UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.	: 8,334,494 B2
APPLICATION NO.	: 13/465229
DATED	: December 18, 2012
INVENTOR(S)	: Olsen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On Title Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 27, delete "Donding" and insert -- Bonding --, therefor.

On Title Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 30, delete "(TOMBO0 with color filters," SPEI" and insert -- (TOMBO) with color filters," SPIE --, therefor.

In the Specification

In Column 2, Line 40, delete "INCORPORATION BY REFERENCE" and insert -- BRIEF DESCRIPTION OF DRAWINGS --, therefor.

In Column 11, Line 21, delete "300 integration time controller" and insert -- integration time controller 300 --, therefor.

In Column 16, Line 43, delete "digital) e.g.," and insert -- digital (e.g., --, therefor.

In Column 18, Line 62, delete "foe" and insert -- for --, therefor.

In Column 18, Lines 64-65, delete "sensor array sensor array" and insert -- sensor array --, therefor.

In Column 19, Line 46, delete "$1780_{1,1}$-1780_{n}," and insert -- $1780_{1,1}$-$1780_{n,m}$, --, therefor.

In Column 20, Line 2, delete "board 1820" and insert -- board 1821 --, therefor.

In Column 21, Line 59, delete "extreme" and insert -- extreme. --, therefor.

In Column 23, Line 9, delete "know" and insert -- known --, therefor.

Signed and Sealed this
Eighth Day of October, 2013

Teresa Stanek Rea

Teresa Stanek Rea
Deputy Director of the United States Patent and Trademark Office

PTO/SB/44 (09-07)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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(Also Form PTO-1050)

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In Column 18, Line 62, delete "foe" and insert - - for - -, therefor.

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, Utah 84098, United States

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
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In Column 21, Line 59, delete "extreme" and insert - - extreme. - -, therefor.

In Column 23, Line 9, delete "know" and insert - - known - -, therefor.

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Park City, Utah 84098, United States

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

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

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

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

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

PATENT NO.: 8,334,494

USPTO CONFIRMATION CODE: 5599

APPLICATION NO.: 13/465,229

FILED: May 7, 2012

EXAMINER: Seung C Sohn

GROUP ART UNIT: 2878

FOR: LARGE DYNAMIC RANGE CAMERAS

37 CFR 1.322 & 37 CFR 1.323 REQUEST FOR CERTIFICATE OF CORRECTION FOR USPTO AND/OR APPLICANT MISTAKE

Commissioner for Patents
Office of Patent Publication
ATTN: Certificate of Correction Branch
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

A certificate of correction under 35 USC 254 is respectfully requested in the above-identified patent.

It is believed that all errors identified herein were the fault of applicant, please charge **$100.00** to our Deposit Account No. 50-5394. In the event that a further fee is required, please charge the amount to the same Deposit Account.

The exact locations where the errors appear in the patent and patent application are as follows:

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 27, delete "Donding" and insert - - Bonding - -, therefor.
(LIST OF REFERENCES CITED BY APPLICANT AND CONSIDERED BY EXAMINER DATED AUGUST 20, 2012, SHEET 5 OF 8, UNDER "NON PATENT LITERATURE DOCUMENTS", ENTRY 1, LINE 1)

On Page 2, in Field (56), under "OTHER PUBLICATIONS", in Column 2, Line 30, delete "(TOMBO0 with color filters," SPEI" and insert - - (TOMBO) with color filters," SPIE - -, therefor.
(LIST OF REFERENCES CITED BY APPLICANT AND CONSIDERED BY EXAMINER DATED AUGUST 20, 2012, SHEET 5 OF 8, UNDER "NON PATENT LITERATURE DOCUMENTS", ENTRY 2, LINE 1)

In Column 2, Line 40, delete "INCORPORATION BY REFERENCE" and insert - - BRIEF DESCRIPTION OF DRAWINGS - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 3, LINE 11)

In Column 11, Line 21, delete "300 integration time controller" and insert - - integration time controller 300 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 17, PARAGRAPH [0072], LINE 4)

In Column 16, Line 43, delete "digital) e.g.," and insert - - digital (e.g., - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 25, PARAGRAPH [0111], LINE 2)

In Column 18, Line 62, delete "foe" and insert - - for - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 29, PARAGRAPH [0126], LINE 2)

In Column 18, Lines 64-65, delete "sensor array sensor array" and insert - - sensor array - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 29, PARAGRAPH [0126], LINE 4)

In Column 19, Line 46, delete "$1780_{1,1}$-1780_{n}," and insert - - $1780_{1,1}$-$1780_{n,m}$, - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 30, PARAGRAPH [0129], LINE 3)

In Column 20, Line 2, delete "board 1820" and insert - - board 1821 - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 31, PARAGRAPH [0132], LINE 2)

In Column 21, Line 59, delete "extreme" and insert - - extreme. - -, therefor. (ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 34, LINE 3)

In Column 23, Line 9, delete "know" and insert - - known - -, therefor. (ORIGINALLY FILED SPECIFICATION DATED MAY 7, 2012, PAGE 36, PARAGRAPH [0150], LINE 1)

The requested corrections are attached on Form PTO/SB/44.

Dated this 12th day of September, 2013.

Respectfully Submitted,

/R. Burns Israelsen/ Reg. # 42,685
R. BURNS ISRAELSEN
Acting in Representative Capacity
(37 CFR 1.34)
Registration No. 42,685
Telephone No. (435) 252-1360

Electronic Patent Application Fee Transmittal

Application Number:	13465229
Filing Date:	07-May-2012
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Filer:	Robert Burns Israelsen/Jeffrey Woodward
Attorney Docket Number:	088245-9946

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of Correction	1811	1	100	100
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt	
EFS ID:	16840132
Application Number:	13465229
International Application Number:	
Confirmation Number:	5599
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Customer Number:	23524
Filer:	Robert Burns Israelsen/Jeffrey Woodward
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	088245-9946
Receipt Date:	12-SEP-2013
Filing Date:	07-MAY-2012
Time Stamp:	17:03:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$100
RAM confirmation Number	4375
Deposit Account	505394
Authorized User	

File Listing:

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

1	Request for Certificate of Correction	2253USCN190834_2013-09-12_CoC.pdf	270404 3f1b205e5314faf53bdc996b9c266c5ca2d56137	no	3
Warnings:					
Information:					
2	Request for Certificate of Correction	2253USCN190834_2013-09-12_Request_Letter.pdf	151028 e6ee364471f40cfc5b706b7fbf0d5271a32f4e3c	no	3
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30225 e28b6b4ecc11e1a09246ab41ff0b9a4139c1a3b3	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	451657	

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.

<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.

<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.

<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.

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.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/465,229	12/18/2012	8334494	088245-9946	5599

23524 7590 11/28/2012

FOLEY & LARDNER LLP
3000 K STREET N.W.
SUITE 600
WASHINGTON, DC 20007-5109

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):

Richard Ian Olsen, Irvine, CA;
Darryl L. Sato, Irvine, CA;
Feng-Qing Sun, Irvine, CA;
James Gates, Irvine, CA;

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PTO/SB/08 (09-06)
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Date Submitted: August 2, 2012

(use as many sheets as necessary)

Sheet 2 of 8

Complete if Known	
Application Number	13/465229
Filing Date	5/7/12
First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

Change(s) applied to document, /K.D.D./ 9/26/2012

U.S. PATENT DOCUMENTS

		Document Number			
		2007/0002159	01-04-2007	OLSEN ET AL.	
		3,609,367	09-28-1971	BARRON, DONALD ROBERT	
		3,971,065	07-20-1976	BAYER, BRYCE E.	
		4,323,925	4/1982	ABELL ET AL.	
		4,385,373	05-24-1983	HOWE, DONALD J.	
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		6,375,075	04-23-2002	ACKLEY ET AL.	
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		6,611,289	08-26-2003	YU ET AL.	
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		6,765,617	07-20-2004	TANGEN ET AL.	
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		6,882,368	04-19-2005	SUDA, YASUO	
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		6,885,404	04-26-2005	SUDA, YASUO	
		6,885,508	04-26-2005	YAMAGUCHI ET AL.	

Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

4813-8738-5360.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /SCS/

PTO/SB/08 (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	13/465229
Date Submitted: August 2, 2012				**Filing Date**	5/7/12
				First Named Inventor	Richard Ian Olsen
(use as many sheets as necessary)				Art Unit	2878
				Examiner Name	Seung C. Sohn
Sheet	3	of	8	Attorney Docket Number	088245-9946

U.S. PATENT DOCUMENTS

		Document Number			
		6,903,770	06-07-2005	KOBAYASHI ET AL.	
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		7,280,290	10-09-2007	ARAKI ET AL.	
		7,305,180	12-04-2007	LABAZIEWICZ	
		7,358,483	04-15-2008	~~ARAKI~~ ET AL. Mitsugi	
		7,362,357	04-22-2008	BROWN ET AL.	
		7,379,104	05-27-2008	HATTORI ET AL.	
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		7,453,510	11-18-2008	KOLEHMAINEN ET AL.	
		7,460,160	12-02-2008	HERSHEY ET AL	

Change(s) applied to document, /L.S./ 10/10/2012

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Documents	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		EP-1 032 045	08-30-2000	SANYO ELECTRIC CO.		
		EP-0 599 470	06-01-1994	PICKER INTERNATIONAL, INC.		
		JP-62-011264	01-20-1987	FUJI PHOTO FILM CO LTD		

Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

4813-8738-5360.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /SCS/

PTO/SB/08 (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Date Submitted: August 2, 2012

(use as many sheets as necessary)

Sheet 1 of 8

Complete if Known	
Application Number	13/465229
Filing Date	5/7/12
First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		2002/0020845	02-21-2002	OGURA ET AL.	
		2002/0024606	02-28-2002	YUKI ET AL.	
		2002/0051071	05-02-2002	ITANO ET AL.	
		2002/0067416	06-06-2002	YONEDA ET AL.	
		2002/0075481	06-20-2002	ROUSTAEI, ALEXANDER	
		2002/0089596	07-11-2002	SUDA, YASUO	
		2002/0113888	08-22-2002	SONODA ET AL.	
		2002/0122124	09-05-2002	SUDA	
		2002/0142798	10-03-2002	HIROYUKI MIYAKE	
		2003/0020814	01-30-2003	ONO, SHUJI	
		2003/0086013	05-08-2003	ARATANI, MICHIHARU	
		2003/0097511	05-22-2003	~~MCGUINNES~~, ET AL. Choi	
Change(s) applied to document, /L.S./ 10/10/2012		2003/0151685	08-14-2003	LA GRONE, MARCUS J.	
		2003/0160886	08-28-2003	MISAWA ET AL	
		2003/0209651	11-13-2003	IWASAKI, TATSUYA	
		2003/0234907	12-25-2003	KAWAI	
		2004/0012688	01-22-2004	TINNERINO ET AL.	
		2004/0012689	01-22-2004	TINNERINO ET AL.	
		2004/0017620	01-29-2004	KANEKO ET AL.	
		2004/0027687	02-12-2004	BITTNER ET AL	
		2004/0080638	04-29-2004	LEE, WON-HO	
		2004/0095495	05-20-2004	~~KAZUYUKI~~ ET AL. Inokuma	
		2004/0183918	09-23-2004	SQUILLA ET AL.	
		2005/0024731	02-03-2005	MITCHELL ET AL.	
		2005/0128335	06-16-2005	KOLEHMAINEN ET AL.	
		2005/0128509	06-16-2005	TOKKONEN ET AL.	
		2005/0134712	06-23-2005	GRUHLKE ET AL.	
		2005/0160112	07-21-2005	MAKELA ET AL.	
		2005/0248667	11-10-2005	SCHWENG ET AL.	
		2005/0285955	12-29-2005	UTZ ET AL.	
		2006/0087572	04-27-2006	SCHROEDER	
		2006/0108505	05-25-2006	GRUHLKE ET AL.	
		2006/0125936	06-15-2006	GRUHLKE ET AL.	
		2006/0187322	08-24-2006	JANSON, JR. ET AL.	
		2006/0187338	08-24-2006	MAY ET AL.	
		2006/0222220	10-05-2006	YAMANO ET AL.	

Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

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4813-8738-5360.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /SCS/

Atty. Dkt. No. 088245-9946

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	OLSEN et al.
Title:	LARGE DYNAMIC RANGE CAMERAS
Appl. No.:	13/465229
Filing Date:	5/7/2012
Examiner:	Seung C. Sohn
Art Unit:	2878
Confirmation Number:	5599

ISSUE FEE TRANSMITTAL

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

Commissioner:

Enclosed herewith please find Issue Fee Transmittal Form PTOL-85(B).

Fees in the amount of $2,070.00 for payment of the Issue Fee and the Publication Fee are being paid by credit card via EFS-Web.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by the credit card payment instructions in EFS-Web being incorrect or absent, resulting in a rejected or incorrect credit card transaction, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741.

Respectfully submitted,

Date November 15, 2012

By _____

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4292
Facsimile: (608) 258-4258

Paul S. Hunter
Attorney for Applicant
Registration No. 44,787

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)

23524 7590 08/20/2012

FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

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.

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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.
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946	5599

TITLE OF INVENTION: LARGE DYNAMIC RANGE CAMERAS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	~~$1740~~ $1770	$300	$0	~~$2040~~ $2070	11/20/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
SOHN, SEUNG C	2878	250-208100

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Protarius Filo AG, L.L.C.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Dover, Delaware

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. XXXXXXXXXXXXXXXX EFS Web

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 19-0741 (enclosed XXXXXXXXXXXXXXXX).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date November 15, 2012

Typed or printed name Paul S. Hunter Registration No. 44,787

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	OLSEN et al.
Title:	LARGE DYNAMIC RANGE CAMERAS
Appl. No.:	13/465229
Filing Date:	5/7/2012
Examiner:	Seung C. Sohn
Art Unit:	2878
Confirmation Number:	5599

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop ISSUE FEE
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PO Box 1450
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These Comments on Statement of Reasons for Allowance under 37 C.F.R. § 1.104 are intended to be responsive to the Notice of Allowance dated August 20, 2012. On page 2 of the Notice of Allowability under "Examiner's Statement of Reasons for Allowance," the Examiner provided a statement of reasons for allowance.

While Applicant agrees that the allowed claims recite a combination of subject matter that is patentable over the cited references, Applicant does not necessarily agree with or acquiesce in the statement of reasons for allowance given by the Examiner. Moreover, the Applicant notes that the recited subject matter as well as various other subject matter and/or combinations of subject matter may be patentable for other reasons than those given by the Examiner. Applicant expressly reserves the right to set forth additional and/or alternative reasons for patentability and/or allowance with the present Application or in any other future proceeding.

Respectfully submitted,

Date: November 15, 2012

By: _____

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4292
Facsimile: (608) 258-4258

Paul S. Hunter
Attorney for Applicant
Registration No. 44,787

Electronic Patent Application Fee Transmittal

Application Number:	13465229
Filing Date:	07-May-2012
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Filer:	Paul S. Hunter/Linda Anderson
Attorney Docket Number:	088245-9946

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1770	1770
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2070**

Electronic Acknowledgement Receipt

EFS ID:	14235348
Application Number:	13465229
International Application Number:	
Confirmation Number:	5599
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Customer Number:	23524
Filer:	Paul S. Hunter/Linda Anderson
Filer Authorized By:	Paul S. Hunter
Attorney Docket Number:	088245-9946
Receipt Date:	15-NOV-2012
Filing Date:	07-MAY-2012
Time Stamp:	14:29:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$2070
RAM confirmation Number	867
Deposit Account	
Authorized User	

File Listing:

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

1		Issuefeeandcomments.pdf	232367 3b9c270082270b897cec27e6f7190f3e7e41526d	yes	4

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Issue Fee Payment (PTO-85B)	1	2
Post Allowance Communication - Incoming	3	4

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	31888 1d08a840567fbf5f47f750a215fee11a3df1f156	no	2

Warnings:

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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
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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946

CONFIRMATION NO. 5599

23524
FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

PUBLICATION NOTICE

OC000000056269334

Title:LARGE DYNAMIC RANGE CAMERAS

Publication No.US-2012-0218435-A1
Publication Date:08/30/2012

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

23524 7590 08/20/2012

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MADISON, WI 53701-1497

EXAMINER	
SOHN, SEUNG C	
ART UNIT	PAPER NUMBER
2878	

DATE MAILED: 08/20/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946	5599

TITLE OF INVENTION: LARGE DYNAMIC RANGE CAMERAS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	11/20/2012

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

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I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

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A. Pay TOTAL FEE(S) DUE shown above, or

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II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

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

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FOLEY & LARDNER LLP
150 EAST GILMAN STREET
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MADISON, WI 53701-1497

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.
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946	5599

TITLE OF INVENTION: LARGE DYNAMIC RANGE CAMERAS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	11/20/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
SOHN, SEUNG C	2878	250-208100

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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.

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946	5599

23524 7590 08/20/2012

FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

EXAMINER	
SOHN, SEUNG C	
ART UNIT	PAPER NUMBER
2878	

DATE MAILED: 08/20/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	13/465,229	OLSEN ET AL.	
	Examiner	Art Unit	
	SEUNG C. SOHN	2878	

-- 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 _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-20*.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 8/2/2012
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

Reasons for Allowance

1. Claims 1-20 are allowed.

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

Claims 1-20 are not disclosed or made obvious by the prior art of record, specifically in combination with the limitation of "a plurality of optics components, wherein each optics component of the plurality of optics components is configured to pass light to a sensor of the plurality of sensors, wherein each optics component and an associated sensor form one of a plurality of channels; and a processing component coupled to the plurality of channels and configured to separately control an integration time of each sensor during a frame, wherein the processing component is configured to combine data from the plurality of sensors received during the flame to provide an image."

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."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SEUNG C. SOHN whose telephone number is (571)272-4123. The examiner can normally be reached on Mon-Thur, 7:30 AM -6 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, GEORGIA Y. EPPS can be reached on 571-272-2328. 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.

/SEUNG C SOHN/

Primary Examiner, Art Unit 2878

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13465229	OLSEN ET AL.
	Examiner	**Art Unit**
	SEUNG C SOHN	2878

ORIGINAL		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
250	208.1	H	0	1	L	27 / 00 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17												
	2		18												
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	13														
	14														
	15														
	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/SEUNG C SOHN/ Primary Examiner.Art Unit 2878	8/13/2012	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13465229	OLSEN ET AL.
	Examiner	**Art Unit**
	SEUNG C SOHN	2878

✓	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	08/13/2012								
	1	=								
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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L2	2	"12496854"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L3	5	"11788122"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
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L5	34	olsen near2 richard near2 ian	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L6	260035	digital adj camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L7	6085	250/208.1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L8	24036	integration adj time	US-PGPUB;	OR	ON	2012/08/13

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L9	2020	L6 and L8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L10	124	L7 and L9	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L11	1624	shorter same (integration adj time)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L12	50	L7 and L11	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
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			IBM_TDB			
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L18	260035	digital adj camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
L19	6085	250/208.1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/08/13 11:55
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L30	3369	348/302,308.ccls.	US-PGPUB;	OR	ON	2012/08/13

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EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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8/13/2012 12:05:02 PM
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 5599

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/465,229	05/07/2012 RULE	250	2878	088245-9946

APPLICANTS

Richard Ian Olsen, Irvine, CA;
Darryl L. Sato, Irvine, CA;
Feng-Qing Sun, Irvine, CA;
James Gates, Irvine, CA;

**** CONTINUING DATA **************************

This application is a CON of 12/496,854 07/02/2009 PAT 8,198,574
which is a CON of 11/788,122 04/19/2007 PAT 7,564,019
which claims benefit of 60/795,882 04/28/2006
and is a CIP of 11/212,803 08/25/2005 ABN
which claims benefit of 60/604,854 08/25/2004
and claims benefit of 60/695,946 07/01/2005

**** FOREIGN APPLICATIONS **************************

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05/17/2012

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ Yes ☑ No	☐ Yes ☑ No	/SEUNG C SOHN/ Examiner's Signature	☐ Initials	CA	24	20	2

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UNITED STATES

TITLE

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13465229	OLSEN ET AL.
	Examiner	Art Unit
	SEUNG C SOHN	2878

SEARCHED			
Class	Subclass	Date	Examiner
250	208.1	8/13/2012	SCS
348	273, 302, 308	8/13/2012	SCS

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (US-PGPUB, USPAT, EPO, JPO, DERWENT)	8/13/2012	SCS
INVENTOR SEARCH	8/13/2012	SCS

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
	TEXT SEARCH (EAST US-PGPUB)	8/13/2012	SCS

	/SEUNG C SOHN/ Primary Examiner.Art Unit 2878

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Date Submitted: August 2, 2012

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Sheet 1 of 8

Complete if Known	
Application Number	13/465229
Filing Date	5/7/12
First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

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Sheet 2 of 8

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Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

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Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

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Date Submitted: August 2, 2012

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Sheet 3 of 8

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First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

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Sheet 4 of 8

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First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
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Examiner Signature	/Seung C Sohn/	Date Considered	08/13/2012

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Date Submitted: August 2, 2012

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Sheet 7 of 8

Complete if Known	
Application Number	13/465229
Filing Date	5/7/12
First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
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				Art Unit	2878
(use as many sheets as necessary)				Examiner Name	Seung C. Sohn
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		Tanida, "Color imaging with an integrated compound imaging system," Optics Express, Vol. 11, No. 18, September 2003, pp. 2109-2117.	
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Sheet 1 of 8

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Art Unit	2878
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Attorney Docket Number	088245-9946

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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Date Submitted: August 2, 2012

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Sheet 2 of 8

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Application Number	13/465229
Filing Date	5/7/12
First Named Inventor	Richard Ian Olsen
Art Unit	2878
Examiner Name	Seung C. Sohn
Attorney Docket Number	088245-9946

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Examiner Signature		Date Considered	

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Date Submitted: August 2, 2012				**Filing Date**	5/7/12
				First Named Inventor	Richard Ian Olsen
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				Examiner Name	Seung C. Sohn
Sheet	3	of	8	Attorney Docket Number	088245-9946

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		EP-1 032 045	08-30-2000	SANYO ELECTRIC CO.		
		EP-0 599 470	06-01-1994	PICKER INTERNATIONAL, INC.		
		JP-62-011264	01-20-1987	FUJI PHOTO FILM CO LTD		

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		Duparre et al., "Artificial apposition compound eye fabricated by micro-optics technology," Applied Optics, Vol. 43, No. 22, August 2004, pp. 4303-4310.	
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		Kitamura et al., "Reconstruction of a high-resolution image on a compound-eye image-capturing system," Applied Optics, Vol. 43, No. 8, March 2004, pp. 1719 - 1727.	

