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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
15/492,738	10015413	2663	68859

PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 00197 on 08/01/2018 via Private PAIR in view of the certification copied below that authorized the change.

- Maintenance Fee Address

The address for Customer Number 00197 is:

00197

CPA GLOBAL LIMITED

2318 Mill Road 12th Floor

ALEXANDRIA, VA 22314

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/D. Benjamin Esplin/
Name:	D. Benjamin Esplin
Registration Number:	58297



UNITED STATES PATENT AND TRADEMARK OFFICE

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Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/492,738	07/03/2018	10015413	46DG-254798	8390

137002 7590 06/13/2018
Sheppard Mullin Richter & Hampton LLP (GoPro)
12275 El Camino Real, Suite 200
San Diego, CA 92130-2006

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 0 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):

Nicholas D. Woodman, Woodside, CA;
GoPro, Inc., San Mateo, CA;
Sumit Chawla, San Carlos, CA;
Loic Segapelli, Oakland, CA;
Scott Patrick Campbell, Belmont, CA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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)

137002 7590 05/09/2018
Sheppard Mullin Richter & Hampton LLP (GoPro)
12275 El Camino Real, Suite 200
San Diego, CA 92130-2006

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.
15/492,738	04/20/2017	Nicholas D. Woodman	46DG-254798	8390

TITLE OF INVENTION: Conversion Between Aspect Ratios in Camera

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	08/09/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
VU, NGOC YEN T	2663	348-333120

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 Sheppard Mullin Richter & Hampton LLP
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)

GoPro, Inc.

San Mateo, California

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.
- ☒ NOTE: The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 504561 (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
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

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.

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.

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 /D. Benjamin Esplin/

Date May 30, 2018

Typed or printed name D. Benjamin Esplin

Registration No. 58297

Electronic Patent Application Fee Transmittal				
Application Number:		15492738		
Filing Date:		20-Apr-2017		
Title of Invention:		Conversion Between Aspect Ratios in Camera		
First Named Inventor/Applicant Name:		Nicholas D. Woodman		
Filer:		D. Benjamin Esplin/Chelsea Pearsall		
Attorney Docket Number:		46DG-254798		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
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	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt	
EFS ID:	32761655
Application Number:	15492738
International Application Number:	
Confirmation Number:	8390
Title of Invention:	Conversion Between Aspect Ratios in Camera
First Named Inventor/Applicant Name:	Nicholas D. Woodman
Customer Number:	137002
Filer:	D. Benjamin Esplin/Chelsea Pearsall
Filer Authorized By:	D. Benjamin Esplin
Attorney Docket Number:	46DG-254798
Receipt Date:	30-MAY-2018
Filing Date:	20-APR-2017
Time Stamp:	17:13:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$1000
RAM confirmation Number	053118INTEFSW00004065504561
Deposit Account	504561
Authorized User	Chelsea Pearsall
<p>The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:</p> <p>37 CFR 1.16 (National application filing, search, and examination fees)</p> <p>37 CFR 1.17 (Patent application and reexamination processing fees)</p>	

37 CFR 1.19 (Document supply fees)
 37 CFR 1.20 (Post Issuance fees)
 37 CFR 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	Issue Fee Payment (PTO-85B)	46DG-254798_Issue_Fee_Transmittal_FINAL.pdf	88377	no	1
			d6ee4ef107e0c18da59b5ff73ce5487c913647b1		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30540	no	2
			ae13dcd594884423c39ee13784c0f79a6315fa0		

Warnings:

Information:

Total Files Size (in bytes):	118917
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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.



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United States Patent and Trademark Office
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P.O. Box 1450
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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

137002 7590 05/09/2018
Sheppard Mullin Richter & Hampton LLP (GoPro)
12275 El Camino Real, Suite 200
San Diego, CA 92130-2006

EXAMINER

VU, NGOC YEN T

ART UNIT

PAPER NUMBER

2663

DATE MAILED: 05/09/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/492,738	04/20/2017	Nicholas D. Woodman	46DG-254798	8390

TITLE OF INVENTION: Conversion Between Aspect Ratios in Camera

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	08/09/2018

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: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or **Fax (571)-273-2885**

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

137002 7590 05/09/2018
Sheppard Mullin Richter & Hampton LLP (GoPro)
12275 El Camino Real, Suite 200
San Diego, CA 92130-2006

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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.
15/492,738	04/20/2017	Nicholas D. Woodman	46DG-254798	8390

TITLE OF INVENTION: Conversion Between Aspect Ratios in Camera

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	08/09/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
VU, NGOC YEN T	2663	348-333120

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, 1 _____
- (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. 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
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

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.

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.

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
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/492,738	04/20/2017	Nicholas D. Woodman	46DG-254798	8390
137002	7590	05/09/2018	EXAMINER	
Sheppard Mullin Richter & Hampton LLP (GoPro)			VU, NGOC YEN T	
12275 El Camino Real, Suite 200			ART UNIT	
San Diego, CA 92130-2006			PAPER NUMBER	

2663

DATE MAILED: 05/09/2018

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. 15/492,738	Applicant(s) WOODMAN ET AL.	
	Examiner Ngoc-Yen Vu	Art Unit 2663	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendments filed 01/17/18.
☐ 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 21-40 (Claims are renumbered as 1-20, respectively). 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)	5. ☐ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material	7. ☐ Other _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .	

/Ngoc-Yen Vu/ Primary Examiner, Art Unit 2663	
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The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Amendment

1. The amendments, filed 01/17/18, have been entered and made of record. Claims 21-40 are pending.

Allowable Subject Matter

2. Claims 21-40 are allowed.

Reasons for Allowance

3. The following is an examiner's statement of reasons for allowance:

No reason for allowance for these claims is needed as the record is clear in light of applicant's arguments/amendment filed on 01/17/18. See MPEP 1302.14(1). According to MPEP 1302.14 (I): "In most cases, the examiner's actions and the applicant's replies make evident the reasons for allowance, satisfying the "record as a whole" proviso of the rule. This is particularly true when applicant fully complies with 37 CFR 1.111 (b) and (e) and 37 CFR 1.133(b). Thus, where the examiner's actions clearly point out the reasons for rejection and the applicant's reply explicitly presents reasons why claims are patentable over the reference, the reasons for allowance are in all probability evident from the record and no statement should be necessary."

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ngoc-Yen Vu whose telephone number is (571) 272-7320. The examiner can normally be reached on Mon. - Fri. from 8:00 am to 5:00 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Twyler Haskins can be reached on 571-272-7406. 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.

/Ngoc-Yen Vu/
Primary Examiner, Art Unit 2663

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	94	((("Woodman") near3 ("Nicholas") near3 ("D"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/04/30 02:29
L2	75	((("Chawla") near3 ("Sumit"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/04/30 02:30
L3	8	((("Segapelli") near3 ("Loic"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/04/30 02:30
L4	195	((("Campbell") near3 ("Scott") near3 ("Patrick"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/04/30 02:30
L5	306	1 2 3 4	US-PGPUB; USPAT	OR	ON	2018/04/30 02:31
L6	17	(aspect near ratio) and 5	US-PGPUB; USPAT	OR	ON	2018/04/30 02:31
S1	0	14/180887	US-PGPUB; USPAT	OR	ON	2014/05/19 08:24
S2	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 08:27
S3	8030962	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 08:30
S4	15532	S2 with S3	US-PGPUB; USPAT	OR	ON	2014/05/19 08:30
S5	504599	(scal\$3 adjust\$3 conversion convert\$3 zoom\$3 crop\$4) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 08:50
S6	11421	warp\$3 with image	US-PGPUB; USPAT	OR	ON	2014/05/19 08:51
S7	7917	S5 and S6	US-PGPUB; USPAT	OR	ON	2014/05/19 08:51
S8	319	S7 and S4	US-PGPUB; USPAT	OR	ON	2014/05/19 08:52
S9	315	S8 and @ad<="20130822"	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S10	156	camera and S9	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S11	3871	S5 same2 S6	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S12	225	S4 and S11	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54
S13	90	camera and S12	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54
S14	87	S13 and @ad<="20130822"	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54

S15	22651	(warp\$3 skew\$3) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 10:23
S16	300	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 10:24
S17	300	"4" and S16	US-PGPUB; USPAT	OR	ON	2014/05/19 10:24
S18	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:25
S19	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:26
S20	300	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 10:26
S21	46	S19 and S20	US-PGPUB; USPAT	OR	ON	2014/05/19 10:27
S22	3	S20 same corner	US-PGPUB; USPAT	OR	ON	2014/05/19 10:28
S23	8030962	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:42
S24	31595	S19 same S23	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S25	32068	S20 same S24	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S26	6	S20 same S24	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S27	6	S26 not S22	US-PGPUB; USPAT	OR	ON	2014/05/19 10:44
S28	5	"8218895"	US-PGPUB; USPAT	OR	ON	2014/05/19 11:36
S29	1	S20 and S28	US-PGPUB; USPAT	OR	ON	2014/05/19 11:37
S30	1	"8218895".pn. and (processor process\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 11:47
S31	1	"8218895".pn. and (computer near5 circuit near5 program\$4)	US-PGPUB; USPAT	OR	ON	2014/05/19 11:53
S32	4961	(aspect near2 ratio) same (4:3) same (16:9)	US-PGPUB; USPAT	OR	ON	2014/05/19 13:25
S33	10	S20 and S32	US-PGPUB; USPAT	OR	ON	2014/05/19 13:26
S34	28	"4951125"	US-PGPUB; USPAT	OR	ON	2014/09/06 13:40
S35	0	H04N5/23229.cpcc.	US-PGPUB; USPAT	OR	ON	2014/09/06 14:01
S36	0	H04N5/23229.cccc.	US-PGPUB; USPAT	OR	ON	2014/09/06 14:01
S37	0	H04N5/23229.cccc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:02
S38	98	H04N5/23229.cpca.	US-PGPUB; USPAT;	OR	ON	2014/09/06 14:02

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S39	2157	H04N5/23229.cpg.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:02
S40	2059	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:03
S41	0	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:03
S42	0	13/908274	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:04
S43	1	13/784234	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:10
S44	98	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17
S45	2157	H04N5/23229.cpg.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17
S46	2059	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17

S47	171376	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/09/06 21:17
S48	11820	(warp\$3 with image)	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S49	2105	S47 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S50	0	S44 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S51	0	S44 and S47	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S52	1	S44 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:19
S53	112	S45 and S47	US-PGPUB; USPAT	OR	ON	2014/09/06 21:20
S54	59	S53 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:20
S55	59	S45 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S56	59	S46 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S57	59	S55 S56	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S58	5	("8340453").URPN.	USPAT	OR	ON	2014/09/06 21:36
S59	3	((("8493459") or ("8340453") or ("8723959")).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 21:45
S60	2	(non adj1 linear\$2) and S59	US-PGPUB; USPAT	OR	ON	2014/09/06 21:45
S61	1	S47 and S59	US-PGPUB; USPAT	OR	ON	2014/09/06 21:47
S62	2	((("8218895") or ("8143013")).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 22:14
S63	2	((("8218895") or ("8145013")).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 22:39
S74	3	("8917329").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/15 14:13
S75	22	("5790696" "8340453" "8723959" "20130141593" "20140032406" "8045788" "8145013" "8218895" "8493459").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 14:16
S76	139	H04N21/234372.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 14:27
S77	872	H04N21/440272.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO;	OR	ON	2015/06/15 14:27

			DERWENT; IBM_TDB			
S78	8728347	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2015/06/15 14:27
S79	49	S76 and S78	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S80	240	S77 and S78	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S81	271	S79 S80	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S82	2	"14180887"	US-PGPUB; USPAT	OR	ON	2015/10/27 17:03
S83	1	"14536315"	US-PGPUB; USPAT	OR	ON	2015/10/27 17:03
S84	151	H04N21/234372.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:20
S85	913	H04N21/440272.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:20
S86	2431	H04N5/23232.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:21
S87	31266	(warp\$3 skew\$3) with image	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:23
S88	1575	G06T5/006.CPC.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:23
S89	388	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S90	2	S84 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S91	2	S85 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S92	0	S86 and S89	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2015/10/27 19:25

			DERWENT			
S93	9	S88 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:25
S94	11	S90 S91 S93	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:25
S95	8	("6369814").URPN.	USPAT	OR	ON	2015/10/27 19:33
S96	60	((Nicholas) near2 (Woodman)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S97	24	((Sumit) near2 (Chawla)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S98	3	((Loic) near2 (Segapelli)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S99	347	((Scott) near2 (Campbell)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:49
S100	1	S87 and S96	USPAT	OR	ON	2015/10/27 19:49
S101	1	S87 and S97	USPAT	OR	ON	2015/10/27 19:49
S102	1	S87 and S98	USPAT	OR	ON	2015/10/27 19:49
S103	3	S87 and S99	USPAT	OR	ON	2015/10/27 19:50
S104	3	S100 S101 S102 S103	USPAT	OR	ON	2015/10/27 19:50
S105	4	((("8917329") or ("9294671")).PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2016/10/17 13:44
S106	1	15/011253	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 13:46
S107	6	"8917329"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 14:32
S108	2	("8218895").PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2016/10/17 14:47
S109	1	(aspect adj ratio) and S108	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 14:49
S110	0	(shift\$3) and S108	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 15:11

S111	0	(shift\$3) and "9253474".pn.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 15:11
S112	1	"9253474"	US-PGPUB; USPAT	OR	ON	2016/10/18 14:10
S113	14	("20040212731" "20120026157" "20120050507" "20120062530" "20130021391" "20130021666" "20130106998" "20130113884" "20130114680" "6055012" "7352910" "8145013" "8595782" "8917329").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:11
S114	1	15/011253	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:18
S115	1	transformation and S114	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:18
S116	1	(shift\$3 near4 pixel) and S114	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:21
S117	2	(shift\$3 near4 pixel) and S113	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:24
S118	325	H04N21/440272.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:33
S119	1730	H04N21/440263.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:34
S120	338	H04N21/44029.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:35
S121	0	H04N22/234372.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:37
S122	69	H04N21/234372.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:37
S123	2159	H04N21/23439.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:38
S124	1258	H04N5/23232.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:42
S125	473	G06T3/0093.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:43
S126	56	(shift\$3 near4 pixel) and S125	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:50
S127	15	(aspect near ratio) and S126	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:53
S128	7	"6915026"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47

S129	91	"6757446"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S130	205092	(aspect near ratio) and "1"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S131	1	(aspect near ratio) and S128	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S132	5	(aspect near ratio) and S129	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S133	2	(shift\$3 near4 pixel) and S128	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S134	1	(shift\$3 near4 pixel) and S129	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S135	7	S131 S132 S133 S134	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S136	1	15/011253	US-PGPUB; USPAT	OR	ON	2016/10/31 15:37
S137	1	13/755901	US-PGPUB; USPAT	OR	ON	2016/10/31 22:30
S138	1	14/927129	US-PGPUB; USPAT	OR	ON	2016/11/01 10:53
S139	3	14/744601	US-PGPUB; USPAT	OR	ON	2016/11/01 10:59
S140	81	((("WOODMAN") near3 ("Nicholas"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S141	59	((("CHAWLA") near3 ("Sumit"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S142	5	((("SEGAPELLI") near3 ("Loic"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S143	434	((("CAMPBELL") near3 ("Scott"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:23
S144	0	15/492738	US-PGPUB; USPAT	OR	ON	2017/10/15 16:28
S145	24	"8218895"	US-PGPUB; USPAT	OR	ON	2017/10/15 16:28
S146	11	(shift\$3) and S145	US-PGPUB; USPAT	OR	ON	2017/10/15 16:55
S147	1	"8218895".pn.	US-PGPUB; USPAT	OR	ON	2017/10/15 16:58
S148	24	"8218895"	US-PGPUB; USPAT	OR	ON	2017/10/15 20:19
S149	11	(shift\$3) and S148	US-PGPUB; USPAT	OR	ON	2017/10/15 20:19
S150	1	"8218895".pn.	US-PGPUB; USPAT	OR	ON	2017/10/15 20:49

S151	234	warp\$3 same (shift\$3 near2 pixel)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:02
S152	39	((non adj linear\$2) (linear\$2) (nonlinear\$2)) same S151	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:03
S153	39	(image imaging) and S152	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:04
S154	1	"8218895".pn.	US-PGPUB; USPAT	OR	ON	2017/10/15 23:08
S155	4	((("8218895") or ("9196228"))).PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2017/10/16 00:54
S156	4	(zoom\$3 scal\$3 contract\$3 extend\$3) and S155	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 00:55
S157	2	(warp\$3) and S155	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:12
S158	3	((zoom\$3 scal\$3 contract\$3 extend\$3) same (aspect adj ratio)) and S155	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:23
S159	25	"8218895"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:36
S160	10	((zoom\$3 scal\$3 contract\$3 extend\$3) same (aspect adj ratio)) and S159	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:41
S161	9	camera and S160	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:41
S162	38	("20040017492" "20090202177" "20130141593" "20140032406" "20160173767" "5790696" "6757446" "6915026" "7079157" "8045788" "8145013" "8218895" "8340453" "8493459" "8525871" "8723959" "8913141" "9253474").PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 01:45
S163	1	video and "20040017492".pn.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2017/10/16 02:07
S164	1	video and S155	US-PGPUB; USPAT;	OR	ON	2017/10/16 02:08

				EPO; JPO; DERWENT			
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4/ 30/ 2018 2:32:41 AM
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Search Notes 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.
	Examiner NGOC-YEN VU	Art Unit 2663

CPC- SEARCHED		
Symbol	Date	Examiner
H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084	10/15/17	/nv/
H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084	4/27/18	/nv/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
Text limited search in the following CPC areas H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084. See search history printout.	10/15/17	/nv/
Text limited search in the following CPC H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084.	4/27/18	/nv/

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	Text search for claimed subject matter in US Patent and US PGPub databases. See search history printout.	4/27/18	/nv/

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<i>Index of Claims</i> 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.
	Examiner NGOC-YEN VU	Art Unit 2663

✓	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	04/29/2018									
	1	-									
	2	-									
	3	-									
	4	-									
	5	-									
	6	-									
	7	-									
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10	30	=									
11	31	=									
12	32	=									
13	33	=									
14	34	=									
15	35	=									
16	36	=									

<i>Index of Claims</i> 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.
	Examiner NGOC-YEN VU	Art Unit 2663

✓	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	04/29/2018								
17	37	=								
18	38	=								
19	39	=								
20	40	=								

Issue Classification 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.	
	Examiner NGOC-YEN VU	Art Unit 2663	

CPC					
Symbol				Type	Version
H04N	5	/	2628	F	2013-01-01
G06T	3	/	0093	I	2013-01-01
G06T	3	/	4069	I	2013-01-01
G06T	3	/	20	A	2013-01-01
G06T	3	/	40	A	2013-01-01
G06T	3	/	4084	A	2013-01-01
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CPC Combination Sets					
Symbol		Type	Set	Ranking	Version
	/				
	/				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/NGOC-YEN VU/ Primary Examiner.Art Unit 2663	04/29/18	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

Issue Classification 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.
	Examiner NGOC-YEN VU	Art Unit 2663

☒ 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	21	17	37												
2	22	18	38												
3	23	19	39												
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13	33														
14	34														
15	35														
16	36														

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 20	
/NGOC-YEN VU/ Primary Examiner.Art Unit 2663 (Primary Examiner) _____ (Date) _____		O.G. Print Claim(s) 1	O.G. Print Figure 4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE PATENT :
APPLICATION OF : Nicholas D. Woodman, *et al.*
SERIAL No. : 15/492,738
FILING DATE : April 20, 2017
ART UNIT : 2663
EXAMINER : VU, NGOC YEN T
FOR : CONVERSION BETWEEN ASPECT RATIOS IN CAMERA

RESPONSE TO NON-FINAL OFFICE ACTION

Mail Stop AMENDMENT

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

Dear Commissioner:

In response to the Non-Final Office Action dated **October 19, 2017** ("Office Action"), please consider the following amendments and remarks in the above-identified application:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks/Arguments begin on page 7 of this paper.

It is believed no extensions of time or fees for net addition of claims are required beyond those which may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned for under 37 C.F.R. § 1.136(a), and any fees required therefore (including fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 504561 (Ref. No. 46DG-254798).

CLAIM AMENDMENTS

This **listing of claims** will replace all prior versions, and listings, of claims in the application:

1-20. **(Cancelled)**

21. **(Currently Amended)** An image capture apparatus, comprising:

an image sensor configured to capture an input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis;

a display coupled to one or more physical processors; and

the one or more physical processors configured by machine-readable instructions to:

obtain the input image;

determine a portion within the input image, the portion including a subset of the pixels; and

apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and

~~the input image includes a portion including a subset of the pixels~~
the transformation non-uniformly shifts the pixels such that differences between the input positions and the output positions of the subset of the pixels within the portion are less than differences between the input positions and the output positions of others of the pixels; and
present the output image on the display.

22. **(Currently Amended)** A system that converts between aspect ratios, the system comprising:

one or more physical processors configured by machine-readable instructions to:

obtain an input image, the input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis;

determine a portion within the input image, the portion including a subset of the pixels; and

apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and

~~the input image includes a portion including a subset of the pixels~~
the transformation non-uniformly shifts the pixels such that differences between the input positions and the output positions of the subset of the pixels within the portion are less than differences between the input positions and the output positions of others of the pixels.

23. **(Previously Presented)** The system of claim 22, wherein the transformation includes:

a scaling function to uniformly stretch or compress the input image along the first axis; and

a warping function to non-uniformly warp the input image along the second axis.

24. **(Previously Presented)** The system of claim 23, wherein the scaling function and the warping function preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels.

25. **(Previously Presented)** The system of claim 23, wherein the scaling function changes the source aspect ratio to the target aspect ratio.
26. **(Previously Presented)** The system of claim 22, wherein the one or more physical processors are included within a camera.
27. **(Previously Presented)** The system of claim 26, wherein the output image is presented on a display of the camera.
28. **(Previously Presented)** The system of claim 22, wherein the portion corresponds to a center portion of the input image.
29. **(Previously Presented)** The system of claim 22, wherein the portion corresponds to a non-center portion of the input image.
30. **(Previously Presented)** The system of claim 22, wherein the transformation non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion.
31. **(Previously Presented)** The system of claim 22, wherein the one or more physical processors are further configured by machine-readable instructions to determine the portion based on a location of an object within the input image such that the portion includes the object.
32. **(Previously Presented)** The system of claim 22, wherein the input image includes a video frame of a video.
33. **(Currently Amended)** A method for converting between aspect ratios, the method performed by a computing system including one or more physical processors, the method comprising:

obtaining, by the computing system, an input image, the input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis;
determining a portion within the input image, the portion including a subset of the pixels; and

applying, by the computing system, a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and

~~the input image includes a portion including a subset of the pixels~~ the transformation non-uniformly shifts the pixels such that differences between the input positions and the output positions of the subset of the pixels within the portion are less than differences between the input positions and the output positions of others of the pixels.

34. **(Previously Presented)** The method of claim 33, wherein the transformation includes:

a scaling function to uniformly stretch or compress the input image along the first axis; and

a warping function to non-uniformly warp the input image along the second axis.

35. **(Previously Presented)** The method of claim 34, wherein the scaling function and the warping function preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels.

36. **(Previously Presented)** The method of claim 33, wherein the portion corresponds to a center portion of the input image.

37. **(Previously Presented)** The method of claim 33, wherein the portion corresponds to a non-center portion of the input image.
38. **(Previously Presented)** The method of claim 33, wherein the transformation non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion.
39. **(Previously Presented)** The method of claim 33, further comprising determining the portion based on a location of an object within the input image such that the portion includes the object.
40. **(Previously Presented)** The method of claim 33, wherein the input image includes a video frame of a video.

REMARKS

By this paper, claims 21, 22, and 33 are amended without prejudice and without disclaimer. Accordingly, claims 21-40 are all of the pending claims. Support for the amendments presented above is provided throughout the Specification and claims as originally filed. Applicant expressly reserves the right to prosecute the subject matter of the unamended and/or cancelled claims, or any other subject matter supported by the Specification, in one or more continuation applications. In view of the foregoing amendments and the following remarks, reconsideration and allowance of all the pending claims is anticipated.

Rejections Under 35 U.S.C. § 103

Claims 21-25, 28-31, and 33- 39 currently stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over U.S. Patent No. 8,218,895 to Gleicher, *et al.* (“Gleicher”) in view of U.S. Patent No. 7,496,243 to Oosawa (“Oosawa”); claims 26, 27, 32, and 40 currently stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Gleicher in view of Oosawa, and in further view of U.S. Patent Application Publication No. 2004/0017492 to Stavely (“Stavely”). Applicant expressly reserves the right to challenge the analogousness of any of the cited references. Applicant traverses the rejections under § 103 at least because the proposed combination of references fails to teach or suggest all of the claimed features. However, solely in an effort to expedite prosecution and without acknowledging the propriety of the alleged rejection, Applicant has amended independent claims 21, 22, and 33.

The cited references fail to disclose each and every claimed feature of the amended independent claims related to, for example, (1) determining a **portion including a subset of pixels** within an input image, and (2) applying a transformation to the input image that **non-uniformly shifts the pixels** of the input image such that **differences between input positions and output positions are less for the subset of the pixels** than other pixels.

In pertinent parts, the amended independent claim 21 recites:

. . . determine a **portion within the input image**, the portion **including a subset of the pixels**; and
apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:
the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and
the transformation **non-uniformly shifts the pixels** such that **differences between the input positions and the output positions of the subset of the pixels within the portion are less** than differences between the input positions and the output positions of others of the pixels.

Amended claims 22 and 33 recite similar limitations.

The Office Action admits Gleicher fails to show “differences between the input positions and the output positions of the subset of the pixels are less than differences between the input positions and the output positions of others of the pixels.” (Office Action, pages 3-4) The Office Action states this “limitation is well-known in the art as taught in Oosawa.” (Office Action, page 4) The Office Action states Oosawa allegedly teaches “an image display apparatus and method wherein the amount of shift (Δx , Δy) to be applied to each pixel is smaller in the center of the image than in the peripheral of the image (Fig. 6, col. 6:35-47). Oosawa further teaches applying transform operations such as the affine transform operation and the non-linear warping transform operation to the first original image P1 (col. 7: 1-7).” (Office Action, page 4)

At best, Oosawa describes facilitating comparison of multiple (e.g., two) images of an identical object by performing a global matching operation between the images and determining the shifting amount of corresponding pixels between the images.

(Oosawa, Abstract, col. 6:6-47) To the extent Oosawa shows the amount of shifting to be applied to the center of the image is smaller than the peripheral of the image, this is merely the result of the visuals captured within two images being compared and is **not result of a transformation that creates less differences between input positions and output positions of the subset of the pixels than the differences between input positions and output positions of other pixels in the input image.** Thus, Oosawa fails to disclose determining a portion (including a subset of pixels) within an input image and non-uniformly shifting the pixels of the input image such that differences between input positions and output positions are less for the subset of the pixels than other pixels of the input image.

For at least the reasons presented above, Applicant submits independent claims 21, 22, and 33 are not anticipated or rendered obvious by the cited references. In addition, claims 23-32 and 34-40 are also not anticipated or rendered obvious at least due to their dependency from one of independent claims 22 or 33, in addition to the features they individually recite.

