ex306
変復調
回路部
ex303
ex203
カメラI/F部
カメラ部
ex205
音声入力部
ex305
音声
処理部
ex208
音声出力部
ex115

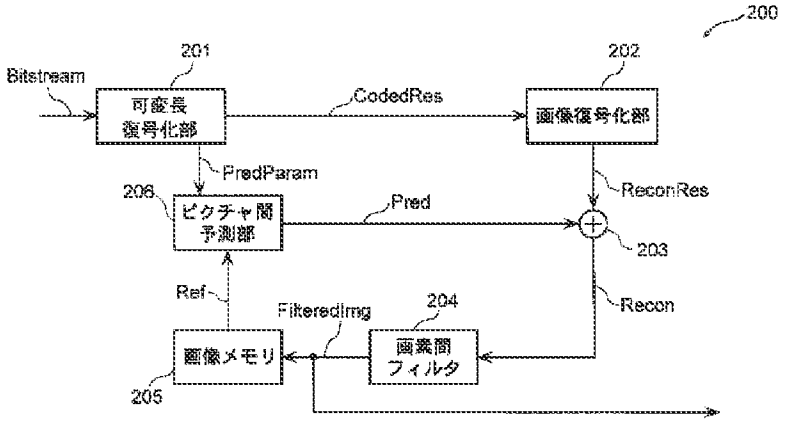
【図２２】


ex402
モニタ ex404
再生装置 ex403
衛星 ex410
アンテナ ex411
車 ex412
アンテナ ex406
カーナビ ex413
ケーブル ex405
放送局 ex409
モニタex408
ex421
STBex407
テレビex401
ex422

【図２３】



【図２４】



フロントページの続き

Ｆターム(参考) 5C059 KK01 MA05 MA14 ME01 PP05
PP06 PP07 SS10 SS20 TA69
TB04 TC01 TD13 UA02 UA12
UA33 UA38 UA39
5J064 AA01 AA04 BA16 BB01 BC01
BC11 BC16 BC26 BD02

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Gregory Scott Weaver/Suzanne Schumacher
Attorney Docket Number:	PU060222

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:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 2nd and Subsequent Request	1820	1	1700	1700
		Total in USD ($)		**1700**

Electronic Acknowledgement Receipt

EFS ID:	23292668
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Gregory Scott Weaver
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	24-AUG-2015
Filing Date:	07-MAY-2009
Time Stamp:	18:14:25
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Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1700
RAM confirmation Number	6021
Deposit Account	070832
Authorized User	WEAVER, GREG

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	PU060222USEXAMINATIONRCE 24AUG2015.pdf	697655 a4ec3695c3d234c3c157087e21d6cd0cde6 4593a	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	PU060222USIDS7AUG2015.pdf	612031 b6ccf46aee219f1856eed468f9754b7e2581 08d1	no	4
Warnings:					
Information:					
3	Foreign Reference	CN1663258A.pdf	2771599 ca155379b2c9697d08437e208bf54817dc0 4d069	no	54
Warnings:					
Information:					
4	Amendment Submitted/Entered with Filing of CPA/RCE	PU060222USPCTamendmentrc e.pdf	113290 8e4f7857836f01334cb46f8734c1c805fffb9 57f	no	3
Warnings:					
Information:					
5	Foreign Reference	JP2003179933a.pdf	612816 c60e2d6cf9b273b23d62145af6b3160ad79 70450	no	37
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30586 dab58f00c01604aabb66e9547f3b837d2a3 c1920	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	4837977		

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 12/312,386	Filing Date 05/07/2009	☐ 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 **08/24/2015**

	(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))	* 1	Minus	** 30	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 1	Minus	***6	= 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
/ALLYSON PURNELL/

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.

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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 08/26/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER	
AHMED, SAMIR ANWAR	

ART UNIT	PAPER NUMBER
2665	

NOTIFICATION DATE	DELIVERY MODE
08/26/2015	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):

uspto@technicolor.com
pat.verlangieri@technicolor.com
russell.smith@technicolor.com

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	12/312,386	KAO ET AL.	
	Examiner	Art Unit	
	SAMIR AHMED	2665	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAMIR AHMED*. (3)_____.

(2) *Greg Weaver(Reg.#53,751)* . (4)_____.

Date of Interview: *21 August 2015*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant's representative discussed proposed amendment's filed in an RCE .