Examiner Signature		Date Considered	

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Substitute for form 1449/PTO				***Complete if Known***	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	13/465229
Date Submitted: August 2, 2012				**Filing Date**	5/7/12
				First Named Inventor	Richard Ian Olsen
(use as many sheets as necessary)				Art Unit	2878
				Examiner Name	Seung C. Sohn
Sheet	5	of	8	Attorney Docket Number	088245-9946

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Miki et al., "A Study of Multi-Stack Silicon-Direct Wafer Donding for MEMS Manufacturing," 2002, IEEE, pp. 407-410.	
		Miyatake et al., "Thin observation module by bound optics (TOMBO0 with color filters," SPEI and IS&T, Vol. 5301, 2004, pp. 7-12.	
		Non-final Office Action on U.S. Application 11/212,803, mailed 2/7/2007.	
		Non-Final Office Action on U.S. Application 11/265,669, mailed 2/28/2006.	
		Non-Final Office Action on U.S. Application 11/322,959, mailed 8/8/2007.	
		Non-Final Office Action on U.S. Application 11/788,122, mailed 6/27/2008.	
		Non-Final Office Action on U.S. Application 11/888,546, mailed 5/1/2008.	
		Non-Final Office Action on U.S. Application 11/888,570, mailed 5/28/2008.	
		Norvell, Robin, " Shellcase Debuts Ultra-Thin Miniaturization for Optics," July 8, 2005, 1 page.	
		Notice of Allowance for U.S. Application 11/478,242, mailed December 30, 2009.	
		Notice of Allowance for U.S. Application 11/888,546, mailed December 14, 2009.	
		Notice of Allowance of U.S. Application 11/825,382, mailed May 5, 2010.	

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Substitute for form 1449/PTO				***Complete if Known***	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	13/465229
Date Submitted: August 2, 2012				**Filing Date**	5/7/12
				First Named Inventor	Richard Ian Olsen
(use as many sheets as necessary)				Art Unit	2878
				Examiner Name	Seung C. Sohn
Sheet	6	of	8	Attorney Docket Number	088245-9946

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Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Notice of Allowance on U.S. Application 11/265,669, mailed 10/27/2006.	
		Notice of Allowance on U.S. Application 11/788,122, mailed 3/9/2009.	
		Notice of Allowance on U.S. Application 11/788,279, mailed October 28, 2010.	
		Notice of Allowance on U.S. Application 11/810,623, mailed 2/2/2011.	
		Notice of Allowance on U.S. Application 11/888,546, mailed 12/2/2008.	
		Notice of Allowance on U.S. Application 11/888,546, mailed 6/3/2009.	
		Notice of Allowance on U.S. Application 11/888,570, mailed 3/23/2009.	
		Notice of Allowance on U.S. Application 11/888,582, mailed August 6, 2010.	
		Office Action for U.S. Application 11/825,382, mailed 10/29/2009.	
		Office Action on U.S. Application 11/788,279, mailed January 21, 2010.	
		Office Action on U.S. Appl. 11/810,623, mailed 8/18/2010	
		Office Action on U.S. Application 11/478,242, mailed 9/16/2009	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	13/465229
Date Submitted: August 2, 2012				**Filing Date**	5/7/12
				First Named Inventor	Richard Ian Olsen
(use as many sheets as necessary)				Art Unit	2878
				Examiner Name	Seung C. Sohn
Sheet	7	of	8	Attorney Docket Number	088245-9946

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action on U.S. Application 11/788,120, mailed 4/16/2010	
		Office Action on U.S. Application 11/788,120, mailed 5/19/2009	
		Office Action on U.S. Application 11/788,120, mailed 7/30/2010	
		Office Action on U.S. Application 11/788,120, mailed 9/18/2009	
		Office Action on U.S. Application 11/788,279, mailed 8/4/2010	
		Non-Final Office Action on U.S. Application 11/810,623 mailed February 4, 2010.	
		Search Report for EP Application 05793927.4, dated February 26, 2010	
		Second Office Action on Chinese Application 200580032374.0, issued September 9, 2010.	
		Shogenji et al., "Bimodal fingerprint capturing system based on compound-eye imaging module," Applied Optics, Vol. 43, No. 6, February 2004, pp. 1355-1359.	
		Shogenji et al., "Multispectral imaging using compact compound optics," Optics Express, Vol. 12, No. 8, April 2004, pp. 1643-1655.	
		Stager et al., "Replicated Micro-Optics for Automotive Applications," SPIE European Workshop on Photonics in the Automobile, Geneva, 2004, (8 pages).	
		Tanida et al., "Compact image capturing system based on compound imaging and digital reconstruction," Proceedings of SPIE, Vol. 4455, 2001, pp. 34-41.	

Examiner Signature		Date Considered	

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Substitute for form 1449/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	13/465229
				Filing Date	5/7/12
Date Submitted: August 2, 2012				**First Named Inventor**	Richard Ian Olsen
				Art Unit	2878
(use as many sheets as necessary)				Examiner Name	Seung C. Sohn
Sheet	8	of	8	Attorney Docket Number	088245-9946

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Tanida, "Color imaging with an integrated compound imaging system," Optics Express, Vol. 11, No. 18, September 2003, pp. 2109-2117.	
		Third Office Action issued on Chinese Application 200580032374.0, mailed 5/24/2011 (with English translation)	
		Volkel et al., "Miniaturization of Imaging Systems," mstnews, February 2003, pp. 36-38.	
		Volkel et al., "Miniaturized imaging systems," Elsevier Science B.V., Microelectronic Engineering 67-68 (2003), pp. 461-472.	
		Wood et al., "Resolution Improvement for Compound Eye Images Through Lens Diversity," IEEE, Signal Processing Society, DSP/SPE Workshop, August 2, 2004 (5 pages).	
		Notice of Allowance on U.S. Application 11/729,132, mailed 10/11/2011.	
		Non-Final Office Action on U.S. Application 11/729,132, mailed 2/3/11.	
		Notice of Allowance on U.S. Application 12/496,854, mailed 2/16/2012	
		Communication from the European Patent Office on European Patent Application 05793927.4, mailed 2/10/2012.	
		Notice of Allowance on U.S. Application 13/006,351, mailed 5/17/2011.	
		Notice of Allowance on U.S. Application 13/100,725 mailed 7/23/2012	

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4813-8738-5360.1

Electronic Acknowledgement Receipt

EFS ID:	13400497
Application Number:	13465229
International Application Number:	
Confirmation Number:	5599
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Customer Number:	23524
Filer:	Christopher L. Kalafut/Linda Anderson
Filer Authorized By:	Christopher L. Kalafut
Attorney Docket Number:	088245-9946
Receipt Date:	02-AUG-2012
Filing Date:	07-MAY-2012
Time Stamp:	12:36:17
Application Type:	Utility under 35 USC 111(a)

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1	Request for Corrected Filing Receipt	ReqforcorrFR.pdf	212760 0aeef6fddf54d8df1b3a11f42dececfde87a644e	no	5

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3	Non Patent Literature	6407NOA2162012.pdf	8212168 91ff4a9ef2cc93cceffb992f420b9e1098c07d5c	no	8
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	OLSEN et al.
Title:	LARGE DYNAMIC RANGE CAMERAS
Appl. No.:	13/465229
Filing Date:	5/7/2012
Examiner:	Seung C. Sohn
Art Unit:	2878
Confirmation Number:	5599

REQUEST FOR CORRECTED FILING RECEIPT

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

Attn: Appl. Processing Division, Customer Correction Branch

Commissioner:

Attached is a copy of the official Filing Receipt received from the PTO in the above-referenced application.

There is an error with respect to the number of Independent Claims. The number of independent claims should be **3**, as indicated in the Transmittal Document and Application filed on 5/7/2012.

The correction is not due to any error by Applicant and, accordingly, no fee is due. Issuance of a corrected Filing Receipt is respectfully requested.

Respectfully submitted,

Date August 2, 2012

By: /Christopher L. Kalafut/

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4286
Facsimile: (608) 258-4258

Christopher L. Kalafut
Attorney for Applicant
Registration No. 57,946

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/465,229	05/07/2012	2622	1250	088245-9946	20	~~2~~ 3

CONFIRMATION NO. 5599

23524
FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

FILING RECEIPT

OC000000054350084

Date Mailed: 05/21/2012

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

Applicant(s)

Richard Ian Olsen, Irvine, CA;
Darryl L. Sato, Irvine, CA;
Feng-Qing Sun, Irvine, CA;
James Gates, Irvine, CA;

Power of Attorney: The patent practitioners associated with Customer Number 23524

Domestic Priority data as claimed by applicant

This application is a CON of 12/496,854 07/02/2009
which is a CON of 11/788,122 04/19/2007 PAT 7564019
which claims benefit of 60/795,882 04/28/2006
and is a CIP of 11/212,803 08/25/2005 ABN
which claims benefit of 60/604,854 08/25/2004
and claims benefit of 60/695,946 07/01/2005

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 05/17/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/465,229**

Projected Publication Date: 08/30/2012

Non-Publication Request: No

Early Publication Request: No

Title

LARGE DYNAMIC RANGE CAMERAS

Preliminary Class

348

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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 AssetsControl, 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).

SelectUSA

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, facilitate, and accelerate 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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	OLSEN et al.
Title:	LARGE DYNAMIC RANGE CAMERAS
Appl. No.:	13/465229
Filing Date:	5/7/2012
Examiner:	Seung C. Sohn
Art Unit:	2878
Confirmation Number:	5599

INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR §1.56

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

Commissioner:

Applicant submits herewith documents for the Examiner's consideration in accordance with 37 CFR §§1.56, 1.97 and 1.98.

Applicants respectfully request that each listed document be considered by the Examiner and be made of record in the present application and that an initialed copy of Form PTO/SB/08 be returned in accordance with MPEP §609.

Applicant requests that, in accordance with 37 CFR §1.98(d), the Examiner review all applications relied on for an earlier effective filing date under 35 U.S.C. 120, including application no. 11/212803, filed 8/25/2005; application no. 11/788122, filed 4/19/2007; application no. 12/496854, filed 7/2/2009, for copies of references of record therein that are not

being provided here; although Applicant would be pleased to provide copies of any such documents at the Examiner's request. Copies are references not previously submitted are provided.

The submission of any document herewith is not an admission that such document constitutes prior art against the claims of the present application or that such document is considered material to patentability as defined in 37 CFR §1.56(b). Applicants do not waive any rights to take any action which would be appropriate to antedate or otherwise remove as a competent reference any document submitted herewith.

TIMING OF THE DISCLOSURE

The listed documents are being submitted in compliance with 37 CFR §1.97(b), within three (3) months of the filing date of the application.

Although Applicant believes that no fee is required, the Commissioner is hereby authorized to charge any additional fees which may be due to Deposit Account No. 19-0741.

Respectfully submitted,

Date August 2, 2012

By: /Christopher L. Kalafut/

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4286
Facsimile: (608) 258-4258

Christopher L. Kalafut
Attorney for Applicant
Registration No. 57,946

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/465,229

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1250

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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
13/465,229	05/07/2012	2622	1250	088245-9946	20	2

CONFIRMATION NO. 5599

23524
FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

FILING RECEIPT

OC000000054350084

Date Mailed: 05/21/2012

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

Applicant(s)

Richard Ian Olsen, Irvine, CA;
Darryl L. Sato, Irvine, CA;
Feng-Qing Sun, Irvine, CA;
James Gates, Irvine, CA;

Power of Attorney: The patent practitioners associated with Customer Number 23524

Domestic Priority data as claimed by applicant

This application is a CON of 12/496,854 07/02/2009
which is a CON of 11/788,122 04/19/2007 PAT 7564019
which claims benefit of 60/795,882 04/28/2006
and is a CIP of 11/212,803 08/25/2005 ABN
which claims benefit of 60/604,854 08/25/2004
and claims benefit of 60/695,946 07/01/2005

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 05/17/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/465,229**

Projected Publication Date: 08/30/2012

Non-Publication Request: No

Early Publication Request: No

Title

LARGE DYNAMIC RANGE CAMERAS

Preliminary Class

348

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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 AssetsControl, 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 USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate 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.

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Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/465,229	05/07/2012	Richard Ian Olsen	088245-9946

CONFIRMATION NO. 5599

23524
FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

POA ACCEPTANCE LETTER

OC000000054350136

Date Mailed: 05/21/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 05/07/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/gmihtsun/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: OLSEN et al.

Title: LARGE DYNAMIC RANGE CAMERAS

Prior Appl. No.: 12/496854

Prior Appl. Filing Date: 7/2/2009

CONTINUING PATENT APPLICATION TRANSMITTAL LETTER

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

Commissioner:

Transmitted herewith for filing under 37 C.F.R. § 1.53(b) is a:

[**X**] Continuation [ ] Division [ ] Continuation-In-Part (CIP)

of the above-identified copending prior application in which no patenting, abandonment, or termination of proceedings has occurred. Priority to the above-identified prior application is hereby claimed under 35 U.S.C. § 120 for this continuing application. The entire disclosure of the above-identified prior application is considered as being part of the disclosure of the accompanying continuing application and is hereby incorporated by reference therein.

[ ] Applicant claims small entity status under 37 CFR 1.27.

Enclosed are:

[**X**] Description, Claim(s), and Abstract (43 pages).

[**X**] Formal drawings (24 sheets, Figures 1-21).

[**X**] Declaration and Power of Attorney (3 pages).

[**X**] Statement Under 37 CFR 3.73(b) directed to U.S. Application 11/788,122 (1 page)

[X] Power of Attorney (1 page)

[**X**] Application Data Sheet (37 CFR 1.76).

The adjustment to the number of sheets for EFS-Web filing follows:

Number of Sheets		**EFS-Web Adjustment**	**Number of Sheets for EFS-Web**
67	x	75%	51

The filing fee is calculated below:

	Number Filed		**Included in Basic Fee**	**Extra**		Rate		Fee Totals
Basic Filing Fee						$380.00	=	$380.00
Search Fee						$620.00		$620.00
Examination Fee						$250.00		$250.00
Size Fee	51	-	100	= 0	x	$310.00		$0.00
Total Claims:	20	-	20	= 0	x	$60.00	=	$0.00
Independents:	3	-	3	= 0	x	$250.00	=	$0.00
If any Multiple Dependent Claim(s) present:					+	$450.00	=	$0.00
Surcharge under 37 CFR 1.16(e) for late filing of Executed Declaration or late payment of filing fee					+	$130.00	=	$0.00
						SUBTOTAL:	=	$1250.00
[ ]				Small Entity Fees Apply (subtract ½ of above):			=	0
				Basic Filing Fee Reduction for Filing via EFS-Web				$0.00
						TOTAL FILING FEE:	=	$1250.00
Assignment Recordation Fee:					+	$40.00	=	$0.00
Processing Fee under 37 CFR 1.17(i) for Late Filing of English Translation of Application:					+	$130.00	=	$0.00
TOTAL FEE							=	$1250.00

The above-identified fees of $1250.00 are being paid by credit card via EFS-Web.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by the credit card payment instructions in EFS-Web being incorrect or absent, resulting in a rejected or incorrect credit card transaction, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741.

Please direct all correspondence to the undersigned attorney or agent at the address indicated below.

Respectfully submitted,

Date May 7, 2012

By _____

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4292
Facsimile: (608) 258-4258

Paul S. Hunter
Attorney for Applicant
Registration No. 44,787

PTO/SB/96 (06-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner:	OLSEN, Richard Ian et al.	Confirmation No.	5081
Application No.:	11/788,122	Filed:	4/19/2007
Patent No.:		Issue Date:	
Docket Number:	088245-6122		
Entitled:	LARGE DYNAMIC RANGE CAMERAS		

PROTARIUS FILO AG, L.L.C. (Name of Assignee)

LLC (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest; or
2. ☐ an assignee of less than the entire right, title, and interest
   The extent (by percentage) of its ownership interest is %

in the patent application/patent identified above by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel/Frame _____ or for which a copy thereof is attached.

OR

B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From: OLSEN, RICHARD IAN To: NEWPORT IMAGING CORPORATION
   The document was recorded in the United States Patent and Trademark Office at
   Reel 019576, Frame 0976, or for which a copy thereof is attached.

2. From: NEWPORT IMAGING CORPORATION To: PROTARIUS FILO AG, L.L.C.
   The document was recorded in the United States Patent and Trademark Office at
   Reel 022046, Frame 0464, or for which a copy thereof is attached.

3. From: _____ To: _____
   The document was recorded in the United States Patent and Trademark Office at
   Reel _____, Frame ____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☐ Copies of assignments or other documents in the chain of title are attached.

[NOTE: A separate copy (i.e., a true copy of the original document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Christopher L. Kalafut — Signature

01/05/09 — Date

Christopher L. Kalafut (Reg. No. 57,946) — Printed or Typed Name

(608) 258-4286 — Telephone Number

Attorney for Applicant — Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. 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.

MADI_1770262.1

PTO/SB/80 (01-0
Approved for use through 12-31-2008. OMB 0651-00
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERC
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 numb

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

[X] Practitioners associated with the Customer Number: **23524**

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

[X] The address associated with Customer Number: **23524**

OR

[ ] Firm or Individual Name					
Address					
City		State		Zip	
Country		Telephone		Email	

Assignee Name and Address:

PROTARIUS FILO AG, L.L.C.
160 Greentree Drive, Suite 101
Dover, DE 19904
USA

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	12/26/08
Name	Jeremiah Miller	Telephone	
Title	Authorized Person for Protarius Filo AG, L.L.C.		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (an 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 minute 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 FORI 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.

MADI_1764079.1



DECLARATION AND POWER OF ATTORNEY
(Docket No. NICO.P007)

As a below-named inventor, I hereby declare that:

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

I believe I am an original, first and joint inventor of the inventions described and claimed in the specification filed:

_____ HEREWITH,
__X__ on April 19, 2007 , Application Number 11/788,122 ,
and entitled:

LARGE DYNAMIC RANGE CAMERAS

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

I acknowledge the duty to disclose information that is material to the examination of this application in accordance with 37 CFR § 1.56.