For example, with respect to claims 24 and 35, the Office Action relies on Figs. 1, 2, & 5; col. 14:3-12 of Gleicher for allegedly teaching a scaling function and a warping function that preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels. (Office Action, page 5) However, Gleicher fails to teach or suggest a scaling function and a warping function that does not change the locations of a subset of pixels of an input image. Gleicher describes modifying portions of an image outside a region of interest at different ratios to maintain the context and positional relationships of the other regions to the region of interest. (Gleicher, Figs. 1, 2, & 5; col. 14:3-12). Warping a region of interest and other regions inside an image differently do not preserve the input positions of a subset of pixels as the output positions of the subset of pixels. Thus, Gleicher fails to disclose or suggest the claimed scaling function and warping function that preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels.

With respect to claims 30 and 38, the Office Action relies on Fig. 6, col. 6:35-47 of Oosawa for allegedly teaching a transformation that non-uniformly shifts the pixels

from the input positions to the output positions further based on distances between the input positions and the portion including the subset of the pixels. (Office Action, page 5) As explained above, Oosawa merely describes facilitating comparison of multiple (e.g., two) images of an identical object by performing a global matching operation between the images and determining the shifting amount of corresponding pixels between the images. The shifting performed in Oosawa is a function of the visuals captured within two images being compared, and is not performed based on distances between the input positions of pixels to the portion including the subset of pixels. Thus, Oosawa fails to disclose or suggest the claimed transformation that non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion including the subset of the pixels.

Accordingly, Applicant requests the above rejection of claims under § 103 be withdrawn.

CONCLUSION

Having addressed each of the foregoing objections and rejections, it is submitted a full and complete response has been made to the outstanding Office Action and, as such, the application is in condition for allowance. Notice to that effect is anticipated.

If the Examiner believes, for any reason, personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Date: January 17, 2018

Submitted,

By: /D. Benjamin Esplin/
D. Benjamin Esplin
Reg. No. 58,297

Customer No. 137002

SHEPPARD MULLIN RICHTER AND HAMPTON
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San Diego, California 92130
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Electronic Acknowledgement Receipt	
EFS ID:	31528675
Application Number:	15492738
International Application Number:	
Confirmation Number:	8390
Title of Invention:	Conversion Between Aspect Ratios in Camera
First Named Inventor/Applicant Name:	Nicholas D. Woodman
Customer Number:	137002
Filer:	D. Benjamin Esplin/victoria borchard
Filer Authorized By:	D. Benjamin Esplin
Attorney Docket Number:	46DG-254798
Receipt Date:	17-JAN-2018
Filing Date:	20-APR-2017
Time Stamp:	17:11:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		46DG-254798_Response.pdf	148458	yes	11
			82950b0f0bdd24ca34db9fc82a896f4685bcd3fa		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	11
Warnings:			
Information:			
Total Files Size (in bytes):		148458	
<p>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.</p> <p>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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>			



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/492,738	04/20/2017	Nicholas D. Woodman	46DG-254798	8390
137002 7590 10/19/2017 Sheppard Mullin Richter & Hampton LLP (GoPro) 12275 El Camino Real, Suite 200 San Diego, CA 92130-2006			EXAMINER VU, NGOC YEN T	
			ART UNIT 2663	PAPER NUMBER
			NOTIFICATION DATE 10/19/2017	DELIVERY MODE 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):

dmipdocketing@sheppardmullin.com

Office Action Summary	Application No. 15/492,738	Applicant(s) WOODMAN ET AL.	
	Examiner Ngoc-Yen Vu	Art Unit 2663	AIA (First Inventor to File) Status Yes

-- 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 5/22/17.
☐ 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) 21-40 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) 21-40 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 4/20/17 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) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____. | 4) ☐ Other: ____. |

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

1. The information disclosure statement (IDS), submitted on 6/1/17, has been entered and made of record. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 103

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 21-25, 28-31 and 33- 39 are rejected under 35 U.S.C. 103 as being unpatentable over Gleicher et al. (US 8,218,895) in view of Oosawa (US 7,496,243).

Re ***Claim 21***, Gleicher teaches an image capture apparatus, comprising:

an image sensor configured to capture an input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second

axis, the first axis perpendicular to the second axis (Gleicher shows in Fig. 1 an original image 100 that is obtained using a digital camera or a camera embedded in a cell phone - col. 4:46-52; col. 5:48-col. 6:17);

a display (display screen 210 of a cell phone 200; col. 6:18-27) coupled to one or more physical processors (it is inherent that the cell phone 200 includes physical processors); and

the one or more physical processors configured by machine-readable instructions to:
obtain the input image (Gleicher shows in Fig. 2 displaying the entire original image 100);

apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis (Gleicher shows in figures 5 and 16-18 a retargeted image 300 which has been modified to have a target aspect ratio different than the aspect ratio of the original image 100 – col. 7:43-col. 8:67; col. 16:50-col. 17:18), wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis (Fig. 14 shows warping functions usable to convert the original image 100 to the retargeted image 300 - col. 12:53-col. 13:37; col. 14:13-col. 15:3; col. 26:34-64; col. 27:46-67; col. 28:17-24); and

present the output image on the display (Figs. 5 and 16-18).

Gleicher shows a portion including a subset of the pixels (region of interest 110' in Figs. 2-3; region of interest 310 in Fig. 5 and region of interest 110/410/510 in Figs. 16-19). Gleicher

fails to show differences between the input positions and the output positions of the subset of the pixels are less than differences between the input positions and the output positions of others of the pixels. The limitation is well-known in the art as taught in Oosawa. In the same field of endeavor, Oosawa teaches an image display apparatus and method wherein the amount of shift (Δx , Δy) to be applied to each pixel is smaller in the center of the image than in the peripheral of the image (Fig. 6, col. 6:35-47). Oosawa further teaches applying transform operations such as the affine transform operation and the non-linear warping transform operation to the first original image P1 (col. 7:1-7). In light of the teaching in Oosawa, it would have been obvious to one of ordinary skill in the art before the filing date of the claimed invention to modify Gleicher by having differences between the input positions and the output positions of the subset of the pixels are less than differences between the input positions and the output positions of others of the pixels in order to display a natural image without loss or distortion.

Re **Claim 22**, although the wording is different, the material is considered substantively equivalent to the material associated with claim 21, as discussed above.

Re **Claim 23**, Gleicher teaches the system of claim 22, wherein the transformation includes a scaling function to uniformly stretch or compress the input image along the first axis (Fig. 3 shows the retargeted image is scaled differently in the horizontal dimension than in the vertical dimension. Gleicher teaches the scaled objects in the remaining image region 320 are scaled using the same magnification value regardless of where a scaled object appears in the particular remaining image region relative to the edges of the region of interest 310 and the retargeted image 300 – col. 14:57-62); and a warping function to non-uniformly warp the input image along the second axis (Gleicher teaches different portions 121-128 of the remaining image

region 120 of the original image 100 that are outside of the region of interest 110 may need to be modified or warped at different ratios, so that the context and positional relationships of the various portions 121-128 of the remaining image region 120 to the region of interest 110 in the original image 100 are maintained in the retargeted image 300 – col. 14:3-12).

Re **Claim 24**, Gleicher teaches the system of claim 23, wherein the scaling function and the warping function preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels (Figs. 1-2 & 5; col. 14:3-12).

Re **Claim 25**, Gleicher teaches the system of claim 23, wherein the scaling function changes the source aspect ratio to the target aspect ratio (col. 13:53-col. 14:56).

Re **Claim 28**, Gleicher teaches the system of claim 22, wherein the portion corresponds to a center portion of the input image (Figs. 1-2, 5 and 16-18).

Re **Claim 29**, Gleicher teaches the system of claim 22, wherein the portion corresponds to a non-center portion of the input image (Figs. 19-21).

Re **Claim 30**, Gleicher in view of Oosawa teaches the system of claim 22, wherein the transformation non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion (Oosawa teaches the amount of shift (Δx , Δy) to be applied to each pixel is smaller in the center of the image –region of interest- than in the peripheral of the image - Fig. 6, col. 6:35-47).

Re **Claim 31**, Gleicher teaches the system of claim 22, wherein the one or more physical processors are further configured by machine-readable instructions to determine the portion based on a location of an object within the input image such that the portion includes the object (col. 9:29-col. 10:26).

Re **Claims 33-39**, they are method claims that correspond to the apparatus claims 22-24 and 28-31. Therefore, claims 33-39 are analyzed and rejected as previously discussed with respect to claims 22-24 and 28-31.

4. Claims 26-27, 32 and 40 are rejected under 35 U.S.C. 103 as being unpatentable over Gleicher et al. (US 8,218,895) in view of Oosawa (US 7,496,243), and further in view of Stavely (US 2004/0017492).

Re **Claims 26-27 and 32**, Gleicher in view of Oosawa fails to teach wherein the one or more physical processors are included within a camera, wherein the output image is presented on a display of the camera, and wherein the input image includes a video frame of a video. The limitations are well-known in the art as taught in Stavely. In the same field of endeavor, Stavely teaches a digital video camera (Figs. 1A-1B, device 100) comprising controller 105, display 125 and firmware/software 145 including digital zoom, correct distortion and rescale image modules. In light of the teaching in Stavely, it would have been obvious to one of ordinary skill in the art before the filing date of the claimed invention to modify Gleicher in view of Oosawa by having the physical processors included within a digital video camera in order to provide an improved resolution digital zoom capability in an electronic imaging device (§05).

Re **Claim 40**, it is a method claim that corresponds to the apparatus claim 32. Therefore, claim 40 is analyzed and rejected as previously discussed with respect to claim 32.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ngoc-Yen Vu whose telephone number is (571) 272-7320. The examiner can normally be reached on Mon. - Fri. from 8:00 am to 5:00 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Twyler Haskins can be reached on 571-272-7406. 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.

*/Ngoc-Yen Vu/
Primary Examiner, Art Unit 2663*

Notice of References Cited	Application/Control No. 15/492,738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.	
	Examiner Ngoc-Yen Vu	Art Unit 2663	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-7,496,243 B2	02-2009	Oosawa; Akira	G06T5/50	382/132
*	B	US-8,218,895 B1	07-2012	Gleicher; Michael Lee	G06T3/0025	345/427
*	C	US-9,196,228 B2	11-2015	Kim; Jung-dae	H04N7/0122	1/1
	D	US-				
	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	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	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.



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BIB DATA SHEET

CONFIRMATION NO. 8390

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.		
15/492,738	04/20/2017 RULE	348	2663	46DG-254798		
APPLICANTS GoPro, Inc., San Mateo, CA; INVENTORS Nicholas D. Woodman, Woodside, CA; Sumit Chawla, San Carlos, CA; Loic Segapelli, Oakland, CA; Scott Patrick Campbell, Belmont, CA; ** CONTINUING DATA ***** This application is a CON of 15/011,253 01/29/2016 PAT 9674429 which is a CON of 14/536,315 11/07/2014 PAT 9294671 which is a CON of 14/180,887 02/14/2014 PAT 8917329 which claims benefit of 61/869,029 08/22/2013 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 04/26/2017						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and / Ngoc-Yen Vu / Acknowledged Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY CA	SHEETS DRAWINGS 6	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 4
ADDRESS Sheppard Mullin Richter & Hampton LLP (GoPro) 12275 El Camino Real, Suite 200 San Diego, CA 92130-2006 UNITED STATES						
TITLE Conversion Between Aspect Ratios in Camera						
FILING FEE RECEIVED 2020	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:			☐ All Fees		
				☐ 1.16 Fees (Filing)		
				☐ 1.17 Fees (Processing Ext. of time)		
				☐ 1.18 Fees (Issue)		
				☐ Other _____		
				☐ Credit		

Search Notes 	Application/Control No. 15492738	Applicant(s)/Patent Under Reexamination WOODMAN ET AL.
	Examiner NGOC-YEN VU	Art Unit 2663

CPC- SEARCHED		
Symbol	Date	Examiner
H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084	10/15/17	/nv/

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
Text limited search in the following CPC areas H04N 5/2628; G06T 3/0093, 3/20, 3/40, 3/4069, 3/4084. See search history printout.	10/15/17	/nv/

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	234	warp\$3 same (shift\$3 near2 pixel)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:02
L2	39	((non adj linear\$2) (linear\$2) (nonlinear\$2)) same 1	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:03
L3	39	(image imaging) and 2	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	OR	ON	2017/10/15 22:04
S1	0	14/180887	US-PGPUB; USPAT	OR	ON	2014/05/19 08:24
S2	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 08:27
S3	8030962	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 08:30
S4	15532	S2 with S3	US-PGPUB; USPAT	OR	ON	2014/05/19 08:30
S5	504599	(scal\$3 adjust\$3 conversion convert\$3 zoom\$3 crop\$4) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 08:50
S6	11421	warp\$3 with image	US-PGPUB; USPAT	OR	ON	2014/05/19 08:51
S7	7917	S5 and S6	US-PGPUB; USPAT	OR	ON	2014/05/19 08:51
S8	319	S7 and S4	US-PGPUB; USPAT	OR	ON	2014/05/19 08:52
S9	315	S8 and @ad<="20130822"	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S10	156	camera and S9	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S11	3871	S5 same2 S6	US-PGPUB; USPAT	OR	ON	2014/05/19 08:53
S12	225	S4 and S11	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54
S13	90	camera and S12	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54
S14	87	S13 and @ad<="20130822"	US-PGPUB; USPAT	OR	ON	2014/05/19 08:54
S15	22651	(warp\$3 skew\$3) with image	US-PGPUB;	OR	ON	2014/05/19

			USPAT			10:23
S16	300	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 10:24
S17	300	"4" and S16	US-PGPUB; USPAT	OR	ON	2014/05/19 10:24
S18	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:25
S19	166066	(aspect near2 ratio)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:26
S20	300	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT	OR	ON	2014/05/19 10:26
S21	46	S19 and S20	US-PGPUB; USPAT	OR	ON	2014/05/19 10:27
S22	3	S20 same corner	US-PGPUB; USPAT	OR	ON	2014/05/19 10:28
S23	8030962	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 10:42
S24	31595	S19 same S23	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S25	32068	S20 same S24	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S26	6	S20 same S24	US-PGPUB; USPAT	OR	ON	2014/05/19 10:43
S27	6	S26 not S22	US-PGPUB; USPAT	OR	ON	2014/05/19 10:44
S28	5	"8218895"	US-PGPUB; USPAT	OR	ON	2014/05/19 11:36
S29	1	S20 and S28	US-PGPUB; USPAT	OR	ON	2014/05/19 11:37
S30	1	"8218895".pn. and (processor process\$3)	US-PGPUB; USPAT	OR	ON	2014/05/19 11:47
S31	1	"8218895".pn. and (computer near5 circuit near5 program\$4)	US-PGPUB; USPAT	OR	ON	2014/05/19 11:53
S32	4961	(aspect near2 ratio) same (4:3) same (16:9)	US-PGPUB; USPAT	OR	ON	2014/05/19 13:25
S33	10	S20 and S32	US-PGPUB; USPAT	OR	ON	2014/05/19 13:26
S34	28	"4951125"	US-PGPUB; USPAT	OR	ON	2014/09/06 13:40
S35	0	H04N5/23229.cpcc.	US-PGPUB; USPAT	OR	ON	2014/09/06 14:01
S36	0	H04N5/23229.cccc.	US-PGPUB; USPAT	OR	ON	2014/09/06 14:01
S37	0	H04N5/23229.cccc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:02
S38	98	H04N5/23229.cPCA.	US-PGPUB; USPAT; USOCR;	OR	ON	2014/09/06 14:02

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S39	2157	H04N5/23229.cpg.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:02
S40	2059	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:03
S41	0	H04N5/23229.cpct.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:03
S42	0	13/908274	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:04
S43	1	13/784234	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 14:10
S44	98	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17
S45	2157	H04N5/23229.cpg.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17
S46	2059	H04N5/23229.cpci.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/09/06 21:17
S47	171376	(aspect near2 ratio)	US-PGPUB;	OR	ON	2014/09/06

			USPAT			21:17
S48	11820	(warp\$3 with image)	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S49	2105	S47 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S50	0	S44 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S51	0	S44 and S47	US-PGPUB; USPAT	OR	ON	2014/09/06 21:18
S52	1	S44 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:19
S53	112	S45 and S47	US-PGPUB; USPAT	OR	ON	2014/09/06 21:20
S54	59	S53 and S48	US-PGPUB; USPAT	OR	ON	2014/09/06 21:20
S55	59	S45 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S56	59	S46 and S49	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S57	59	S55 S56	US-PGPUB; USPAT	OR	ON	2014/09/06 21:21
S58	5	("8340453").URPN.	USPAT	OR	ON	2014/09/06 21:36
S59	3	((("8493459") or ("8340453") or ("8723959"))).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 21:45
S60	2	(non adj 1 linear\$2) and S59	US-PGPUB; USPAT	OR	ON	2014/09/06 21:45
S61	1	S47 and S59	US-PGPUB; USPAT	OR	ON	2014/09/06 21:47
S62	2	((("8218895") or ("8143013"))).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 22:14
S63	2	((("8218895") or ("8145013"))).PN.	US-PGPUB; USPAT	OR	OFF	2014/09/06 22:39
S74	3	("8917329").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/15 14:13
S75	22	("5790696" "8340453" "8723959" "20130141593" "20140032406" "8045788" "8145013" "8218895" "8493459").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 14:16
S76	139	H04N21/234372.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 14:27
S77	872	H04N21/440272.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT;	OR	ON	2015/06/15 14:27

			IBM_TDB			
S78	8728347	(conversion convert\$3) (chang\$3) (translation translat\$3) (modification modif\$4) (alteration alter\$3) (translation translat\$3)	US-PGPUB; USPAT	OR	ON	2015/06/15 14:27
S79	49	S76 and S78	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S80	240	S77 and S78	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S81	271	S79 S80	US-PGPUB; USPAT	OR	ON	2015/06/15 14:28
S82	2	"14180887"	US-PGPUB; USPAT	OR	ON	2015/10/27 17:03
S83	1	"14536315"	US-PGPUB; USPAT	OR	ON	2015/10/27 17:03
S84	151	H04N21/234372.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:20
S85	913	H04N21/440272.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:20
S86	2431	H04N5/23232.qpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/10/27 19:21
S87	31266	(warp\$3 skew\$3) with image	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:23
S88	1575	G06T5/006.CPC.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:23
S89	388	((non adj1 linear\$2) (nonlinear\$2)) with (warp\$3 skew\$3) with image	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S90	2	S84 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S91	2	S85 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:24
S92	0	S86 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:25

S93	9	S88 and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:25
S94	11	S90 S91 S93	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2015/10/27 19:25
S95	8	("6369814").URPN.	USPAT	OR	ON	2015/10/27 19:33
S96	60	((Nicholas) near2 (Woodman)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S97	24	((Sumit) near2 (Chawla)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S98	3	((Loic) near2 (Segapelli)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:48
S99	347	((Scott) near2 (Campbell)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/10/27 19:49
S100	1	S87 and S96	USPAT	OR	ON	2015/10/27 19:49
S101	1	S87 and S97	USPAT	OR	ON	2015/10/27 19:49
S102	1	S87 and S98	USPAT	OR	ON	2015/10/27 19:49
S103	3	S87 and S99	USPAT	OR	ON	2015/10/27 19:50
S104	3	S100 S101 S102 S103	USPAT	OR	ON	2015/10/27 19:50
S105	4	((("8917329") or ("9294671")).PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2016/10/17 13:44
S106	1	15/011253	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 13:46
S107	6	"8917329"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 14:32
S108	2	("8218895").PN.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2016/10/17 14:47
S109	1	(aspect adj ratio) and S108	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 14:49
S110	0	(shift\$3) and S108	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2016/10/17 15:11
S111	0	(shift\$3) and "9253474".pn.	US-PGPUB;	OR	ON	2016/10/17

			USPAT; EPO; JPO; DERWENT			15:11
S112	1	"9253474"	US-PGPUB; USPAT	OR	ON	2016/10/18 14:10
S113	14	("20040212731" "20120026157" "20120050507" "20120062530" "20130021391" "20130021666" "20130106998" "20130113884" "20130114680" "6055012" "7352910" "8145013" "8595782" "8917329").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:11
S114	1	15/011253	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:18
S115	1	transformation and S114	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:18
S116	1	(shift\$3 near4 pixel) and S114	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:21
S117	2	(shift\$3 near4 pixel) and S113	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:24
S118	325	H04N21/440272.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:33
S119	1730	H04N21/440263.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:34
S120	338	H04N21/44029.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:35
S121	0	H04N22/234372.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:37
S122	69	H04N21/234372.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:37
S123	2159	H04N21/23439.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:38
S124	1258	H04N5/23232.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:42
S125	473	G06T3/0093.CLAS,OCLS,CPC,CPCL.	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:43
S126	56	(shift\$3 near4 pixel) and S125	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:50
S127	15	(aspect near ratio) and S126	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 14:53
S128	7	"6915026"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47

S129	91	"6757446"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S130	205092	(aspect near ratio) and "1"	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S131	1	(aspect near ratio) and S128	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S132	5	(aspect near ratio) and S129	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:47
S133	2	(shift\$3 near4 pixel) and S128	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S134	1	(shift\$3 near4 pixel) and S129	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S135	7	S131 S132 S133 S134	US-PGPUB; USPAT; USOCR	OR	ON	2016/10/18 16:48
S136	1	15/011253	US-PGPUB; USPAT	OR	ON	2016/10/31 15:37
S137	1	13/755901	US-PGPUB; USPAT	OR	ON	2016/10/31 22:30
S138	1	14/927129	US-PGPUB; USPAT	OR	ON	2016/11/01 10:53
S139	3	14/744601	US-PGPUB; USPAT	OR	ON	2016/11/01 10:59
S140	81	((("WOODMAN") near3 ("Nicholas")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S141	59	((("CHAWLA") near3 ("Sumit")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S142	5	((("SEGAPELLI") near3 ("Loic")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:22
S143	434	((("CAMPBELL") near3 ("Scott")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2017/04/03 13:23
S144	0	15/492738	US-PGPUB; USPAT	OR	ON	2017/10/15 16:28
S145	24	"8218895"	US-PGPUB; USPAT	OR	ON	2017/10/15 16:28
S146	11	(shift\$3) and S145	US-PGPUB; USPAT	OR	ON	2017/10/15 16:55
S147	1	"8218895".pn.	US-PGPUB; USPAT	OR	ON	2017/10/15 16:58
S148	24	"8218895"	US-PGPUB; USPAT	OR	ON	2017/10/15 20:19
S149	11	(shift\$3) and S148	US-PGPUB; USPAT	OR	ON	2017/10/15 20:19
S150	1	"8218895".pn.	US-PGPUB; USPAT	OR	ON	2017/10/15 20:49

10/ 15/ 2017 10:50:31 PM

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Receipt date: 06/01/2017

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Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)

Approved for use through 07/31/2016. OMB 0651-0031

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	Filing Date	2017-04-20
	First Named Inventor	Nicholas D. WOODMAN
	Art Unit	2661
	Examiner Name	TBD
	Attorney Docket Number	46DG-254798

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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	5790696		1998-08-04	Hiroyasu Takahashi	
	2	6757446		2004-06-29	Jiang Li	
	3	6915026		2005-07-05	Toshihiro Sasai	
	4	7079157		2006-07-18	Michael F. Deering	
	5	8045788		2011-10-25	Cory Watkins	
	6	8145013		2012-03-27	Shilpi Sahu	
	7	8218895		2012-07-10	Michael Lee Gleicher	
	8	8340453		2012-12-25	Simon Chen	

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9	8493459		2013-07-23	Felix Albu	
10	8525871		2013-09-03	Aseem Agarwala	
11	8723959		2014-05-13	Peter Corcoran	
12	8913141		2014-12-16	Scott Patrick Campbell	
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	2	20140032406		2014-01-30	John J. Roach	
	3	20160173767		2016-06-16	Nicholas D. Woodman	
	4	20040017492		2004-01-29	Donald Stavely	

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5	20090202177	2009-08-13	Eric Jeffrey
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	1	2334058	EP		2016-09-21	Huawei Device Co., Ltd.		
	2	2010073192	WO		2010-07-01	Koninklijke Philips Electronics N.V.		

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	1	Office Action for U.S. Application No. 14/536,315 mailed June 19, 2015, 5 pages.	
	2	PCT International Search Report and Written Opinion for PCT/US14/51750, September 9, 2014, 9 pages	
	3	United States Office Action for U.S. Application No. 14/180,887, May 28, 2014, 10 pages.	
	4	AVIDAN, S., et al., "Seam Carving for Content-Aware Image Resizing", ACM Transactions on Graphics (TOG), ACM, Volume 26, No. 3, Article 10, July 1, 2007, XP007904203, 10 pages.	

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5	HWANG, Daw-Sen, et al., "Content-Aware Image Resizing Using Perceptual Seam Carving with Human Attention Model", International Conference on Multimedia and Expo, 2008 IEEE, Piscataway, NJ, June 23, 2008, XP032965469, pages 1029-1032.
6	WANG, Yu-Shuen, et al., "Optimized Scale-and-Stretch for Image Resizing", ACM Transactions on Graphics (TOG), ACM, Volume 27, No. 5, Article 118, December 1, 2008, XP002609797, 8 pages.

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5	20090202177	2009-08-13	Eric Jeffrey
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	2	2010073192	WO		2010-07-01	Koninklijke Philips Electronics N.V.		

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	First Named Inventor	Nicholas D. WOODMAN
	Art Unit	2661
	Examiner Name	TBD
	Attorney Docket Number	46DG-254798

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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).

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See attached certification statement.

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

☒ A certification statement is not submitted herewith.

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

Signature	/D. Benjamin Esplin/	Date (YYYY-MM-DD)	2017-06-01
Name/Print	D. Benjamin Esplin	Registration Number	58297

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(11) **EP 2 334 058 A1**

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15.06.2011 Bulletin 2011/24

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H04N 5/44 (2011.01)

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(22) Date of filing: **02.06.2009**

(87) International publication number:
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(30) Priority: **28.09.2008 CN 200810169225**

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(74) Representative: **Charles, Glyndwr**
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Patent- und Rechtsanwälte
Friedrichstrasse 31
80801 München (DE)

(54) **IMAGE ZOOMING METHOD AND APPARATUS**

(57) The present invention relates to image processing technologies, and discloses an image scaling method and apparatus to reduce distortion of a scaled image. The image scaling method includes: determining a distribution direction of main objects in a source image; and scaling the source image to a target image through a

nonlinear scaling method according to the distribution direction of the main objects in the source image, where the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image. The embodiments of the present invention are primarily applicable to the image scaling field.

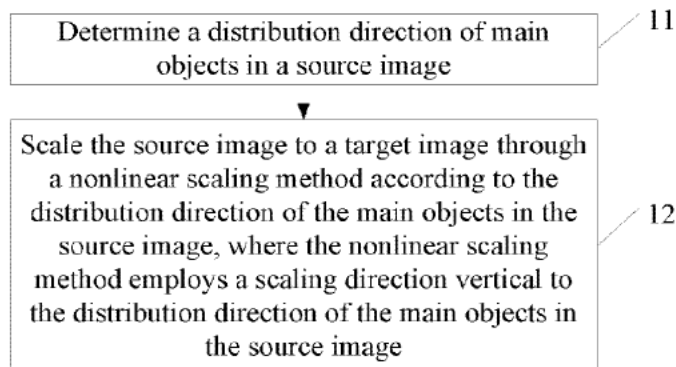


FIG. 1

EP 2 334 058 A1

Description

[0001] This application claims priority to Chinese Patent Application No. 200810169225.4, filed with the Chinese Patent Office on September 28, 2008 and entitled "Image Scaling Method and Apparatus", which is incorporated herein by reference in its entirety.