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAMIR AHMED/ Primary Examiner, Art Unit 2665	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

24498 7590 09/14/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER
AHMED, SAMIR ANWAR

ART UNIT	PAPER NUMBER
2665	

DATE MAILED: 09/14/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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	12/14/2015

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)

24498 7590 09/14/2015

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

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.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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	12/14/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
AHMED, SAMIR ANWAR	2665	382-232000

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
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 09/14/2015

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EXAMINER	
AHMED, SAMIR ANWAR	
ART UNIT	**PAPER NUMBER**
2665	

DATE MAILED: 09/14/2015

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. 12/312,386	Applicant(s) KAO ET AL.	
	Examiner SAMIR AHMED	Art Unit 2665	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 *8/24/2015*.
   ☐ 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 *16 (now renumbered as 1 for issue)*. 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 _____
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 _____.

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after allowance or after an Office action under *Ex Parte Quayle*, 25 USPQ 74, 453 O.G. 213 (Comm'r Pat. 1935). Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, prosecution in this application has been reopened pursuant to 37 CFR 1.114. Applicant's submission filed on 8/24/2015 has been entered.

Drawings

3. Figures 1 and 2 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

4. Claim 16 (now renumbered as 1 for issue) is allowed.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMIR AHMED whose telephone number is (571)272-7413. The examiner can normally be reached on Mon-Fri 8:30am-6:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bhavesh Mehta can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/SAMIR AHMED/
Primary Examiner, Art Unit 2665

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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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	12312386
Filing Date	2006-11-08
First Named Inventor	Meng-Ping KAO
Art Unit	2665
Examiner Name	AHMED, SAMIR ANWAR
Attorney Docket Number	PU060222-US-PCT

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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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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
/SA/	1	20130077693		2013-03-28	DOLBY LABS LICENSING CORP.	EQCN1663258
/SA/	2	20120213276		2012-08-23	HAGAI ET AL.	EQJP2003179933

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
/SA/	1	CN1663258	CN		2005-08-30	DOLBY LABS LICENSING CORP.	US20130077693	☐
/SA/	2	JP2003179933	JP		2003-06-27	MATSUSHITA ELECTRIC IND CO LTD.	US20120213276	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12312386
	Filing Date	2006-11-08
	First Named Inventor	Meng-Ping KAO
	Art Unit	2665
	Examiner Name	AHMED, SAMIR ANWAR
	Attorney Docket Number	PU060222-US-PCT

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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]
	1		☐

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EXAMINER SIGNATURE

Examiner Signature	/Samir Ahmed/	Date Considered	09/07/2015

*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	12312386
	Filing Date	2006-11-08
	First Named Inventor	Meng-Ping KAO
	Art Unit	2665
	Examiner Name	AHMED, SAMIR ANWAR
	Attorney Docket Number	PU060222-US-PCT

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	/Gregory S. Weaver, #53,751/	Date (YYYY-MM-DD)	2015-08-24
Name/Print	Gregory S. Weaver	Registration Number	53,751

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.**

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 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 (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	(encod$3 and image and region and two and filters and successiv$3 and in-loop and filtering and reduc$3 and quantization and artifacts and deblocking and filter and blocking and artifact and adaptive and sparse and de-noising and filter and level and picture and sequence and level).CLM.	USPAT; UPAD	OR	ON	2015/09/07 18:18

9/7/2015 6:18:47 PM

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	12/312386	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:45
L2	5	"20130077693"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:45
L3	2	"20120213276"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:45
L4	41	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:45
L5	28	L4 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:46
L6	21	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:46
L7	11	L5 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:46

L8	14	L4 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:47
L9	39	L4 and level	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:47
L10	28	L5 and level	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:47
L11	28	L5 and level	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:48
L12	28	L11 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:48
L13	20878	((382/232) or (382/236) or (382/238) or (382/251) or (375/240.02) or (375/240.03) or (375/240.13)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:48
L14	12	L13 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:49
L15	20	L13 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) and ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:50
L16	6	L14 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:51
L17	9246	L13 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2015/09/07 16:51

			IBM_TDB			
L18	866	L17 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:52
L19	41	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:52
L20	39	L19 and level	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:52
L21	39	L20 and(encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:52
L22	41	(encod$3 or decod$3 or deblock$3 or denois$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:53
L23	28	L22 and (on/off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:53
L24	21	("20030061055" | "20030115041" | "20030115052" | "20040267543" | "20050165611" | "20060004583" | "5285498" | "5394473" | "5434948" | "5694332" | "5812971" | "5890125" | "5956674" | "6012031" | "6446037" | "6487535" | "6591241" | "7447629" | "7725324").PN. OR ("7945055").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:53
L25	11	L23 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:53
L26	39	L22 and level	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:56