I hereby appoint the **registered patent practitioners associated with Customer Number 53186** with full power of substitution and revocation, to prosecute this application and transact all business in the U.S. Patent and Trademark Office connected therewith. The current mailing address and telephone and facsimile numbers are:

P.O. Box 9686
San Jose, California 95157

Tel: (408) 342-1900
Fax: (408) 342-1909

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

Inventor: Richard Ian OLSEN
Address: 101 Academy Drive, Suite 100
Irvine, CA 92617

Citizenship: US

Date: 5·25·07

Richard Ian OLSEN

Inventor: Darryl L. SATO
Address: 101 Academy Drive, Suite 100
Irvine, CA 92617

Citizenship: US

Date: 5-25-07

Darryl L. SATO

Inventor: Feng-Qing SUN
Address: 101 Academy Drive, Suite 100
Irvine, CA 92617

Citizenship: CN

Date: 5/25/07

Feng-Qing SUN

Inventor: James GATES
Address: 101 Academy Drive, Suite 100
Irvine, CA 92617

Citizenship: US

Date: 24 MAY, 2007

James Gates

James GATES

Application Data Sheet

Application Information

Application Type::	Continuation
Subject Matter::	Utility
Suggested classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Computer Readable Form (CRF)?::	No
Title::	LARGE DYNAMIC RANGE CAMERAS
Attorney Docket Number::	088245-9946
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	1
Total Drawing Sheets::	24
Small Entity?::	No
Petition included?::	No
Secrecy Order in Parent Appl.?::	No

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	US
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Domestic Priority Information

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This Application	Continuation of	12/496,854	7/2/2009
12/496,854	Continuation of	11/788,122	4/19/2007
11/788,122	An application claiming the benefit under 35 USC 119(e)	60/795,882	4/28/2006
11/788,122	Continuation in part of	11/212,803	8/25/2005
11/212,803	An application claiming the benefit under 35 USC 119(e)	60/604,854	8/25/2004
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Assignee Information

LARGE DYNAMIC RANGE CAMERAS

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

[0001] This application is a Continuation of U.S. Patent Application No. 12/496,854, filed 7/02/2009, which is a Continuation of U.S. Patent Application No. 11/788,122, filed 4/19/2007, which is a Continuation-In-Part of U.S. Patent Application No. 11/212,803, filed 8/25/2005, which claims priority to U.S. Provisional Patent Application No. 60/695,946 filed on 07/01/05 and to U.S. Provisional Patent Application No. 60/604,854 filed on 08/25/04; U.S. Patent Application No. 11/788,122 also claims priority to U.S. Provisional Patent App. No. 60/795,882 filed 04/28/06. Each of the above-referenced patent applications is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The following disclosure relates generally to optical devices and more particularly to expanding the dynamic exposure range in digital cameras.

BACKGROUND

[0003] Image sensors can be realized with semiconductors based on their capability to convert locally impinging light energy into a proportional amount of electronic charge. This electronic charge "Q" is often referred to as photo-charge, and can be integrated within the pixel on a storage device such as a reverse biased diode or as a pre-charged metal-oxide-semiconductor capacitance. The finite charge storage capacitance within each pixel limits the amount of integrated photo-charge. Dynamic range is measured as the ratio of the maximum photo-charge that can be meaningfully integrated in a pixel of the imager to the pixel noise level.

[0004] Intrascene dynamic range refers to the range of incident light that can be accommodated by an image sensor in a single frame of pixel data. Examples of high dynamic scenes range scenes include an indoor room with a window view of the outdoors, an outdoor scene with mixed shadows and bright sunshine, and evening or night scenes combining

artificial lighting and shadows. In a typical charge coupled device (CCD) or CMOS active pixel sensor (APS), the available dynamic range is in a range of 1,000:1 to about 4,000:1. Unfortunately, many outdoor and indoor scenes with highly varying illumination have a dynamic range significantly greater than 4,000:1. Image sensors with intrascene dynamic range significantly greater than 4,000:1 are required to meet many imaging requirements.

[0005] The dynamic range of an image sensor can be increased by using multiple exposure times and/or integration times. For example, U.S. Pat. No. 4,647,975 describes a method based on the acquisition of two or more images, each having an exposure time. Once numerous images have been taken at different exposure times, the images have to be fused or merged to form one single piece of pixel information having a wide dynamic range. U.S. Pat. Nos. 4,647,975, 5,168,532, and 5,671,013 disclose the use of a selection rule to combine information from the most suitable of the multiple images. The merged pixel information or value is then multiplied by a suitable factor that corrects for the respective exposure times. This method however exhibits undesirable temporal aliasing if the scene or camera is moving because the two or more images having different exposure times are captured using the same image sensor and thus are not captured concurrently.

[0006] Despite improvements in solid-state image sensor and digital camera technology, the light signal or brightness range of scenes often exceeds the dynamic range of the sensor. For this reason, numerous methods have been described in the art of image sensors to extend the dynamic or signal range. A summary of some methods is presented in: "Wide dynamic range sensors", Optical Engineering, Vol. 38, No. 10, pp. 1650-1660, October 1999. Methods to provide wide dynamic range imaging capability with a single image sensor include: (a) logarithmic or compressed response photo-detection; (b) multiple integration and charge storage capability within each pixel; (c) frequency based sensors, where the sensor output is converted to pulse frequency; (d) local integration time control, where different areas within the sensor can have different exposure times; (e) signal charge versus integration time rate (signal slope) measurement; (f) analog to digital conversion per pixel; and (g) autonomous pixel control. These methods require complex pixel circuitry and are difficult to implement in small pixel areas without taking up area required for the photo-detection mechanism (such as a photodiode).

[0007] Typical scenes imaged by digital cameras have light levels that span a range including low light (1-100 lux), moderate light (100-1000 lux), and bright light (1000-1,000,000 lux) under outdoor conditions. To accommodate lighting changes from scene to scene (the interscene dynamic range) an electronic shutter is used to change the integration time of all pixels in an array from frame to frame. To cover a single scene that might involve indoor lighting (100 lux) and outdoor lighting (100,000 lux), the required intrascene dynamic range is approximately 10,000:1, corresponding to 80 dB (14-bits). This exceeds the dynamic range of a single image sensor using a single integration time (typically 3,100:1 corresponding to 70 dB (12-bits)). Therefore, there is a need for a digital camera in which the effective single-frame dynamic exposure range is expanded.

INCORPORATION BY REFERENCE

[0008] Each patent, patent application, and/or publication mentioned in this specification is herein incorporated by reference in its entirety to the same extent as if each individual patent, patent application, and/or publication was specifically and individually indicated to be incorporated by reference.diagram of a digital camera that includes multiple channels, under an embodiment.

[0009] FIG. 1 is a block diagram of a conventional digital camera.

[0010] FIG. 2 is a block diagram of a digital camera that includes multiple channels, under an embodiment.

[0011] FIG. 3 is a block diagram of a digital camera subsystem, under an embodiment.

[0012] FIG. 4 is a digital camera subsystem, under an alternative embodiment.

[0013] FIG. 5 is a digital camera subsystem, under another alternative embodiment.

[0014] FIG. 6 is a digital camera subsystem, under still another alternative embodiment.

[0015] FIG. 7 is a block diagram of a method for forming images having a large dynamic range, under an embodiment.

[0016] FIG. 8 is a block diagram of a digital camera, under an embodiment.

[0017] FIG. 9 is an exploded view of a digital camera subsystem, under an embodiment.

[0018] FIG. 10 is a block diagram of a digital camera having a three array/lens configuration, under an embodiment.

[0019] FIG. 11 is a block diagram of a digital camera subsystem that employs separate arrays on one image sensor, under an embodiment.

[0020] FIG. 12 is a block diagram of arrays, each of which receives a respective color as passed by a respective lens, under an embodiment.

[0021] FIG. 13 is a block diagram of processing circuitry of a digital camera subsystem, under an embodiment.

[0022] FIG. 14 is a block diagram of signal processing circuitry, under an embodiment.

[0023] FIG. 15 is an exploded perspective view of a digital camera, under an embodiment.

[0024] FIGS. 16A-16D are schematic exploded representations of one embodiment of an optics portion, under an embodiment.

[0025] FIGS. 17A-17C are schematic representations of a sensor array, under an embodiment.

[0026] FIG. 18 is a schematic cross-sectional view of a digital camera apparatus, under an embodiment.

[0027] FIG. 19 is a schematic perspective view of a digital camera apparatus having one or more optics portions with the capability to provide color separation, under an embodiment.

[0028] FIG. 20A is a block diagram of a processor of a digital camera subsystem, under an embodiment.

[0029] FIG. 20B is a block diagram of a channel processor of a digital camera subsystem, under an embodiment.

[0030] FIG. 20C is a block diagram of an image pipeline of a digital camera subsystem, under an embodiment.

[0031] FIG. 20D is a block diagram of an image post processor of a digital camera subsystem, under an embodiment.

[0032] FIG. 21 is a block diagram of digital camera system, including system control components, under an embodiment.

DETAILED DESCRIPTION

[0033] Digital camera systems and methods are described below that provide an expanded effective single-frame dynamic exposure range. The digital camera systems and methods, collectively referred to herein as digital camera systems, generally include two or more camera channels. Each channel includes an optics component and an image sensor having an active area including multiple picture elements (pixels). Each sensor is controlled under or with an independent signal integration time as described in detail below. Image capture by the camera is performed using the multiple camera channels, and each camera channel is controlled during a frame under an independent integration time. The integration time for each channel can be automatically controlled and/or controlled in response to a user input. A wide range of integration times are available for use in an embodiment. The images obtained in each channel under the different integration times are obtained simultaneously or nearly simultaneously, so undesirable temporal aliasing from moving scenes or camera motion is minimized.

[0034] The digital camera systems, through the use of multiple integration times, enable formation of an image having a wide dynamic range by combining the data from all camera channels to form a composite single frame. The wide dynamic range of an embodiment is generally greater that the dynamic range obtained by a conventional digital camera with a single image sensor channel and one integration time.

[0035] Conventional digital cameras may have a maximum photo-signal storage capacity that limits the dynamic range of the particular system. The photo-signal charge is stored on a

capacitor within the pixel area. The charge handling capacity is limited by the maximum voltage swing in the integrated circuitry and the storage capacitance within the pixel. The amount of integrated photo-charge is directly related to the time the image sensor collects and integrates signal from the scene. This is known as integration time. A long integration time is desired for weak signals since more photo-charge is integrated within the pixel and the signal-to-noise of the digital camera is improved. Once a maximum charge capacity is reached, the sensor no longer senses image brightness resulting in data loss. Therefore, the use of a single integration time for the entire field of view creates an imaging dilemma in conventional cameras. The digital camera integration time can be set to image low light levels and saturate bright signals or image high light levels and not detect low light levels (since the integrated photo-charge from low light levels is below the signal-to-noise of the sensor).

[0036] The digital cameras described herein overcome this dynamic range limitation through the use of multiple camera channels, including multiple optics and image sensors on a single integrated circuit (IC) or semiconductor substrate. The multiple camera channels are configured to image the same field of view simultaneously, and each operates independently under a different integration time. The digital camera can include, for example, a 3 by 3 assembly of image sensors, perhaps three sensor of each color (e.g., red (R), green (G), and blue (B)) and the integration time of the sensors associated with each color can be varied, for example, each color can have three distinct values (e.g., 0.1 msec, 1 msec, and 10 msec integration time, respectively). The data from all sensors can be digitally combined to provide a much greater dynamic range within one frame of digital camera data. The raw digital camera data could be used by digital signal processing of the scene. The digital data can also be stored and displayed to exhibit low light or bright light characteristics as desired.

[0037] Exposure is the total amount of light allowed to fall on a sensor during the process of taking a photograph. Exposure control is control of the total amount of light incident on a sensor during the process of taking a photograph.

[0038] In contrast to exposure control, which is used by conventional digital cameras to manage dynamic range, the digital camera systems of an embodiment use integration time control to control the time the electrical signal is integrated on a charge storage device

(capacitance) within a sensor (pixel), as described herein. Integration time control, also referred to as "focal plane shutter" control, controls the time the electrical signal is integrated or accumulated by controlling a switch (e.g., charge integration switch) coupled or connected to the sensor or a photo-detection mechanism of a sensor. For example, the charge integration switch is placed in a state to allow charge to accumulate within the sensor for a period of time approximately equal to the integration time corresponding to that sensor; upon completion of the integration period, the switch is placed in a state to transfer the accumulated charge as a photo-signal to a processing component. Digital camera components or circuitry are configured to allow independent control of the charge integration switch associated with each sensor, thereby making possible dynamic range control for each sensor. The integration time control can be executed (depending on readout configuration) according to a number of techniques, for example, rolling mode and/or snap-shot mode to name a few.

[0039] Generally, the digital camera systems of an embodiment provide digital cameras with large effective single-frame dynamic exposure ranges. The digital camera systems include multiple channels. Each channel includes an optics component and sensor comprising an array of photo-detectors. The sensors of the camera channels are integrated on a semiconductor substrate. The camera systems include a processing component coupled to the channels. The processing component is configured to separately and simultaneously control an integration time of each channel. The integration time of at least one channel is controlled relative to the integration time of at least one other channel so that an image formed by combining data of a frame received simultaneously from the channels has a relatively large dynamic range.

[0040] A digital camera according to an embodiment includes multiple (e.g., two or more) closely spaced image sensor camera channels integrated on or in a common semiconductor substrate. Each sensor camera channel has its own optics, photo-detection and readout mechanism that includes a plurality of picture elements (pixels) with independent signal integration time control. The pixel area, including photo-detector and circuitry, can be as small as 2 μm by 2 μm but is not so limited. The individual camera channels of an embodiment look at the same field of view.

[0041] Each image sensor camera channel for example includes a plurality of pixels, wherein at least two channels may be individually interrogated, for example, the channels can independently be reset, integrate charge for a predetermined and unique time period, and read out. The digital camera further comprises circuitry and/or algorithms for individually interrogating the camera image sensor camera channels, for combining output values of said subsets into combined output values to from a high dynamic range composite image within a single frame of data, and for electrically outputting said composite image.

[0042] The digital camera systems and methods of an embodiment use a range of integration times, T_{long} to T_{short}, for each channel to increase significantly the dynamic range of the digital camera, while insuring a signal overlap between the images. For example, the dynamic range of a digital camera using the methods described herein can be increased from approximately 70 dB to 90 dB using a ratio of T_{long}/T_{short} equal to 25. The use of a long integration time in one camera channel allows dark objects to be detected, whereas very bright objects are not, due to saturation of the corresponding pixels storage capacity. In contrast, the use of a short integration time in another channel enables detection of bright objects, whereas very dark objects are not detected due to a weak signal below the noise floor of the pixel. The digital camera systems and methods described below suitably combine the output signals of both exposures to increase the dynamic range of the digital camera.

[0043] The sensor camera channel output values P_{short} to P_{long}, measured with different exposure times, of the camera system described below may not be related ideally through the ratio ($t=T_{long}/T_{short}$), for example, P_{long} may be close to but not identical with $t\text{-}P_{short}$ due to non-linear photo-response. For this reason the methods of an embodiment include algorithms that combine the two values to form a large dynamic range composite image in a manner that does not lead to image artifacts and pattern noise.

[0044] FIG. 1 is a block diagram of a conventional digital camera 100. The digital camera 100 includes a lens assembly 110, a color filter array layer 112, an image sensor 116, and an electronic image storage media 120. The camera 100 also includes a power supply 124, a peripheral user interface (represented as a shutter button) 132, a circuit board 136 (which supports and electrically interconnects the aforementioned components), a housing 140 (including housing portions 141, 142, 143, 144, 145 and 146) and a shutter assembly (not

shown), which controls an aperture 150 and passage of light into the digital camera 100. A mechanical frame 164 is used to hold the various parts of the lens assembly 110 together. The lens assembly 110 includes lenses 161 and 162 and one or more electro-mechanical devices 163 to move the lenses 161 and 162 along a center axis 165. The lenses 161 and 162 can be made up of multiple elements arranged together to in any combination to form an integral optical component. Additional lenses can be used if necessary. The electromechanical device 163 portion of the lens assembly 110 and the mechanical frame 164 portion of the lens assembly 110 can include numerous components and/or complex assemblies.

[0045] The color filter array layer 112 has an array of color filters arranged in a Bayer pattern (e.g., a 2 by 2 matrix of colors with alternating red and green in one row and alternating green and blue in the other row, although other colors may be used). The Bayer pattern is repeated throughout the color filter array. In some imaging applications, such as broadband visible imaging color filter layers 112 are not required. In other color imaging applications different color filters are used or color separation capability is built into the image sensor detection mechanism.

[0046] The image sensor 116 contains a plurality of identical photo detectors (alternatively referred to as "picture elements" or "pixels") arranged in a matrix. The number of photo detectors is usually in a range of hundreds of thousands to millions. The lens assembly 110 spans the diagonal of the array.

[0047] Each of the color filters in the color filter array 112 is disposed above a respective one of the photo detectors in the image sensor 116, such that each photo detector in the image sensor receives a specific band of visible light (e.g., red, green or blue) and provides a signal indicative of the color intensity of the respective band. Signal processing circuitry (not shown) receives signals from the photo detectors, processes the signals, and ultimately outputs a color image.

[0048] The peripheral user interface 132, which includes the shutter button, can further include one or more additional input devices (e.g., for settings, controls and/or input of other information), one or more output devices, (e.g., a display for output of images or other information) and associated electronics.

[0049] FIG. 2 is a block diagram of a digital camera 200 that includes multiple channels, under an embodiment. The digital camera 200 includes a digital camera subsystem 210 and an electronic image storage media 220. The digital camera 200 also includes a power supply 224, a peripheral user interface (represented as a shutter button) 232, a circuit board 236 (which electrically interconnects and/or supports one or more components), a housing 240 (including housing portions 241, 242, 243, 244, 245 and 246) and a shutter assembly (not shown), which controls an aperture 250 and passage of light into the digital camera 200.

[0050] The digital camera subsystem 210, also referred to herein as the "DCS" 210, includes one or more camera channels (e.g., four camera channels 260A-260D) and replaces (and/or fulfills one, some or all of the roles fulfilled by) the lens assembly 110, the color filter 112 and the image sensor 116 of the digital camera 100 described above. The four camera channels 260A-260D have a configurable or selectable signal integration time control that can be made optimal for a range of incident optical signal levels. The combination of signals from the four camera channels representing the varying integration times allow a greater range of incident photo-signal levels to be detected. Each camera channel, working in conjunction with a selected or programmed integration time, can be optimized to collect an incident light range; for example the optical f-number, photo-detector design, in-pixel circuitry and readout circuitry can be selected for low, medium or high light levels.

[0051] The peripheral user interface 232, which includes the shutter button, may further include one or more additional input devices (e.g., for settings, controls and/or input of other information), one or more output devices, (e.g., a display for output of images or other information) and associated electronics.

[0052] The electronic image storage media 220, power supply 224, peripheral user interface 232, circuit board 236, housing 240, shutter assembly (not shown), and aperture 250, may be, for example, similar to the electronic image storage media 120, power supply 124, peripheral user interface 132, circuit board 136, housing 140, shutter assembly (not shown), and aperture 150 of the digital camera 100 described above.

[0053] FIG. 3 is a block diagram of a digital camera subsystem 210, under an embodiment. As described above, the subsystem 210 includes one or more camera channels. The digital

camera subsystem 210 for example is a four channel signal integration time control system (e.g., four camera channels 260A-260D), but the embodiment is not limited to four channels and can include any number of camera channels. Each of the camera channels 260A-260D includes an optics component or portion and a sensor component or portion. The optics component can have different optical f-number among the included camera channels but is not so limited. For example, camera channel 260A includes an optics portion 290A and a sensor portion 292A. Camera channel B includes an optics portion 290B and a sensor portion 292B. Camera channel C includes an optics portion 290C and a sensor portion 292C. Camera channel D includes an optics portion 290D and a sensor portion 292D. The optics portions of the one or more camera channels are collectively referred to herein as an optics subsystem. The sensor portions of the one or more camera channels are collectively referred to herein as a sensor subsystem. Each camera channel has a selectable integration, and the integration time setting between channels is selected to cover a range of incident light level onto the digital camera.

[0054] In the digital camera subsystem 210, each channel can have the same configuration or a different configuration relative to at least one other channel of the subsystem 210. For example, in some embodiments, the camera channels are all identical to one another. In some other embodiments, one or more of the camera channels are different, in one or more respects, from one or more of the other camera channels. In some of the latter embodiments, each camera channel may be used to detect a different color (or band of colors) and/or band of light than that detected by the other camera channels. For example, in some embodiments, one of the camera channels (e.g., camera channel 260A) detects red light, one of the camera channels (e.g., camera channel 260B) detects green light, and one of the camera channels (e.g., camera channel 260C) detects blue light; any other color combinations can also be used. The color detection capability can be provided by optical materials, color filter layers over the detector, and/or color separation mechanisms built into the photo-detector structure.

[0055] Thus, the optics portions can each be the same or different relative to other optics portions. In some embodiments, all optics portions are identical. In some other embodiments, one or more of the optics portions are different, in one or more respects, from one or more of the other optics portions. For example, in some embodiments, one or more of the

characteristics (for example, but not limited to, its type of element(s), size, and/or performance) of one or more of the optics portions is tailored to the respective sensor portion and/or to help achieve a desired result. For example, if a particular camera channel is dedicated to a particular color (or band of colors) or wavelength (or band of wavelengths) then the optics portion for that camera channel may be adapted to transmit only that particular color (or band of colors) or wavelength (or band of wavelengths) to the sensor portion of the particular camera channel and/or to filter out one or more other colors or wavelengths.