Field of the Invention

[0002] The present invention relates to image processing technologies, and in particular, to an image scaling method and apparatus.

Background of the Invention

[0003] Image scaling is a common image processing technology, and the scaling is rather difficult if the source image and the target image have different aspect ratios. With the aspect ratios being different, distortion occurs when the source image is scaled up or down to the target image, especially when the aspect ratio of the source image is sharply different from that of the target image.

[0004] A typical scenario of image scaling is the adaptation between an image with a 4:3 aspect ratio and an image with a 16:9 aspect ratio. Currently, the video communication system needs to be compatible with both the standard-definition image (such as 4CIF) with the existing aspect ratio of 4:3 and the high-definition image (such as 720p and 1080p) with a new aspect ratio of 16:9. The traditional Cathode Ray Tube (CRT) television sets generally employ an aspect ratio of 4:3, and the latest high-definition Liquid Crystal Display (LCD) television sets generally employ an aspect ratio of 16:9. Therefore, there is a problem as regards how to scale a standard-definition video image with an aspect ratio of 4:3 to an image presentable on a high-definition television set with an aspect ratio of 16:9, and vice versa.

[0005] The prior art puts forward many solutions to the foregoing problem to implement scaling between images with different aspect ratios, for example, linear scaling, edge trimming, horizontal nonlinear scaling, and filling of black edges of images. However, in the process of implementing the present invention, the inventor finds at least the following problems in the prior art:

[0006] When images are scaled through linear scaling, the method is simple, but distortion of images is serious. When images are scaled through edge trimming, the distortion of images is avoided, but the main objects of the images are vulnerable to loss. When the black edge of an image is filled in the scaling process, the scaled image is smaller than the source image, and it is impossible to fill the whole display area. The filling of the black edge leads to interference to the audience. When an image is scaled through a horizontal nonlinear scaling algorithm, if the main objects in the image are in the middle of the image, the main object area is little distorted after the scaling, and the visual effect is good; however, if the main objects (such as persons) exist on the edge of the image, the persons at the edge are distorted sharply against the persons in the middle of the image after the image scaling, and the visual effect is deteriorated. Meanwhile, if objects are moving horizontally, for example, captions which scroll horizontally or persons who walk horizontally, the captions or persons crossing areas are distorted sharply, and the audience is sensitive to such distortion.

Summary of the Invention

[0007] The embodiments of the present invention provide an image scaling method and apparatus to reduce distortion of a scaled image.

[0008] To fulfill such objectives, the embodiments of the present invention are based on the following technical solution:

An image scaling method includes:

determining a distribution direction of main objects in a source image; and
scaling the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, where the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

An image scaling apparatus includes:

a distribution direction determining unit, adapted to determine a distribution direction of main objects in a source image; and
an image scaling unit, adapted to scale the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, where the nonlinear scaling

method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

[0009] Through the image scaling method and apparatus under the present invention, the distribution direction of the main objects in the source image is determined, and the source image is scaled to the target image through a proper nonlinear scaling method according to the distribution direction of the main objects in the source image. Therefore, the method and apparatus under the present invention prevent distortion of the target image in the important area to which human eyes are sensitive, and reduce the distortion of the scaled image.

Brief Description of the Drawings

[0010]

FIG. 1 is a flowchart of an image scaling method provided in a first embodiment of the present invention;
 FIG. 2 is a flowchart of an image scaling method which applies a vertical nonlinear scaling method in a second embodiment of the present invention;
 FIG. 3 is a flowchart of an image scaling method which applies a vertical nonlinear scaling method in a third embodiment of the present invention;
 FIG. 4 shows segmenting of a source image and a target image in an image scaling method provided in a fourth embodiment of the present invention;
 FIG. 5 shows transformation relations of pixel positions at different heights of a source image and a target image in the fourth embodiment of the present invention;
 FIG. 6a shows a source image and FIG. 6b shows a target image after scaling;
 FIG. 7 shows segmenting of a source image and a target image in an image scaling method provided in a fifth embodiment of the present invention;
 FIG. 8 shows an image scaling apparatus provided in a sixth embodiment of the present invention;
 FIG. 9 shows a structure of a distribution direction determining unit in the image scaling apparatus provided in the sixth embodiment of the present invention; and
 FIG. 10 shows a structure of an image scaling unit in the image scaling apparatus provided in the sixth embodiment of the present invention.

Detailed Description of the Embodiments

[0011] The present invention is hereinafter described in detail with reference to exemplary embodiments and accompanying drawings. To describe the technical solution under the present invention more clearly, the following outlines the accompanying drawings involved in the embodiments of the present invention. Apparently, the accompanying drawings outlined below are not exhaustive, and persons of ordinary skill in the art can derive other drawings from such accompanying drawings without any creative effort.

First Embodiment

[0012] To reduce distortion of a scaled image, this embodiment puts forward an image scaling method. As shown in FIG. 1, the image scaling method in this embodiment includes the following steps:

Step 11: Determine the distribution direction of the main objects in a source image.

[0013] The distribution direction of the main objects in the source image may be determined by detecting the source image. The distribution direction of the main objects in the source image may be characterized by great symmetry, or even distribution, or rich textures.

[0014] The source image may be detected through face detection method, edge detection method, or entropy coding method. Taking the face detection method as an example, it is regarded that the persons in the scene are the main objects. Therefore, before scaling of the image, the distribution of the faces of persons is detected in the image, and the distribution direction of the persons and the symmetry information are obtained as a basis for deciding the scaling direction. The face detection method may be performed through a mature algorithm currently available. In an edge detection method, it is regarded that human eyes are sensitive to the area with rich textures (main objects) but not sensitive to the flat area with few textures (trivial objects). Therefore, the edge detection algorithm such as Sobel and Laplacian can be used to calculate the edge distribution of the scene, and determine the distribution of the main objects of the scene. Alternatively, through an entropy coding method, the direction with even distribution of the main objects is detected in the source image, and the distribution of the main objects in the scene is determined.

[0015] Alternatively, the direction of the main objects in the image may be preset to decide whether to employ a horizontal nonlinear scaling method or to employ a vertical nonlinear scaling method, or to employ other methods.

[0016] Step 12: Scale the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, where the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

[0017] An image may be scaled in the horizontal direction or the vertical direction, whichever makes the scaling direction of the image vertical to the distribution direction of the main objects. For example, when the main objects in the image are distributed vertically, the image is scaled according to the horizontal nonlinear scaling method in the prior art. When the main objects in the image are distributed horizontally, the image is scaled according to a vertical nonlinear scaling method.

[0018] Through the image scaling method in the first embodiment, the distribution direction of the main objects in the source image is determined through detection of the image content, and the source image is scaled to the target image through a proper nonlinear scaling method according to the distribution direction of the main objects in the source image. Therefore, the method provided in this embodiment avoids distortion of the target image in the important area to which human eyes are sensitive, and reduces the distortion of the scaled image.

[0019] In the image scaling process detailed below, the vertical nonlinear scaling method is taken as an example.

Second Embodiment

[0020] As shown in FIG. 2, an image scaling method which applies a vertical nonlinear scaling method in the second embodiment includes the following steps:

Step 21: Divide the source image into at least two segments in the scaling direction. Specifically, with respect to vertical nonlinear scaling, this step is to divide the source image into at least two segments in the vertical direction.

[0021] Generally, the main objects such as persons or things in the scene are distributed horizontally. The persons or things which change positions in a wide scope move horizontally, for example, persons who walk in the scene. In the vertical direction of the image, few main objects are distributed and contents change scarcely, and the symmetrical distribution of the image contents in the horizontal direction is much more than the symmetrical distribution of the image contents in the vertical direction. The nonlinear scaling method in the prior art scales the image in the horizontal direction, which generates obvious distortion in the horizontal direction. The vertical nonlinear scaling is better.

[0022] In the prior art, the horizontal nonlinear scaling method is almost symmetrical. To obtain a better effect of image scaling, this embodiment uses an asymmetrical scaling method to scale an image on the basis of vertical nonlinear scaling. In general scenes, the contents distributed vertically are of different importance. For example, in an indoor scene, persons and important things are generally centralized in the middle and lower part of the image, and trivial objects are generally distributed in the upper part of the image. The audience is generally sensitive to the main objects, which should be protected from distortion in the scaling process. The upper part of the image is generally unimportant, and allows more distortion.

[0023] Based on the foregoing principles, in the method provided in the second embodiment, the source image is divided into at least two segments in the vertical direction. In the segmenting process, the height of each segment may be specified as required, or determined according to the percentage of the height of each segment to the total height of the source image. Moreover, all segments may have the same height or not. For example, supposing that the aspect ratio of the source image is 4:3, the source image may be divided into an upper segment, a middle segment and a lower segment. The heights of the segments may be 30%, 50%, and 20% of the total height of the source image respectively.

[0024] Step 22: Set a different scaling factor for each segment in the source image.

[0025] In practice, the scaling factor may be set for the segment of the main objects and the segment of the trivial objects respectively in the source image. For the segment that includes more main objects in the source image, the scaling factor may be smaller; for the segment that includes fewer main objects in the source image, the scaling factor may be larger. The scaling factor is set manually or empirically.

[0026] It is assumed that the source image is divided into three segments in step 21. In the source image, the middle segment and the lower segment include a majority of the main objects, and the upper segment includes a minority of the main objects. Therefore, to prevent the important area critical to human eyes from distortion, the scaling factor of the middle segment and the lower segment is set to 1, and the scaling factor of the upper segment is set to 0.5. In an extreme circumstance, every pixel in the source image is regarded as a segment, and a different scaling factor is set for every pixel.

[0027] Step 23: Transform pixels in each segment of the source image into the target image at the corresponding scaling factor.

[0028] In the transformation process, the pixels of the source image are mapped to the pixels of the target image. In

this way, valid image data can be selected for the target image. In practice, when a reverse mapping method is applied to the transformation process, in the corresponding segment of the source image, one or more corresponding source pixels are found for each target pixel in the target image, and then the coordinate position and the value of the target pixel are determined in the source image according to the coordinate position and the value of one or more source pixels.

In practice, a differential filtering algorithm such as bilinear differential filtering algorithm and cubic convolution interpolation algorithm may be used to calculate the value of the target pixel.

[0029] In the image scaling method in the second embodiment, the image is scaled through asymmetrical scaling on the basis of vertical nonlinear scaling. Therefore, the method provided in the second embodiment prevents the important area critical to human eyes from distortion in the target image, reduces the distortion caused in the scaling process, and achieves a better scaling effect of the image.

Third Embodiment

[0030] To improve efficiency and accuracy of image scaling, the third embodiment adds more steps after step 22 of the second embodiment, as shown in FIG. 3:

Step 31: Divide the source image into at least two segments, and then divide the target image accordingly. At the time of segmenting the source image, the width and the height of the target image may be calculated out according to the source image. The target image can be segmented in the same way as segmenting the source image. For example, the source image is divided into an upper segment, a middle segment, and a lower segment, and the heights of the segments are 30%, 50%, and 20% of the total height of the source image respectively; therefore, the target image can be divided into three segments according to the height of the target image, and the heights of the segments are 20%, 60%, and 20% of the total height of the target image respectively.

[0031] In the vertical nonlinear image scaling method provided in the second and third embodiments above, because the main objects of an image are generally distributed in the middle part and the lower part of the image, the source image is divided into at least two segments in the vertical direction, and a different scaling factor is set for each segment, and then the source image is transformed into the target image at the scaling factors. Because the segmenting mode and the scaling factor of each segment are determined according to the distribution of main objects in the image, the methods provided in the second embodiment and the third embodiment avoid distortion of the target image in the important area to which human eyes are sensitive, and reduce the distortion caused in the scaling process.

Fourth Embodiment

[0032] The following describes the image scaling method in this embodiment, supposing that the aspect ratio of the source image is 4:3 and that the aspect ratio of the target image is 16:9.

[0033] To detect the source image and determine that the main objects in the source image are distributed vertically, the following operations are performed.

[0034] Step 41: As shown in FIG. 4, divide the source image into an upper segment, a middle segment, and a lower segment. It is assumed that the width of the source image is W and that the height of the source image is H . The source image is divided into an upper segment R_1 , a middle segment R_2 , and a lower segment R_3 , and the heights of the segments are H_1 ,

H_2 and H_3 respectively, where $H_1 + H_2 + H_3 = H$. After scaling, the width of the target image is the same as the width of the source target, and the height of the target image is H' . Accordingly, the target image is divided into three

segments, namely, an upper segment R'_1 , a middle segment R'_2 , and a lower segment R'_3 , and their heights are

H'_1 , H'_2 and H'_3 respectively, where $H'_1 + H'_2 + H'_3 = H'$.

[0036] Step 42: Perform scaling for each segment in the source image. A reverse mapping method is applied here. One or more source pixels corresponding to a target pixel of the target image are found in the source image, and the coordinate position and the value of the target pixel are determined in the target image according to the coordinate position and the value of the source pixels.

[0037] It is assumed that the coordinates of the source image pixel l are (x, y) , and that the coordinates of the target image pixel l' are (x', y') . According to the 2-dimensional image scaling transformation theory, the following formula (1) applies:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \quad (1)$$

where S_x is a scaling factor of transformation from the source image to the target image in the horizontal direction, and S_y is the scaling factor in the vertical direction.

[0038] The reverse mapping relation from the target image to the source image is (2):

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1/S_x & 0 & 0 \\ 0 & 1/S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \quad (2)$$

[0039] In this embodiment, the reverse mapping relation in formula (2) can be used to deduce the transformation relations in formulas (3)-(5):

[0040] For $l, l' \in R_1$, the following formula applies:

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & H_1/H'_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \quad (3)$$

[0041] For $l, l' \in R_2$, the following formula applies:

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & H_2/H'_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \quad (4)$$

[0042] For $l, l' \in R_3$, the following formula applies:

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & H_3/H'_3 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \quad (5)$$

[0043] Through formulas (3)-(5) above, the source pixels corresponding to the target pixel of the target image can be determined in the source image, the coordinate positions of the corresponding source pixels are obtained, and the valid image data corresponding to the target image is determined in the source image.

[0044] FIG. 5 shows transformation relations of pixel positions on different heights of a source image and a target image. As shown in FIG. 5, the pixels in the same segment are scaled linearly, and the scaling factor varies between segments. Therefore, the entire image is scaled nonlinearly. In the foregoing example, the transformation relation takes on a fold line; if every pixel is regarded as a segment and a scaling factor is specified for it, the transformation relation takes on a continuous curve.

[0045] Step 43: Perform data transformation for the target image after transformation. For example, perform filtering or average smoothing for the target image.

[0046] In the transformation, the pixel position mapped from the target image to the source image is generally not an

integer, but a fraction. Therefore, the target image needs to be processed through an interpolation filtering algorithm, for example, a bilinear interpolation algorithm or a cubic convolution algorithm. The following description takes the bilinear interpolation algorithm as an example. First, the linear interpolation algorithm is introduced below: Values of four neighboring points around an origin are interpolated linearly in two directions to obtain values of the points to be sampled. That is, the corresponding weight is determined according to the distance between the point to be sampled and the neighboring point, and the value of the point to be sampled is calculated out. A fractional mapping position may be divided into an integer part and a decimal part that falls within $[0,1)$, supposing that i, j are the integer part of the pixel, and that u, v are the decimal part, where $u, v \in [0,1)$. Therefore, the value of the pixel $f(i+u, j+v)$ can be determined according to four neighboring pixels s around through this formula:

$$f(i+u, j+v) = (1-u)(1-v)f(i, j) + (1-u)vf(i, j+1) + u(1-v)f(i+1, j) + uvf(i+1, j+1) \quad (6)$$

[0047] To obtain better processing effects, the interpolation may be based on a cubic convolution algorithm, which is an improvement of the bilinear interpolation algorithm. It allows for not only the impact caused by the grayscale values of the four neighboring points, but also the impact caused by the change rate of the grayscale value between the neighboring points, and uses pixel values in wider neighboring areas around the point to be sampled to perform three interpolations. Its principles are the same as the principles of the prior art, and are not further described here.

[0048] FIG. 6a shows a source image with an aspect ratio of 4:3, and FIG. 6b shows a target image after the source image is scaled vertically through an asymmetrical nonlinear scaling method provided herein. In FIG. 6a, the main objects of the image are distributed in the middle part and the lower part of the image, as indicated by the rectangle and the circle in FIG. 6a. In the image scaling process, a cubic convolution algorithm is applied as an interpolation algorithm. Because the main objects of the source image are centralized in the middle part and the lower part of the image and distributed horizontally, the scaling factor of the upper part is larger, and the scaling factor of the middle part and the lower part is very small and approaches 1. The comparison between FIG. 6a and FIG. 6b shows that in the scaled image, the main objects are scarcely distorted in the middle part and the lower part, to which the human eyes are sensitive, and that the trivial objects in the upper part are distorted greatly.

[0049] The principles of scaling an image with an aspect ratio of 16:9 to an image with an aspect ratio of 4:3 are the same as the principles described in the fourth embodiment. The difference is: The aspect ratio of the source image is 16:9, and the aspect ratio of the target image is 4:3.

[0050] In the image scaling method in the fourth embodiment, the distribution of the main objects in the image is taken into account, and the segments of the source image and the corresponding scaling factor are determined according to the distribution of main objects in the image. Therefore, the method avoids distortion of the target image in the area of the main objects, reduces the distortion caused in the scaling process, and brings a good visual effect.

Fifth Embodiment

[0051] As shown in FIG. 7, it is assumed that the main objects in the source image take on a 45° angle to the horizontal, and the scaling direction of the nonlinear scaling method takes on a 135° angle to the horizontal. The fifth embodiment includes the following steps:

Step 51: Divide the source image into an upper segment, a middle segment, and a lower segment at an angle of 45° to the horizontal, supposing that the three segments of the source image from the upper left side to the lower right side are $R1_1$, $R1_2$, and $R1_3$ respectively.

[0052] Accordingly, divide the target image into three segments at an angle of 45° to the horizontal, supposing that the three segments from the upper left side to the lower right side are $R1'_1$, $R1'_2$, and $R1'_3$ respectively.

[0053] Step 52: Perform scaling for each segment in the source image. A reverse mapping method may be applied here. One or more source pixels corresponding to a target pixel of the target image are found in the source image, and the coordinate position and the value of the target pixel are determined in the target image according to the coordinate position and the value of the source pixels. This step may be based on the method described in the fourth embodiment above.

[0054] Step 53: Perform data transformation for the target image after transformation. For example, perform filtering or average smoothing for the target image. Similarly to the fourth embodiment, in the transformation, the pixel position

mapped from the target image to the source image is generally not an integer, but a fraction. Therefore, the target image needs to be processed through an interpolation filtering algorithm, for example, a bilinear interpolation algorithm or a cubic convolution algorithm.

[0055] Through the image scaling method in the fifth embodiment, the distribution direction of the main objects in the source image is determined through detection of the image content, and the source image is scaled to the target image through a proper nonlinear scaling method according to the distribution direction of the main objects in the source image. Therefore, the method provided in this embodiment avoids distortion of the target image in the important area to which human eyes are sensitive, and reduces the distortion of the scaled image.

Sixth Embodiment

[0056] An image scaling apparatus is provided in this embodiment.

[0057] As shown in FIG. 8, the image scaling apparatus in the sixth embodiment includes a distribution direction determining unit 81 and an image scaling unit 82.

[0058] The distribution direction determining unit 81 is adapted to determine a distribution direction of main objects in a source image; and the image scaling unit 82 is adapted to scale the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, where the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

[0059] The distribution direction determining unit 81 may determine the distribution direction of main objects in the source image in different modes. As shown in FIG. 9, the distribution direction determining unit 81 may include a detecting module 811, which is adapted to detect the source image and determine the distribution direction of the main objects in the source image.

[0060] Depending on the result of the distribution direction determining unit 81, the image scaling unit 82 may apply different scaling methods. For example, when the main objects in the image are distributed vertically, the image scaling unit 82 applies a horizontal nonlinear scaling method in the prior art. When the main objects in the image are distributed horizontally, the image scaling unit 82 applies a vertical nonlinear scaling method. Any scaling method is appropriate as long as the scaling direction of the image is vertical to the distribution direction of the main objects.

[0061] As shown in FIG. 10, the image scaling unit 82 includes: a segment setting module 821, adapted to divide the source image into at least two segments vertically, and set a different scaling factor for each segment; and an image transforming module 822, adapted to transform pixels in each segment of the source image into the target image at the corresponding scaling factor.

[0062] As shown in FIG. 10, the image transforming module 822 includes: a pixel mapping submodule 8221, adapted to query a segment of the source image for at least one source pixel corresponding to each target pixel in each corresponding segment of the target image; and an image generating submodule 8222, adapted to determine coordinate positions and values of the target pixels in the target image according to the coordinate positions and values of the source pixels.

[0063] Through the image scaling apparatus in the sixth embodiment, the distribution direction of the main objects in the source image is determined through detection of the image content, and the source image is scaled to the target image through a proper nonlinear scaling method according to the distribution direction of the main objects in the source image. Therefore, the apparatus provided in this embodiment avoids distortion of the target image in the important area to which human eyes are sensitive, and reduces the distortion of the scaled image.

Seventh Embodiment

[0064] To improve efficiency and accuracy of image scaling, on the basis of the image scaling apparatus shown in FIG. 9 and FIG. 10, the segment setting module 821 is further adapted to divide the target image into at least two segments corresponding to the source image. Similarly to the method embodiment described above, at the time of segmenting the source image, the width and the height of the target image may be calculated out according to the source image. The target image can be segmented in the same way as segmenting the source image.

[0065] The apparatus provided in the seventh embodiment avoids distortion of the target image in the important area to which human eyes are sensitive, reduces the distortion of the scaled image, and improves efficiency and accuracy of image scaling.

[0066] In conclusion, through the image scaling method and apparatus in the embodiments of the present invention, the distribution direction of the main objects in the source image is determined through detection of the image content, and the source image is scaled to the target image through a proper nonlinear scaling method according to the distribution direction of the main objects in the source image. Therefore, the method and apparatus under the present invention prevent distortion of the target image in the important area to which human eyes are sensitive, and reduce the distortion of the scaled image.

[0067] After reading the foregoing embodiments, those skilled in the art are clearly aware that the present invention may be implemented through hardware, or through software in addition to a necessary universal hardware platform. The technical solution under the present invention may be embodied in a software product. The software product may be stored in a nonvolatile storage medium (such as a Compact Disk-Read Only Memory (CD-ROM), a Universal Serial Bus (USB) flash disk, or a mobile hard disk), and may incorporate several instructions that enable a computer device (such as a personal computer, a server, or a network device) to perform the methods provided in any embodiment of the present invention.

[0068] The above descriptions are merely exemplary embodiments of the present invention, but not intended to limit the scope of the present invention. Any modifications, variations or replacements that can be easily derived by those skilled in the art should fall within the scope of the present invention. Therefore, the scope of the present invention is subject to the appended claims.

Claims

1. An image scaling method, comprising:

determining a distribution direction of main objects in a source image; and
scaling the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, wherein the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

2. The image scaling method according to claim 1, wherein:

the step of determining the distribution direction of the main objects in the source image is:
detecting the source image to determine the distribution direction of the main objects in the source image.

3. The image scaling method according to claim 2, wherein:

if the distribution direction of the main objects in the source image is determined as horizontal, the step of scaling the source image to the target image through the nonlinear scaling method according to the distribution direction of the main objects in the source image is:
dividing the source image into at least two segments vertically;
setting a different scaling factor for each segment in the source image; and
transforming pixels in each segment of the source image into the target image at a corresponding scaling factor.

4. The image scaling method according to claim 3, wherein:

after dividing the source image into at least two segments vertically, the method further comprises:
dividing the target image into at least two segments corresponding to the source image.

5. The image scaling method according to claim 3, wherein:

the step of setting a different scaling factor for each segment in the source image is:
setting a scaling factor for each segment of the main objects and each segment of trivial objects respectively in the source image.

6. The image scaling method according to claim 3, wherein:

the step of transforming the pixels in each segment of the source image into the target image at the corresponding scaling factor is:
querying a segment of the source image for at least one source pixel corresponding to each target pixel in each corresponding segment of the target image; and
determining coordinate positions and values of target pixels in the target image according to coordinate positions and values of the source pixels.

7. An image scaling apparatus, comprising:

5 a distribution direction determining unit 81, adapted to determine a distribution direction of main objects in a source image; and
an image scaling unit 82, adapted to scale the source image to a target image through a nonlinear scaling method according to the distribution direction of the main objects in the source image, wherein the nonlinear scaling method employs a scaling direction vertical to the distribution direction of the main objects in the source image.

10 8. The image scaling apparatus according to claim 7, wherein the distribution direction determining unit 81 comprises:
a detecting module 811, adapted to detect the source image and determine the distribution direction of the main objects in the source image.

15 9. The image scaling apparatus according to claim 7, wherein the image scaling unit 82 comprises:
a segment setting module 821, adapted to divide the source image into at least two segments vertically, and set a different scaling factor for each segment; and
an image transforming module 822, adapted to transform pixels in each segment of the source image into the target image at the corresponding scaling factor.

20 10. The image scaling apparatus according to claim 9, wherein:
the segment setting module 821 is further adapted to divide the target image into at least two segments corresponding to the source image.

25 11. The image scaling apparatus according to claim 9, wherein the image transforming module 822 comprises:
a pixel mapping submodule 8221, adapted to query a segment of the source image for at least one source pixel corresponding to each target pixel in each corresponding segment of the target image; and
an image generating submodule 8222, adapted to determine coordinate positions and values of target pixels in the target image according to coordinate positions and values of source pixels.