L27	28	L23 and level	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:57
L28	28	L23 and level	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:57
L29	28	L28 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:57
L30	17202	quantization with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:58
L31	13959	quantization with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 16:58
L32	10373	L31 and (on/off or on or off or enabl$3 or disabl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:58
L33	28	L32 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:58
L34	12	L33 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:59
L35	6458	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 16:59
L36	5468	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:00
L37	142	L36 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1	US-PGPUB; USPAT;	OR	ON	2015/09/07 17:00

		loop))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L38	142	L36 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:00
L39	17	L38 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:00
L40	6458	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:01
L41	5468	quantization near2 (error artifact noise) with filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:01
L42	142	L41 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:01
L43	142	L41 same (deblock$3 block$3 (de adj1 block$3)) with (loop inloop (in adj1 loop))	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:02
L44	17	L43 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:02
L45	96703	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:02
L46	30	L45 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:03
L47	8495	375/240.12.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2015/09/07 17:04

			JPO; DERWENT; IBM_TDB			
L48	5	L47 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:04
L49	2098	375/240.27.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:04
L50	65615	first near2 filter$3 with second near2 filter$3	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:04
L51	22	L49 and L50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:04
L52	2151	G06T5/001.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:05
L53	0	L52 and (encod$3 or decod$3 or deblock$3 or denois$3 or deartifact$3) same ((adapt$3 adj1 filter) and (quantiz$5 adj1 filter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:06
L54	47	L52 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:08
L55	0	L54 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:09
L56	11614	G06T5/002.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:10
L57	4483	G06T5/002.cpc.	US-PGPUB; USPAT;	OR	ON	2015/09/07 17:10

			USOCR			
L58	395	L57 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:10
L59	395	L57 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:11
L60	0	L59 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:11
L61	2522	H04N7/50.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:11
L62	470	H04N7/50.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:12
L63	3	L62 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:12
L64	123	H04N7/64.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:12
L65	0	L64 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:13
L66	1	L64 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:14
L67	292	H04N7/26888.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:16
L68	2	L67 and (first near2 filter$3 with second	US-PGPUB;	OR	ON	2015/09/07

		near2 filter$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			17:17
L69	0	L68 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:18
L70	4	L67 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:18
L71	1148	H04N7/26244.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:19
L72	182	H04N7/26244.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:19
L73	5	L72 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:19
L74	196	H04N7/26276.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:20
L75	0	L74 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:20
L76	6	(meng-ping near2 kao).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:22
L77	2045	(peng near2 yin).in.	US-PGPUB; USPAT; USOCR;	OR	ON	2015/09/07 17:23

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
L78	10	L77 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:24
L79	216	(oscar near2 escoda).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:25
L80	2	L79 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:25
L81	19785	(thomson near2 licensing).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:27
L82	127	L81 and (first near2 filter$3 with second near2 filter$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/07 17:27
L83	1	L82 and ((macroblock adj1 level) (slice adj1 level) (picture adj1 level) (sequence adj1 level))	US-PGPUB; USPAT; USOCR	OR	ON	2015/09/07 17:28

9/7/2015 5:34:23 PM
C:\Users\sahmed1\Documents\EAST\Workspaces\12312386.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	Art Unit
	SAMIR AHMED	2665

CPC- SEARCHED		
Symbol	Date	Examiner
G06T 5/001	12/20/2013	/SA/
G06T 5/001	9/07/2015	/SA/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
382	232,236,238,251	7/02/2012	/SA/
375	240.02, 240.03, 240.13	7/02/2012	/SA/
382	232, 236, 238, 251	12/20/2013	/SA/
375	240.02; 240.03; 240.12; 240.13	12/20/2013	/SA/
382	232, 236, 238, 251	5/18/2015	/SA/
375	240.02; 240.03, 240.13	5/18/2015	/SA/
382	232; 236; 238; 251	9/07/2015	/SA/
375	240.02; 240.3; 240.12; 240.13	9/07/2015	/SA/

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (USPAT, US-PGPUB, EPO, JPO, DERWENT, IBM_TDB, USOCR)- See search history printout	2/14/2012	YG
Updated East search history, see search history printout	7/02/2012	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	12/20/2013	SA
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	12/20/2013	SA
Updated previous East search history, see search history printout	7/10/2014	SA
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	5/18/2015	SA

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

SEARCH NOTES

Search Notes	Date	Examiner
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	5/18/2015	SA
Updated previous East search history, see search history printout	5/18/2015	SA
Updated East search history, see search history prinyouy	9/07/2015	/SA/
Text limited search within the following US subclasses: 382/232, 236, 238, 251; 375/240.02, 240.03, 240.12, 240.13. See search history printout.	9/07/2015	/SA/
Text limited search within the following CPC subgroups: G06T 5/001; G06T 5/002; H04N 7/26888; H04N 7/50; H04N 7/26244; H04N 7/64; H04N 26276.See search history printout	9/07/2015	/SA/
Searched inventors' names	9/07/2015	/SA/