[0056] Similar to the optics portion, if the digital camera subsystem 210 includes more than one sensor portion, configurations of the sensor portions can be the same or different relative to one or more other sensor portions. In some embodiments, the sensor portions are similar or identical to the other sensor portions. In some other embodiments, one or more of the sensor portions are different, in one or more respects, from one or more of the other sensor portions. In some embodiments, for example, one or more of the characteristics (for example, but not limited to, its type of element(s), size, and/or performance) of one or more of the sensor portions is tailored to the respective optics portion and/or to help achieve a desired result. For example, if a particular camera channel is dedicated to a particular color (or band of colors) or wavelength (or band of wavelengths) then the sensor portion for that camera channel may be adapted to have a sensitivity that is higher to that particular color (or band of colors) or wavelength (or band of wavelengths) than other colors or wavelengths and/or to sense only that particular color (or band of colors) or wavelength (or band of wavelengths). The sensor portion for that camera may be adapted for optimized operation by features such as array size, pixel size, pixel design, image sensor design, image sensor integrated circuit process and electrical circuit operation.

[0057] The digital camera subsystem 210 further includes a processor. The processor includes an image processor portion 270 (referred to as image processor 270) and an integration time controller portion 300 (referred to as controller 300). The controller is a component of the variable integration time that provides integration time control for each of the camera channels. The processor 270 is coupled or connected to the one or more sensor portions (e.g., sensor portions 292A-292D) via one or more communication couplings or links, represented by a signal line 330. A communication link may be any kind of

communication link including but not limited to, for example, wired (e.g., conductors, fiber optic cables) links, wireless links (e.g., acoustic links, electromagnetic links, and/or any combination of links including but not limited to microwave links, satellite links, infrared links), and/or combinations of wired and/or wireless links.

[0058] The operation of the digital camera subsystem 210 is described below. For example, the user selects a desired incident light range and the camera automatically adjusts the integration time setting between the camera channels to give an optimal dynamic range result. Alternatively the user can select an integration time for each camera channel. An optics portion of a camera channel receives light from within a field of view and transmits one or more portions of such light. The sensor portion receives one or more portions of the light transmitted by the optics portion and, in response, generates an output signal representative or indicative of information of the received light. The output signal from the sensor portion is coupled to the image processor 270 which, as is further described below, can generate an image based at least in part on the output signal from the sensor.

[0059] When the digital camera subsystem 210 includes more than one camera channel, the image processor 270 generates a combined image based at least in part on the images from two or more of the camera channels. For example, in an embodiment, each of the camera channels is dedicated to a different color (or band of colors) or wavelength (or band of wavelengths) relative to the other camera channels, and the image processor 270 combines the images from the two or more camera channels to provide a full-color large dynamic range image. In other embodiments, all camera channels provide the same color capability (such as RGB Bayer patterns on each color channel) and the image processor 270 combines the camera channels to create a large dynamic range image.

[0060] The image processor 270 can also combine sensor channels and analyze the resultant image on a frame by frame basis. The image processor 270 can send a signal to the integration time controller 300 for real-time, or near real-time, dynamic range management by adjustment of each channel's integration time control. This same method can be used to optimize a subsequent single field exposure for optimal picture taking.

[0061] In the digital camera subsystem 210 of an embodiment, the four camera channels 260A-260D are configured to detect RGB light. Each of the camera channels can be identical in configuration or optimized for a specified light level as described above; for example if camera channel 260A is intended to detect dim light the optics f-number in that channel could be reduced. The pixel photo-detector can be configured for low dark current and the pixel circuitry configured for low noise. The integration time control on camera channel 260A is increased to allow increased signal collection. Some pixels in channel 260A would saturate due to incident light levels; this would be determined electrically and data from those pixels would not be used in creating a composite image. Channels 260B-260D would be configured and operated in a similar fashion to sense larger incident light levels.

[0062] In the digital camera subsystem 210 of another alternative embodiment, the four camera channels 260A-260D are configured to provide different imaging capability; for example channel 260A is configured to detect red and blue light, while channel 260B is configured to detect green light. The combined response from channels 260A and 260B of this embodiment thus comprises a RGB color camera. The integration time settings for channels 260A and 260B are configured or set for low incident light levels. Camera channel 260C is configured to collect red and blue light and channel 260D is configured to collect green light. The combined images of channels 260C and 260D generate a second RGB imaging capability and the integration time of channels 260C and 260D is configured for high incident light levels.

[0063] In the digital camera subsystem 210 of yet another alternative embodiment, camera channel 260A is configured for red light, camera channel 260B is configured for green light, and camera channel 260C is configured for blue light. Camera channels of a single color can provide superior low light response since the color transmission with each channel is high (high transmission color filters within the optical path) and the photo-detection mechanism in each camera channel is configured or set for a specific color for high responsivity. The combined response from channels 260A, 260B and 260C thus comprises a RGB color camera. The integration time settings for channels 260A, 260B and 260C are configured for low incident light levels. Camera channel 260D is configured for RGB light detection and the integration time of that channel configured or set for high incident light levels. Various other

combinations of integration times among the channels are possible under the description herein.

[0064] FIG. 4 is a digital camera subsystem 410, under an alternative embodiment. The digital camera subsystem 410 for example is a three channel signal integration time control system (e.g., three camera channels 260A-260C), but the embodiment is not limited to three channels and can include any number of camera channels. The digital camera subsystem 410 includes camera channel 260A configured for RGB light, camera channel 260B configured for RGB light, and camera channel 260C configured for RGB light. The integration time of camera channel 260A is configured for low light, the integration time of camera channel 260B is configured for medium high, and the integration time of camera channel 260C is configured for high incident light levels. The combined response from camera channels 260A, 260B and 260C provides a large dynamic range imaging capability.

[0065] The digital camera subsystem 410 of one alternative configuration is a three channel system in which camera channel 260A is configured for RGB light, camera channel 260B is configured for RGB light, and camera channel 260C is configured for RGB light. The integration time of camera channel 260A is configured for medium light, the integration time of camera channel 260B is configured for medium high, and the integration time of camera channel 260C is configured for high incident light levels. The combined response from camera channels 260A, 260B and 260C provides a large dynamic range imaging capability. Various other combinations of integration times among the channels are possible under the description herein.

[0066] While the triangular layout configuration of the three camera channels 260A-260C can provide area reduction advantages in imager layout and processing on semiconductor wafers, and can provide optical symmetry between the channels, alternative layout configurations are possible using the three camera channels. For example, one alternative layout includes a 1 by 3 vertical configuration. Another alternative layout includes a 1 by 3 horizontal configuration.

[0067] FIG. 5 is a digital camera subsystem 510, under another alternative embodiment. The digital camera subsystem 510 for example is a two channel signal integration time

control system (e.g., two camera channels 260A-260B), but the embodiment is not limited to two channels and can include any number of camera channels. The digital camera subsystem 510 includes camera channel 260A configured for RGB light and camera channel 260B configured for RGB light. The integration time of camera channel 260A is configured or set for low light and camera channel 260B is configured for high incident light levels. The combined response from camera channels 260A and 260B provides a large dynamic range imaging capability. Alternative configurations of the two camera channels include a 1 by 2 vertical layout and a 1 by 2 diagonal layout of camera channels.

[0068] The digital camera subsystem 510 of one alternative configuration is a two channel system in which camera channel 260A is configured for RGB light and camera channel 260B is configured for RGB light. The integration time of camera channel 260A is configured or set for low light and camera channel 260B is configured for medium incident light levels. The combined response from camera channels 260A and 260B provides a large dynamic range imaging capability.

[0069] The digital camera subsystem 510 of another alternative configuration is a two channel system in which camera channel 260A is configured for RGB light and camera channel 260B is configured for RGB light. The integration time of camera channel 260A is configured or set for medium light and camera channel 260B is configured for high incident light levels. The combined response from camera channels 260A and 260B provides a large dynamic range imaging capability. Various other combinations of integration times among the channels are possible under the description herein.

[0070] FIG. 6 is a digital camera subsystem 610, under still another alternative embodiment. The digital camera subsystem 610 is a six channel signal integration time control system (e.g., six camera channels 260A-260F), but the embodiment is not limited to six channels and can include any number of camera channels. The digital camera subsystem 610 includes camera channel 260A configured for incident red light, camera channel 260B configured for green light, and camera channel 260C configured for blue light. The combined response from camera channels 260A, 260B and 260C provides a first RGB color camera. The integration time settings for camera channels 260A, 260B and 260C are configured for low incident light levels.

[0071] The digital camera subsystem 610 also includes camera channel 260D configured for incident red light, camera channel 260E configured for green light, and camera channel 260F configured for blue light. The combined response from camera channels 260D, 260E and 260F provides a second RGB color camera. The integration time settings for camera channels 260D, 260E and 260F are configured for high incident light levels.

[0072] The digital camera system described above includes a method for forming images having a large dynamic range. FIG. 7 is a block diagram for forming images 700 having a large dynamic range, under an embodiment. The method for forming images 700 can be implemented using the image processor 270 and/or the 300 integration time controller as described above with reference to FIGS. 3-6. The method of an embodiment includes selecting 702 an integration time for each image sensor camera channel from a range of integration times. The photo-signal from each camera channel is integrated 704 within a single frame of data, and the resultant photo-charge for each pixel is stored within that pixel. The photo-signal is read from each pixel and each pixel response is corrected 706 for one or more of non-linearity, gain and offset as appropriate and/or required. The method combines 708 data of the multiple camera channels, and thus provides a continuous monotonic representation of the combined pixel response from low to high incident light levels. The method of an embodiment includes processing (e.g. post-processing), storing, displaying and/or outputting the resultant large dynamic range image from the combined camera channels. Information of the resultant image and/or any post-processing operations is used to determine integration time control settings 710 that provide optimum dynamic range on subsequent frames of data but is not so limited.

[0073] FIGS. 8-21 illustrate further examples of apparatus and systems in which the imaging module and focusing method embodiments disclosed above can be implemented. FIG. 8 is a block diagram of a digital camera 800, under an embodiment. The digital camera includes a digital camera subsystem 802, a circuit board 812, a peripheral user interface electronics 810 (here represented as a shutter button, but could also include display and/or one or more other output devices, setting controls and/or one or more additional input devices etc), a power supply 806, and electronic image storage media 804. The digital camera 800

may further include a housing and a shutter assembly (not shown), which controls an aperture 814 and passage of light into the digital camera 800.

[0074] FIG. 9 is an exploded view of the digital camera subsystem 802, under an embodiment. In this embodiment, the digital camera subsystem includes an image sensor 904, an optics frame (also referred to as a frame) 902, and lenses 912A-912D. The frame 902 is used to mount the lenses 912A-912D to the image sensor 904. The image sensor, or imager die 904 generally includes a semiconductor integrated circuit or "chip" having several higher order features including multiple arrays 904A-904D and signal processing circuits 908 and 910. Each of the arrays 904A-904D captures photons and outputs electronic signals. The signal processing circuit 908, in certain embodiments, processes signals for each of the individual arrays 904. The signal processing circuit 910 may combine the output from signal processing 908 into output data (usually in the form of a recombined full color image). Each array and the related signal processing circuitry may be tailored to address a specific band of visible spectrum.

[0075] Each of lenses 912A-912D may be tailored for the respective wavelength of the respective array. Lenses are approximately the same size as the underlying array 904, and will differ from one another in size and shape depending upon the dimensions of the underlying array. In alternative embodiments a lens could cover only a portion of an array, and could extend beyond the array. Lenses can comprise any suitable material or materials, including for example, glass and plastic. Lenses can be doped in any suitable manner, such as to impart a color filtering, polarization, or other property. Lenses can be rigid or flexible.

[0076] In the example of FIG. 9, each lens, array, and signal processing circuit constitutes an image generating subsystem for a band of visible spectrum (e.g., red, blue, green, etc). These individual images are then combined with additional signal processing circuitry within the semiconductor chip to form a full image for output.

[0077] Although the digital camera subsystem 904 is depicted in a four array/lens configuration, the digital camera subsystem can be employed in a configuration having any number of arrays/lenses and any combination of shapes of arrays/lenses. FIG. 10 is a block diagram of a digital camera 1000 having a three array/lens configuration, under an

embodiment. The digital camera 1000 includes a digital camera subsystem 1002 that includes three lenses. The digital camera 1000 further includes a circuit board 1012, a peripheral user interface electronics 1010 (here represented as a shutter button, but could also include display and/or one or more other output devices, setting controls and/or one or more additional input devices etc), a power supply 1006, and electronic image storage media 1004. The digital camera 1000 may further include a housing and a shutter assembly (not shown), which controls an aperture 1014 and passage of light into the digital camera 1000.

[0078] FIG. 11 is a block diagram of a digital camera subsystem that employs separate arrays, e.g., arrays 1104A-1104D, on one image sensor, in contrast to the prior art. For example, typical prior art approaches employ a Bayer pattern (or variations thereof), perform operations across the array (a pixel at a time), and integrate each set of four pixels (for example, red/green/blue/green or variation thereof) from the array into a single full color pixel.

[0079] Each of the arrays 1104 focuses on a specific band of visible spectrum. Each lens only needs to pass a respective color (1106A-1106D) on to the image sensor. The traditional color filter sheet is eliminated. Each array 1104 outputs signals to signal processing circuitry. Signal processing circuitry for each of these arrays is also tailored for each of the bands of visible spectrum. In effect, individual images are created for each of these arrays. Following this process, the individual images are combined or to form one full color or black/white image. By tailoring each array and the associated signal processing circuitry, a higher quality image can be generated than the image resulting from traditional image sensors of like pixel count.

[0080] As such, each array may be tuned to be more efficient in capturing and processing the image in that particular color. Individual lenses (1112A-D) can be tailored for the array's band of spectrum.

[0081] FIG. 12 is a block diagram of arrays 1204A-1204D. Each array 1204 receives a respective color as passed by a respective lens. The traditional color filter sheet is eliminated. Each array 1204 outputs signals to signal processing circuitry. Signal processing circuitry for each of these arrays is also tailored for each of the bands of visible spectrum. In effect,

individual images are created for each of these arrays. Following this process, the individual images are combined or to form one full color or black/white image. By tailoring each array and the associated signal processing circuitry, a higher quality image can be generated than the image resulting from traditional image sensors of like pixel count.

[0082] FIG. 13 is a block diagram of processing circuitry of a digital camera subsystem, under an embodiment. FIG. 13 includes an array 1304, including arrays 1304A-1304D, and signal processing circuitry (also referred to as image processing circuitry) 1414 and 1416. Each array outputs signals to signal processing circuitry.

[0083] FIG. 14 is a block diagram of image processing circuitry 1414 and 1416. Within the image processing circuitry 1414, each array can be processed separately to tailor the processing to the respective bands of spectrum.

[0084] Column logic 1414.1A-1414.1D is the portion of the signal processing circuitry that reads the signals from the pixels. For example, the column logic 1414.1A reads signals from the pixels in array 1404A. Column logic 1414.1B reads signals from the pixels in array 1404B. Column logic 1414.1C reads signals from the pixels in array 1404C. Column logic 1414.1D reads signals from the pixels in array 1404D.

[0085] Since an array is targeting a specific wavelength, wavelengths, band of wavelength, or band of wavelengths, the column logic may have different integration times for each array enhancing dynamic range and/or color specificity. Signal processing circuitry complexity for each array can be substantially reduced since logic may not have to switch between extreme color shifts.

[0086] Analog Signal Logic (ASL) 1414.2A-1414.2D for each array may be color specific. As such, the ASL processes a single color and therefore can be optimized for gain, noise, dynamic range, linearity, etc. Due to color signal separation, dramatic shifts in the logic and settling time are not required as the amplifiers and logic do not change on a pixel by pixel (color to color) basis as in traditional Bayer patterned designs.

[0087] Black level control 1414.3A-1414.3D assesses the level of noise within the signal, and filters it out. With each array focused upon a narrower band of visible spectrum than traditional image sensors, the black level control can be more finely tuned to eliminate noise.

[0088] Exposure control 1414.4A-1414.4D measures the overall volume of light being captured by the array and adjusts the capture time for image quality. Traditional cameras must make this determination on a global basis (for all colors). The embodiments describe herein allow for exposure control to occur differently for each array and targeted band of wavelengths.

[0089] These processed images are then passed to a second group of signal processing circuitry 1416. First, image processing logic 1416.1 integrates the multiple color planes into a single color image. The image is adjusted for saturation, sharpness, intensity, hue, artifact removal, and defective pixel correction.

[0090] In an embodiment, the final two operations include encoding the signal into standard protocols such as MPEG, JPEG, etc. in an encoder 1416.2 before passing the result to a standard output interface 1416.3, such as USB.

[0091] Although the signal processing circuitries 1414 and 1416 are shown at specific areas of the image sensor, the signal processing circuitries 1414 and 1416 can be placed anywhere on the chip and subdivided in any fashion. The signal processing circuitries are often placed in multiple locations.

[0092] As previously stated, the image sensor 1404 generally includes a semiconductor chip having several higher order features including multiple arrays (1404A-1404D), and signal processing circuitry 1414, in which each array and the related signal processing circuitry is preferably tailored to address a specific band of visible spectrum. As noted above, the image sensor array can be configured using any multiple numbers and shapes of arrays.

[0093] The image sensor 1404 can be constructed using any suitable technology, including silicon and germanium technologies. The pixels can be formed in any suitable manner, can be sized and dimensioned as desired, and can be distributed in any desired pattern. Pixels that are distributed without any regular pattern may also be used.

[0094] Any range of visible spectrum can be applied to each array depending on the specific interest of the customer. Further, an infrared array could also be employed as one of the array/lens combinations giving low light capabilities to the sensor.

[0095] As previously described, arrays 1404A-1404D may be of any size or shape. While some figures referenced herein show the arrays as individual, discrete sections of the image sensor, these arrays may also be touching. There may also be one large array configured such that the array is subdivided into sections, and each section is focused upon one band of spectrum, creating the same effect as separate arrays on the same chip.

[0096] Although the well depth of the photo detectors across each individual array 1404 may be the same, the well depth of any given array may be different from that of other arrays of the sensor subsystem. A photo detector includes an area or portion of the photo detector that captures, collects, is responsive to, detects and/or senses the intensity illumination of incident light. In some embodiments, the well depth is the distance from the surface of the photo detector to a doped region.

[0097] Selection of an appropriate well depth depends on many factors, including the targeted band of visible spectrum. Since each entire array is likely to be targeted at one band of visible spectrum (e.g., red) the well depth can be configured to capture that wavelength and ignore others (e.g., blue, green). Doping of the semiconductor material in the color specific arrays can further be used to enhance the selectivity of the photon absorption for color-specific wavelengths.

[0098] In various embodiments, a digital camera subsystem can have multiple separate arrays on a single image sensor, each with its own lens. The simple geometry of smaller, multiple arrays allows for a smaller lenses (e.g., smaller diameter, thickness and focal length), which allows for reduced stack height in the digital camera.

[0099] The lens and frame concept is applicable to traditional image sensors (without the traditional color filter sheet) to gain physical size, cost and performance advantages.

[0100] Each array can advantageously be focused on one band of visible and/or detectable spectrum. Among other things, each lens may be tuned for passage of one specific band of

wavelength. Since each lens would therefore not need to pass the entire light spectrum, the number of elements may be reduced, for example, to one or two.

[0101] Further, due to the focused bandwidth for each lens, each of the lenses may be dyed during the manufacturing process for its respective bandwidth (e.g., red for the array targeting the red band of visible spectrum). Alternatively, a single color filter may be applied across each lens. This process eliminates the traditional color filters (such as the sheet of individual pixel filters) thereby reducing cost, improving signal strength and eliminating the pixel reduction barrier.

[0102] The above-described devices can include any suitable number of combinations, including as few as two arrays/lenses, and many more than two arrays/lenses. Examples include: two arrays/lenses configured as red/green and blue; two arrays/lenses configured as red and blue/green; two arrays/lenses configured as red, green, blue; four arrays/lenses configured as red, blue, green, emerald (for color enhancement); four arrays/lenses configured as red, blue, green, infrared (for low light conditions); and eight arrays/lenses configured as double the above configurations for additional pixel count and image quality.

[0103] The cameras or camera subsystems described herein are intended to be emblematic of a generic appliance containing the digital camera subsystem. Thus, the description herein should be interpreted as being emblematic of still and video cameras, cell phones, other personal communications devices, surveillance equipment, automotive applications, computers, manufacturing and inspection devices, toys, plus a wide range of other and continuously expanding applications. Of course these alternative interpretations may or may not include the specific components as depicted herein. For example, the circuit board may not be unique to the camera function but rather the digital camera subsystem may be an add-on to an existing circuit board, such as in a cell phone.

[0104] Any or all of the methods and/or apparatus disclosed herein may be employed in any type of apparatus or process including, but not limited to still and video cameras, cell phones, other personal communications devices, surveillance equipment, automotive applications, computers, manufacturing and inspection devices, toys, plus a wide range of other and continuously expanding applications.