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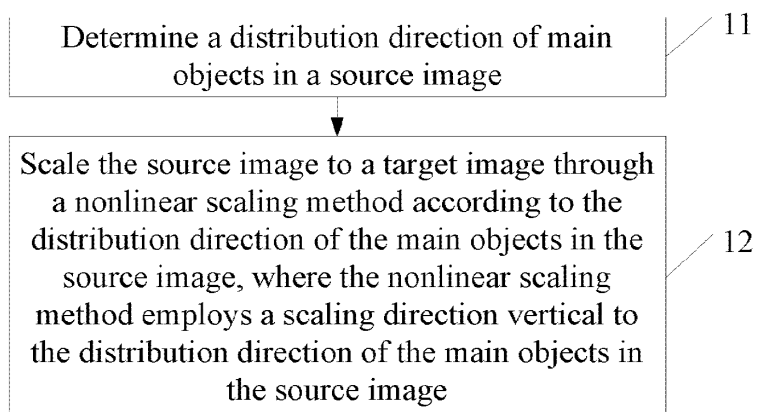


FIG. 1

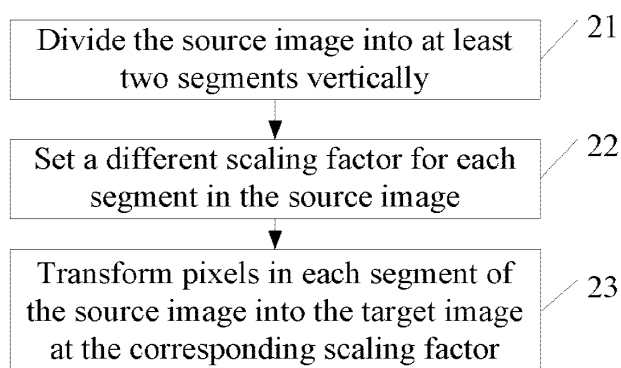


FIG. 2

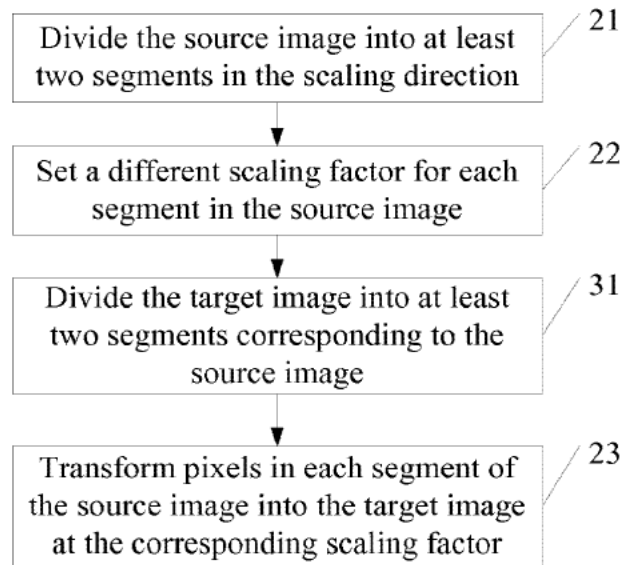


FIG. 3

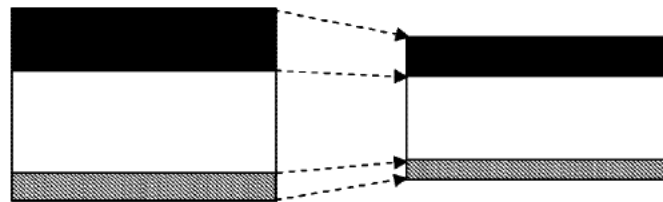


FIG. 4

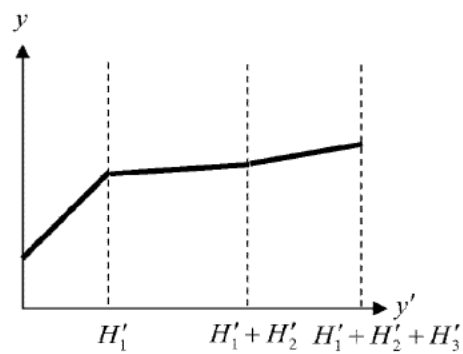


FIG. 5

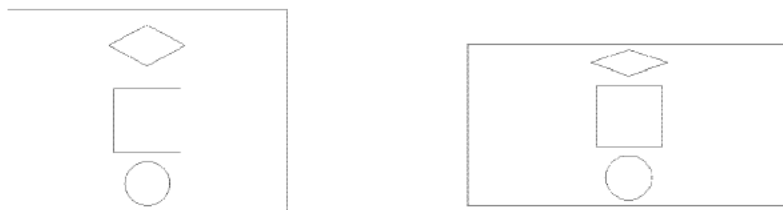


FIG. 6

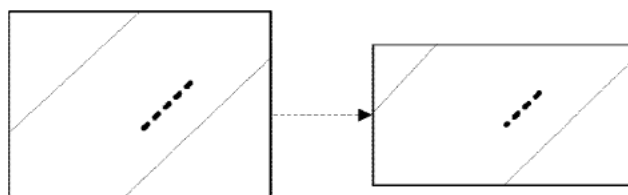


FIG. 7

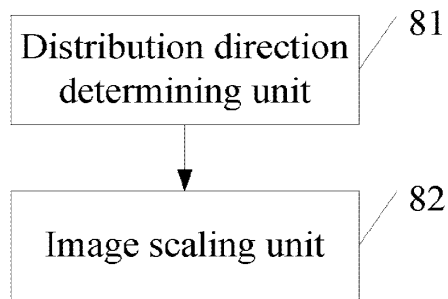


FIG. 8

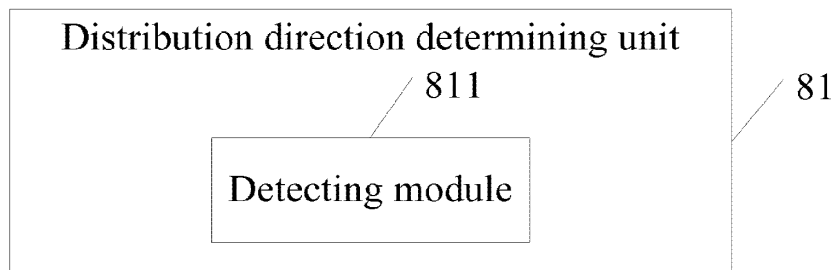


FIG. 9

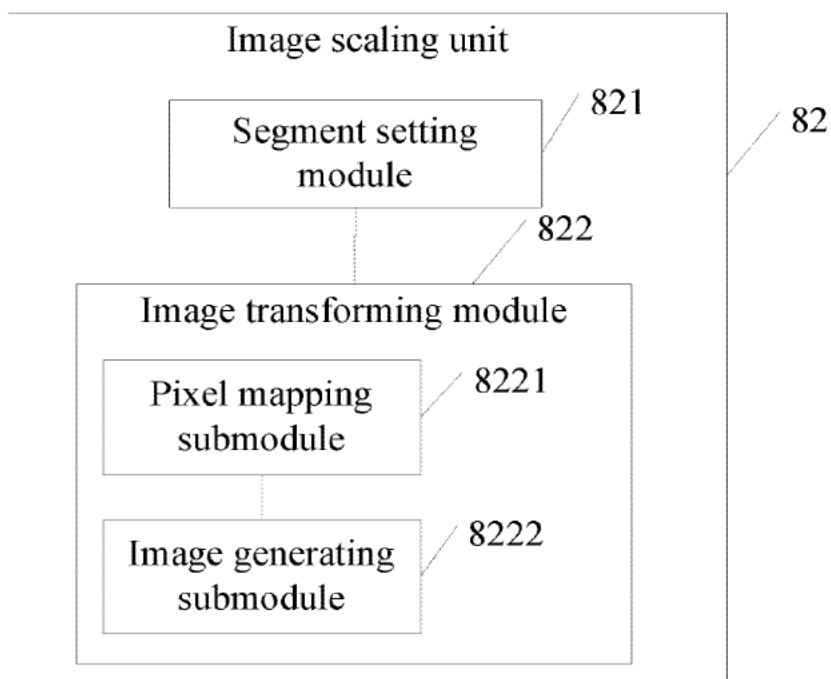


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/072093

A. CLASSIFICATION OF SUBJECT MATTER

H04N5/44 (2006.01) i

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)

IPC:H04N5/-, G06T

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 practicable, search terms used)

CNPAT;CNKI;WPI;EPODOC;PAJ: image? Picture? video zoom scal+ expand+ ratio format size conver+ adjust+ non?line+ vertical horizon+ perpendicular+ direction face area? region? segment distribut+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN101365077A(SHENZHEN HUAWEI COMMUNICATION TECHNOLOGY) 11Feb.2009(11.02.2009) Claims 1-11	1-11
Y	US5435669A (Sumio BABA et.al) 25 Jul.1995 (25.07.1995) Description column 2 line 9-line 49,column 5 line 30-line 58, column 6 line 46-line 59, fig.1-fig 3,fig.8	1-11
Y	CN1997113A (UNIV. SHANGHAI COMMUNICATION) 11 Jul.2007(11.07.2007) Description page 2 line 23-page 3 line 3, fig.2	1-11
A	CN101197957A (SHANGHAI SUPER VALUE ACTION GROUP CO., LTD.) 11 Jun. 2008 (11.06.2008) Description page 5 line 11-page 6 line 8	3-6,9-11

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
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"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)	"&"document member of the same patent family
"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	

Date of the actual completion of the international search 05Aug.2009(05.08.2009)	Date of mailing of the international search report 10 Sep. 2009 (10.09.2009)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer YUE, Yongjuan Telephone No. (86-10)62414109

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/072093

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1685715A (MATSUSHITA ELECTRIC IND. CO., LTD. [JP]) 19 Oct.2005 (19.10.2005) The whole document	1-11
A	CN1967654A (OKI ELECTRIC IND CO., LTD.) 23 May.2007 (23.05.2007) The whole document	1-11
A	CN1894957A (KONINK PHILIPS ELECTRONICS NV) 10 Jan.2007 (10.01.2007) The whole document	1-11

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2009/072093

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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Form PCT/ISA/210 (patent family annex) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- (74) **Agents:** UITTENBOGAARD, Frank et al.; Philips Ip&s - NL, High Tech Campus 44, NL-5656 AE Eindhoven (NL).
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(54) **Title:** IMAGE SCALING CURVE GENERATION

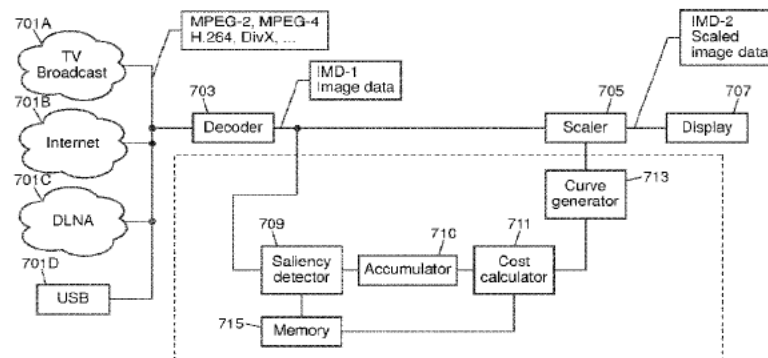


FIG. 7

(57) **Abstract:** The present invention relates to a method of generating an image scaling curve, where local saliency is detected in a received image. The detected local saliency is then accumulated in the first direction. A final scaling curve is derived from the detected local saliency and the image is then possibly rescaled in a second direction by using the derived scaling curve, wherein the second direction is substantially orthogonal to the first direction.

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IMAGE SCALING CURVE GENERATION

TECHNICAL FIELD

The present invention relates to a method of generating an image scaling curve for correcting aspect ratio of an image or image sequence. More specifically, the method relies on detecting local saliency in an image. The invention equally relates to a corresponding apparatus and a computer program product comprising instructions for implementing the steps of the method.

BACKGROUND OF THE INVENTION

Recent developments in the field of display technologies have seen great diversity in display sizes. Displays vary from low resolution hand-held devices to high definition wide-screen TVs. Computing and communications infrastructures are also evolving to support images and video into this ever expanding set of potential displays. Visual content is becoming more important for sharing, expressing, and exchanging information on devices such as cell phones and hand-held personal computers (PCs), personal digital assistants (PDAs) with video capabilities and home-networked media appliances. The same content is required to be displayed in different dimensions and aspect ratio for different devices. Standard image processing methods of scaling and cropping are not proving to be sufficient. The aspect ratio is understood as being the ratio of a width of an image to a height of the image.

With the use of computers to generate or convert video files it can be often seen that the resulting video becomes distorted. This is usually caused by inappropriate operation of the involved software by an inexperienced user – it requires quite a bit of knowledge about computer and video, such as understanding that TV systems use a non-square pixel aspect ratio.

Furthermore, legacy computer video file formats such as the audio video interleave (AVI) container lack the appropriate means to store aspect ratio information. A typical example of this problem are wide screen digital versatile discs (DVDs) converted into computer files, played on a TV, for instance via digital living network alliance (DLNA). Often movies are stored in anamorphic wide screen format. Unless care is taken during conversion into a computer file, the resulting movie will be rendered distorted during playback as can be seen by comparing Figures 1 and 2.

Figure 1 illustrates a wide screen movie image in the correct aspect ratio, whereas Figure 2 shows the same image when incorrectly processed on a computer. In this figure the characters and objects are clearly distorted.

With the popularity of wide-screen TVs, efficient solutions which could
5 effectively display video on displays other than originally intended is needed. Traditionally TVs implement a method called "black bar detection" to automatically adjust the aspect ratio. The video is scaled vertically in such a way that the black bars disappear. This is especially done in modern wide screen flat TVs.

US patent 7,339,627 by Brian Schoner et al. describes a method for aspect
10 ratio correction based on black bars surrounding the image. While applied in TVs in the market, this method has the disadvantage that it fails if the source video is encoded incorrectly (such as many videos downloaded from the Internet show), or for movies in 2.35:1 movie aspect ratio, which requires to be shown with black bars even on a 16:9 widescreen TV.

15 In Philips TVs, a technique of *Panoramic Stretch* is used, where the boundaries of image are stretched to take up the wider screen. Although the assumption on which the method is based, i.e. most essential information is in the centre view, is often a good one, there may be cases where such an anisotropic stretch is not the optimal solution. Better methods are desired enabling effective resizing for a
20 variety of displays.

Aspect ratio correction may not be enough to render the image suitable for viewing. Image retargeting can also be invoked. Retargeting is scaling the image while taking the content, the important objects in the scene, in consideration. It is therefore often called content-aware resizing. The image retargeting in certain
25 implementations first consist of image cropping and then scaling. The video retargeting problem is more challenging than image targeting. Due to motion and camera movement, determining important aspects of video is difficult. Moreover, maintaining temporal consistency, when important aspects change dynamically, is demanding. Fortunately, what is important to preserve depends highly on low-level
30 visual saliency which can be modelled quite well, but in some cases it can even depend on high level aspects of the underlying story.

The proposed prior art methods for content-aware aspect ratio correction or retargeting, usually lack temporal consistency, are computationally complex, or introduce unacceptable distortions in some cases.

It is thus the object of the present invention to overcome the above-identified
5 difficulties and disadvantages by proposing an improved solution for image or video processing.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a method of generating an image scaling curve, the method comprising:

- 10 - receiving an image;
- detecting local saliency in the received image;
- accumulating the local saliency in a first direction; and
- deriving an image scaling curve from the accumulated local saliency, wherein
 the derived image scaling curve is suitable for image rescaling in a second
15 direction which is substantially orthogonal to the first direction.

Thus, the present invention provides a very efficient method for generating an image scaling curve. Furthermore, the proposed method does not rely on meta data. The proposed method does not rely on knowledge of aspect ratio or orientation of the picture (or video) as the method automatically determines from the image itself
20 important objects, regions and/or pixels. The present invention is of special interest because of recent plans to introduce ultra wide-screen TV (21:9). It is likely that the old Panoramic Stretch no longer suffices to upscale legacy content. On the other hand, current more advanced methods from the literature suffer from serious flaws for TV-viewing and are often too costly.

25 According to a second aspect of the invention, there is provided a computer program product comprising instructions for implementing the method according to the first aspect of the invention when loaded and run on computer means of an apparatus.

According to a third aspect of the invention, there is provided an apparatus for generating an image scaling curve, the apparatus comprising:

- 30 - a receiver for obtaining an image;
- a saliency detector for detecting local saliency of the received image;

- an accumulator for accumulating the local saliency in a first direction; and
- a curve generator for deriving an image scaling curve from the local saliency, wherein the derived scaling curve is suitable for image rescaling in a second direction which is substantially orthogonal to the first direction.

5 Other aspects of the invention are recited in the dependent claims attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will become apparent from the following description of non-limiting exemplary embodiments, with reference to the
10 appended drawings, in which:

- Figure 1 shows a still image of a wide screen movie shown in the correct aspect ratio;
- Figure 2 shows the same image of Figure 1, but incorrectly processed;
- Figure 3 shows three different local magnification curves;
- 15 - Figure 4 shows an image divided into eight vertical sections and four horizontal sections;
- Figure 5 illustrates the usage of a nonlinear position transformation curve;
- Figure 6 shows a scaled image obtained by the nonlinear position transformation curve of Figure 5;
- 20 - Figure 7 is a simplified block diagram illustrating an apparatus in accordance with an embodiment of the present invention capable of performing aspect ratio correction;
- Figures 8-11 show different magnification curves obtained by using the method in accordance with an embodiment of the present invention;
- 25 - Figure 12 is a flow chart illustrating a first embodiment for correcting aspect ratio in accordance with the present invention;
- Figure 13 is a flow chart illustrating a second embodiment for correcting aspect ratio in accordance with the present invention; and
- 30 - Figure 14 is another flow chart illustrating the second embodiment for correcting aspect ratio in accordance with the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

One embodiment of the present invention is based on an idea of having a set of initial scaling curves and then cost values are calculated for these curves. A new scaling curve to be used in the actual image scaling is calculated so that it results as a weighted average of the individual curves where the weights are inversely related to the
5 aforementioned cost. Thus, by looking at the video sequence itself, the system does not rely on any meta-data that, if available, could even be wrong.

Figure 3 shows three exemplary scaling curves and more specifically magnification curves describing local magnification. These curves are: one linear scaling curve with constant magnification multiplier, one linear scaling curve with
10 negative multiplier and the so called “bathtub” curve used in the Panoramic Stretching. The shape of the bathtub curve is such that the unity scaling is used at the centre of the image, whereas the magnification increases toward the edges of the image. Unity scaling at the centre of the image means that the objects at the centre of the image remain undistorted. Usually magnification is between 0.5 and 2.0

15 Figures 4, 5 and 6 illustrate nonlinear image scaling by use of a nonlinear scaling curve and more specifically position transformation (or mapping) curve. The position transformation curve results as the integral of the magnification curve. Figure 4 shows an image 401 divided into eight vertical sections with equal width and four horizontal sections with equal width. There is also shown a line 403 from one corner of
20 the image to the opposite corner.

To arrive at a nonlinearly scaled image 601 as shown in Figure 6, a nonlinear position transformation curve 501 is used as shown in Figure 5. Figure 5 clearly shows an image scaling curve, i.e. position transformation curve, which results as the integral of the magnification curve. A horizontal/vertical magnification curve has to be
25 integrated over the horizontal/vertical positions to result in a horizontal/vertical position transformation curve. In the figure it can further be seen that near the edges of the image, the vertical sections become narrower, whereas close to the centre, the horizontal sections remain unchanged. By using this kind of curve, it is assumed that the most important information of the image is located near the centre of the image. In
30 Figure 6, the straight line 403 of a slant angle is displayed as a curve 603 due to the nonlinear scaling in the horizontal direction.

However, it is to be noted that the most relevant information is not always located near the centre of the image. For this purpose the present invention proposes a new solution, where different scaling curves can be advantageously used.

Figure 7 illustrates an electrical apparatus, such as a TV, arranged for performing image or video aspect ratio correction in accordance with the present invention. The TV has a variety of input sources, namely TV broadcast 701A, Internet 701B, DLNA 701C and universal serial bus (USB) 701D. Those input sources are transporting video in a compressed format, such as MPEG-2, MPEG-4 or other formats. The decoder 703 generates raw image data IMD-1, a stream of pictures, one picture per frame. This image data is fed into the scaler 705, which resizes the picture for the proper resolution to be shown on the display 707. The blocks 703, 705 and 707 describe a traditional liquid crystal display (LCD) TV in a very simplified form.

In accordance with an embodiment of the present invention, there is further provided the following units: saliency detector 709, accumulator 710, cost calculator 711, curve generator 713 and memory 715. The decoded image data from the decoder 703 is not only fed into the scaler 705 but is fed in parallel into the saliency detector 709, which is arranged to detect salient features, also referred to as local saliency, in images. The salient features reflect the perceived distortion in the image in case the corresponding image segment is stretched or shrunk. In this example the saliency detector 709 makes use of what is known to the person skilled in the art as "computer vision library". A computer vision library is a library of programming functions stored in the memory 715 mainly aimed at real time computer vision. These functions can e.g. detect people's faces and especially certain features such as eyes or lips. Round structures, such as wheels and watches, can also be detected relatively easily. The exact definition of the object depends on the particular computer vision library used for the saliency detector 709. Instead of relying on the computer vision library, a simpler method could be used as well, such as detecting edges in the images.

Information about the local saliency is fed into the accumulator 710 which is arranged to accumulate the detected local saliency in one direction (horizontal or vertical) as will be explained later in more detail. From the accumulator 710 the accumulated local saliency is fed into the cost calculator 711. The cost calculator is arranged to calculate costs for different scaling curves stored in the memory 715. In

this example the memory 715 also contains a set of initial horizontal and/or vertical scaling curves that include the standard curve, i.e. the “bathtub” curve, of the Panoramic Stretching, but also some curves that might be suitable in cases where the standard curve fails. This happens mainly when most important object(s) are near the side panels of the screen. The number of stored initial scaling curves is at least 2, but smaller than the number of pixels in the image. In most applications the usage of 3-10 initial scaling curves suffices.

Given the salient features or local saliency of the current image, a “cost” for each of these initial curves can be calculated. The cost of a scaling curve depends on the position of essential objects such as faces, moving objects, etc., in the image, such that the cost increases the more the local scaling factor differs from unity scaling (scaling factor 1) particularly at the position of these essential objects. In other words, a high number of salient features in locations where the scaling factor differs from 1 leads to a high cost value. For the calculation of the cost values, the salient features in locations where the scaling factor is 1 can be neglected.

The curve generator 713 is arranged to calculate the scaling curve, i.e. the position transformation curve, to be used in the actual image rescaling as a weighted average of the individual curves where the weights are inversely related to the aforementioned cost. This means that the weights are decreasing with increasing cost of a predefined scaling curve. All candidate curves (both horizontal and vertical scaling curves) individually cause the desired aspect ratio change. In this case when the sum of the weights equals 1 the resulting curves will also lead to the desired aspect ratio change. In case the input video sequence has a good temporal stability (no scene change), the weights will only change gradually causing also the output retargeted video to be temporally stable. In the event of low temporal stability of the input video (scene change), the output can react immediately to the updated cost without remaining effects from the previous scene. Consequently, the so much appreciated temporal stability of the proposed rescaling method does not prohibit rapid adaptation to the new shot. Moreover, by selecting the initial curves more or less ambitiously (i.e. the curves differ from the standard curve) it can be guaranteed that the artefacts of the aspect ratio correction are modest.

Tables 1-4 illustrate concrete examples for calculating the correct magnification curve to be used in the image scaling. In the tables each column represents a specific horizontal location in the image. For simplicity the predefined scaling curves in these examples use only two different magnification values, namely values 1 and 2. These magnification values can also be referred to as local magnification values or local scaling curves in more general. Thus, the predefined scaling curves can be considered as consisting of several local scaling curves that can be considered as glued together. The predefined set of scaling curves contains three scaling curves in each example. The quality figure shown in the tables is inversely related to the cost values, which are calculated for each curve in the predefined set by taking into account the local saliency in the image as was explained above. For the final scaling curve, for each location Y the resulting magnification in one direction, i.e. horizontal or vertical, can be calculated by using the following formula:

$$\sum_{X=1}^{\text{Number of curves}} \text{QUALITY_FIGURE}_{\text{Curve_X}} \cdot \text{MAGNIFICATION}_{\text{Location_Y}} \cdot$$

15

Table 1 - example 1

	Quality figure	MAGNIFICATION								
Curve 1	1,00	1	1	1	1	1	1	2	2	2
Curve 2	10,00	1	1	1	2	2	2	1	1	1
Curve 3	1,00	2	2	2	1	1	1	1	1	1
	Result	1.08	1.083	1.083	1.833	1.833	1.833	1.083	1.083	1.083

Table 2 - example 2

	Quality figure	MAGNIFICATION								
Curve 1	10,00	1	1	1	1	1	1	2	2	2
Curve 2	1,00	1	1	1	2	2	2	1	1	1
Curve 3	1,00	2	2	2	1	1	1	1	1	1
	Result	1.08	1.083	1.083	1.083	1.083	1.083	1.833	1.833	1.833

Table 3 - example 3

	Quality figure	MAGNIFICATION								
Curve 1	10,00	1	1	1	1	1	1	2	2	2
Curve 2	10,00	1	1	1	2	2	2	1	1	1
Curve 3	1,00	2	2	2	1	1	1	1	1	1
	Result	1.05	1.047	1.047	1.476	1.476	1.476	1.476	1.476	1.476

Table 4 - example 4

	Quality figure	MAGNIFICATION								
Curve 1	10,00	1	1	1	1	1	1	2	2	2
Curve 2	1,00	1	1	1	2	2	2	1	1	1
Curve 3	10,00	2	2	2	1	1	1	1	1	1
	Result	1.48	1.476	1.476	1.047	1.047	1.047	1.476	1.476	1.476

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The resulting final magnification curves for Tables 1, 2, 3 and 4 are shown in Figures 8, 9, 10 and 11, respectively. The curves shown in Figures 8, 9, 10 and 11 exhibit abrupt changes in magnification and for this reason in order to avoid unacceptable distortions, these curves may have to be smoothed e.g. by filtering or starting from smooth curves.

10

Figure 12 illustrates a flow chart describing the first embodiment of rescaling an image in accordance with an embodiment of the present invention. An image is first received in step 1201. Then in step 1203 the decoder 703 decodes the image having a certain aspect ratio. The saliency detector 709 detects in step 1204 local saliency of the image. For this purpose the computer vision library can be invoked. Once the local saliency is detected, then a two-dimensional saliency map can be created in step 1205. By using the saliency map, the local saliency is then accumulated in step 1206 in a first direction, such as vertical direction, for obtaining a one-dimensional projection in a second direction (horizontal in this example) of the two-dimensional saliency map. The projection into one direction also covers the situation where the projection takes place over columns (or rows) that are wider than a single pixel line. In other words, the projection projects the local saliency of individual pixels in the received image, or a

15

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combination of local saliencies over a group of pixels orthogonal to the accumulation direction. The combination of local saliencies can for instance allow using a median or weighted average.

In step 1207, a set of initial scaling curves is obtained. These curves can be stored in the memory 715. Then in step 1209 costs are calculated for the different initial curves as explained above by taking into account the local saliency in the image.

In step 1211 a new scaling curve is calculated based on the calculated costs. Finally in step 1213 the image is rescaled in a second direction (horizontal direction in this example) by the scaler 705 by applying the new scaling curve. The image is now ready to be displayed to the user. The second direction is substantially orthogonal to the first direction. It is to be noted that in the example above scaling was applied in just one direction, but is equally possible to apply scaling in both horizontal and vertical directions. If the scaling is done in both of these directions, then the scaling apparatus shown in Figure 7 may comprise two separate scalers in cascade, i.e. one scaler in each direction.

Naturally not every scene or picture of a video sequence will have objects that can be recognised by a computer. This is not an issue since the aspect ratio usually remains constant throughout a large part of it, if not the whole video sequence. This also means that for performance reasons the method does not rely on monitoring all video frames i.e. images, but can sample every x-th frame.

The flow chart of Figure 13 illustrates the second embodiment in accordance with the present invention. Steps 1301, 1303, 1304, 1305 and 1306 correspond to steps 1201, 1203, 1204, 1205 and 1206, respectively. In step 1306 the one-dimensional projection in the second direction is obtained. In this projection, peaks indicate the location of the salient features. Next the created projection is inverted in step 1309 to obtain a local magnification factor profile. The inversion is done since for salient features a magnification factor close to one (i.e. no extra magnification) is desirable. The local magnification profile is also advantageously smoothed in step 1311.