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
382	232	7/02/2012	SA
	EAST PGPUB text search see interference search printout	7/02/2012	SA
	EAST PGPUB text search see interference search printout	5/18/2015	SA
	EAST PGPUB text search see interference search printout	9/07/2015	/SA/

	/SAMIR AHMED/ Primary Examiner.Art Unit 2624

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

CPC								
Symbol							**Type**	**Version**
H04N		19	/	86			F	2014-11-01
H04N		19	/	159			I	2014-11-01
H04N		19	/	176			I	2014-11-01
H04N		19	/	70			I	2014-11-01
H04N		19	/	46			I	2014-11-01
H04N		19	/	61			I	2014-11-01
H04N		19	/	117			I	2014-11-01
H04N		19	/	126			I	2014-11-01
H04N		19	/	154			I	2014-11-01
H04N		19	/	174			I	2014-11-01
H04N		19	/	44			I	2014-11-01
H04N		19	/	82			I	2014-11-01
			/					
			/					
			/					

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	1	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665	09/07/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		G	0	6	K	9 / 36 (2006.01.01)						
CROSS REFERENCE(S)												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	1	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665	09/07/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

U.S. Patent and Trademark Office

Part of Paper No. 20150907

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

☐ 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		17		33										
	2		18		34										
	3		19		35										
	4		20		36										
	5		21		37										
	6		22		38										
	7		23		39										
	8		24		40										
	9		25		41										
	10		26		42										
	11		27		43										
	12		28		44										
	13		29		45										
	14		30		46										
	15		31												
1	16		32												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	1	
/SAMIR AHMED/ Primary Examiner.Art Unit 2665	09/07/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

✓	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	02/14/2012	07/02/2012	12/20/2013	07/10/2014	05/18/2015	09/07/2015			
	1	✓	=	✓	✓	=	-			
	2	✓	=	✓	✓	=	-			
	3	✓	=	✓	✓	=	-			
	4	✓	=	✓	-	-	-			
	5	✓	=	✓	✓	=	-			
	6	✓	=	✓	✓	=	-			
	7	✓	=	✓	✓	=	-			
	8	✓	=	✓	✓	=	-			
	9	✓	=	✓	-	-	-			
	10	✓	=	✓	✓	=	-			
	11	✓	=	✓	✓	=	-			
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	15	✓	=	✓	✓	=	-			
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	31					=	-			
	32					=	-			
	33					=	-			
	34					=	-			
	35					=	-			
	36					=	-			

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12312386	KAO ET AL.
	Examiner	**Art Unit**
	SAMIR AHMED	2665

✓	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	02/14/2012	07/02/2012	12/20/2013	07/10/2014	05/18/2015	09/07/2015			
	37					=	-			
	38					=	-			
	39					=	-			
	40					=	-			
	41					=	-			
	42					=	-			
	43					=	-			
	44					=	-			
	45					=	-			
	46					=	-			

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)

24498 7590 09/14/2015
Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

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.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

TITLE OF INVENTION: METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING

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	12/14/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
AHMED, SAMIR ANWAR	2665	382-232000

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 Vincent E. Duffy
2 Gregory S. Weaver
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: THOMSON LICENSING
(B) RESIDENCE: (CITY and STATE OR COUNTRY): BOULOGNE-BILLANCOURT, FRANCE

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 070832 (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 /Gregory S. Weaver, #53,751/ Date December 14, 2015
Typed or printed name Gregory S. Weaver Registration No. 53751

CERTIFICATE OF TRANSMISSION UNDER 37 CFR § 1.8

I hereby certify that this document is being electronically transmitted via the United States Patent and Trademark Office via EFS-Web on December 14, 2015.

Signature: /Gregory S. Weaver, #53,751/
Gregory S. Weaver, Reg. No. 53,751

PU060222-US-PCT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Meng-Ping Kao et al. Serial No.: 12/312,386 Filed: May 7, 2009 For: METHOD AND APPARATUS FOR IN-LOOP DE-ARTIFACT FILTERING	Examiner: Samir Anwar Ahmed Group Art: 2665 Conf. No.: 8783

RESPONSE TO NOTICE OF ALLOWANCE

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

Madam:

This is in response to the Notice of Allowance dated September 14, 2015, for which a response is due on December 14, 2015. Accordingly, this response is timely filed. The issue fee is submitted herewith.