[0105] Although each array and the related signal processing circuitry is can be tailored to address a specific band of visible spectrum, and each lens may be tuned for passage of that one specific band of wavelength, there is no requirement that each such array and the related signal processing circuitry be tailored to address a specific band of the visible spectrum. Nor is there any requirement that each lens be tuned for passage of a specific band of wavelength or that each of the arrays be located on the same semiconductor device. Indeed, the embodiments described and illustrated herein, including the specific components thereof, need not employ wavelength-specific features. For example, the arrays and/or signal processing circuitry need not be tailored to address a specific wavelength or band of wavelengths.

[0106] FIG. 15 is an exploded perspective view of a digital camera 1500, under an embodiment. The digital camera apparatus 1500 includes one or more sensor arrays, e.g., four sensor arrays 1504A-1504D, and one or more optics portions, e.g., four optics portions 1512A-1512D. Each of the optics portions 1504A-1504D may include a lens, and may be associated with a respective one of the sensor arrays sensor arrays 1504A-1504D. In some embodiments a support 1502, for example a frame, is provided to support the one or more optics portions 1512A-1512D, at least in part. Each sensor array and the respective optics portion may define an optical channel. For example, an optical channel 1506A may be defined by the optics portion 1512A and the sensor array 1504A. An optical channel 1506B may be defined by the optics portion 1512B and the sensor array 1504B. An optical channel 1506C may be defined by optics portion 1512C and the sensor array 1504C. An optical channel 1506D may be defined by optics portion 1512D and a sensor array 1504D. The optics portions of the one or more optical channels are also collectively referred to as an optics subsystem.

[0107] The sensor arrays of the one or more optical channels are collectively referred as a sensor subsystem. The two or more sensor arrays may be integrated in or disposed on a common substrate, referred to as an image device, on separate substrates, or any combination thereof. For example, where the system includes three or more sensor arrays, two or more sensor arrays may be integrated in a first substrate, and one or more other sensor arrays may be integrated in or disposed on a second substrate.

[0108] In that regard, the one or more sensor arrays 1504A-1504D, may or may not be disposed on a common substrate. For example, in some embodiments two or more of the sensor arrays are disposed on a common substrate. In some embodiments, however, one or more of the sensor arrays is not disposed on the same substrate as one or more of the other sensor arrays. The one or more optical channels may or may not be identical to one another.

[0109] In some embodiments, one of the optical channels 1506 detects red light, one of the optical channels 1506 detects green light, and one of the optical channels 1506 detects blue light. In some of such embodiments, one of the optical channels 1506 detects infrared light, cyan light, or emerald light. In some other embodiments, one of the optical channels 1506 detects cyan light, one of the optical channels 1506 detects yellow light, one of the optical channels 1506 detects magenta light and one of the optical channels 1506 detects clear light (black and white). Any other wavelength or band of wavelengths (whether visible or invisible) combinations can also be used.

[0110] A processor 1514 is coupled to the one or more sensor arrays 1504A-1504D, via one or more communication links, e.g., communication links 1508A-1508D, respectively. A communication link may be any kind of communication link including but not limited to, for example, wired (e.g., conductors, fiber optic cables) or wireless (e.g., acoustic links, electromagnetic links or any combination thereof including but not limited to microwave links, satellite links, infrared links), and combinations thereof, each of which may be public or private, dedicated and/or shared (e.g., a network). A communication link may include for example circuit switching or packet switching or combinations thereof. Other examples of communication links include dedicated point-to-point systems, wired networks, and cellular telephone systems. A communication link may employ any protocol or combination of protocols including but not limited to the Internet Protocol.

[0111] The communication link may transmit any type of information. The information may have any form, including, for example, but not limited to, analog and/or digital) e.g., a sequence of binary values, or a bit string). The information may or may not be divided into blocks. If divided into blocks, the amount of information in a block may be predetermined or determined dynamically, and/or may be fixed (e.g., uniform) or variable.

[0112] As will be further described hereinafter, the processor may include one or more channel processors, each of which is coupled to a respective one (or more) of the optical channels and generates an image based at least in part on the signal(s) received from the respective optical channel, although this is not required. In some embodiments, one or more of the channel processors is tailored to its respective optical channel, for example, as described herein. For example, when one of the optical channels is dedicated to a specific wavelength or color (or band of wavelengths or colors) the respective channel processor may be adapted or tailored to such wavelength or color (or band of wavelengths or colors). Further, the gain, noise reduction, dynamic range, linearity and/or any other characteristic of the processor, or combinations of such characteristics, may be adapted to improve and/or optimize the processor to such wavelength or color (or band of wavelengths or colors). Tailoring the channel processing to the respective optical channel may facilitate generating an image of a quality that is higher than the quality of images resulting from traditional image sensors of like pixel count. In addition, providing each optical channel with a dedicated channel processor may help to reduce or simplify the amount of logic in the channel processors as the channel processor may not need to accommodate extreme shifts in color or wavelength, e.g., from a color (or band of colors) or wavelength (or band of wavelengths) at one extreme to a color (or band of colors) or wavelength (or band of wavelengths) at another extreme.

[0113] In operation, an optics portion of a optical channel receives light from within a field of view and transmits one or more portions of such light, e.g., in the form of an image at an image plane. The sensor array receives one or more portions of the light transmitted by the optics portion and provides one or more output signals indicative thereof. The one or more output signals from the sensor array are supplied to the processor. In some embodiments, the processor generates one or more output signals based, at least in part, on the one or more signals from the sensor array. In some other embodiments, the processor may generate a combined image based, at least in part, on the images from two or more of such optical channels.

[0114] Although the processor 1514 is shown separate from the one or more sensor arrays 1504A-1504D, the processor 1514, or portions thereof, may have any configuration and may

be disposed in one or more locations. For example, certain operations of the processor may be distributed to or performed by circuitry that is integrated in or disposed on the same substrate or substrates as one or more of the one or more of the sensor arrays and certain operations of the processor are distributed to or performed by circuitry that is integrated in or disposed on one or more substrates that are different from (whether such one or more different substrates are physically located within the camera or not) the substrates the one or more of the sensor arrays are integrated in or disposed on.

[0115] The digital camera apparatus 1500 may or may not include a shutter, a flash and/or a frame to hold the components together.

[0116] FIGS. 16A-16D are schematic exploded representations of one embodiment of an optics portion, such as optic portion 1512A, under an embodiment. In FIG. 16A, the optics portion 1512A includes one or more lenses, e.g., a complex aspherical lens module 1680, one or more color coatings, e.g., a color coating 1682, one or more masks, e.g., an auto focus mask 1684, and one or more IR coatings, e.g., an IR coating 1686.

[0117] Lenses can comprise any suitable material or materials, including for example, glass and plastic. Lenses can be doped in any suitable manner, such as to impart a color filtering, polarization, or other property. Lenses can be rigid or flexible. In this regard, some embodiments employ a lens (or lenses) having a dye coating, a dye diffused in an optical medium (e.g., a lens or lenses), a substantially uniform color filter and/or any other filtering technique through which light passes to the underlying array.

[0118] The color coating 1682 helps the optics portion filter (or substantially attenuate) one or more wavelengths or bands of wavelengths. The auto focus mask 1684 may define one or more interference patterns that help the digital camera apparatus perform one or more auto focus functions. The IR coating 1686 helps the optics portion 1512A filter a wavelength or band of wavelength in the IR portion of the spectrum.

[0119] The one or more color coatings, e.g., color coating 1682, one or more masks, e.g., mask 1684, and one or more IR coatings, e.g., IR coating 1686 may have any size, shape and/or configuration.

[0120] In some embodiments, as shown in FIG. 16B, one or more of the one or more color coatings, e.g., the color coating 1682, are disposed at the top of the optics portion. Some embodiments of the optics portion (and/or components thereof) may or may not include the one or more color coatings, one or more masks and one or more IR coatings and may or may not include features in addition thereto or in place thereof.

[0121] In some embodiments, as shown in FIG. 16C, one or more of the one or more color coatings, e.g., the color coating 1682, are replaced by one or more filters 1688 disposed in the optics portion, e.g., disposed below the lens. In other embodiments, as shown in FIG. 16D, one or more of the color coatings are replaced by one or more dyes diffused in the lens.

[0122] The one or more optics portions, e.g., optics portions 1512A-1512D of FIG. 15, may or may not be identical to one another. In some embodiments, for example, the optics portions are identical to one another. In some other embodiments, one or more of the optics portions are different, in one or more respects, from one or more of the other optics portions. For example, in some embodiments, one or more of the characteristics (for example, but not limited to, its type of element(s), size, response, and/or performance) of one or more of the optics portions is tailored to the respective sensor array and/or to help achieve a desired result. For example, if a particular optical channel is dedicated to a particular color (or band of colors) or wavelength (or band of wavelengths) then the optics portion for that optical channel may be adapted to transmit only that particular color (or band of colors) or wavelength (or band of wavelengths) to the sensor array of the particular optical channel and/or to filter out one or more other colors or wavelengths. In some of such embodiments, the design of an optical portion is optimized for the respective wavelength or bands of wavelengths to which the respective optical channel is dedicated. It should be understood, however, that any other configurations may also be employed. Each of the one or more optics portions may have any configuration.

[0123] In some embodiments, each of the optics portions, e.g., optics portions 1512A-1512D of FIG. 15, comprises a single lens element or a stack of lens elements (or lenslets), although, as stated above. For example, in some embodiments, a single lens element, multiple lens elements and/or compound lenses, with or without one or more filters, prisms and/or masks are employed.

[0124] An optical portion can also contain other optical features that are desired for digital camera functionality and/or performance. For example, these features can include electronically tunable filters, polarizers, wavefront coding, spatial filters (masks), and other features not yet anticipated. Some of the features (in addition to the lenses) are electrically operated (such as a tunable filter), or are mechanically movable with MEMs mechanisms.

[0125] In some embodiments, one or more photochromic (or photochromatic) materials are employed in one or more of the optical portions. The one or more materials may be incorporated into an optical lens element or as another feature in the optical path, for example, above one or more of the sensor arrays. In some embodiments, photochromatic materials may be incorporated into a cover glass at the camera entrance (common aperture) to all optics (common to all optical channels), or put into the lenses of one or more optical channels, or into one or more of the other optical features included into the optical path of an optics portion over any sensor array.

[0126] FIGS. 17A-17C are schematic representations of one embodiment of a sensor array 1704. The sensor array is similar to one of the sensor arrays 1504A-1504D of FIG. 15, foe example. As shown in FIG. 17A, the sensor array 1704 is coupled to circuits 1770, 1772, and 1774. The sensor array sensor array 1704 captures light and converts it into one or more signals, such as electrical signals, which are supplied to one or more of the circuits 1770, 1772, and 1774. The sensor array 1704 includes a plurality of sensor elements such as for example, a plurality of identical photo detectors (sometimes referred to as "picture elements" or "pixels"), e.g., pixels $1780_{1,1}$-$1780_{n,m}$. The photo detectors $1780_{1,1}$-$1780_{n,m}$, are arranged in an array, for example a matrix-type array. The number of pixels in the array may be, for example, in a range from hundreds of thousands to millions. The pixels may be arranged for example, in a two-dimensional array configuration, for example, having a plurality of rows and a plurality of columns, e.g., 640 by 480, 1280 by 1024, etc. However, the pixels can be sized and dimensioned as desired, and can be distributed in any desired pattern. Pixels that are distributed without any regular pattern can also used. Referring to FIG. 17B, a pixel, for example pixel $1780_{1,1}$, may be viewed as having x and y dimensions, although the photon capturing portion of a pixel may or may not occupy the entire area of the pixel and may or may not have a regular shape. In some embodiments, the sensor elements are disposed in a

plane, referred to herein as a sensor plane. The sensor may have orthogonal sensor reference axes, including for example, an x-axis, a y-axis, and a z-axis, and may be configured so as to have the sensor plane parallel to the x-y plane XY and directed toward the optics portion of the optical channel. Each optical channel has a field of view corresponding to an expanse viewable by the sensor array. Each of the sensor elements may be associated with a respective portion of the field of view.

[0127] The sensor array may employ any type of technology, for example, but not limited to MOS pixel technologies (e.g., one or more portions of the sensor are implemented in "Metal Oxide Semiconductor" technology), charge coupled device (CCD) pixel technologies, or combination of both. The sensor array may comprise any suitable material or materials, including, but not limited to, silicon, germanium and/or combinations thereof. The sensor elements or pixels may be formed in any suitable manner.

[0128] In operation, the sensor array 1704A, is exposed to light on a sequential line per line basis (similar to a scanner, for example) or globally (similar to conventional film camera exposure, for example). After being exposed to light for certain period of time (exposure time), the pixels $1780_{1,1}$-$1780_{n,m}$, are read out, e.g., on a sequential line per line basis.

[0129] In some embodiments, circuitry 1770, also referred to as column logic 1770, is used to read the signals from the pixels $1780_{1,1}$-$1780_{n,m}$. FIG. 17C is a schematic representation of a pixel circuit. The pixels $1780_{1,1}$-1780_{n}, also referred to as sensor elements, may be accessed one row at a time by asserting one of the word lines 1782, which run horizontally through the sensor array 1704A. A single pixel $1780_{1,1}$ is shown. Data is passed into and/or out of the pixel $1780_{1,1}$ via bit lines (such as bit line 1784) which run vertically through the sensor array 1704A.

[0130] The pixels are not limited to the configurations shown in FIGS. 17A-17C. As stated above, each of the one or more sensor arrays may have any configuration (e.g., size, shape, pixel design).

[0131] The sensor arrays 1502A-1502D of FIG. 15 may or may not be identical to one another. In some embodiments, for example, the sensor arrays are identical to one another. In some other embodiments, one or more of the sensor arrays are different, in one or more

respects, from one or more of the other sensor arrays. For example, in some embodiments, one or more of the characteristics (for example, but not limited to, its type of element(s), size (for example, surface area), and/or performance) of one or more of the sensor arrays is tailored to the respective optics portion and/or to help achieve a desired result.

[0132] FIG. 18 is a schematic cross-sectional view of a digital camera apparatus 1800 including a printed circuit board 1820 of a digital camera on which the digital camera elements are mounted, under an embodiment. In this embodiment, the one or more optics portions, e.g., optics portions 1812A and 1812B are seated in and/or affixed to a support 1814. The support 1814 (for example a frame) is disposed superjacent a first bond layer 1822, which is disposed superjacent an image device 1820, in or on which sensor portions 1812A-1812D (sensor portions 1812C and 1812D are not shown), are disposed and/or integrated. The image device 1820 is disposed superjacent a second bond layer 1824 which is disposed superjacent the printed circuit board 1821.

[0133] The printed circuit board 1821 includes a major outer surface 1830 that defines a mounting region on which the image device 1820 is mounted. The major outer surface 1830 may further define and one or more additional mounting regions (not shown) on which one or more additional devices used in the digital camera may be mounted. One or more pads 1832 are provided on the major outer surface 1830 of the printed circuit board to connect to one or more of the devices mounted thereon.

[0134] The image device 1820 includes the one or more sensor arrays (not shown), and one or more electrically conductive layers. In some embodiments, the image device 1820 further includes one, some or all portions of a processor for the digital camera apparatus 1800. The image device 1820 further includes a major outer surface 1840 that defines a mounting region on which the support 1814 is mounted.

[0135] The one or more electrically conductive layers may be patterned to define one or more pads 1842 and one or more traces (not shown) that connect the one or more pads to one or more of the one or more sensor arrays. The pads 1842 are disposed, for example, in the vicinity of the perimeter of the image device 1820, for example along one, two, three or four

sides of the image device 1820. The one or more conductive layers may comprise, for example, copper, copper foil, and/or any other suitably conductive material(s).

[0136] A plurality of electrical conductors 1850 may connect one or more of the pads 1842 on the image device 1820 to one or more of the pads 1832 on the circuit board 1821. The conductors 1850 may be used, for example, to connect one or more circuits on the image device 1820 to one or more circuits on the printed circuit board 1821.

[0137] The first and second bond layers 1822 and 1824 may comprise any suitable material(s), including but not limited to adhesive, and may comprise any suitable configuration. The first and second bond layers 1822, 1824 may comprise the same material(s) although this is not required. As used herein, a bond layer may be continuous or discontinuous. For example, a conductive layer may be an etched printed circuit layer. Moreover, a bond layer may or may not be planar or even substantially planar. For example, a conformal bond layer on a non-planar surface will be non-planar.

[0138] FIG. 19 is a schematic perspective view of a digital camera apparatus having one or more optics portions with the capability to provide color separation in accordance with one embodiment of the present invention. In some of such embodiments, one or more of the optics portions, e.g., optics portion 1912C includes an array of color filters, for example, but not limited to a Bayer patter. In some of such embodiments, one or more of the optics portions, e.g., optics portion 1912C has the capability to provide color separation similar to that which is provided by a color filter array.

[0139] In some embodiments, the lens and/or filter of the optical channel may transmit both of such colors or bands of colors, and the optical channel may include one or more mechanisms elsewhere in the optical channel to separate the two colors or two bands of colors. For example, a color filter array may be disposed between the lens and the sensor array, and/or the optical channel may employ a sensor capable of separating the colors or bands of colors. In some of the latter embodiments, the sensor array may be provided with pixels that have multiband capability, e.g., two or three colors. For example, each pixel may comprise two or three photodiodes, wherein a first photodiode is adapted to detect a first color or first band of colors, a second photodiode is adapted to detect a second color or band

of colors and a third photodiode is adapted to detect a third color or band of colors. One way to accomplish this is to provide the photodiodes with different structures and/or characteristics that make them selective, such that the first photodiode has a higher sensitivity to the first color or first band of colors than to the second color or band of colors, and the second photodiode has a higher sensitivity to the second color or second band of colors than to the first color or first band of colors. Alternatively, the photodiodes are disposed at different depths in the pixel, taking advantage of the different penetration and absorption characteristics of the different colors or bands of colors. For example, blue and blue bands of colors penetrate less (and are thus absorbed at a lesser depth) than green and green bands of colors, which in turn penetrate less (and are thus absorbed at a lesser depth) than red and red bands of colors. In some embodiments, such a sensor array is employed, even though the pixels may see only one particular color or band of colors, for example, to in order to adapt such sensor array to the particular color or band of colors.

[0140] FIG. 20A is a block diagram of a processor 2002 of a digital camera subsystem 2000, under an embodiment. In this embodiment, the processor 2002 includes one or more channel processors, one or more image pipelines, and/or one or more image post processors. Each of the channel processors is coupled to a respective one of the optical channels (not shown) and generates an image based at least in part on the signal(s) received from the respective optical channel. In some embodiments the processor 2002 generates a combined imaged based at least in part on the images from two or more of the optical channels. In some embodiments, one or more of the channel processors are tailored to its respective optical channel, as previously described.

[0141] In various embodiments, the gain, noise reduction, dynamic range, linearity and/or any other characteristic of the processor, or combinations of such characteristics, may be adapted to improve and/or optimize the processor to a wavelength or color (or band of wavelengths or colors). Tailoring the channel processing to the respective optical channel makes it possible to generate an image of a quality that is higher than the quality of images resulting from traditional image sensors of like pixel count. In such embodiments, providing each optical channel with a dedicated channel processor helps to reduce or simplify the amount of logic in the channel processors, as the channel processor may not need to

accommodate extreme shifts in color or wavelength, e.g., from a color (or band of colors) or wavelength (or band of wavelengths) at one extreme to a color (or band of colors) or wavelength (or band of wavelengths) at another extreme

[0142] The images (and/or data which is representative thereof) generated by the channel processors are supplied to the image pipeline, which may combine the images to form a full color or black/white image. The output of the image pipeline is supplied to the post processor, which generates output data in accordance with one or more output formats.

[0143] FIG. 20B shows one embodiment of a channel processor. In this embodiment, the channel processor includes column logic, analog signal logic, and black level control and exposure control. The column logic is coupled to the sensor and reads the signals from the pixels. Each of the column logic, analog signal logic, black level control and exposure control can be configured for processing as appropriate to the corresponding optical channel configuration (e.g., specific wavelength or color, etc.). For example, the analog signal logic is optimized, if desired, for processing. Therefore, gain, noise, dynamic range and/or linearity, etc., are optimized as appropriate to the corresponding optical channel configuration (e.g., a specific wavelength or color, etc.). As another example, the column logic may employ an integration time or integration times adapted to provide a particular dynamic range as appropriate to the corresponding optical channel.

[0144] The output of the analog signal logic is supplied to the black level control, which determines the level of noise within the signal, and filters out some or all of such noise. If the sensor coupled to the channel processor is focused upon a narrower band of visible spectrum than traditional image sensors, the black level control can be more finely tuned to eliminate noise.