In order to match the local magnification factor profile to a targeted image, it is constrained in step 1313 by adapting the profile so that the integral of the profile matches the desired output size while limiting the minimum and maximum magnification values of the local magnification factor profile. The present method can

be used for both enlarging and compressing the image. The minimum scaling factor is 1 if the image is enlarged. On the other hand, the maximum scaling factor is 1, if the image is compressed. Next in step 1315 the local magnification factor profile is integrated to obtain the final scaling curve. Finally in step 1317 the image is rescaled
5 in a second direction by applying the final scaling curve. Again the second direction is substantially orthogonal to the first direction.

Depending on the implementation details, it is possible to end up with a scaling curve where the input pixels should go into the output. However, if there are more output pixels than input pixels then some output pixels are unassigned. This issue
10 can be solved by simple interpolation.

The flow chart of Figure 13 can be better understood when considered together with Figure 14. In the upper left corner there is shown the received image which needs to be rescaled. Once the saliency has been detected, the two-dimensional saliency map is obtained as shown in the image, the blurred image illustrating the saliency map. The
15 local magnification factor profile is then obtained from the horizontal projection of the saliency map. In other words, the local saliency is accumulated in vertical direction for obtaining the horizontal projection. In this profile there can be seen peaks where in the received image there are the house and the lighthouse. The profile is then inverted, smoothed and constrained. The inverted profiled is then integrated from left to right to
20 obtain the final scaling curve. If the slope of the resulting curve is 45 degrees, then this corresponds to unity magnification as this curve gives the image input conversion into image output. Finally the output image (upper right corner in Figure 14) is obtained by applying the obtained final scaling curve to the received image.

It should be noted that the term "accumulation" used above or in the claims
25 does not limit the actual implementation of the calculation of the projections and costs. Most evidently, the linearity of the calculations in the steps performed for the saliency projection and the cost of the scaling curves allows for several implementation options. As an illustration: in the calculation of the cost of initial scaling curves this can mean that first the saliency is accumulated and later multiplied with the local magnification
30 curve, or alternatively first the saliency can be multiplied with the local magnification and later accumulated. These are mathematically identical because of the linearity of

the operations and the constancy of the local magnification in the direction of accumulation.

Besides the above, it can be imagined that accumulation is not limited to a simple sum or average of the saliency in a direction, it can be imagined that instead of these measures the median, maximum or a weighted sum is used. In other words: other
5 kinds of projections can be used, for instance maximum (saliency) projection, where the maximum in a direction is projected. Furthermore, sub-sampling schemes can be imagined or parts of the image might be discarded all together. For instance, subtitle areas or logos might be discarded in the accumulations.

10 The present invention can be applied in display products such as TVs, monitors, projectors, especially when they are designed to play videos that could originate from a computer, such as DLNA, Internet TV, USB and so forth. Another application where this invention is very beneficial is the area of "User Generated Content" on the Internet, i.e. websites such as YouTube. Due to the popularity of such
15 services, the website has to deal with a large number of poorly generated content, amongst which are videos that are uploaded with wrong aspect ratios. Implementing the method described in this invention, the website would apply the algorithm to uploaded videos and correct any distortions due to incorrect aspect ratio before processing them further.

20 The invention also relates to a computer program product that is able to implement any of the method steps as described above when loaded and run on computer means of an image resizing apparatus. The computer program may be stored/distributed on a suitable medium supplied together with or as a part of other hardware, but may also be distributed in other forms, such as via the Internet or other
25 wired or wireless telecommunication systems.

The invention also relates to an integrated circuit that is arranged to perform any of the method steps in accordance with the embodiments of the invention.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered
30 illustrative or exemplary and not restrictive, the invention being not restricted to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention,

from a study of the drawings, the disclosure and the appended claims. For instance, not all the steps shown in the flow charts need to be performed. More specifically, if the object is to simply obtain an image scaling curve, then the actual image scaling is not necessary.

- 5 In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. A single processor or other unit may fulfil the functions of several items recited in the claims. The mere fact that different features are recited in mutually different dependent claims does not indicate that a combination of these features cannot be advantageously used. Any
- 10 reference signs in the claims should not be construed as limiting the scope of the invention.

CLAIMS

1. A method of generating an image scaling curve, the method comprising:
 - receiving (1201; 1301) an image;
 - 5 - detecting (1204; 1304) local saliency in the received image;
 - accumulating (1206; 1306) the local saliency in a first direction; and
 - deriving (1211; 1315) an image scaling curve from the accumulated local saliency, wherein the derived image scaling curve is suitable for image rescaling in a second direction which is substantially orthogonal to the first direction.
- 10 2. A method according to claim 1, further comprising rescaling (1213; 1317) the image in the second direction by using the derived scaling curve.
3. A method according to any one of claims 1 to 2, wherein detecting local saliency comprises creating a two-dimensional saliency map.
4. A method according to any of the preceding claims, wherein the local magnification of
15 the scaling curve approaches unity when the corresponding accumulated local saliency in the first direction increases.
5. A method according to any one of the preceding claims, wherein accumulating the local saliency comprises creating a one-dimensional projection in the second direction of the two-dimensional saliency map, wherein the projection projects the local saliency of
20 individual pixels in the received image, or a combination of local saliencies over a group of pixels orthogonal to the accumulation direction.
6. A method according to claim 5, wherein deriving a scaling curve comprises:
 - inverting (1309) the created projection to obtain a local magnification factor profile;
 - smoothing (1311) the obtained local magnification factor profile;
 - 25 - constraining (1313) the local magnification factor profile to a targeted image output size by adapting the profile so that the integral of the profile matches the desired

output size while limiting the minimum and maximum magnification values of the local magnification factor profile; and

- integrating (1315) the scaling profile to obtain the image scaling curve.

5 7. A method according to any one of claims 1 to 5, wherein deriving the scaling curve comprises:

- providing (1207) a set of initial image scaling curves for mapping pixels from the received image to an image to be output;
- calculating (1209) cost values for at least some of the provided initial image scaling curves, the cost values being based on the local magnification of the provided initial image scaling curve and the accumulated local saliency in the first direction to which the provided initial image scaling curve is applied; and
- deriving (1211) the image scaling curve from the calculated cost values.

8. A method according to claim 7, wherein the provided initial image scaling curves consist of concatenated and smoothed local image scaling curves.

15 9. A method according to any one of claims 7 to 8, wherein the image scaling curve results as a weighted average of the provided initial image scaling curves where the weights are decreasing with increasing cost of a provided initial image scaling curve.

20 10. A method according to any of the preceding claims, wherein the local saliency reflects the perceived distortion in the image in case the corresponding image segment is stretched or shrunk.

11. A method according to any one of the preceding claims, wherein a sequence of images is received and the method is applied to at least some images of that sequence.

12. A method according to claim 11, wherein the detection, accumulation and derivation steps of the method are applied only to every x-th image of the image sequence.

25 13. A method according to any of the preceding claims, wherein the image is rescaled in at least one of the following directions: horizontal direction and vertical direction.

14. A computer program product comprising instructions for implementing the steps of a method according to any one of claims 1 through 13 when loaded and run on computer means of an apparatus.

15. An apparatus for generating an image scaling curve, the apparatus comprising:
- 5 - a receiver (701A; 701B; 701C; 701D; 703) for obtaining an image;
 - a saliency detector (709) for detecting local saliency of the received image;
 - an accumulator (710) for accumulating the local saliency in a first direction; and
 - a curve generator (713) for deriving an image scaling curve from the local saliency, wherein the derived scaling curve is suitable for image rescaling in a second
 - 10 direction which is substantially orthogonal to the first direction.

16. An apparatus according to claim 15, further comprising a memory (715) for providing a set of initial image scaling curves and a cost calculator (711) for calculating cost values for at least some of the provided image scaling curves.

17. An apparatus according to any one of claims 15 to 16, further comprising a scaler
- 15 (705) for rescaling the image in a second direction by using the derived image scaling curve.

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FIG. 1



FIG. 2

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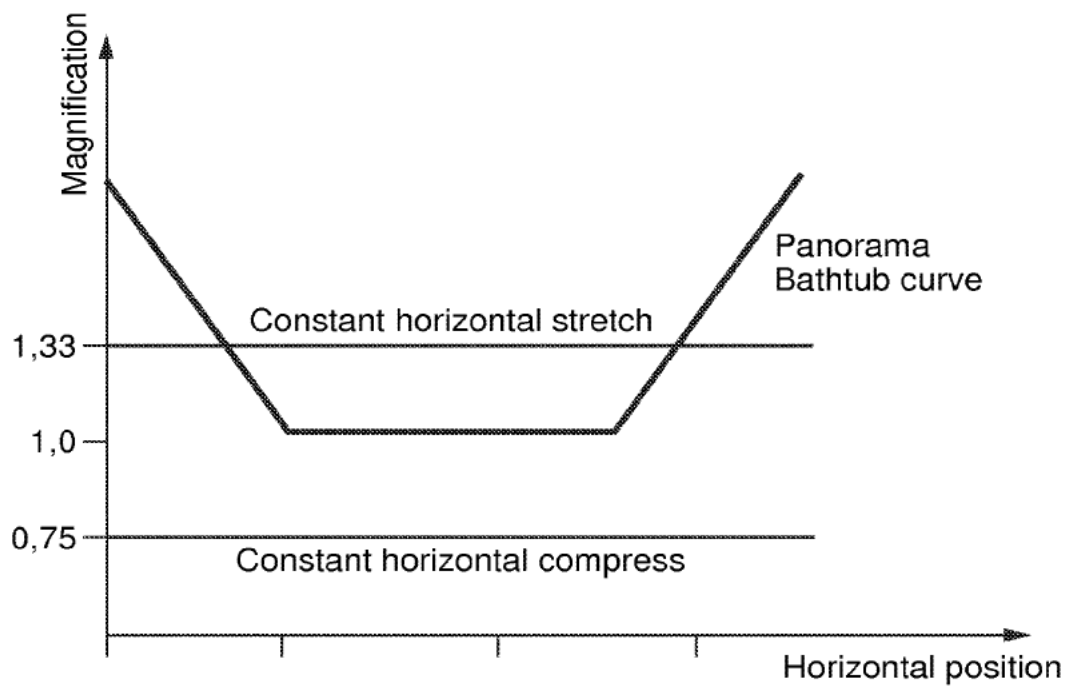


FIG. 3

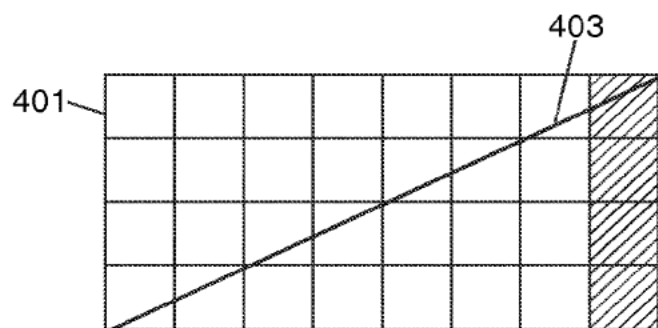


FIG. 4

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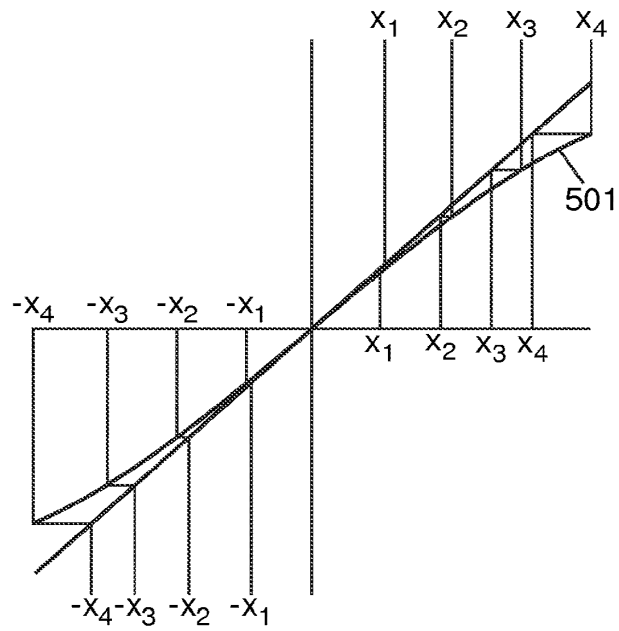


FIG. 5

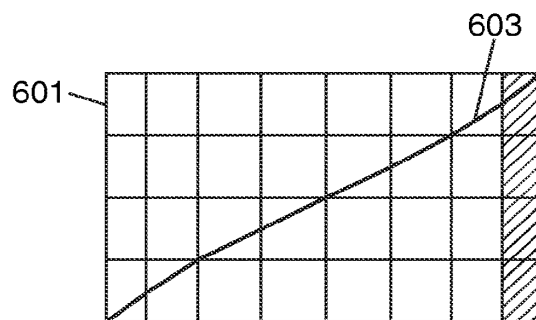


FIG. 6

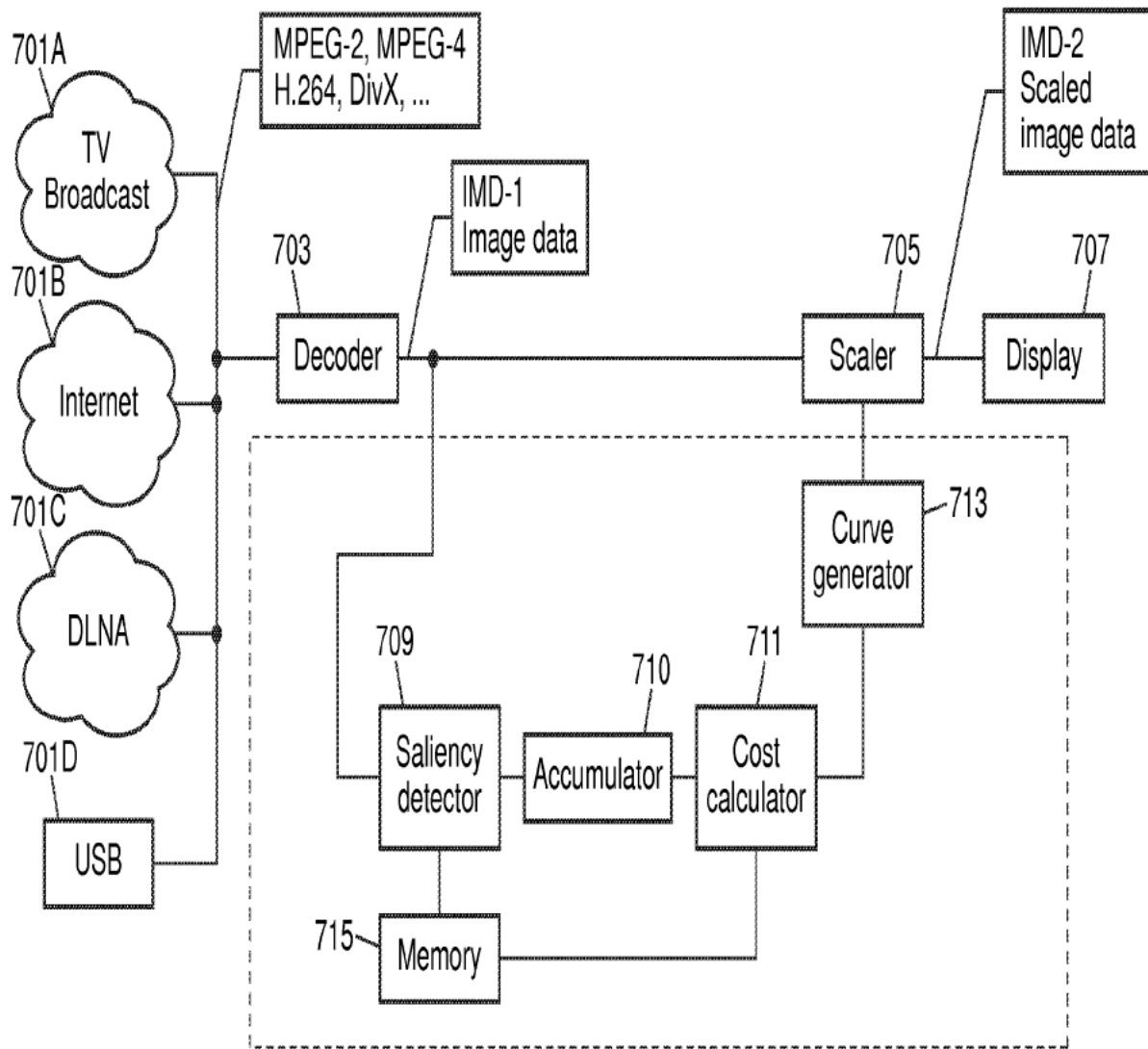


FIG. 7

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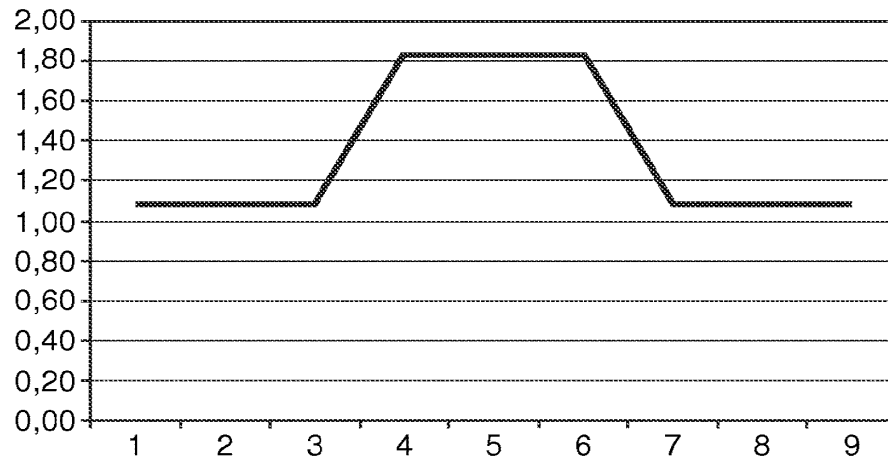


FIG. 8

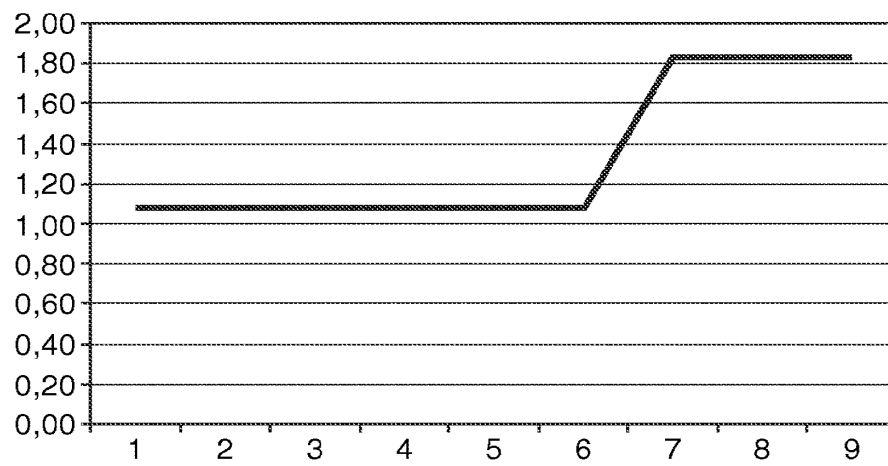


FIG. 9

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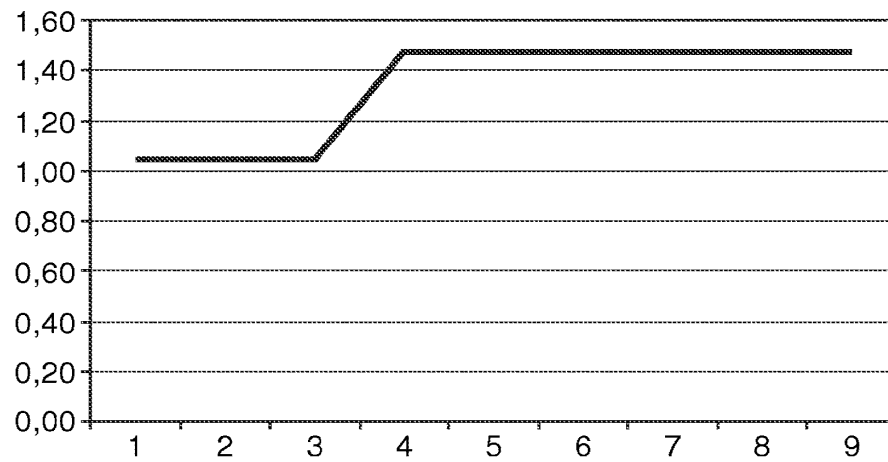


FIG. 10

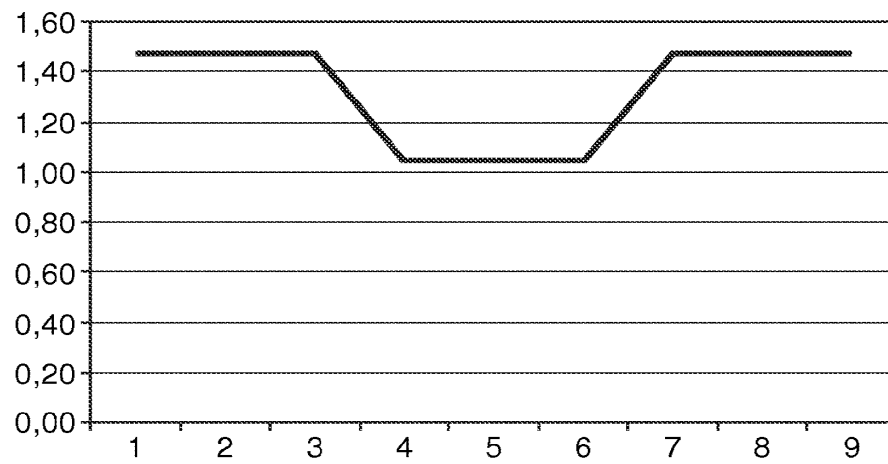


FIG. 11

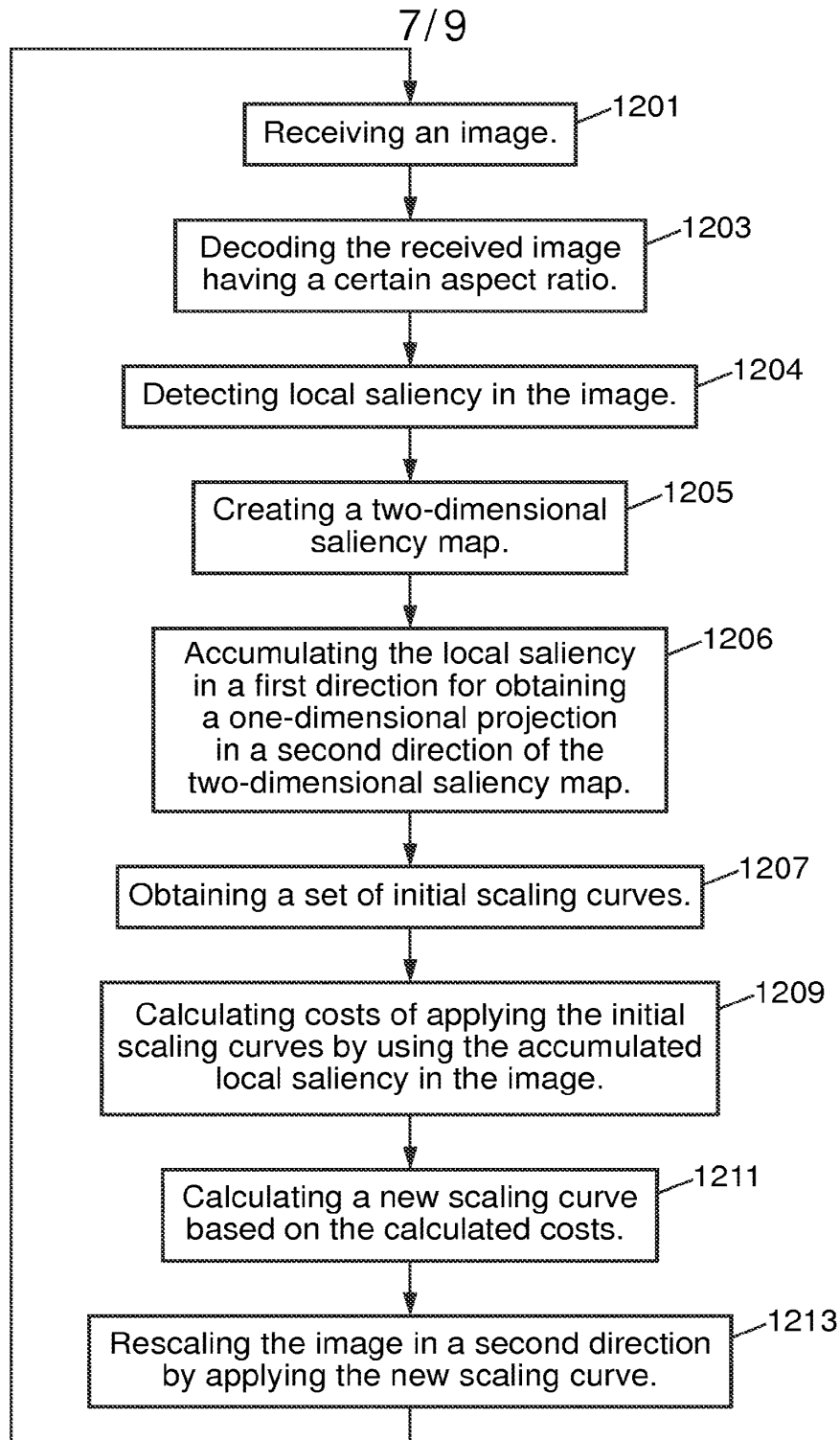


FIG. 12

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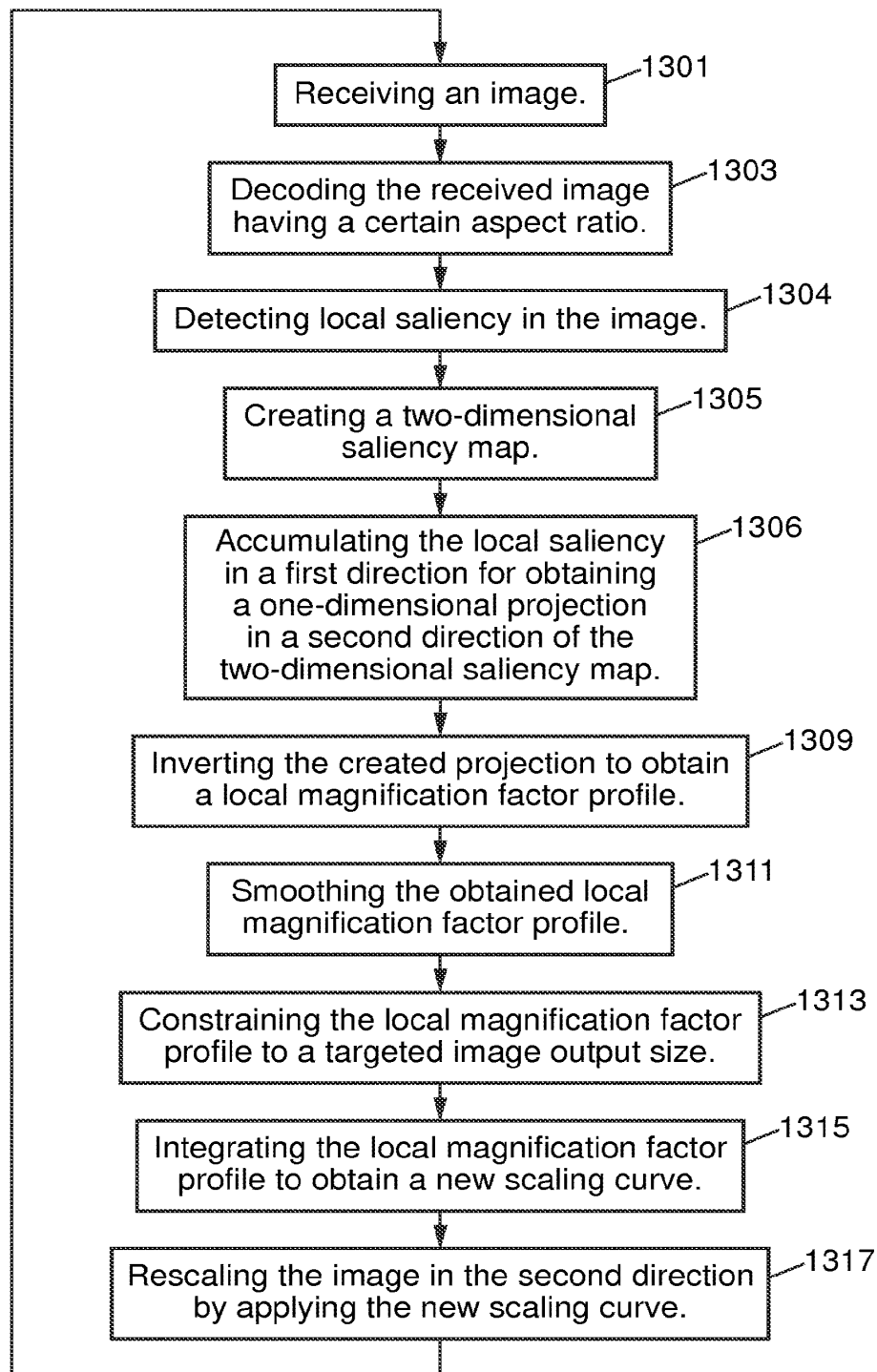