REMARKS

The Notice of Allowance asserts that FIGS. 1 and 2 must be amended to be labeled as "Prior Art." However, FIGS. 1 and 2 were previously amended to be labeled as "Prior Art," in Applicants' Amendment filed on June 2, 2014. Accordingly, the Notice of Allowance's request is in erroneous.

Issuance of the application is respectfully requested.

In the event there are any errors with respect to the fees for this response or any other papers related to this response, the Director is hereby given permission to charge any shortages and credit any overcharges of any fees required for this submission to Deposit Account No. 07-0832.

Respectfully submitted,

By: /Gregory S. Weaver, #53,751/
Gregory S. Weaver
Attorney for Applicants
Reg. No. 53,751
(818) 480-5064

Patent Operations
Thomson Licensing LLC
P.O. Box 5312
Princeton, New Jersey 08540

December 14, 2015

Electronic Patent Application Fee Transmittal

Application Number:	12312386
Filing Date:	07-May-2009
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Filer:	Gregory Scott Weaver
Attorney Docket Number:	PU060222

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:	24358317
Application Number:	12312386
International Application Number:	
Confirmation Number:	8783
Title of Invention:	METHODS AND APPARATUS FOR IN -LOOP DE-ARTIFACT FILTERING
First Named Inventor/Applicant Name:	Meng-Ping Kao
Customer Number:	24498
Filer:	Gregory Scott Weaver
Filer Authorized By:	
Attorney Docket Number:	PU060222
Receipt Date:	14-DEC-2015
Filing Date:	07-MAY-2009
Time Stamp:	19:59:40
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	$960
RAM confirmation Number	7261
Deposit Account	070832
Authorized User	WEAVER, GREG

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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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)	PTO_PU060222_Part_B_Fees.pdf	215555 bb7861dce046602fcfb4c12516aa4d729829ca2d	no	1
Warnings:					
Information:					
2	Issue Fee Payment (PTO-85B)	PTO_PU060222-US-PCT_response_to_noa.pdf	25322 54736c16bddadd74e1ec06b06bbf710337eacba1	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30545 e40da0e324dfb3b556180c8f5f82718309ccb226	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	271422		

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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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	05/07/2009	Meng-Ping Kao	PU060222	8783

24498 7590 01/29/2016

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
4 Research Way
3rd Floor
Princeton, NJ 08543

EXAMINER
AHMED, SAMIR ANWAR

ART UNIT	PAPER NUMBER
2665	

NOTIFICATION DATE	DELIVERY MODE
01/29/2016	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):

uspto@technicolor.com
pat.verlangieri@technicolor.com
russell.smith@technicolor.com

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
12/312,386	07 May, 2009	KAO ET AL.	PU060222

		EXAMINER	
Robert D. Shedd, Patent Operations THOMSON Licensing LLC 4 Research Way 3rd Floor Princeton, NJ 08543		SAMIR AHMED	
		ART UNIT	PAPER
		2665	20160121

DATE MAILED:

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Commissioner for Patents

In response to 12-14-15 Response to Notice of Allowance, the drawings requirement in the 9-14-15 NOA is waived. The drawings were previously amended to be labeled as "Prior Art," in Applicants' Amendment filed on June 3, 2014.

/SAMIR AHMED/
Primary Examiner, Art Unit 2665

PTO-90C (Rev.04-03)

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12312386
Filing Date	2006-11-08
First Named Inventor	Meng-Ping KAO
Art Unit	2665
Examiner Name	AHMED, SAMIR ANWAR
Attorney Docket Number	PU060222-US-PCT

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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
/SA/ Change(s) applied to document. /T.C.T./ /SA/ 2/2/2016	1	20130077693		2013-03-28	~~DOLBY LABS LICENSING CORP.~~ Demos	EQCN1663258
	2	20120213276		2012-08-23	HAGAI ET AL.	EQJP2003179933

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
/SA/	1	CN1663258	CN		2005-08-30	DOLBY LABS LICENSING CORP.	US20130077693	☐
/SA/	2	JP2003179933	JP		2003-06-27	MATSUSHITA ELECTRIC IND CO LTD.	US20120213276	☐

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/312,386	03/01/2016	9277243	PU060222	8783

24498 7590 02/10/2016

Robert D. Shedd, Patent Operations
THOMSON Licensing LLC
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Princeton, NJ 08543

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 158 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):

Meng-Ping Kao, La Jolla, CA;
Peng Yin, West Windsor, NJ;
Oscar Divorra Escoda, Princeton, NJ;

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