[0145] The output of the black level control is supplied to the exposure control, which measures the overall volume of light being captured by the array and adjusts the capture time for image quality. Traditional cameras must make this determination on a global basis (for all colors). In the camera of an embodiment, however, the exposure control can be specifically adapted to the wavelength (or band of wavelengths) to which the sensor is configured. Each channel processor is thus able to provide a capture time that is specifically adapted to the

sensor and/or specific color (or band of colors) targeted, and which may be different than the capture time provided by another channel processor for another optical channel.

[0146] FIG. 20C is a block diagram of the image pipeline, under an embodiment. In this embodiment, the image pipeline includes two portions. The first portion includes a color plane integrator and an image adjustor. The color plane integrator receives an output from each of the channel processors and integrates the multiple color planes into a single color image. The output of the color plane integrator, which is indicative of the single color image, is supplied to the image adjustor, which adjusts the single color image for saturation, sharpness, intensity and hue. The adjustor also adjusts the image to remove artifacts and any undesired effects related to bad pixels in the one or more color channels. The output of the image adjustor is supplied to the second portion of the pipeline, which provides auto focus, zoom, windowing, pixel binning and camera functions.

[0147] FIG. 20D is a block diagram of the image post processor, under an embodiment. In this embodiment, the image post processor includes an encoder and an output interface. The encoder receives the output signal from the image pipeline and provides encoding to supply an output signal in accordance with one or more standard protocols (e.g., MPEG and/or JPEG). The output of the encoder is supplied to the output interface, which provides encoding to supply an output signal in accordance with a standard output interface, e.g., universal serial bus (USB) interface.

[0148] FIG. 21 is a block diagram of digital camera system, including system control components, under an embodiment. The system control portion includes a serial interface, configuration registers, power management, voltage regulation and control, timing and control, a camera control interface and a serial interface, but is not so limited. In some embodiments, the camera interface comprises an interface that processes signals that are in the form of high level language (HLL) instructions. In some embodiments the camera interface comprises an interface that processes control signals that are in the form of low level language (LLL) instructions and/or of any other form now known or later developed. Some embodiments may process both HLL instructions and LLL instructions.

[0149] As used herein, the following terms are interpreted as described below, unless the context requires a different interpretation.

[0150] "Array" means a group of photodetectors, also know as pixels, which operate in concert to create one image. The array captures photons and converts the data to an electronic signal. The array outputs this raw data to signal processing circuitry that generates the image sensor image output.

[0151] "Digital Camera" means a single assembly that receives photons, converts them to electrical signals on a semiconductor device ("image sensor"), and processes those signals into an output that yields a photographic image. The digital camera would included any necessary lenses, image sensor, shutter, flash, signal processing circuitry, memory device, user interface features, power supply and any mechanical structure (e.g. circuit board, housing, etc) to house these components. A digital camera may be a stand-alone product or may be imbedded in other appliances, such as cell phones, computers or the myriad of other imaging platforms now available or to be created in the future, such as those that become feasible as a result of this invention.

[0152] "Digital Camera Subsystem" (DCS) means a single assembly that receives photons, converts them to electrical signals on a semiconductor device ("image sensor") and processes those signals into an output that yields a photographic image. The Digital Camera Subsystem includes any necessary lenses, image sensor, signal processing circuitry, shutter, flash and any frame to hold the components as may be required. The power supply, memory devices and any mechanical structure are not necessarily included.

[0153] "Electronic media" means that images are captured, processed and stored electronically as opposed to the use of film.

[0154] "Frame" or "thin plate" means the component of the DCS that is used to hold the lenses and mount to the image sensor.

[0155] "Image sensor" means the semiconductor device that includes the photon detectors ("pixels"), processing circuitry and output channels. The inputs are the photons and the output is the image data.

[0156] "Lens" means a single lens or series of stacked lenses (a column one above the other) that shape light rays above an individual array. When multiple stacks of lenses are employed over different arrays, they are called "lenses."

[0157] "Package" means a case or frame that an image sensor (or any semiconductor chip) is mounted in or on, which protects the imager and provides a hermetic seal.

[0158] "Packageless" refers to those semiconductor chips that can be mounted directly to a circuit board without need of a package.

[0159] The terms "Photo-detector" and "pixels" mean an electronic device that senses and captures photons and converts them to electronic signals. These extremely small devices are used in large quantities (hundreds of thousands to millions) in a matrix to capture an image.

[0160] "Semiconductor Chip" means a discrete electronic device fabricated on a silicon or similar substrate, which is commonly used in virtually all electronic equipment.

[0161] "Signal Processing Circuitry" means the hardware and software within the image sensor that translates the photon input information into electronic signals and ultimately into an image output signal.

[0162] Aspects of the digital camera systems and methods described herein may be implemented as functionality programmed into any of a variety of circuitry, including programmable logic devices (PLDs), such as field programmable gate arrays (FPGAs), programmable array logic (PAL) devices, electrically programmable logic and memory devices and standard cell-based devices, as well as application specific integrated circuits (ASICs). Some other possibilities for implementing aspects of the digital camera systems and methods include: microcontrollers with memory (such as electronically erasable programmable read only memory (EEPROM)), embedded microprocessors, firmware, software, etc. Furthermore, aspects of the digital camera systems and methods may be embodied in microprocessors having software-based circuit emulation, discrete logic (sequential and combinatorial), custom devices, fuzzy (neural) logic, quantum devices, and hybrids of any of the above device types. Of course the underlying device technologies may be provided in a variety of component types, e.g., metal-oxide semiconductor field-effect

transistor (MOSFET) technologies like complementary metal-oxide semiconductor (CMOS), bipolar technologies like emitter-coupled logic (ECL), polymer technologies (e.g., silicon-conjugated polymer and metal-conjugated polymer-metal structures), mixed analog and digital, etc.

[0163] It should be noted that components of the various systems and methods disclosed herein may be described using computer aided design tools and expressed (or represented), as data and/or instructions embodied in various computer-readable media, in terms of their behavioral, register transfer, logic component, transistor, layout geometries, and/or other characteristics. Computer-readable media in which such formatted data and/or instructions may be embodied include, but are not limited to, non-volatile storage media in various forms (e.g., optical, magnetic or semiconductor storage media).

[0164] Examples of transfers of such formatted data and/or instructions by carrier waves include, but are not limited to, transfers (uploads, downloads, e-mail, etc.) over the Internet and/or other computer networks via one or more data transfer protocols (e.g., HTTP, FTP, SMTP, etc.). When received within a computer system via one or more computer-readable media, such data and/or instruction-based expressions of the above described systems and methods may be processed by a processing entity (e.g., one or more processors) within the computer system in conjunction with execution of one or more other computer programs.

[0165] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in a sense of "including, but not limited to." Words using the singular or plural number also include the plural or singular number respectively. Additionally, the words "herein," "hereunder," "above," "below," and words of similar import refer to this application as a whole and not to any particular portions of this application. When the word "or" is used in reference to a list of two or more items, that word covers all of the following interpretations of the word: any of the items in the list, all of the items in the list and any combination of the items in the list.

[0166] The above description of illustrated embodiments of the digital camera systems and methods is not intended to be exhaustive or to limit the digital camera systems and methods

to the precise form disclosed. While specific embodiments of, and examples for, the digital camera systems and methods are described herein for illustrative purposes, various equivalent modifications are possible within the scope of the digital camera systems and methods, as those skilled in the relevant art will recognize. The teachings of the digital camera systems and methods provided herein can be applied to other processing systems and methods, not only for the systems and methods described above.

[0167] The elements and acts of the various embodiments described above can be combined to provide further embodiments. These and other changes can be made to the digital camera systems and methods in light of the above detailed description.

[0168] In general, in the following claims, the terms used should not be construed to limit the digital camera systems and methods to the specific embodiments disclosed in the specification and the claims, but should be construed to include all systems that operate under the claims. Accordingly, the digital camera systems and methods are not limited by the disclosure, but instead the scope of the digital camera systems and methods is to be determined entirely by the claims.

[0169] While certain aspects of the digital camera systems and methods are presented below in certain claim forms, the inventors contemplate the various aspects of the digital camera systems and methods in any number of claim forms. Accordingly, the inventors reserve the right to add additional claims after filing the application to pursue such additional claim forms for other aspects of the digital camera systems and methods

WHAT IS CLAIMED IS:

1. A digital camera comprising:

a plurality of sensors, wherein each sensor of the plurality of sensors comprises an array of photo-detectors;

a plurality of optics components, wherein each optics component of the plurality of optics components is configured to pass light to a sensor of the plurality of sensors, wherein each optics component and an associated sensor form one of a plurality of channels; and

a processing component coupled to the plurality of channels and configured to separately control an integration time of each sensor during a frame, wherein the processing component is configured to combine data from the plurality of sensors received during the frame to provide an image.

2. The digital camera of claim 1, wherein each sensor is configured to image the same field of view.

3. The digital camera of claim 1, wherein the integration time of at least one sensor is relatively shorter than the integration time of at least one other sensor.

4. The digital camera of claim 1, further comprising an interface operatively coupled to the processing component, wherein the interface is configured to receive the integration time of each sensor as an input to the digital camera.

5. The digital camera of claim 1, further comprising an interface operatively coupled to the processing component, wherein the interface is configured to receive an indication of an amount of incident light as an input.

6. The digital camera of claim 1, wherein the processing component is configured to control the integration time of each sensor in response to an input by an operator.

7. The digital camera of claim 1, wherein the integration times of the plurality of sensors are controlled based on an incident light level.

8. The digital camera of claim 1, wherein the image corresponds to a first frame, and wherein the processing component is further configured to determine one or more integration times for a second frame based at least in part on the image.

9. A digital camera comprising:

a plurality of channels, wherein each channel of the plurality of channels includes an optics component and a sensor comprising an array of photo-detectors; and

a processing component coupled to the plurality of channels, wherein the processing component is configured to separately control an integration time of each channel of the plurality of channels during a frame, wherein the processing component is configured to combine data from the plurality of channels received during the frame to provide an image.

10. The digital camera of claim 9, wherein each sensor is configured to image the same field of view.

11. The digital camera of claim 9, wherein the integration time of at least one channel is relatively shorter than the integration time of at least one other channel.

12. The digital camera of claim 9, wherein the processing component is configured to use the image to determine the integration time for each channel for use during a subsequent frame.

13. The digital camera of claim 9, wherein the processing component is configured to automatically control the integration time of each sensor.

14. The digital camera of claim 9, wherein the integration time is used to control an amount of electrical charge placed on one or more storage devices associated with a sensor.

15. A method comprising:

controlling each sensor of a plurality of sensors of a digital camera based at least in part on an integration time corresponding to the sensor;

capturing data with each of the plurality of sensors, wherein the data captured by each sensor is based at least in part on the integration time of the sensor; and

generating an image by combining the data captured by each of the plurality of sensors.

16. The method of claim 15, wherein a first integration time of a first sensor is less than a second integration time of a second sensor.

17. The method of claim 15, further comprising determining a subsequent integration time for each of the plurality of sensors based at least in part on the image.

18. The method of claim 15, further comprising analyzing a previous image generated by the digital camera.

19. The method of claim 15, further comprising separately controlling a parameter of an optics component associated with each channel of a plurality of channels.

20. The method of claim 15, wherein controlling each sensor comprises providing an electrical charge to each sensor for a period of time, wherein the period of time comprises an integration time corresponding to the sensor.

ABSTRACT OF THE DISCLOSURE

A digital camera includes a plurality of channels and a processing component operatively coupled to the plurality of channels. Each channel of the plurality of channels includes an optics component and a sensor that includes an array of photo-detectors. The processing component is configured to separately control an integration time of each channel, where a first integration time of a first channel is less than a second integration time of a second channel. The processing component is also configured to combine data from the plurality of channels to generate an image.

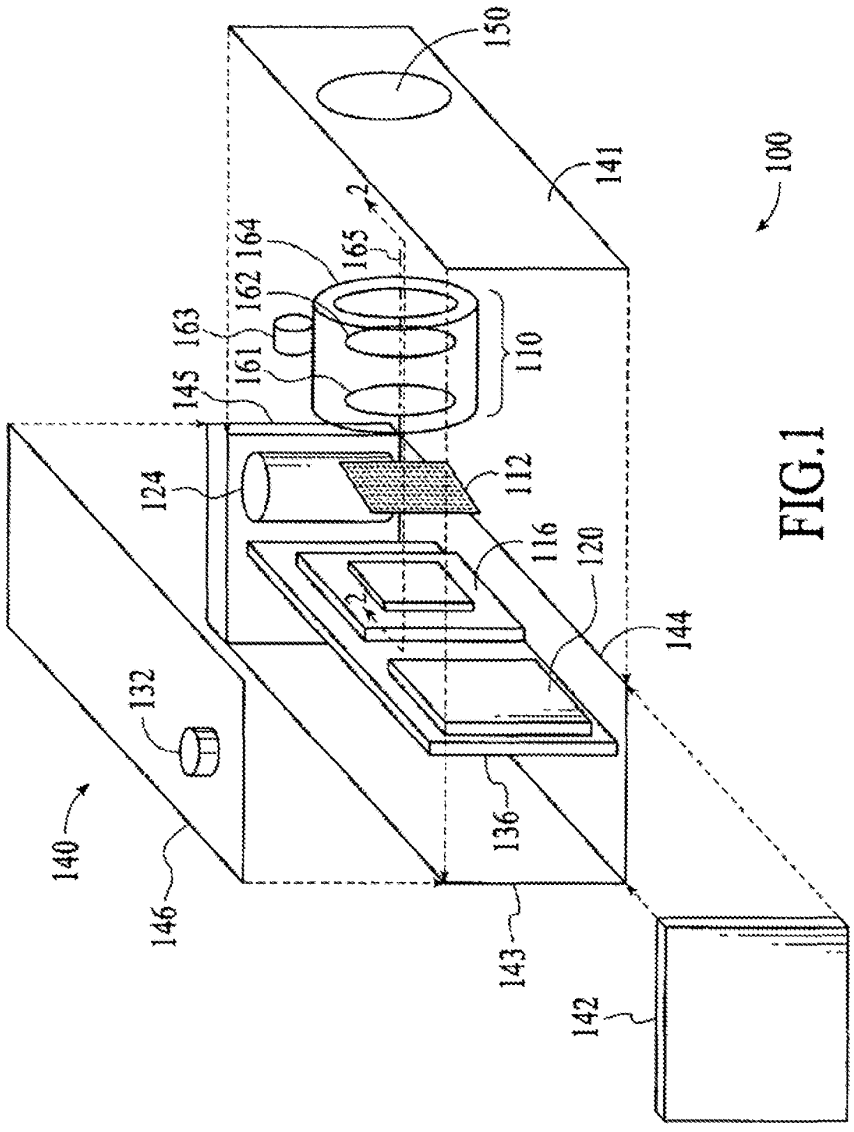

150
141
100
2
164
165
162
163
161
145
110
124
112
116
120
144
132
140
146
136
143
142

FIG.1

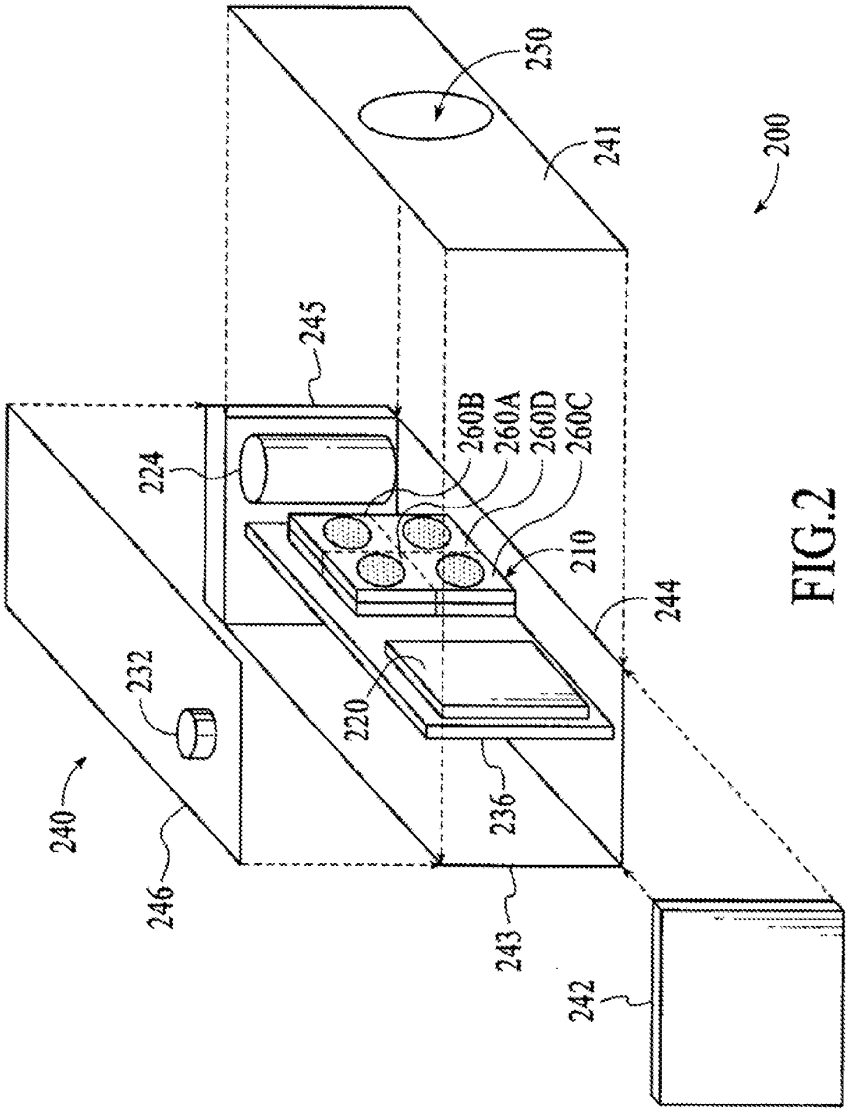

250
241
200
245
260B
260A
260D
260C
224
210
244
232
220
240
236
246
243
242

FIG.2

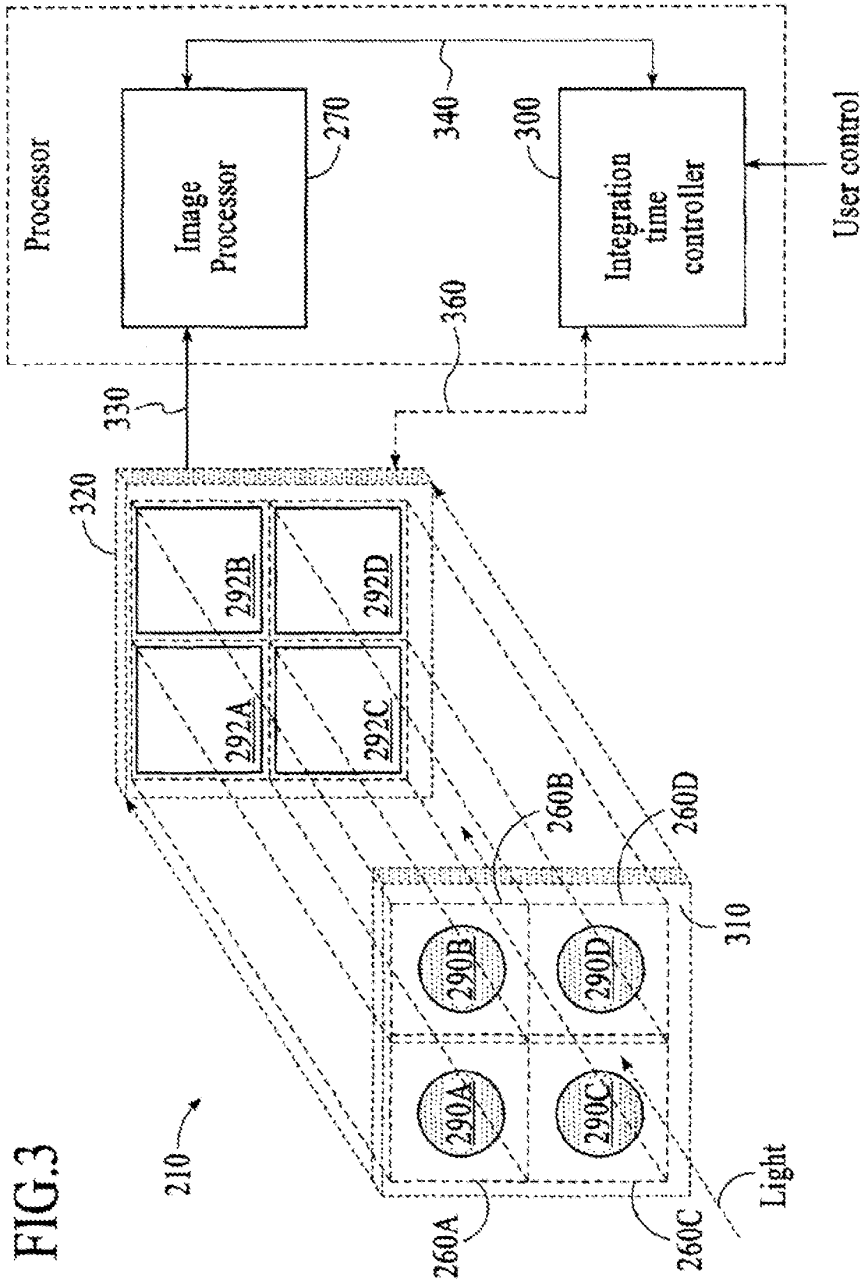

Processor
Image Processor
270
340
300
Integration time controller
User control
360
330
320
292B
292D
292A
292C
260B
260D
310
290B
290D
290A
290C
210
260A
260C
Light