FIG. 13

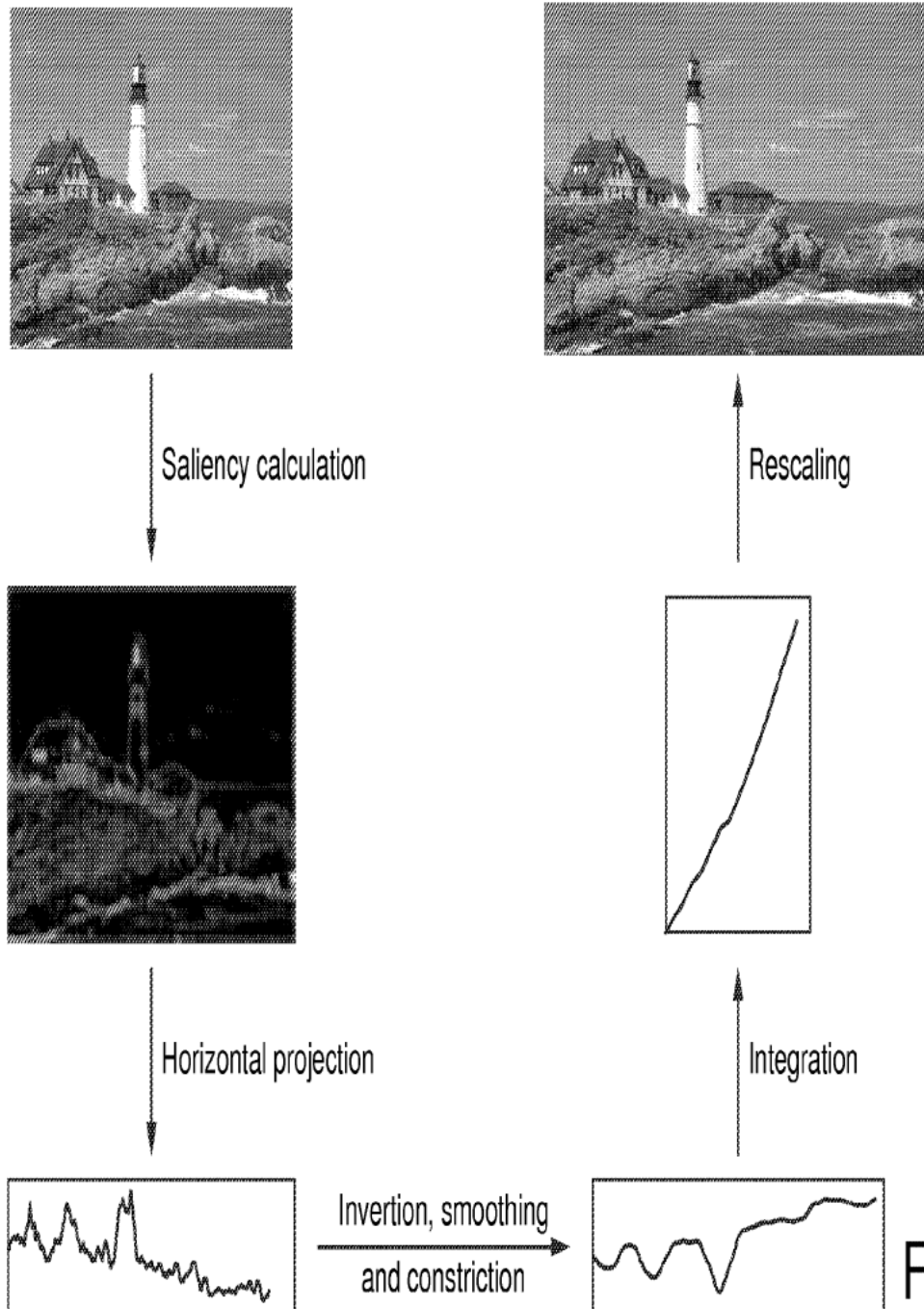


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/055793

A. CLASSIFICATION OF SUBJECT MATTER INV. H04N5/44 G06T3/40 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04N G06T		
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, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/060243 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; OP DE BEECK MARC J R [BE]) 30 June 2005 (2005-06-30) abstract page 1, line 1 - page 5 page 7, line 7 - page 11, line 12 figures 1-8	1-17
A	US 7 158 158 B1 (FLEMING CHARLES G [US] ET AL) 2 January 2007 (2007-01-02) abstract column 1, line 35 - column 2, line 30 column 5, lines 17-64 figure 1	1-17
----- -/--		
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search 16 April 2010		Date of mailing of the international search report 22/04/2010
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Horstmannshoff, Jens

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/055793

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>DAW-SEN HWANG ET AL: "Content-aware image resizing using perceptual seam carving with human attention model"</p> <p>MULTIMEDIA AND EXPO, 2008 IEEE INTERNATIONAL CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 23 June 2008 (2008-06-23), pages 1029-1032, XP031312900</p> <p>ISBN: 978-1-4244-2570-9</p> <p>the whole document</p> <p>-----</p>	1-17
A	<p>AVIDAN S ET AL: "Seam carving for content-aware image resizing"</p> <p>ACM TRANSACTIONS ON GRAPHICS, ACM, US LNKD- DOI:10.1145/1276377.1276390, vol. 26, no. 3, 1 July 2007 (2007-07-01), pages 10-1, XP007904203</p> <p>ISSN: 0730-0301</p> <p>the whole document</p> <p>-----</p>	1-17
A	<p>MIKE KNEE & ROBERTA PIRODDI: "White Paper: 'Aspect Processing - The Shape of Things to Come'"</p> <p>INTERNET CITATION</p> <p>12 September 2008 (2008-09-12), XP007908406</p> <p>Retrieved from the Internet: URL: http://www.snellwilcox.com/features/ibc/whitepapers.php [retrieved on 2009-05-04]</p> <p>the whole document</p> <p>-----</p>	1-17

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2009/055793

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005060243 A1	30-06-2005	CN 1894957 A JP 2007515891 T KR 20060135667 A US 2007195194 A1	10-01-2007 14-06-2007 29-12-2006 23-08-2007
US 7158158 B1	02-01-2007	US 2007076020 A1	05-04-2007

Form PCT/ISA/210 (patent family annex) (April 2005)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 25242/PCT	FOR FURTHER ACTION		see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US14/51750	International filing date (day/month/year) 19 August 2014 (19.08.2014)	(Earliest) Priority Date (day/month/year) 22 August 2013 (22.08.2013)	
Applicant GOPRO, INC.			

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 3 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:

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. 2A

- ☒ 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/US14/51750																		
A. CLASSIFICATION OF SUBJECT MATTER IPC: H04N 5/232(2006.01) USPC: 348/222.1 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) U.S. : 348/222.1 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 practicable, search terms used) Please See Continuation Sheet																				
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category *</th> <th style="width: 60%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 30%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">X</td> <td>US 8,218,895 B1 (GLEICHER et al.) 10 July 2012 (10.07.2012), entire document.</td> <td>1-4, 8-11, and 14-18</td> </tr> <tr> <td style="text-align: center;">---</td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Y</td> <td></td> <td style="text-align: center;">7 and 14</td> </tr> <tr> <td style="text-align: center;">Y</td> <td>US 8,145,013 B1 (SAHU et al.) 27 March 2012 (27.03.2012), entire document.</td> <td style="text-align: center;">7 and 14</td> </tr> <tr> <td style="text-align: center;">A</td> <td>US 8,045,788 B2 (WATKINS et al.) 25 October 2011 (25.10.2011), entire document.</td> <td style="text-align: center;">5-6, 12, 13, 19 and 20</td> </tr> </tbody> </table>			Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 8,218,895 B1 (GLEICHER et al.) 10 July 2012 (10.07.2012), entire document.	1-4, 8-11, and 14-18	---			Y		7 and 14	Y	US 8,145,013 B1 (SAHU et al.) 27 March 2012 (27.03.2012), entire document.	7 and 14	A	US 8,045,788 B2 (WATKINS et al.) 25 October 2011 (25.10.2011), entire document.	5-6, 12, 13, 19 and 20
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
X	US 8,218,895 B1 (GLEICHER et al.) 10 July 2012 (10.07.2012), entire document.	1-4, 8-11, and 14-18																		

Y		7 and 14																		
Y	US 8,145,013 B1 (SAHU et al.) 27 March 2012 (27.03.2012), entire document.	7 and 14																		
A	US 8,045,788 B2 (WATKINS et al.) 25 October 2011 (25.10.2011), entire document.	5-6, 12, 13, 19 and 20																		
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																				
<table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> * 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 application or patent 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 </td> <td style="width: 50%; vertical-align: top;"> "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 </td> </tr> </table>			* 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 application or patent 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																
* 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 application or patent 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 04 September 2014 (04.09.2014)		Date of mailing of the international search report <div style="font-size: 1.2em; font-weight: bold;">09 SEP 2014</div>																		
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201		Authorized officer Ken Wieder Telephone No. (571) 272-2986																		

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/51750

Continuation of B. FIELDS SEARCHED Item 3:

EAST: US-PGPUB; USPAT

Search Terms: aspect, ratio, non, linear\$2, nonlinear\$2, warp\$3, skew\$3, image, conversion, convert\$3, chang\$3, translation, translat\$3, modification, modifi\$4, alteration, alter\$3, computer, circuit, program\$4

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

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
FENWICK & WEST LLP
SILICON VALLEY CENTER
801 CALIFORNIA STREET
MOUNTAIN VIEW, CA 94041
USA

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Applicant's or agent's file reference 25242/PCT		Date of mailing (day/month/year) 09 SEP 2014
International application No. PCT/US14/51750		International filing date (day/month/year) 19 August 2014 (19.08.2014)
International Patent Classification (IPC) or both national classification and IPC IPC: H04N 5/232 (2006.01) USPC: 348/222.1		Priority date (day/month/year) 22 August 2013 (22.08.2013)
Applicant GOPRO, INC.		

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Date of completion of this opinion 04 September 2014 (04.09.2014)	Authorized officer Ken Wieder Telephone No. (571) 272-2986
--	--	--

Form PCT/ISA/237 (cover sheet) (April 2007)

International application No.
PCT/US14/51750

1. With regard to the **language**, this opinion has been established 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)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ on paper

☐ in electronic form

c. time of filing/furnishing

☐ contained in the international application as filed.

☐ filed together with the international application in electronic form.

☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Exhibit 1003 Insta360 Page 126

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US14/51750

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

V. 2. Citations and Explanations:

Claims 1, 4, 8, 11, 15 and 18 lack novelty under PCT Article 33(2) as being anticipated by Gleicher et al. (US 8,218,895).

Claim 15 will be discussed first. Re Claim 1.5, Gleicher discloses a camera system (Figs. 2-4) comprising:

an image sensor (it is inherent that the phone 200 includes an image sensor) to capture an input image having a source aspect ratio (Fig. 1, original image 100);

a processor to process the input image captured by the image sensor (it is inherent that the phone 200 includes an image processor to process the original image 100 so that it can be displayed as a displayed resized image 300 as shown in figure 5); and

a non-transitory computer-readable storage medium (col. 27, 1.37, 56 and 61) storing instructions that when executed by the processor cause the processor to perform steps including:

applying a transformation to the input image to scale and warp (Figs. 24-25; col. 7:43 - col. 9:28; col. 19:31-col.21:17) the image to generate an output image having a target aspect ratio (the aspect ratio of the displayed resized images 300 is different than the aspect ratio of the original image 100), the target aspect ratio different than the source aspect ratio, the output image having a same field of view as the input image (Fig. 5, the displayed resized images 300 has the same field of view as the original image 100 of Fig. 1), and the output image non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image (Fig. 5 shows non-linearly warping is greater at the corner regions A, C, F and H- see col. 26:33- 64; col. 27:46-67; col. 28:17-24; col. 30:14-34); and

outputting the output image having the target aspect ratio (Fig. 5, displayed resized image 300).

Re Claim 1, it is a method claim that corresponds to the apparatus claim 15. Therefore, claim 1 is analyzed and objected to as previously discussed with respect to claim 15.

Re Claim 8, although the wording is different, the material is considered substantively equivalent to the material associated with claim 1, as discussed above. It is noted that Gleicher discloses a computer-readable storage medium for storing instructions (col. 27, lines 37, 56 and 61).

Form PCT/ISA/237 (Supplemental Box) (April 2007)

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US14/51750

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Re Claim 18, Gleicher discloses the camera system of claim 15, wherein applying the transformation comprising applying a combined function that performs both warping and scaling (Figs. 24-25; col. 7:43- col. 9:28; col. 19:31-col.21:17).

Re Claim 4, it is a method claim that corresponds to the apparatus claim 18. Therefore, claim 4 is analyzed and objected to as previously discussed with respect to claim 18.

Re Claim 11, although the wording is different, the material is considered substantively equivalent to the material associated with claim 4, as discussed above. It is noted that Gleicher discloses a computer-readable storage medium for storing instructions (col. 27, lines 37, 56 and 61).

Claims 2-3, 9-10 and 16-17 lack inventive step under PCT Article 33(3) as being obvious over Gleicher et al. (US 8,218,895).

Re Claim 16, Gleicher discloses the camera system of claim 15, wherein applying the transformation to the image to scale and warp the image comprises applying a non-linear warping function the scaled image to reduce distortion of a center region of the scaled image relative to the input image and increase distortion of a corner region of the scaled image relative to the input image (col. 7:43 - col. 9:28; col. 19:31-col.21:17).

In the embodiment shown in Fig. 5, Gleicher fails to show applying a scaling function to the input image to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio. However, Gleicher shows in Figs. 28 and 30-31 a scaling function applied to the input image (extended region of interest) to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio (col. 22:55-col.23:38; col. 24:6- 65). It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio, as shown in figure 30 of Gleicher, in order to allow a user to discern fine details in the displayed resized image.

Re Claim 2, it is a method claim that corresponds to the apparatus claim 16. Therefore, claim 2 is analyzed and objected to as previously discussed with respect to claim 16.

Re Claim 9, although the wording is different, the material is considered substantively equivalent to the material associated with claim 2, as discussed above. It is noted that Gleicher discloses a computer-readable storage medium for storing instructions (col. 27, lines 37, 56 and 61).

Re Claim 17, Gleicher discloses the camera system of claim 15, wherein applying the transformation to the image to scale and warp the image comprises applying a non-linear warping function the input image to generate a warped image, the warped image having a reduced distortion of a center region of the warped image relative to the input image and an increased distortion of a corner region of the warp image relative to the input image (col. 7:43 - col. 9:28; col. 19:31-col.21:17).

In the embodiment shown in Fig. 5, Gleicher fails to show applying a scaling function to the input image to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio. However, Gleicher shows in Figs. 28 and 30-31 a scaling function applied to the input image (extended region of interest) to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio (col. 22:55-col.23:38; col. 24:6- 65). It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio, as shown in figure 30 of Gleicher, in order to allow a user to discern fine details in the displayed resized image.

Re Claim 3, it is a method claim that corresponds to the apparatus claim 17. Therefore, claim 3 is analyzed and objected to as previously discussed with respect to claim 17.

Re Claim 10, although the wording is different, the material is considered substantively equivalent to the material associated with claim 3, as discussed above. It is noted that Gleicher discloses a computer-readable storage medium for storing instructions (col. 27, lines 37, 56 and 61).

Claims 7 and 14 lack inventive step under PCT Article 33(3) as being obvious over Gleicher et al. (US 8,218,895) in view of Sahu et al. (US 8,145,013).

Re Claim 7, Gleicher discloses the method of claim 1 except for wherein the source aspect ratio comprises a 4:3 aspect ratio and the target aspect ratio comprises a 16:9 aspect ratio. In the same field of endeavor, Sahu discloses a multi-purpose scaler wherein a 4:3 video may be scaled to fill a 16:9 display (col. 5:3-10). In light of the teaching in Sahu, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to modify the apparatus taught in Gleicher by linearly stretching or compressing a source aspect ratio comprises a 4:3 aspect ratio to obtain a target aspect ratio comprises a 16:9 aspect ratio in order to fill

Form PCT/ISA/237 (Supplemental Box) (April 2007)

<p align="center">WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY</p>	<p>International application No. PCT/US14/51750</p>
<p>Supplemental Box In case the space in any of the preceding boxes is not sufficient.</p>	
<p>the incoming image data to a desired display resolution.</p> <p>Re Claim 14, although the wording is different, the material is considered substantively equivalent to the material associated with claim 7, as discussed above. It is noted that Gleicher discloses a computer-readable storage medium for storing instructions (col. 27, lines 37, 56 and 61).</p> <p>Claims 5-6, 12, 13, 19 and 20 meet the criteria set out under PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest the claimed invention.</p> <p>Claims 1-20 meet the criteria set out under PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.</p>	

Form PCT/ISA/237 (Supplemental Box) (April 2007)

Electronic Acknowledgement Receipt	
EFS ID:	29374035
Application Number:	15492738
International Application Number:	
Confirmation Number:	8390
Title of Invention:	Conversion Between Aspect Ratios in Camera
First Named Inventor/Applicant Name:	Nicholas D. Woodman
Customer Number:	137002
Filer:	Andrew W. Kloser
Filer Authorized By:	
Attorney Docket Number:	46DG-254798
Receipt Date:	01-JUN-2017
Filing Date:	20-APR-2017
Time Stamp:	19:36:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	46DG-254798_PTO_IDS-Form.pdf	1060067 aa28a254ed049bc2a745947c747ab4c91c731f29	no	6

Warnings:

Information:					
2	Foreign Reference	46DG-254798-Foreign-001.pdf	814764	no	19
			8dbdbb108192ff32fd0ef8599e389d58f91fd494		
Warnings:					
Information:					
3	Foreign Reference	46DG-254798-Foreign-002.pdf	1283922	no	29
			1b7ea174aec8ac405babc4047386f58fa8c48ff0		
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	46DG-254798-NPL-001.pdf	196972	no	5
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Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	46DG-254798-NPL-002.pdf	372799	no	9
			7ebcf3e94fde5bb43ee14ec6a9e44b7d6fdac9fe		
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	46DG-254798-NPL-003.pdf	361248	no	10
			aa914ea7d98aaac9ebcac948c300eb51ba28e7c5		
Warnings:					
Information:					
7	Non Patent Literature	46DG-254798-NPL-004.pdf	1600830	no	10
			dbc318af7e7d0efbede6b4c1790e7378fce36c1		
Warnings:					
Information:					
8	Non Patent Literature	46DG-254798-NPL-005.pdf	452649	no	4
			520cbf040847303615be2aacbb93b651121373e		
Warnings:					
Information:					

9	Non Patent Literature	46DG-254798-NPL-006.pdf	1318558 83bec7038fd04c158a487a0084c36376de2559f3	no	8
Warnings:					
Information:					
Total Files Size (in bytes):			7461809		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

Attorney Docket: 46DG-254798

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE PATENT :
APPLICATION OF : Nicholas D. Woodman, *et al.*
SERIAL No. : 15/492,738
FILING DATE : April 20, 2017
ART UNIT : 2661
EXAMINER : TBD
FOR : CONVERSION BETWEEN ASPECT RATIOS IN CAMERA

PRELIMINARY AMENDMENT

Mail Stop AMENDMENT

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

Dear Sir:

Further to the application filing of **April 20, 2017**, please enter the following amendments:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 8 of this paper.

CLAIM AMENDMENTS

This **listing of claims** will replace all prior versions, and listings, of claims in the application:

1-20. (**Cancelled**)

21. (**New**) An image capture apparatus, comprising:

an image sensor configured to capture an input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis;

a display coupled to one or more physical processors; and

the one or more physical processors configured by machine-readable instructions to:

obtain the input image;

apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and

the input image includes a portion including a subset of the pixels such that differences between the input positions and the output positions of the subset of the pixels are less than differences between the input positions and the output positions of others of the pixels; and

present the output image on the display.

22. **(New)** A system that converts between aspect ratios, the system comprising:
one or more physical processors configured by machine-readable instructions to:
obtain an input image, the input image having a source aspect ratio, the
input image including pixels located at input positions defined along a first axis
and a second axis, the first axis perpendicular to the second axis; and
apply a transformation to the input image to generate an output image, the
output image having a target aspect ratio different than the source aspect ratio,
the output image including the pixels located at output positions defined along
the first axis and the second axis, wherein:
the transformation non-uniformly shifts the pixels from the input
positions to the output positions based on (1) the input positions along the
first axis, and (2) the input positions along the second axis; and
the input image includes a portion including a subset of the pixels
such that differences between the input positions and the output positions
of the subset of the pixels are less than differences between the input
positions and the output positions of others of the pixels.

23. **(New)** The system of claim 22, wherein the transformation includes:
a scaling function to uniformly stretch or compress the input image along the first
axis; and
a warping function to non-uniformly warp the input image along the second axis.

24. **(New)** The system of claim 23, wherein the scaling function and the warping function preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels.
25. **(New)** The system of claim 23, wherein the scaling function changes the source aspect ratio to the target aspect ratio.
26. **(New)** The system of claim 22, wherein the one or more physical processors are included within a camera.
27. **(New)** The system of claim 26, wherein the output image is presented on a display of the camera.
28. **(New)** The system of claim 22, wherein the portion corresponds to a center portion of the input image.
29. **(New)** The system of claim 22, wherein the portion corresponds to a non-center portion of the input image.
30. **(New)** The system of claim 22, wherein the transformation non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion.

31. **(New)** The system of claim 22, wherein the one or more physical processors are further configured by machine-readable instructions to determine the portion based on a location of an object within the input image such that the portion includes the object.

32. **(New)** The system of claim 22, wherein the input image includes a video frame of a video.

33. **(New)** A method for converting between aspect ratios, the method performed by a computing system including one or more physical processors, the method comprising:

obtaining, by the computing system, an input image, the input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis; and
applying, by the computing system, a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis; and

the input image includes a portion including a subset of the pixels such that differences between the input positions and the output positions of the

subset of the pixels are less than differences between the input positions and the output positions of others of the pixels.

34. **(New)** The method of claim 33, wherein the transformation includes:
- a scaling function to uniformly stretch or compress the input image along the first axis; and
 - a warping function to non-uniformly warp the input image along the second axis.
35. **(New)** The method of claim 34, wherein the scaling function and the warping function preserves the input positions of the subset of the pixels as the output positions of the subset of the pixels.
36. **(New)** The method of claim 33, wherein the portion corresponds to a center portion of the input image.
37. **(New)** The method of claim 33, wherein the portion corresponds to a non-center portion of the input image.
38. **(New)** The method of claim 33, wherein the transformation non-uniformly shifts the pixels from the input positions to the output positions further based on distances between the input positions and the portion.

39. **(New)** The method of claim 33, further comprising determining the portion based on a location of an object within the input image such that the portion includes the object.

40. **(New)** The method of claim 33, wherein the input image includes a video frame of a video.

REMARKS

By this paper, claims 21-40 are added, and claims 1-20 are cancelled without prejudice and without disclaimer. Accordingly, claims 21-40 are all of the pending claims. Support for the amendments presented above is provided throughout the specification and claims as originally filed. Applicant expressly reserves the right to prosecute the subject matter of the unamended and/or cancelled claims, or any other subject matter supported by the Specification, in one or more continuation applications.

CONCLUSION

If the Examiner believes, for any reason, personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Date: May 22, 2017

Submitted,

By: /D. Benjamin Esplin
D. Benjamin Esplin
Reg. No. 58,297

Customer No. 137002

SHEPPARD MULLIN RICHTER AND HAMPTON
12275 El Camino Real, Suite 200
San Diego, California 92130
BEsplin@SheppardMullin.com
(858) 720-8933

Electronic Acknowledgement Receipt	
EFS ID:	29273072
Application Number:	15492738
International Application Number:	
Confirmation Number:	8390
Title of Invention:	Conversion Between Aspect Ratios in Camera
First Named Inventor/Applicant Name:	Nicholas D. Woodman
Customer Number:	137002
Filer:	D. Benjamin Esplin/victoria borchard
Filer Authorized By:	D. Benjamin Esplin
Attorney Docket Number:	46DG-254798
Receipt Date:	22-MAY-2017
Filing Date:	20-APR-2017
Time Stamp:	14:21:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	46DG-254798_Preliminary_Amendment.pdf	128497	no	8
			e8485a5b59da21ded345245ce3fd1fcd4934e2d3		

Warnings:

Information:	
Total Files Size (in bytes):	128497
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>	

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 15/492,738		Filing Date 04/20/2017		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED – PART I									
		(Column 1)		(Column 2)					
FOR		NUMBER FILED		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), (l), 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									
		(Column 1)		(Column 2)		(Column 3)			
AMENDMENT	05/22/2017		CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))		* 20		Minus	** 20	= 0	X \$80 =	0
	Independent (37 CFR 1.16(h))		* 3		Minus	*** 4	= 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
		(Column 1)		(Column 2)		(Column 3)			
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR	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								
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>									

LDRC
ROBERT SHERMAN

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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 15/492,738				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720			
TOTAL CLAIMS (37 CFR 1.16(i))	20	minus 20 = *				x 80 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4	minus 3 = * 1				x 420 =	420			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL		TOTAL	2020			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
TOTAL ADD'L FEE									TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
TOTAL ADD'L FEE									TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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
15/492,738	04/20/2017	2673	2020	46DG-254798	20	4

CONFIRMATION NO. 8390

FILING RECEIPT



137002
Sheppard Mullin Richter & Hampton LLP (GoPro)
12275 El Camino Real, Suite 200
San Diego, CA 92130-2006

Date Mailed: 04/28/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Nicholas D. Woodman, Woodside, CA;
Sumit Chawla, San Carlos, CA;
Loic Segapelli, Oakland, CA;
Scott Patrick Campbell, Belmont, CA;

Applicant(s)

GoPro, Inc., San Mateo, CA;

Power of Attorney: The patent practitioners associated with Customer Number 137002

Domestic Priority data as claimed by applicant

This application is a CON of 15/011,253 01/29/2016
which is a CON of 14/536,315 11/07/2014 PAT 9294671
which is a CON of 14/180,887 02/14/2014 PAT 8917329
which claims benefit of 61/869,029 08/22/2013

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 04/26/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/492,738**

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

Early Publication Request: No
Title

Conversion Between Aspect Ratios in Camera

Preliminary Class

358

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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

page 2 of 4

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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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The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	Herewith
First Named Inventor	Nicholas D. Woodman
Title	Conversion Between Aspect Ratios in Camera
Art Unit	
Examiner Name	
Attorney Docket Number	46DG-254798

SIGNATURE of Applicant or Patent Practitioner

Signature	/D. Benjamin Esplin/	Date (Optional)	April 20, 2017
Name	D. Benjamin Esplin	Registration Number	58297
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐

*Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, 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 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)



I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

OR

137002



I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:



The address associated with the above-mentioned Customer Number

OR



The address associated with Customer Number:

OR

Firm or
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):



Inventor or Joint Inventor (title not required below)



Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)



Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)



Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Sharon Zazima

Title

General Counsel of GoPro, Inc.

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.



Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, 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 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: ECOMM.AUTH/ECOMM.WTDW

Doc Description: Internet Communications Authorized/Internet Communications Authorization Withdrawn

PTO/SB/439 (11-15)

**AUTHORIZATION FOR INTERNET
COMMUNICATIONS IN A PATENT
APPLICATION OR REQUEST TO
WITHDRAW AUTHORIZATION FOR
INTERNET COMMUNICATIONS**

Application No.	
Filing Date	Herewith
First Named Inventor	Nicholas D. Woodman
Art Unit	
Examiner Name	
Practitioner Docket No.	46DG-254798

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I. To authorize permission for Internet Communications.

☒ Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned and practitioners in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via video conferencing, instant messaging, or electronic mail. I understand that a copy of these communications will be made of record in the application file. (MPEP 502.03)

II. To withdraw authorization for Internet Communications.

☐ The authorization given on _____, to the USPTO to communicate with the undersigned and any practitioner in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via Internet communications such as video conferencing, instant messaging, or electronic mail is hereby withdrawn. I understand that the withdrawal is effective when approved rather than when received.

I am the

- ☐ applicant.
- ☒ attorney or agent of record. Registration number 58297.
- ☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/D. Benjamin Esplin/
Signature

April 20, 2017
Date

D. Benjamin Esplin
Typed or printed name

(858) 720-8900
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. Juristic entities must be represented by a patent practitioner (see 37 CFR 1.31, which is applicable to any paper filed on or after September 16, 2012, that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

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:				
Filing Date:				
Title of Invention:		Conversion Between Aspect Ratios in Camera		
First Named Inventor/Applicant Name:		Nicholas D. Woodman		
Filer:		D. Benjamin Esplin/Chelsea Pearsall		
Attorney Docket Number:		46DG-254798		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
Pages:				
Claims:				
INDEPENDENT CLAIMS IN EXCESS OF 3	1201	1	420	420
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2020

Electronic Acknowledgement Receipt	
EFS ID:	28984288
Application Number:	15492738
International Application Number:	
Confirmation Number:	8390
Title of Invention:	Conversion Between Aspect Ratios in Camera
First Named Inventor/Applicant Name:	Nicholas D. Woodman
Customer Number:	137002
Filer:	D. Benjamin Esplin/Chelsea Pearsall
Filer Authorized By:	D. Benjamin Esplin
Attorney Docket Number:	46DG-254798
Receipt Date:	20-APR-2017
Filing Date:	
Time Stamp:	16:36:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$2020
RAM confirmation Number	042117INTEFSW00003775504562
Deposit Account	504562
Authorized User	Chelsea Pearsall
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.17 (Patent application and reexamination processing fees) 37 CFR 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	Application Data Sheet	ADS_46DG-254798.pdf	1823590	no	9
			4b3903dff3edeffe4827383b4775f39f1ce717bb		
Warnings:					
Information:					
2		Spec_46DG-254798.pdf	121946	yes	22
			07316fd965b5e6cd5234ac784fbad68e6659e814		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	15	
	Claims		16	21	
	Abstract		22	22	
Warnings:					
Information:					
3	Drawings-only black and white line drawings	Drawings_from_parent_46DG-254798.pdf	177486	no	6
			8670e7ff0c516fa56dd8d6f2552319cf778fb1d0		
Warnings:					
Information:					
4	Oath or Declaration filed	Declaration_from_parent_46DG-254798.pdf	524036	no	4
			898a10ee985446258a9aaf6180f600bccc71218c		
Warnings:					
Information:					
5	Power of Attorney	POA_46DG-254798.pdf	197545	no	2
			68585c1ff6d98eaa341ec400eba6b656d8b22e36		

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:					
6	Internet Communications Authorized	email_authorization_46DG-254798.pdf	78901	no	2
			dba638614849d24f6be99080ed7d6ef5500e7077		
Warnings:					
Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	37137	no	2
			cecabca107fa37ba058ee38811b8c1ff29d78ba2		
Warnings:					
Information:					
Total Files Size (in bytes):			2960641		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Nicholas	D.	Woodman			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	Woodside	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1	GoPro, Inc.					
Address 2	3000 Clearview Way, Bldg. E					
City	San Mateo	State/Province	CA			
Postal Code	94402	Country	US			
Inventor	2				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Sumit		Chawla			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	San Carlos	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1	GoPro, Inc.					
Address 2	3000 Clearview Way, Bldg. E					
City	San Mateo	State/Province	CA			
Postal Code	94402	Country	US			
Inventor	3				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Loic		Segapelli			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

City	Oakland	State/Province	CA	Country of Residence	US
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Mailing Address of Inventor:

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Postal Code	94402	Country i	US		
Inventor	4				<input type="button" value="Remove"/>
Legal Name					

Prefix	Given Name	Middle Name	Family Name	Suffix
	Scott	Patrick	Campbell	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service

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Mailing Address of Inventor:

Address 1	GoPro, Inc.				
Address 2	3000 Clearview Way, Bldg. E				
City	San Mateo	State/Province	CA		
Postal Code	94402	Country i	US		
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Correspondence Information:

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

Customer Number	137002		
Email Address	DMIPdocketing@sheppardmullin.com	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

Application Information:

Title of the Invention	Conversion Between Aspect Ratios in Camera		
Attorney Docket Number	46DG-254798	Small Entity Status Claimed ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

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For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

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

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

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Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	137002		

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This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	15/011253	2016-01-29

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number		46DG-254798	
		Application Number			
Title of Invention		Conversion Between Aspect Ratios in Camera			
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/011253	Continuation of	14/536315	2014-11-07	9294671	2016-03-22
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14/536315	Continuation of	14/180887	2014-02-14	8917329	2014-12-23
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14/180887	Claims benefit of provisional	61/869029	2013-08-22		
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This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant	1	<input type="button" value="Remove"/>	
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p>			
		<input type="button" value="Clear"/>	
☒ Assignee	Legal Representative under 35 U.S.C. 117		Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>			
Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>			
If the Applicant is an Organization check here. ☒			
Organization Name	GoPro, Inc.		
Mailing Address Information For Applicant:			
Address 1	3000 Clearview Way, Bldg. E		
Address 2			
City	San Mateo	State/Province	CA
Country	US	Postal Code	94402
Phone Number		Fax Number	
Email Address			
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Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
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This Application Data Sheet must be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/D. Benjamin Esplin/		Date (YYYY-MM-DD)	2017-04-20
First Name	D. Benjamin	Last Name	Esplin	Registration Number
				58297
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	46DG-254798
		Application Number	
Title of Invention	Conversion Between Aspect Ratios in Camera		

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

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CONVERSION BETWEEN ASPECT RATIOS IN CAMERA

INVENTORS:

NICHOLAS D. WOODMAN
SUMIT CHAWLA
LOIC SEGAPPELLI
SCOTT PATRICK CAMPBELL

BACKGROUND

[0001] Converting between aspect ratios is a common problem in the field of image and video processing. For example, a display that displays images according to a 16:9 aspect ratio may receive images natively captured according to a 4:3 aspect ratio and perform an aspect ratio conversion to fit the image to the display. Conventional conversion techniques such as cropping, linearly scaling, and padding each result in a perceivable reduction in the quality of the image or video. For example, cropping removes content from the image and reduces the field of view of the image. Linear scaling maintains the full field of view but introduces perceivable distortion into the image. For example, if an image is vertically compressed and/or horizontally stretched to convert from a 4:3 to a 16:9 aspect ratio, features in scene will appear “short and fat” relative to the original image. Padding maintains the full field of view without distortion, but results in unused display space around the sides and/or top of the image, thus rendering an image that appears too small relative to the display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1 is a block diagram illustrating an embodiment of a camera system.

[0003] FIG. 2A is a flowchart illustrating an embodiment of a process for converting an image from a source aspect ratio to a target aspect ratio.

[0004] FIG. 2B is set of example images being converted from a source aspect ratio to a target aspect ratio.

[0005] FIG. 3 is a first set of example images showing an original image in a source aspect ratio, a cropped image converted to a target aspect ratio using a cropping technique, and a non-linear warped image converted to the target aspect ratio using a non-linear warping technique.

[0006] FIG.4 is a second set of example images showing an original image in a source aspect ratio, a cropped image converted to a target aspect ratio using a cropping technique, and a non-linear warped image converted to the target aspect ratio using a non-linear warping technique.

[0007] FIG. 5 is a graph illustrating an embodiment of a function for applying a horizontal warp to an image.

[0008] FIG. 6 is a graph illustrating an embodiment of a function for applying a vertical warp to an image.

DETAILED DESCRIPTION

[0009] The Figures (FIGS.) and the following description relate to preferred embodiments by way of illustration only. It should be noted that from the following discussion, alternative embodiments of the structures and methods disclosed herein will be readily recognized as viable alternatives that may be employed without departing from the principles of what is claimed.

[0010] Reference will now be made in detail to several embodiments, examples of which are illustrated in the accompanying figures. It is noted that wherever practicable similar or like reference numbers may be used in the figures and may indicate similar or like functionality. The figures depict embodiments of the disclosed system (or method) for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative

embodiments of the structures and methods illustrated herein may be employed without departing from the principles described herein.

OVERVIEW

[0011] A camera system comprises an image sensor, a processor, and a non-transitory computer-readable storage medium that stores instructions executable by the processor. The image sensor captures an input image having a source aspect ratio. The processor applies a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio different than the source aspect ratio. The output image has the same field of view as the input image, maintains image resolution, and limits distortion to levels that do not substantially affect the viewing experience. In one embodiment, the output image is non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image. The processor outputs the output image having the target aspect ratio.

[0012] In one embodiment, the aspect ratio conversion is performed directly on the camera itself rather than in an external post-processing device, such as the display device. This enables the camera to output images directly to a display in the desired target aspect ratio without requiring conversion by the display device. For example, a camera that natively captures images according to a 4:3 aspect ratio can perform conversion and output the images according to a 16:9 aspect ratio that may be displayed directly on a 16:9 display device. Furthermore, in one embodiment, the conversion may occur in substantially real-time such that images captured in the source aspect ratio can be outputted in the target aspect ratio with substantially no delay.

[0013] Beneficially, since the aspect ratio conversion preserves the entire field of view of the image, the converted image can be reverted back to its original aspect ratio without any loss of

field of view or resolution. Furthermore, since the aspect ratio discrepancy is handled by the camera system, the end user needs not to make any additional adjustments apart from selecting the desired output video format on the camera. The embodiments described herein may apply to both individual images and video (which comprises a sequence of images (or “frames”).

EXAMPLE CAMERA SYSTEM

[0014] FIG. 1 illustrates an embodiment of an example camera system 102. The camera system 102 comprises an image sensor 104, video storage 106, and a processing unit 108. Other optional components of the camera system 102 such as control interfaces, display screen, etc. are omitted from the figure for clarity of description. The image sensor 104 captures digital images or video. Because video comprises a sequence of images (or “frames”), description herein referring to images can be similarly applied to video and vice versa. Each captured image comprises a two-dimensional array of pixels. The captured frames depict a “scene,” which may include, for example, landscape, people, objects, etc represented by the captured pixels. Each pixel represents a depicted point in a scene captured in the digital video. Furthermore, each pixel is located at a pixel location, referring to, for example, (x,y) coordinates of the pixel within the frame. For example, a pixel may comprise {Red, Green, Blue} (RGB) values describing the relative intensities of the colors sensed by the image sensor 104 at a particular set of (x,y) coordinates in the frame. In various embodiments, the image sensor 104 may capture video suitable for providing output videos having high definition resolutions (for example, 4k resolution, 2k resolution, 1080p, 1080i, 960p, or 720p), standard definition resolutions, or other resolutions. The image sensor 104 may capture video at various frame rates such as, for example, 120 frames per seconds (FPS), 60 fps, 48, fps, or 30 fps, although other frame rates may also be used. Additionally, the image sensor 104 may include a lens that allows for wide-

angle or ultra wide-angle video capture having fields of view of, for example, 90 degrees, 127 degrees, or 170 degrees, although other field of view angles may also be used.

[0015] Image frames captured by the image sensor 102 may be temporarily or permanently stored in the video storage 106 which may comprise, for example, a hard drive or a solid-state memory device (e.g., a memory card or universal serial bus (USB) memory device). The processing unit 108 processes images to convert between aspect ratios as will be described in further detail below. In one embodiment, the processing unit 108 comprises a processor 112 and a memory 114. The memory 114 comprises a non-transitory computer-readable storage medium that stores computer-executable program instructions for aspect ratio conversion, among other functions. To perform the aspect ratio conversion described herein, the processor 112 loads program instructions from the memory 114 and executes the instructions. Alternatively, the processing unit 108 could implement the aspect ratio conversion in hardware, firmware, or a combination of hardware, firmware, and/or software.

[0016] In one embodiment, the processing unit 108 converts between a source aspect ratio (i.e., the aspect ratio of the original images captured by the image sensor 104) and a target aspect ratio (i.e., the aspect ratio of the image for storing or outputting by the camera system 102). In one embodiment, the source aspect ratio makes full use of the available field of view of the image sensor 104 (remaining sensitive to mapping distortion effects). For example, in a camera system 102 having a 4:3 image sensor, the image sensor 104 captures the native content according to a 4:3 aspect ratio, although other source aspect ratios are also possible. The processing unit 108 then uses resolution compression and/or stretching in the appropriate axes to convert the captured images in the source aspect ratio to the target aspect ratio. In one embodiment, the conversion is achieved using a resolution remapping that applies a non-linear

function across the image so as to minimize or reduce undesirable key feature aspect ratio distortions. Furthermore, in one embodiment, the aspect ratio conversion does not result in any loss of field of view.

[0017] In one embodiment, the aspect ratio conversion is performed by a warp module of the processing unit 108. In addition to performing the aspect ratio conversion, the warp module may perform other functions such as, for example, reducing optical lens distortions such as typical barrel and pincushion distortions.

ASPECT RATIO CONVERSION

[0018] Examples of techniques for aspect ratio conversion are discussed in further detail below. For the sake of clarity, the following description discusses examples involving conversions between a source aspect ratio of 4:3 and a target aspect ratio of 16:9. However, the described embodiments similarly apply to any source or target aspect ratios.

[0019] FIG. 2A illustrates an example embodiment of a process for converting from a source aspect ratio to a target aspect ratio in a camera system. In the process of FIG. 2A, an input image is obtained 202 in the source aspect ratio (e.g., a 4:3 aspect ratio). The image is then scaled 204 from the source aspect ratio (e.g., the 4:3 aspect ratio) to the target aspect ratio (e.g., a 16:9 aspect ratio) using a linear scaling function. A non-linear warping is then applied 206 to the scaled image. FIG. 2B illustrates the process of FIG. 2A as applied to an example image 212 containing an array of circles. As can be seen, the scaling function applied in step 204 causes the circles to be stretched horizontally and compressed vertically as shown in example image 214. Because the scaling function applied in step 204 is linear, each circle is stretched/compressed equally independent of horizontal and vertical position. In the warping step 206, a non-linear

warping is applied which results in the circles being stretched/compressed by different amounts depending on their horizontal and vertical positions resulting in example image 216.

[0020] As can also be observed from FIG. 2B, the scaling and warping steps 204, 206 preserves the full field of view in the resulting image 216 relative to the original image 212. To achieve this, the warp module is configured so that some areas of the image are fully corrected geometrically, while some other areas are distorted. In the illustrated example, the center of the image is chosen to be the region of interest that is most fully corrected and the distortion increases in each direction as the frame boundary is approached. Thus, in image 216, the center circle is fully corrected so that it maintains the original circular shape of the corresponding circle in the input image 212. In the vertical direction, the circles become more distorted (e.g., more vertically compressed) in the as they approach the top and bottom edges. In the horizontal direction, the circles become more distorted (e.g., more horizontally stretched) as they approach the left and right edges. As a result, the circles in the corners exhibit the most distortion, because they have the highest amount of both vertical compression and horizontal stretching. In other embodiments, a different part of the image may be selected as the area most fully corrected, or in the case, of video, the area may dynamically change between images (e.g., to follow a moving object).

[0021] The distribution of distortion levels in different portions of the image may furthermore be tuned in one embodiment to control the size of objects as they pan from horizontally within a scene of video. Fully correcting the geometrical distortion in the center of the image would result in objects looking small in the center and very large on the sides. Thus, in the case of a video, an object may noticeably grow in size as it moves from the center to the

edges of the display. In one embodiment, the warping function in step 206 is tuned to reduce this effect.

[0022] In an alternative embodiment, the scaling and warping functions applied in steps 204, 206 could be performed in reverse order, such that the warping function in step 206 is applied first followed by scaling in step 204. In another embodiment, the scaling and warping are combined into a single function such that only a single transformation is applied to the image that achieves both the scaling and warping. For example, in FIG. 2B, image 212 may be converted directly to image 216 via a single function without producing the intermediate image 214.

[0023] As will be apparent to those skilled in the art, an equitable horizontal remapping can be performed in manners similar to those described herein for vertical remapping if it is desired to decrease image width without decreasing horizontal image field of view and without creating undesirable key feature distortions. For example, images having a source aspect ratio of 2.39:1 may be converted to a 16:9 aspect ratio in this similar manner.

[0024] The scaling step (e.g., step 204 of FIG. 2A) may be achieved either by scaling down one dimension (either the horizontal or vertical one, depending on the formats being converted) or scaling up the orthogonal direction. Scaling up has the benefit of preserving one dimension and only interpolates existing information to extend the other dimension, meaning all resolution is preserved. On the contrary, scaling down causes a loss of information.

[0025] FIG. 3 illustrates example images illustrating the aspect ratio conversion technique described herein. Image 302 illustrates an original image captured with a 4:3 aspect ratio. Image 304 illustrates a conventional cropping of the image to fit it to a 16:9 aspect ratio. As can be seen, the field of view is reduced with this technique and a portion of the image is lost. Image

306 illustrates the original image converted according to the techniques described herein. As can be seen, the aspect ratio conversion is achieved while maintaining the full field of view.

Although some distortion may be introduced, the distortion is concentrated near the boundaries of the image (away from the center) and perceivable distortion is limited to an acceptable level.

[0026] FIG. 4 illustrates additional example images representing a checkerboard pattern, where image 502 represent an original 4:3 image, image 504 represents an image that has been cropped to achieve the 16:9 aspect ratio, and image 506 illustrates an image converted according to the techniques described herein. As can be seen, the perceivable distortion is small or zero near the center of image and increases somewhat at the edges and corners.

Examples of Warping Functions

[0027] In one embodiment, the warping function involves both a horizontal and vertical warping. For convenience of description, the horizontal and vertical warping is described as two steps, e.g., first horizontal then vertical. However, both horizontal and vertical warping can be executed in one step, for example, by applying a single transformation to the image. Furthermore, due to the symmetrical nature of the distortion, vertical and horizontal distortion profiles can be swapped.

[0028] An example of a horizontal warping function is illustrated in FIG. 5. In this graph, the horizontal coordinate of a pixel is expressed as a percentage of the horizontal pixel position relative to the horizontal width of the image, where the percentage increases in a direction away from a reference edge. The vertical coordinate is similarly expressed. The amount of distortion is expressed in terms of the horizontal distortion offset ΔH that a point in the image moves in a direction away from the reference edge divided by the horizontal image size H . Since the warping function is horizontally symmetric in this embodiment, the reference edge can be either

the right edge or the left edge. In this embodiment, the horizontal warp is function of the horizontal coordinate only and is independent of vertical position. The horizontal warp distortion stretches pixels horizontally in a manner that corrects for the “short and fat” effect introduced by 4:3 to 16:9 stretching, or similarly undesirable effects introduced by other aspect ratio conversions. In one embodiment of the horizontal warp, pixels along vertical edges are not offset (the offset value is zero) because there is no information beyond the edges and it may be undesirable to introduce padding (e.g., black vertical lines) on the sides of the image. The magnitude of the distortion is symmetric in one embodiment, with pixels on the left half of the image shifting to the right and pixels on the right half of the image shifting to the left to compensate for the horizontal stretching effect. Since the center receives the contributions of pixels from both sides, the center region of the image is corrected the most, while the geometry on the sides is distorted to a small extent. This degradation in image quality along the sides can be compensated for to some extent in the vertical warping, as will be discussed below.

[0029] In one embodiment, the amount of horizontal correction applied can be manually tuned to reduce perceivable distortion in the output image. For example, fully correcting the geometrical distortion in the center may cause the objects in the center to be much smaller than on the sides. Thus, in one embodiment, the amount of horizontal correction can be tuned in combination with the vertical correction in order to preserve the width of objects throughout the horizontal plane.

[0030] In one embodiment, a similarly shaped function is used for vertical warping. In another embodiment, the vertical warping function is modified so that the amount of compensation in the vertical direction also depends on horizontal position. FIG. 6 illustrates an example of a vertical warping function, where the amount of distortion is express in terms of the

vertical distortion offset ΔV indicating an amount that a pixel moves in a vertical direction away from a reference edge (e.g., the top edge or the bottom edge) divided by the vertical image size V . In one embodiment, vertical warping is a function of both the horizontal and vertical coordinates.

[0031] As mentioned above, a goal of the vertical distortion is to further correct the geometry that was not already corrected by horizontal distortion. The image center could be fully corrected using the horizontal distortion only (with no vertical warping). However, spreading the correction along both horizontal and vertical axis effectively improves the geometry of not only the center, but also the top, bottom, left and right image sides. The most distorted regions in this embodiment are the four image corners, but this distortion does not substantially reduce perceived image quality. Having residual distortion in the corners while correcting the rest in the image results in a much more natural-looking effect since key scene features are usually not framed in the corners. Examples of this effect can be visible, however, in FIG. 4, where the squares in the corners are more rectangular (as opposed to square), and FIG. 3 where the diver's right flipper is somewhat stretched. However, as a good trade off for these corner distortions, it can be observed that the central rows of squares in FIG. 4 maintain a relatively consistent width throughout the image. Furthermore, the diver's body in FIG. 3 has proportions that are relatively preserved across the image width.

[0032] In one embodiment, tunable parameters can be controlled to adjust the vertical distortion along both horizontal and vertical directions, resulting in the 3D-wave in FIG. 7. In one embodiment, pixels are not offset along the horizontal edges to avoid introducing horizontal padding (e.g., black bands along the edges).

[0033] In the description above, the horizontal and vertical distortions have been decoupled for the sake of clarity. However, both distortions could be implemented in a single step.

Similarly, in the description above, the aspect ratio conversion (4:3 to 16:9 in this example) has been decoupled from warp distortion, but these could also be combined into a single step.

[0034] Example equations are provided below for implementing an example warping function applied in step 206 of FIG. 2. Those of ordinary skill in the art will understand that variations of these equations may also be used, and other implementations may apply that result in functions having substantially similar characteristics.

[0035] As explained above, the horizontal warp distortion in one embodiment is a function of the horizontal position only. It can therefore be represented in terms of a horizontal coordinate h in an equation such as the example equation below, or an equation substantially similar to the equation below:

$$\Delta h/H = 0.1107h^6 + 0.534h^5 - 1.7813h^4 + 1.3167h^3 - 0.0722h^2 - 0.1073h$$

[0036] The vertical warp distortion, in one embodiment, is a function of both the horizontal and vertical positions. Therefore, the vertical warp distortion can be represented as a family of equations $\Delta v/V_n$, where “n” is the horizontal coordinate expressed as a percent of the total horizontal image size. Intermediate horizontal coordinates can be interpolated from the example equations given below, or equations substantially similar to these:

$$\Delta v/V_0 = -0.0749v^6 - 0.3167v^5 + 1.0939v^4 - 0.8113v^3 + 0.0408v^2 + 0.0678v$$

$$\Delta v/V_{10} = -0.0658v^6 - 0.2785v^5 + 0.9617v^4 - 0.7132v^3 + 0.0359v^2 + 0.0596v$$

$$\Delta v/V_{20} = -0.0568v^6 - 0.2402v^5 + 0.8294v^4 - 0.6152v^3 + 0.0309v^2 + 0.0514v$$

$$\Delta v/V_{30} = -0.0444v^6 - 0.188v^5 + 0.6491v^4 - 0.4814v^3 + 0.0242v^2 + 0.0403v$$

$$\Delta v/V_{40} = -0.0337v^6 - 0.1427v^5 + 0.4928v^4 - 0.3655v^3 + 0.0184v^2 + 0.0306v$$

$$\Delta v/V_{50} = -0.0296v^6 - 0.1253v^5 + 0.4327v^4 - 0.3209v^3 + 0.0161v^2 + 0.0268v$$

$$\Delta v/V_{60} = -0.0337v^6 - 0.1427v^5 + 0.4928v^4 - 0.3655v^3 + 0.0184v^2 + 0.0306v$$

$$\Delta v/V_{70} = -0.0444v^6 - 0.188v^5 + 0.6491v^4 - 0.4814v^3 + 0.0242v^2 + 0.0403v$$

$$\Delta v/V_{80} = -0.0568v^6 - 0.2402v^5 + 0.8294v^4 - 0.6152v^3 + 0.0309v^2 + 0.0514v$$

$$\Delta v/V_{90} = -0.0658v^6 - 0.2785v^5 + 0.9617v^4 - 0.7132v^3 + 0.0359v^2 + 0.0596v$$

$$\Delta v/V_{100} = -0.0749v^6 - 0.3167v^5 + 1.0939v^4 - 0.8113v^3 + 0.0408v^2 + 0.0678v$$

[0037] The warp distortion described above may be used with cameras producing either rectilinear images (without distortion) or images affected by optical lens distortion characterized by the following equation:

$$(FOV) = (21.904)*(IH) - (.6852)*(IH)^2.$$

where FOV is the field of view and IH is image height. As will be apparent to those of ordinary skill in the art, the equations above may vary when used with lenses having different distortion characteristics.