FIG.3

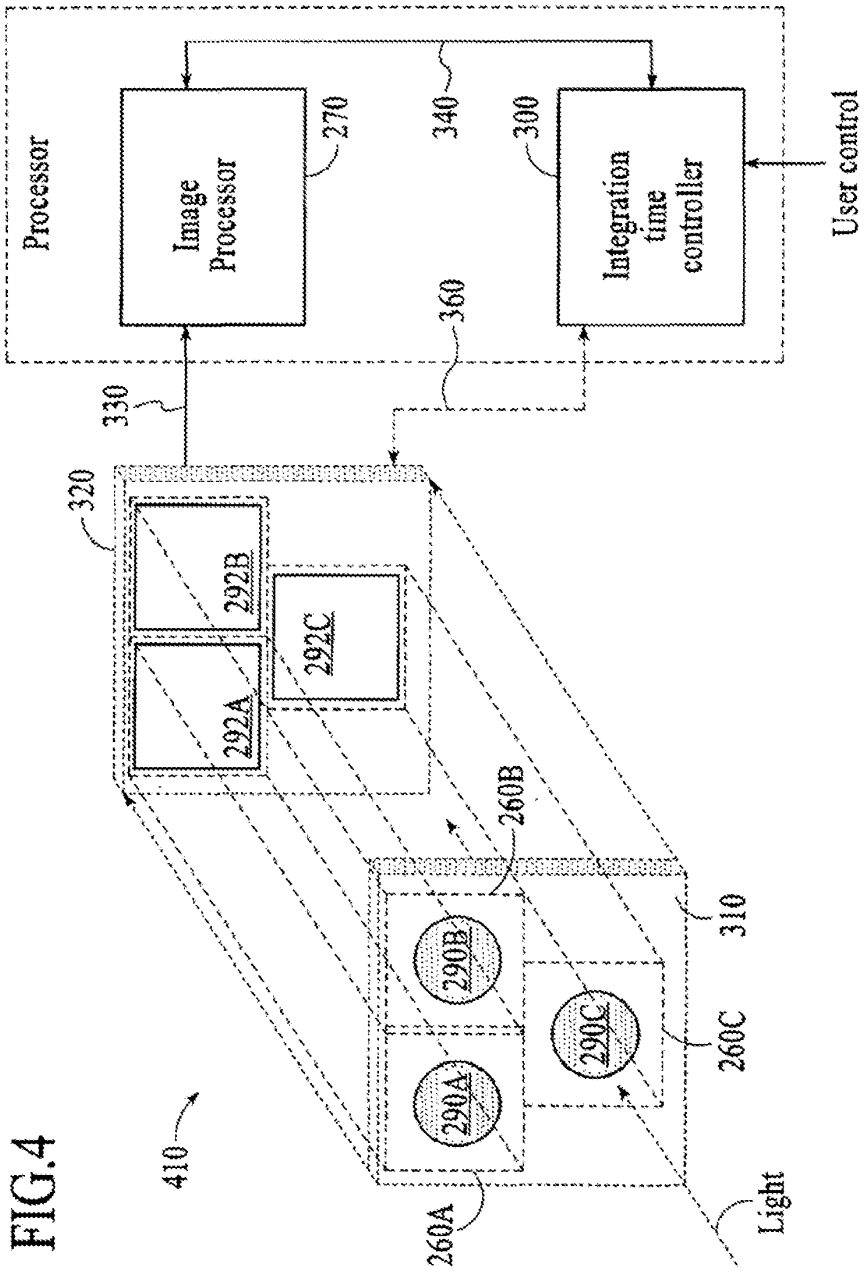

Processor
Image Processor
270
340
300
Integration time controller
User control
360
330
320
292B
292C
292A
260B
290B
290C
290A
310
260C
260A
Light
410

FIG.4

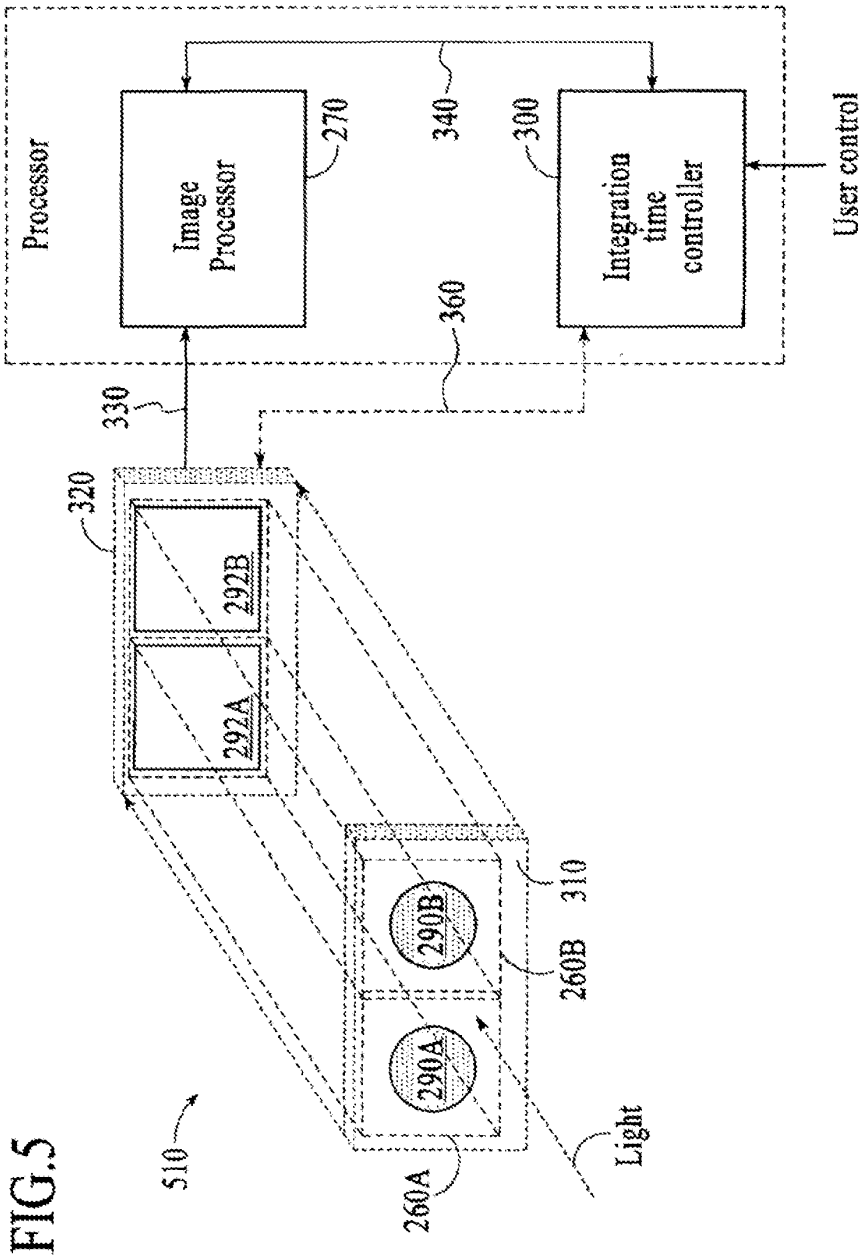

Processor
Image Processor
270
340
300
Integration time controller
User control
360
330
320
292B
292A
290B
290A
310
260B
260A
510
Light

FIG.5

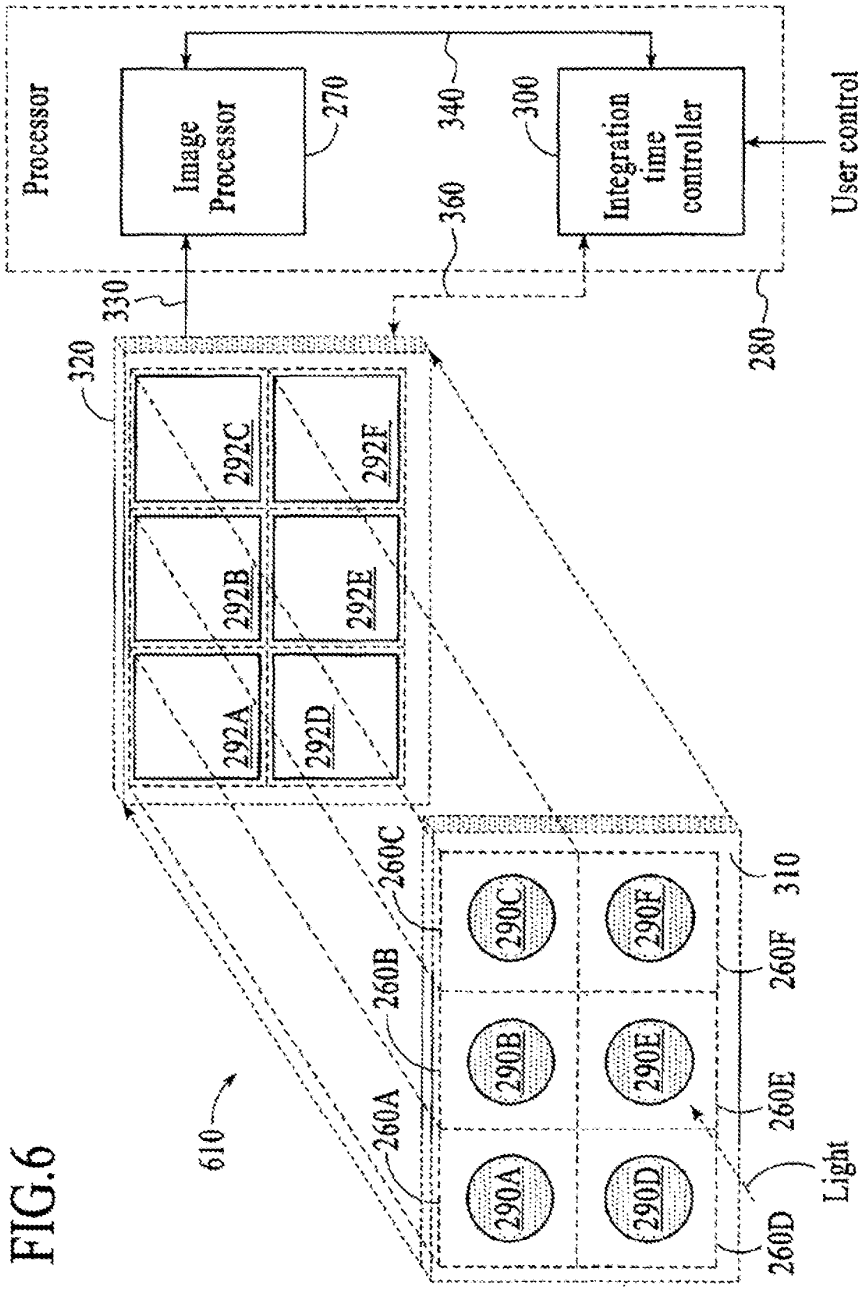

Processor
Image Processor
270
340
300
Integration time controller
User control
360
330
320
280
292A
292B
292C
292D
292E
292F
260C
260B
260A
290A
290B
290C
290D
290E
290F
310
260F
260E
260D
Light
610

FIG.6

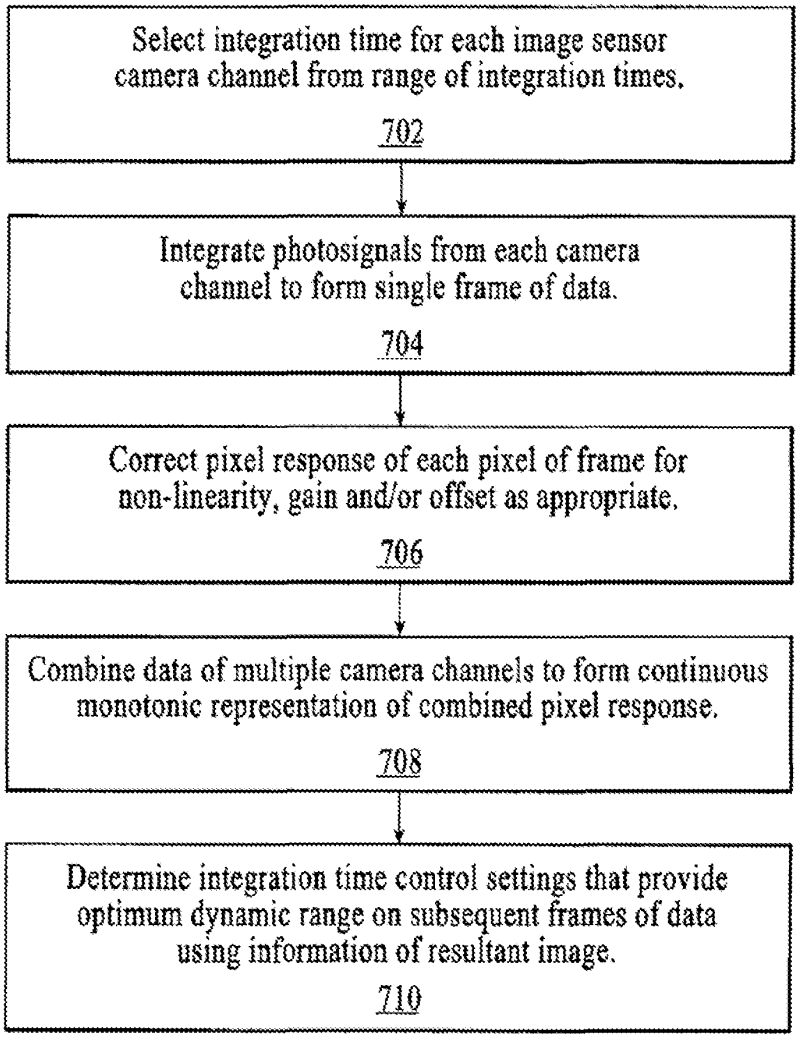

Select integration time for each image sensor camera channel from range of integration times.
702
Integrate photosignals from each camera channel to form single frame of data.
704
Correct pixel response of each pixel of frame for non-linearity, gain and/or offset as appropriate.
706
Combine data of multiple camera channels to form continuous monotonic representation of combined pixel response.
708
Determine integration time control settings that provide optimum dynamic range on subsequent frames of data using information of resultant image.
710
700