[0038] As described above, the above equations can be combined with a scaling function to generate a transformation that performs both scaling and warping.

[0039] In alternative embodiments, different equations may be used to achieve similar distortion characteristics. As mentioned above, the symmetric nature of the distortion and the fact that it can be expressed as a percent of image coordinates allows swapping horizontal and vertical distortions. Thus, in an alternative embodiment, the equations above for the horizontal axis can instead be applied in the vertical direction and vice versa.

[0040] Furthermore, in other alternative embodiments, the equations may change dynamically in different frames of a video. For example, warping may be applied in a manner that reduces distortion applied to a particular object in motion across different frames of a video since the viewer is likely to focus attention on the object in motion.

[0041] Although the example embodiments described herein relate to conversion between a 4:3 aspect ratio and a 16:9 aspect ratio, other aspect ratios may be used for the target and source aspect ratios. For example, in alternative embodiments the source aspect ratio can comprise a 4:3 aspect ratio, a 16:9 aspect ratio, a 1.85:1 aspect ratio, a 2.39:1 aspect ratio, a 3:2 aspect ratio, a 5:3 aspect ratio, a 5:4 aspect ratio, a 1:1 aspect ratio or any other aspect ratio. Similarly, in alternative embodiments, the target aspect ratio can comprise a 4:3 aspect ratio, a 16:9 aspect ratio, a 1.85:1 aspect ratio, a 2.39:1 aspect ratio, a 3:2 aspect ratio, a 5:3 aspect ratio, a 5:4 aspect ratio, a 1:1 aspect ratio or any other aspect ratio.

ADDITIONAL CONFIGURATION CONSIDERATIONS

[0042] Throughout this specification, some embodiments have used the expression “coupled” along with its derivatives. The term “coupled” as used herein is not necessarily limited to two or more elements being in direct physical or electrical contact. Rather, the term “coupled” may also encompass two or more elements are not in direct contact with each other, but yet still co-operate or interact with each other, or are structured to provide a thermal conduction path between the elements.

[0043] Likewise, as used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of elements

is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

[0044] In addition, use of the “a” or “an” are employed to describe elements and components of the embodiments herein. This is done merely for convenience and to give a general sense of the invention. This description should be read to include one or at least one and the singular also includes the plural unless it is obvious that it is meant otherwise.

[0045] Finally, as used herein any reference to “one embodiment” or “an embodiment” means that a particular element, feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of the phrase “in one embodiment” in various places in the specification are not necessarily all referring to the same embodiment.

[0046] Upon reading this disclosure, those of skill in the art will appreciate still additional alternative structural and functional designs for a camera expansion module as disclosed from the principles herein. Thus, while particular embodiments and applications have been illustrated and described, it is to be understood that the disclosed embodiments are not limited to the precise construction and components disclosed herein. Various modifications, changes and variations, which will be apparent to those skilled in the art, may be made in the arrangement, operation and details of the method and apparatus disclosed herein without departing from the spirit and scope defined in the appended claims.

CLAIMS

1. A method for converting between aspect ratios, comprising:
 - obtaining an input image having a source aspect ratio;
 - applying, by a processing device, a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio, the target aspect ratio different than the source aspect ratio, the output image non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image, wherein applying the transformation comprises shifting pixels of the input image by an amount represented by a non-linear function of original pixel positions of the pixels;
 - outputting the output image having the target aspect ratio.
2. The method of claim 1, wherein applying the transformation to the input image to scale and warp the image comprises:
 - applying a scaling function to the input image to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio; and
 - applying a non-linear warping function to the scaled image to reduce distortion of a center region of the scaled image relative to the input image and increase distortion of a corner region of the scaled image relative to the input image.
3. The method of claim 1, wherein applying the transformation to the image to scale and warp the image comprises:
 - applying a non-linear warping function to the input image to generate a warped image, the warped image having a reduced distortion of a center region of the warped

image relative to the input image and an increased distortion of a corner region of the warped image relative to the input image;

applying a scaling function to the warped image to linearly stretch or compress the warped image to generate the output image having the target aspect ratio.

4. The method of claim 1, wherein applying the transformation comprising applying a combined function that performs both warping and scaling.
5. The method of claim 1, wherein the processing device comprises a camera.
6. The method of claim 1, wherein the output image has a same field of view as the input image.
7. The method of claim 1, wherein the source aspect ratio comprises a 4:3 aspect ratio and the target aspect ratio comprises a 16:9 aspect ratio.
8. A non-transitory computer-readable storage medium storing instructions for converting between aspect ratios, the instructions when executed by a processor causing the processor to perform steps including:
 - obtaining an input image having a source aspect ratio;
 - applying a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio, the target aspect ratio different than the source aspect ratio, the output image non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image, wherein applying the transformation comprises shifting pixels of the input image by an amount represented by a non-linear function of original pixel positions of the pixels and
 - outputting the output image having the target aspect ratio.

9. The non-transitory computer-readable storage medium of claim 8, wherein applying the transformation to the input image to scale and warp the input image comprises:
- applying a scaling function to the input image to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio; and
- applying a non-linear warping function to the scaled image to reduce distortion of a center region of the scaled image relative to the input image and increase distortion of a corner region of the scaled image relative to the input image.
10. The non-transitory computer-readable storage medium of claim 8, wherein applying the transformation to the input image to scale and warp the input image comprises:
- applying a non-linear warping function to the input image to generate a warped image, the warped image having a reduced distortion of a center region of the warped image relative to the input image and an increased distortion of a corner region of the warped image relative to the input image;
- applying a scaling function to the warped image to linearly stretch or compress the warped image to generate the output image having the target aspect ratio.
11. The non-transitory computer-readable storage medium of claim 8, wherein applying the transformation comprises applying a combined function that performs both warping and scaling.
12. The non-transitory computer-readable storage medium of claim 8, wherein the output image has a same field of view as the input image.
13. The non-transitory computer-readable storage medium of claim 8, wherein the source aspect ratio comprises a 4:3 aspect ratio and the target aspect ratio comprises a 16:9 aspect ratio.

14. A computing apparatus comprising:

an input device to obtain an input image having a source aspect ratio;

a processor to process the input image captured by the image sensor; and

a non-transitory computer-readable storage medium storing instructions that when executed by the processor cause the processor to perform steps including:

applying a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio, the target aspect ratio different than the source aspect ratio, and the output image non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image, wherein applying the transformation comprises:

shifting a pixel of the input image along a first axis as a non-linear function of an original pixel position of the pixel along the first axis, independently of an original pixel position of the pixel along a second axis perpendicular to the first axis; and

shifting the pixel of the input image along the second axis as a non-linear function of the original pixel position of the pixel along the first and second axes; and

an output device to output the output image having the target aspect ratio.

15. A computing apparatus comprising:

an input device to obtain an input image having a source aspect ratio;

a processor to process the input image captured by the image sensor; and

a non-transitory computer-readable storage medium storing instructions that when executed by the processor cause the processor to perform steps including:

applying a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio, the target aspect ratio different than the source aspect ratio, the output image non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image, wherein applying the transformation comprises shifting pixels of the input image by an amount represented by a non-linear function of original pixel positions of the pixels; and

an output device to output the output image having the target aspect ratio.

16. The computing apparatus of claim 15, wherein applying the transformation to the input image to scale and warp the input image comprises:

applying a scaling function to the input image to linearly stretch or compress the input image to generate a scaled image having the target aspect ratio; and

applying a non-linear warping function to the scaled image to reduce distortion of a center region of the scaled image relative to the input image and increase distortion of a corner region of the scaled image relative to the input image.
17. The computing apparatus of claim 15, wherein applying the transformation to the input image to scale and warp the input image comprises:

applying a non-linear warping function to the input image to generate a warped image, the warped image having a reduced distortion of a center region of the warped

image relative to the input image and an increased distortion of a corner region of the warped image relative to the input image;

applying a scaling function to the warped image to linearly stretch or compress the warped image to generate the output image having the target aspect ratio.

18. The computing apparatus of claim 15, wherein applying the transformation comprising applying a combined function that performs both warping and scaling.
19. The computing apparatus of claim 15, wherein the computing device comprises a camera.
20. The computing apparatus of claim 15, wherein the output image has a same field of view as the input image.

CONVERSION BETWEEN ASPECT RATIOS IN CAMERA

ABSTRACT

A camera system captures an image in a source aspect ratio and applies a transformation to the input image to scale and warp the image to generate an output image having a target aspect ratio different than the source aspect ratio. The output image has the same field of view as the input image, maintains image resolution, and limits distortion to levels that do not substantially affect the viewing experience. In one embodiment, the output image is non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image.

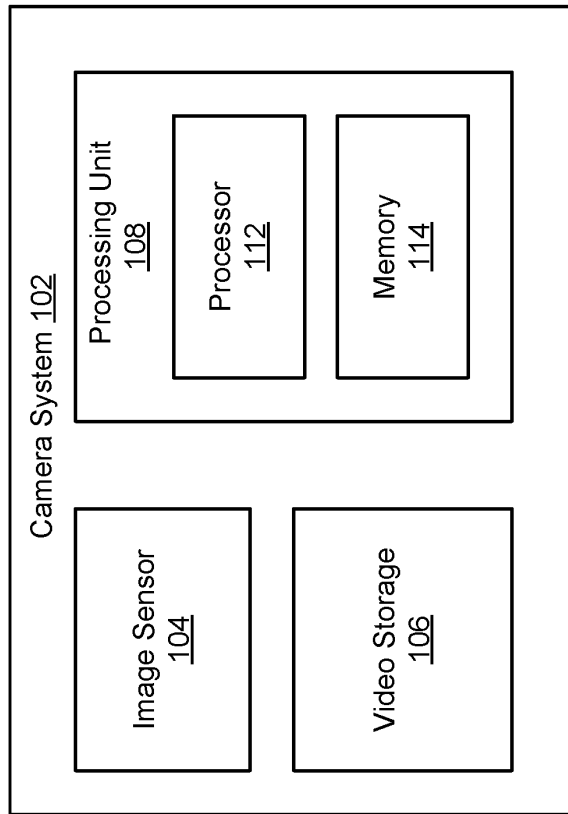


FIG. 1

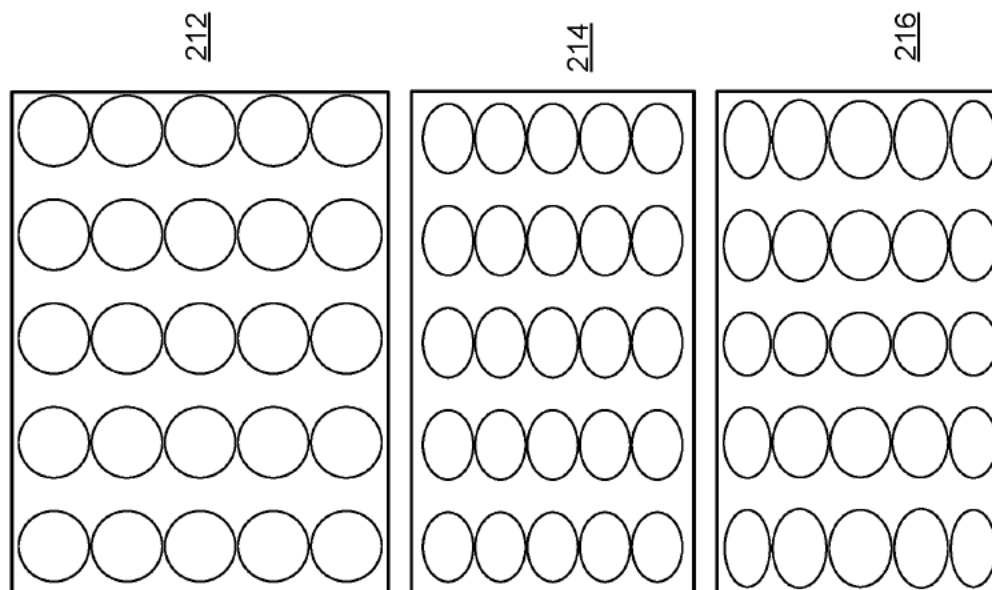


FIG. 2B

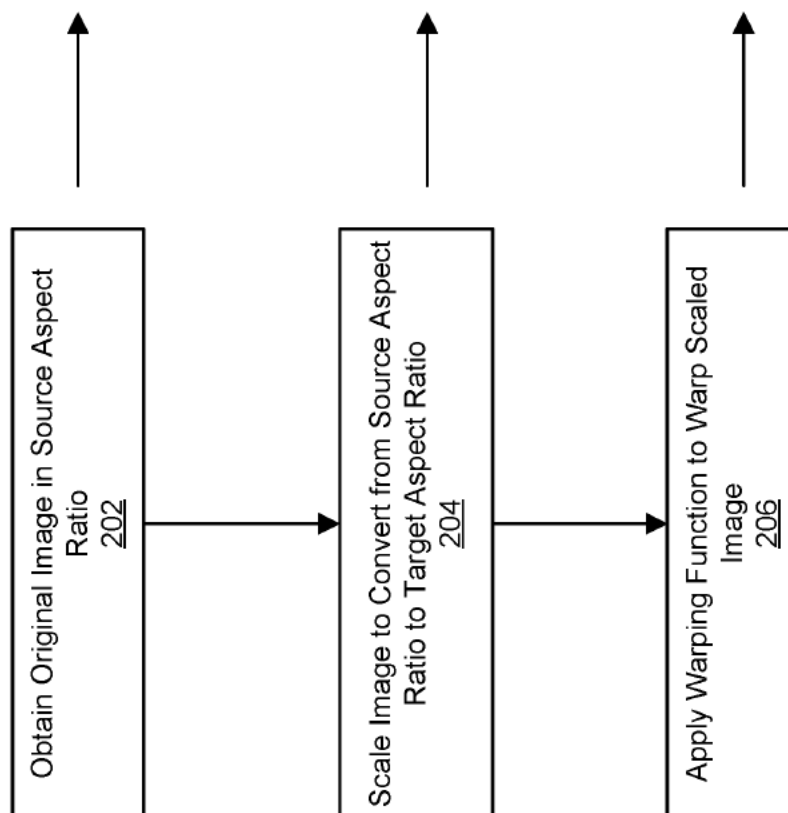


FIG. 2A



306

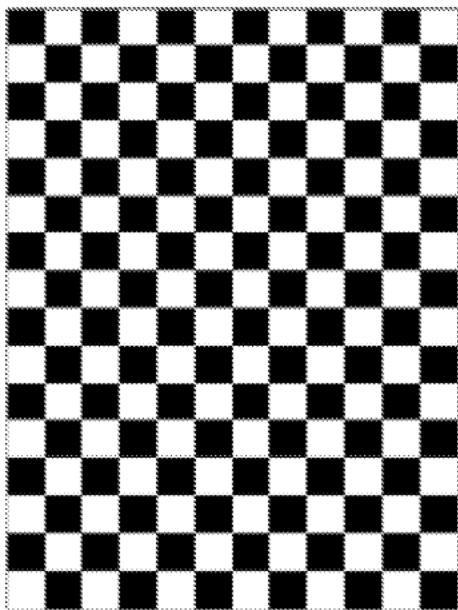


302

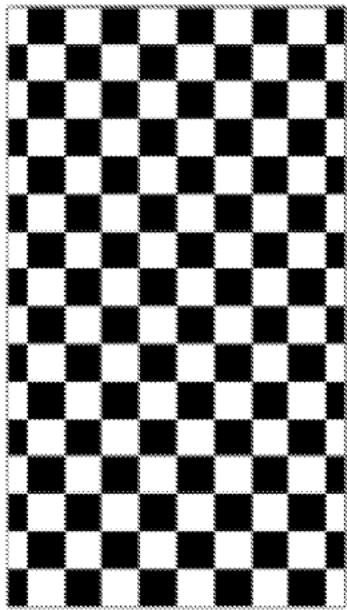


304

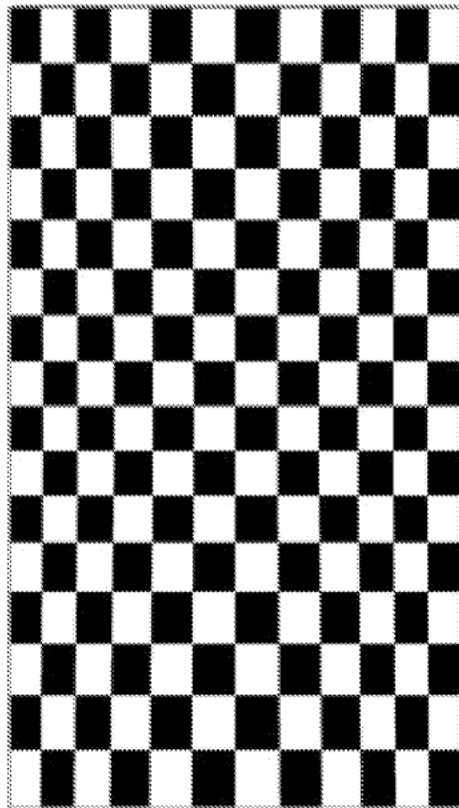
FIG. 3



Original Image (4:3)
402



Cropped Image (16:9)
404



Non-Linear Warped
Image (16:9)
406

FIG. 4

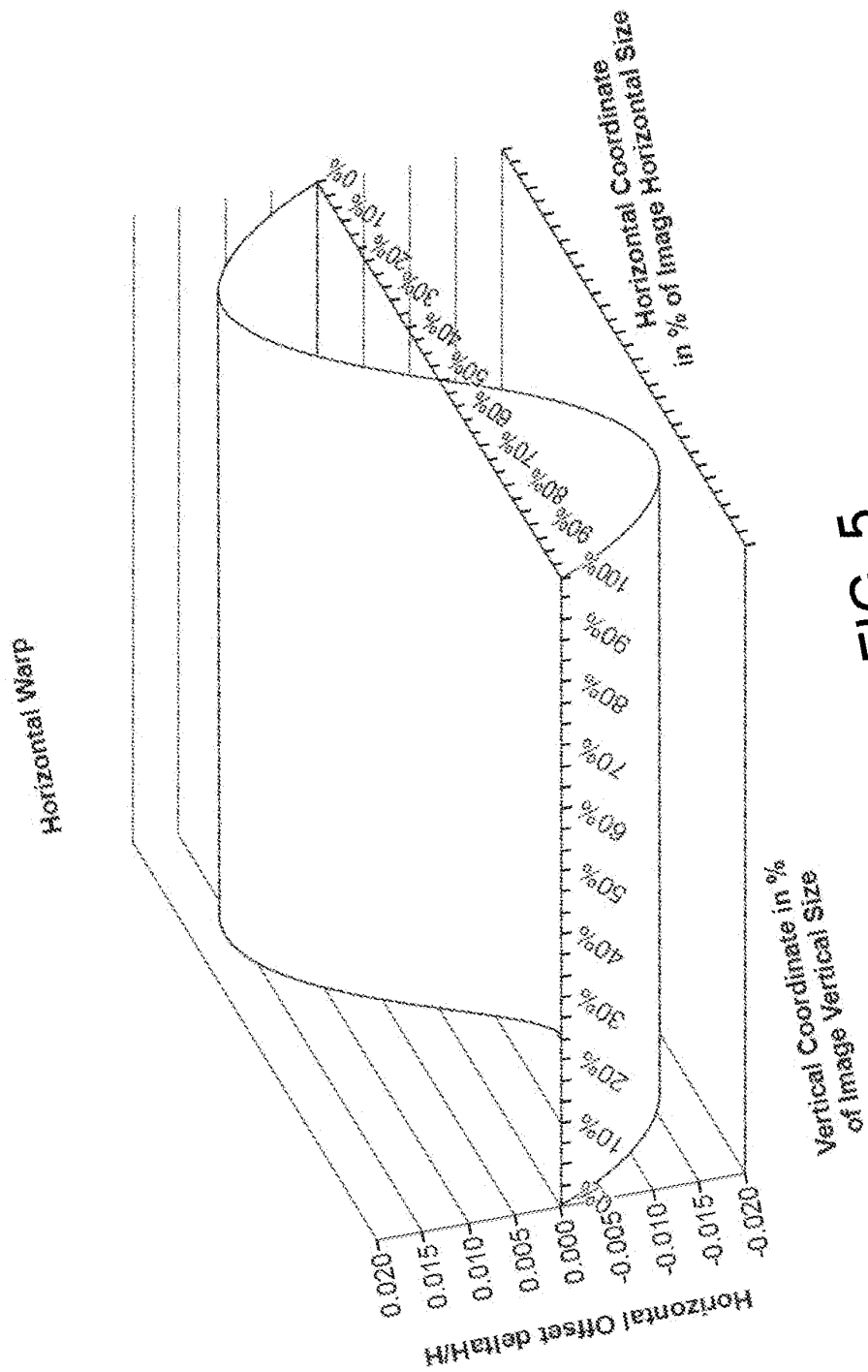


FIG. 5

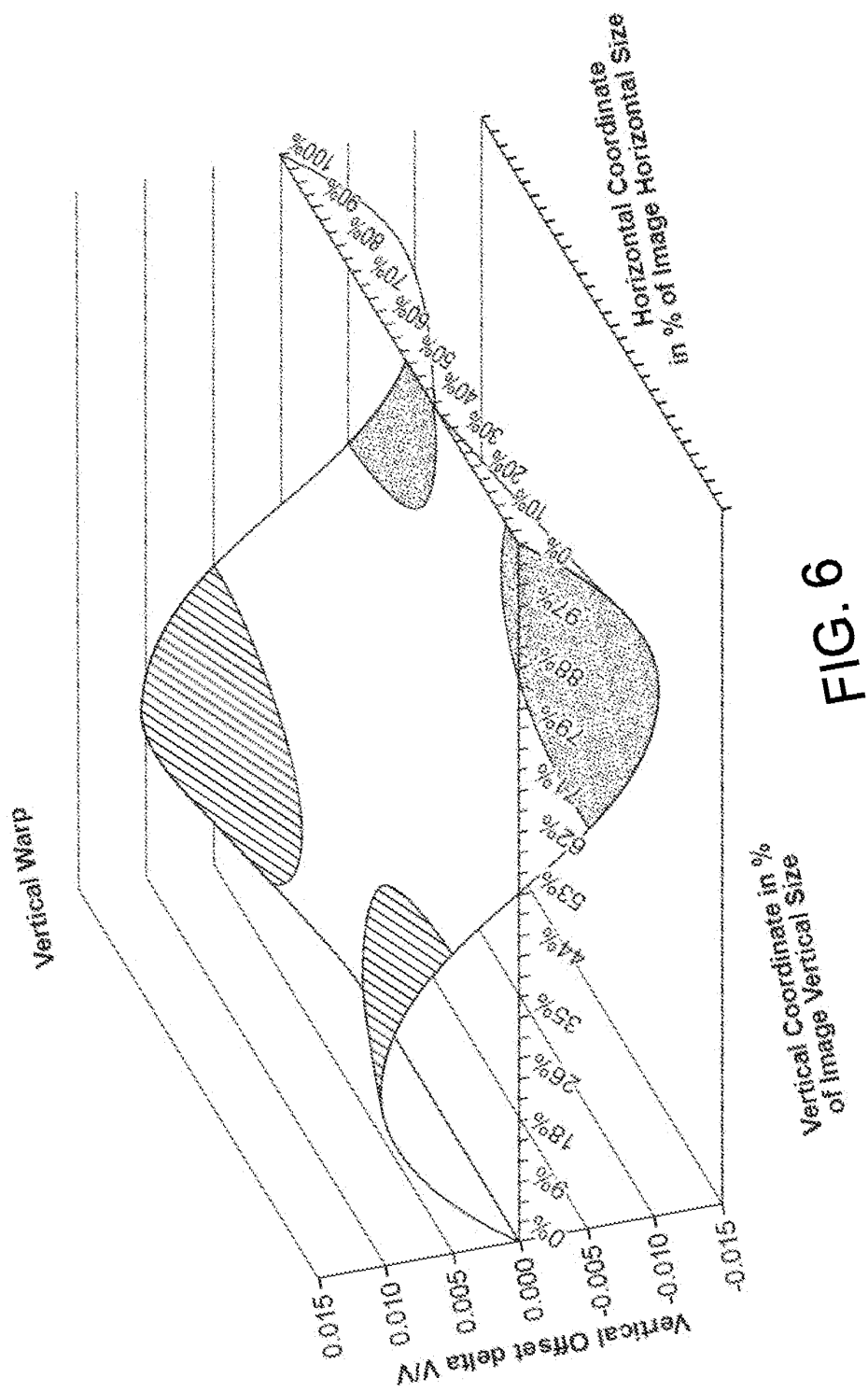


FIG. 6

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**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
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Invention**CONVERSION BETWEEN ASPECT RATIOS IN CAMERA**

As the below named inventor, I hereby declare that:

This declaration
is directed to:

The attached application, or



United States application or PCT international application number _____

filed on _____

The above-identified application was made or authorized to be made by me.

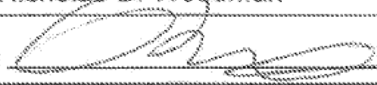
I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001
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LEGAL NAME OF INVENTORInventor: Nicholas B. Woodman

Date (Optional)

2/10/14Signature: 

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APPLICATION DATA SHEET (37 CFR 1.76)**

Title of
Invention

CONVERSION BETWEEN ASPECT RATIOS IN CAMERA

As the below named inventor, I hereby declare that:

This declaration
is directed to:



The attached application, or



United States application or PCT international application number _____
filed on _____

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001
by fine or imprisonment of not more than five (5) years, or both.

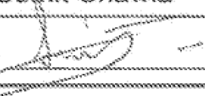
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LEGAL NAME OF INVENTOR

Inventor: Sumit Chawla

Date (Optional): _____

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	CONVERSION BETWEEN ASPECT RATIOS IN CAMERA
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As the below named inventor, I hereby declare that:

This declaration is directed to: ☒ The attached application, or
☐ United States application or PCT international application number _____
 filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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.

LEGAL NAME OF INVENTOR

Inventor: Loic Segapelli Date (Optional): _____

Signature: 

Note. An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
APPLICATION DATA SHEET (37 CFR 1.76)**

Title of Invention	CONVERSION BETWEEN ASPECT RATIOS IN CAMERA	
As the below named inventor, I hereby declare that:		
This declaration is directed to: ☒ The attached application, or		
☐ United States application or PCT international application number _____		
filed on _____		
The above-identified application was made or authorized to be made by me.		
I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.		
I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.		
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.		
LEGAL NAME OF INVENTOR		
Inventor: <u>Scott Patrick Campbell</u>		Date (Optional): <u>10 Feb 2014</u>
Signature: 		
Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.		

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