FIG.7

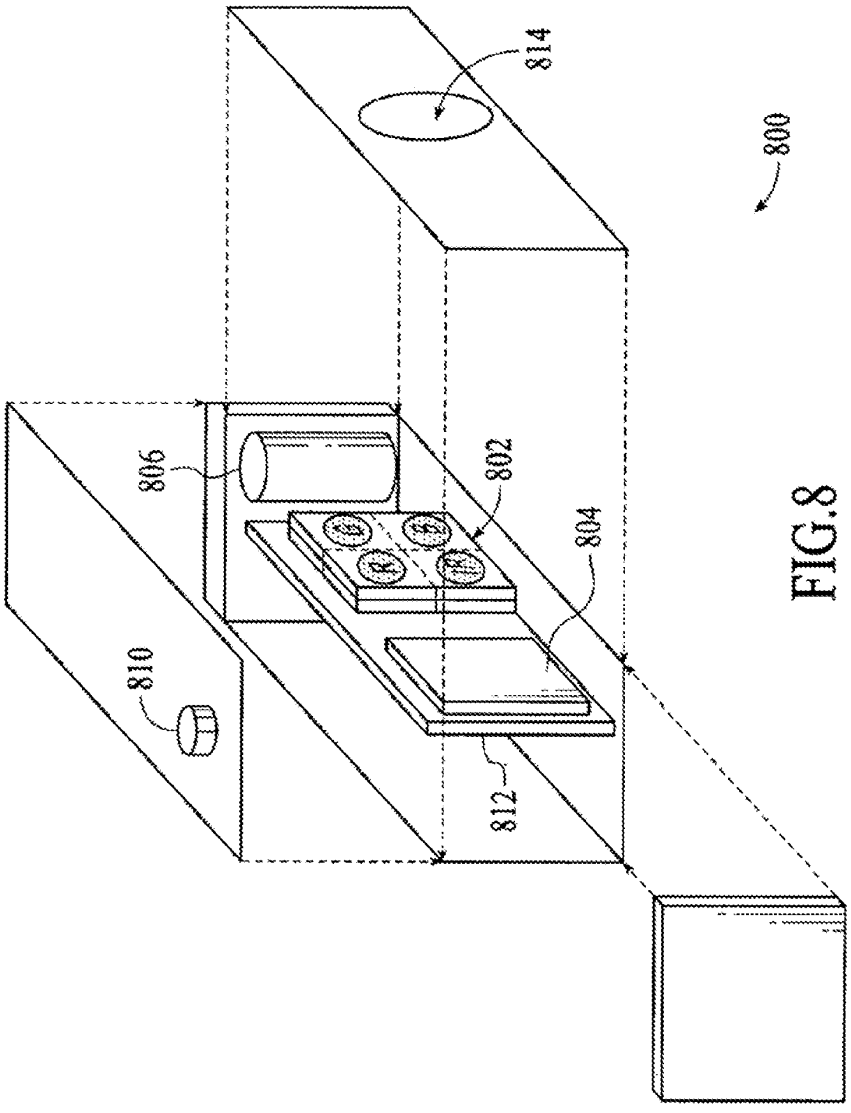


FIG.8

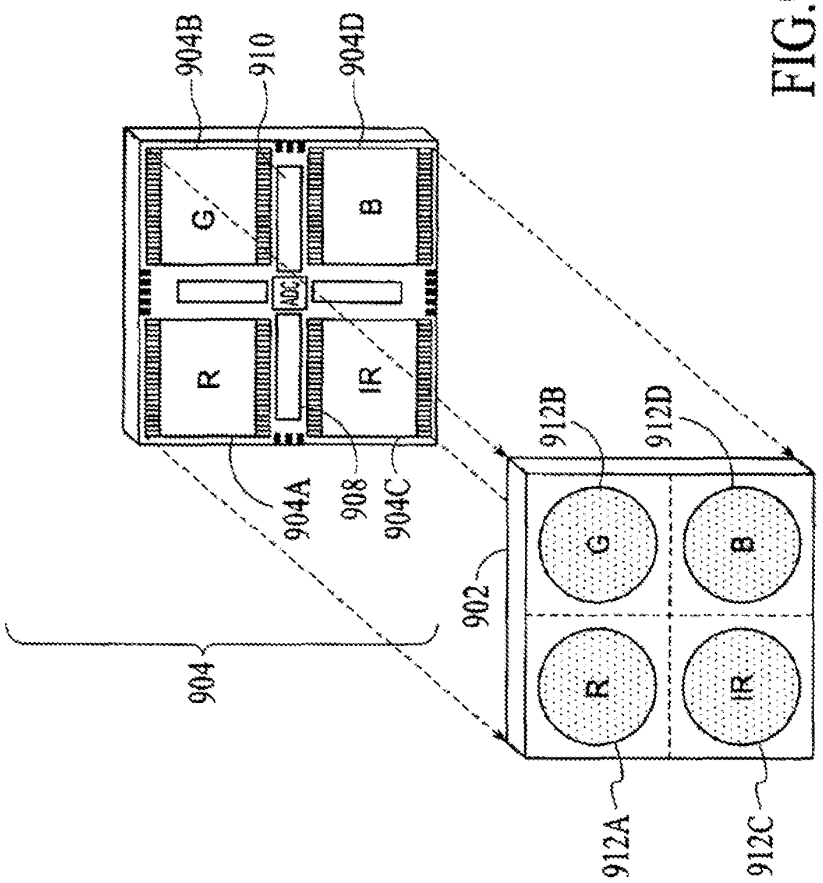

904B
910
904D
G
B
R
IR
ADC
904A
908
904C
904
902
912B
912D
912A
912C

FIG.9

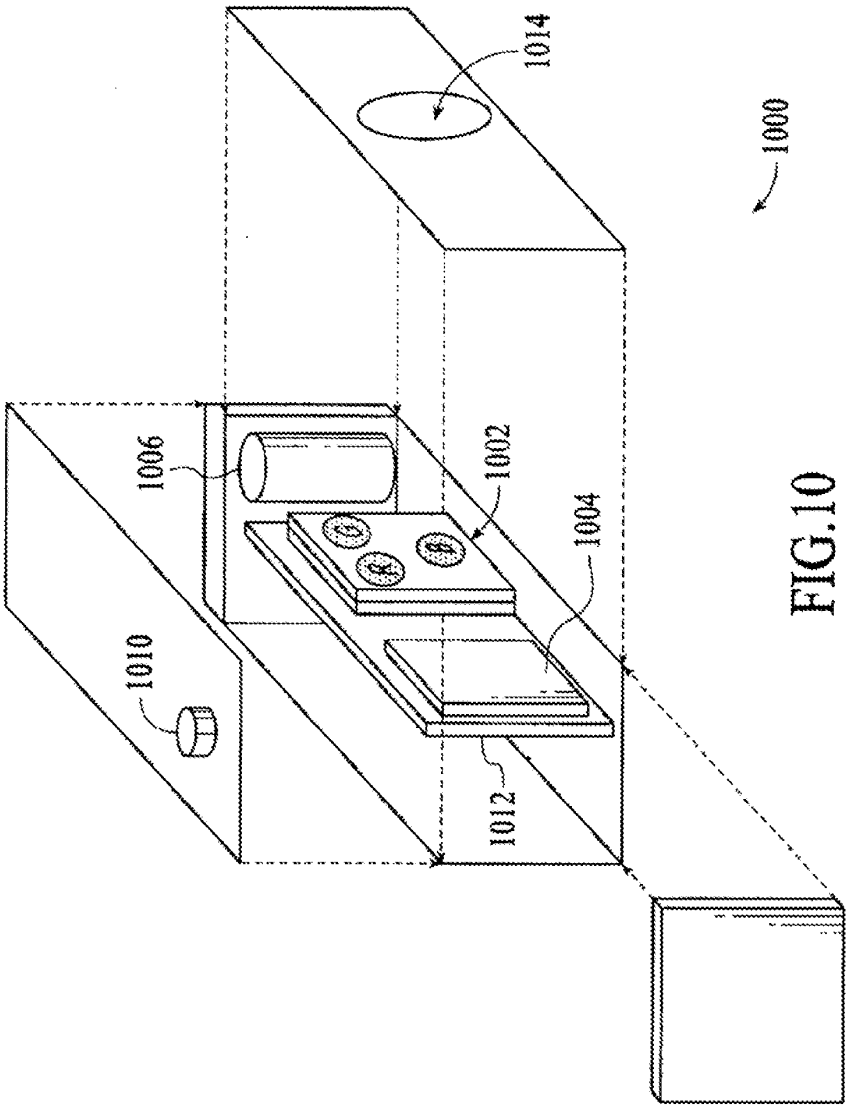


FIG.10

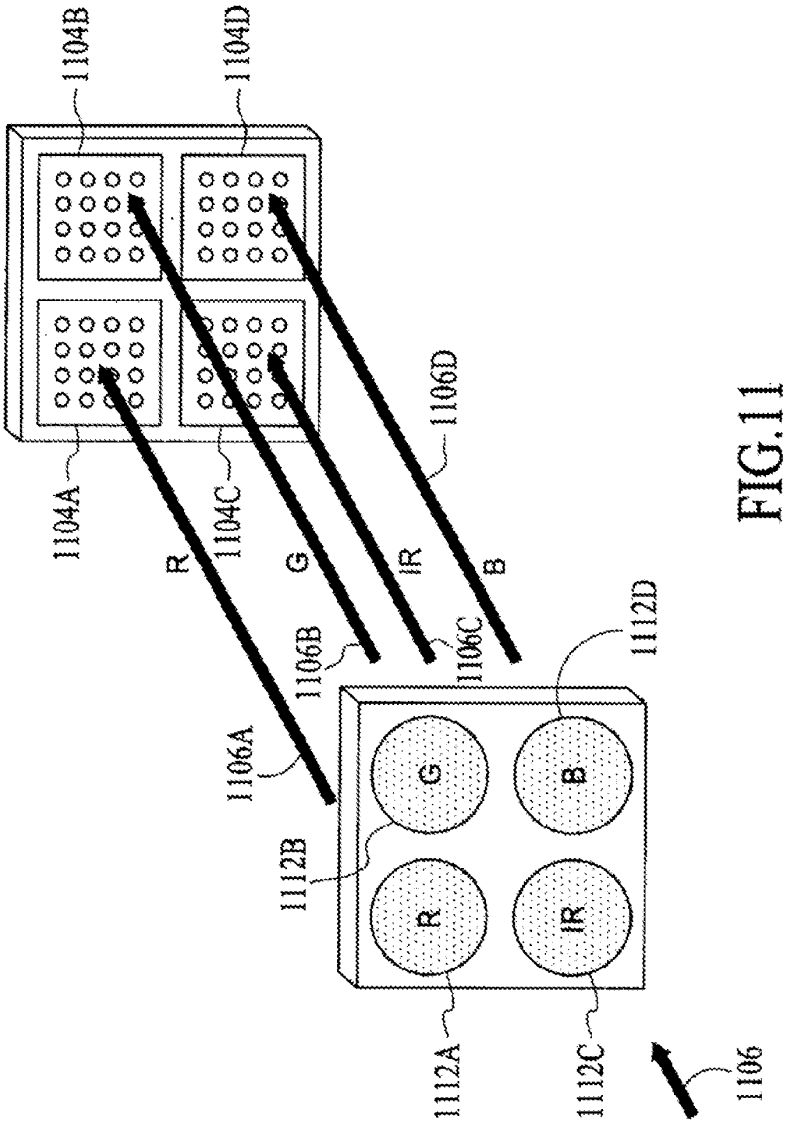
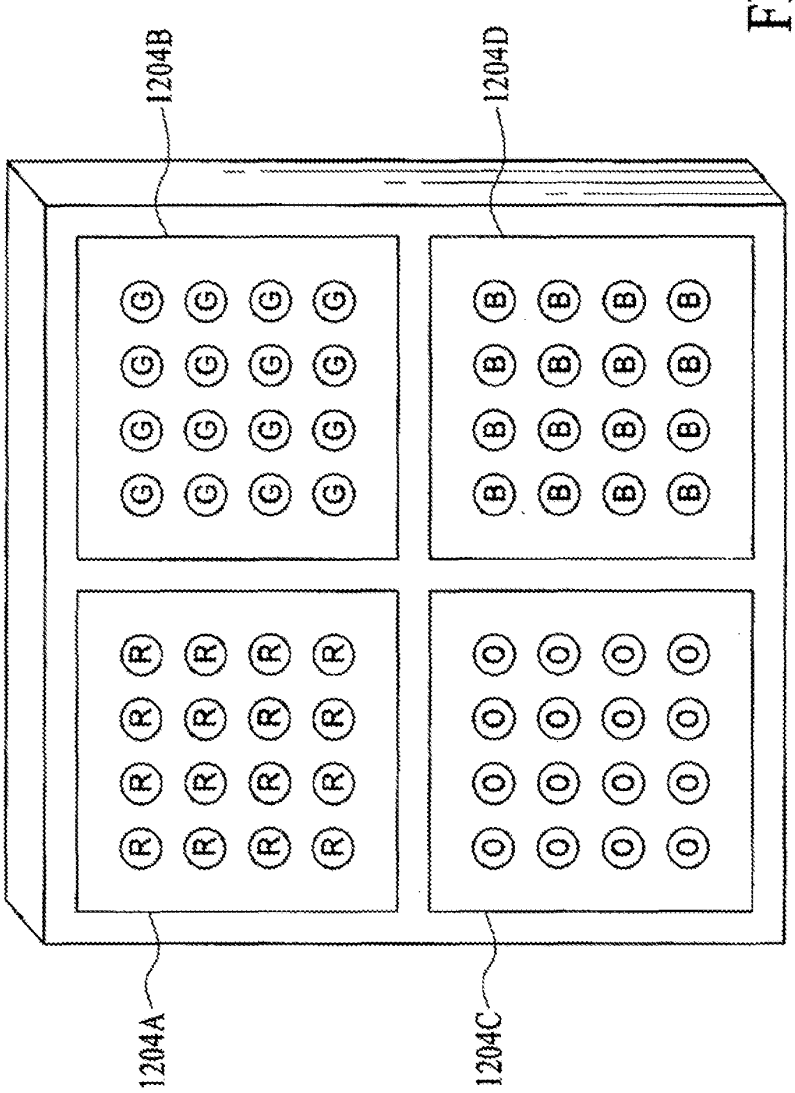

1104B
1104D
1106D
1104A
1104C
R
G
IR
B
1106B
1106C
1112D
1106A
G
B
1112B
R
IR
1112A
1112C
1106

FIG.11

FIG.12



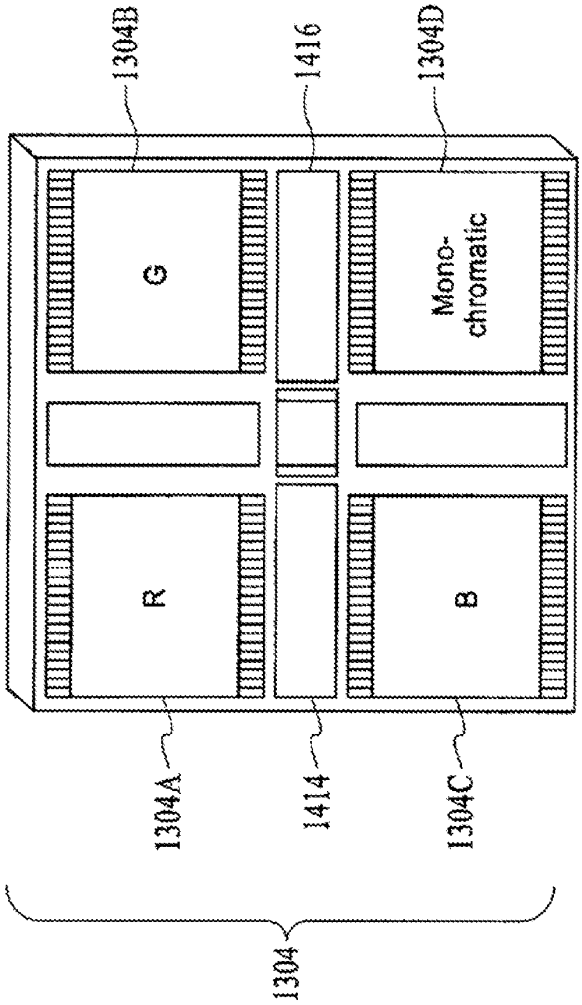
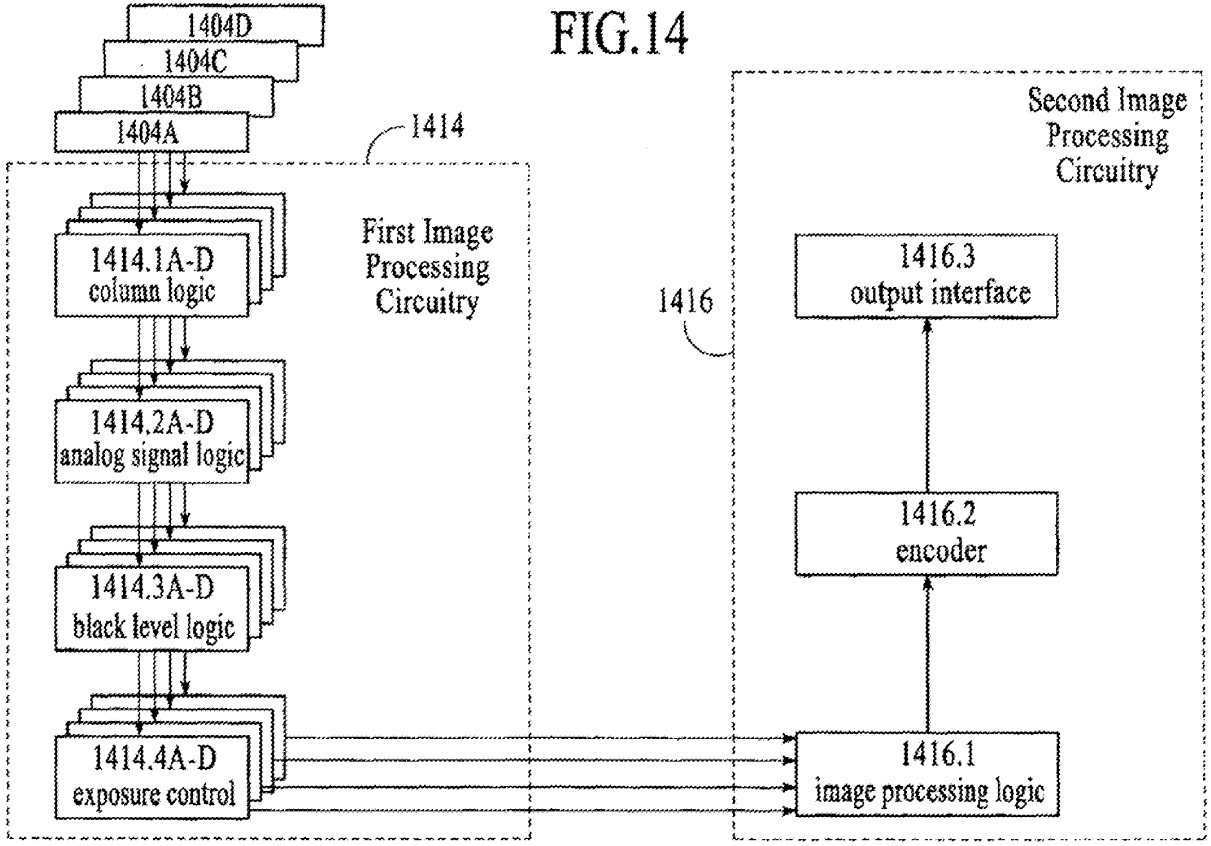


FIG.13

FIG.14


1404D
1404C
1404B
1404A
1414
First Image Processing Circuitry
1414.1A-D column logic
1414.2A-D analog signal logic
1414.3A-D black level logic
1414.4A-D exposure control
Second Image Processing Circuitry
1416
1416.3 output interface
1416.2 encoder
1416.1 image processing logic

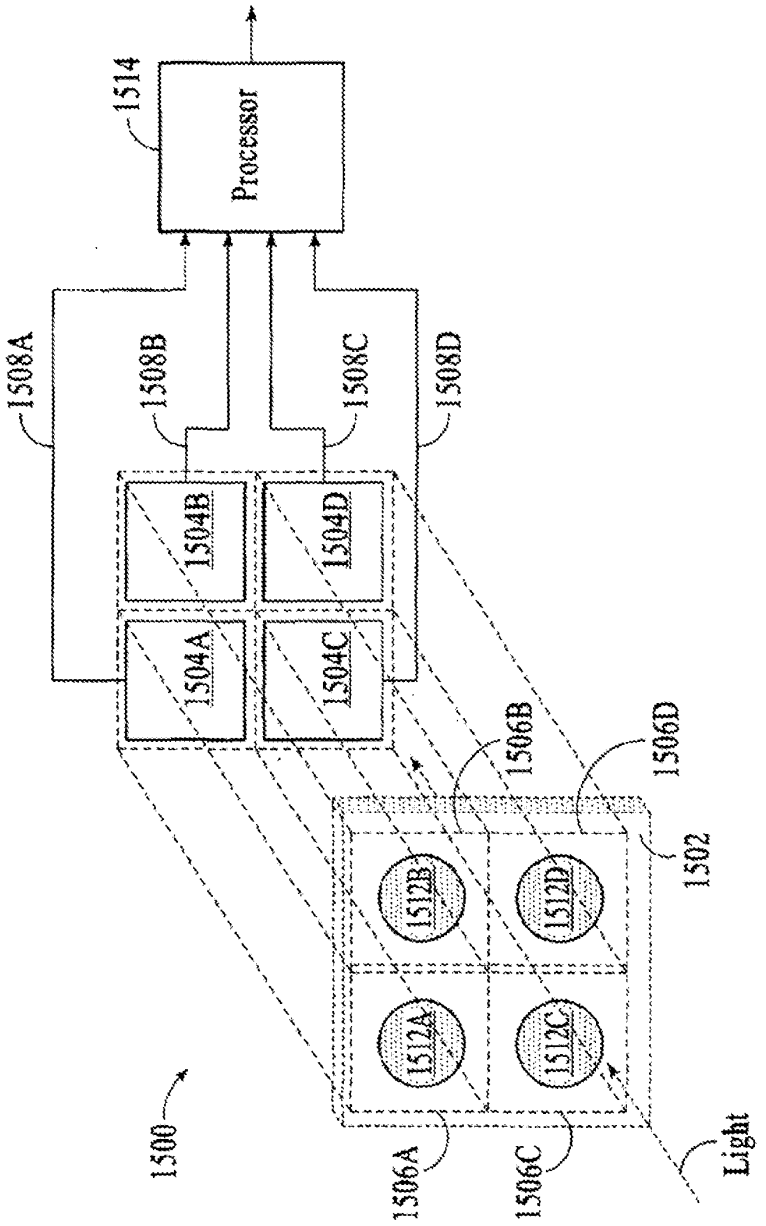

1514
Processor
1508A
1508B
1508C
1508D
1504A
1504B
1504C
1504D
1506A
1506B
1506C
1506D
1502
1512A
1512B
1512C
1512D
1500
Light

FIG.15

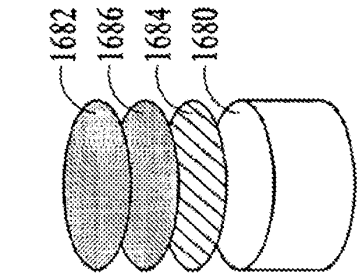


FIG.16B

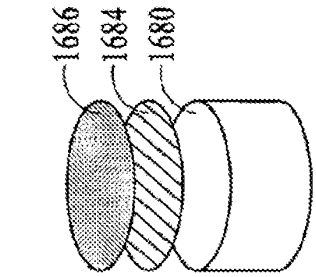


FIG.16D

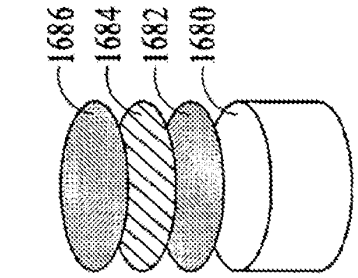


FIG.16A

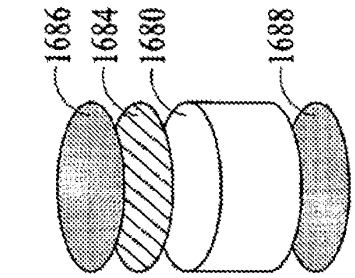


FIG.16C

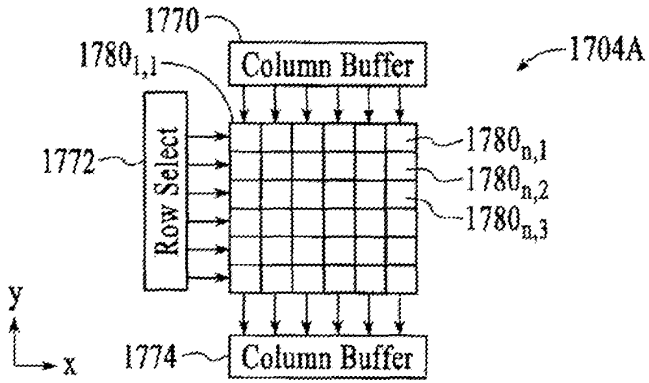


FIG.17A

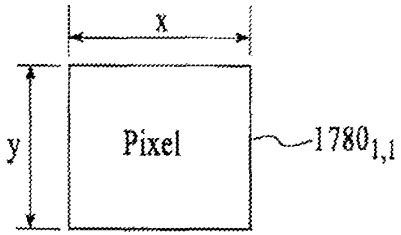


FIG.17B

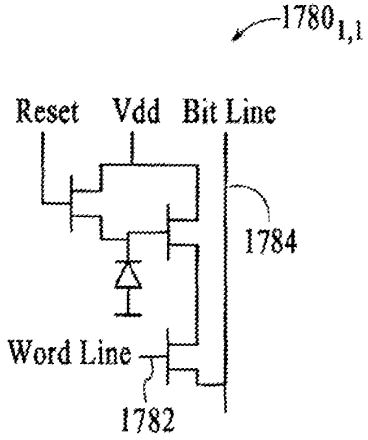


FIG.17C

Applicants: Olsen, et al.
Title: LARGE DYNAMIC RANGE CAMERAS
Attorney: Paul S. Hunter
Atty. Docket No.: 088245-9946
Drawing Sheet 17 of 24

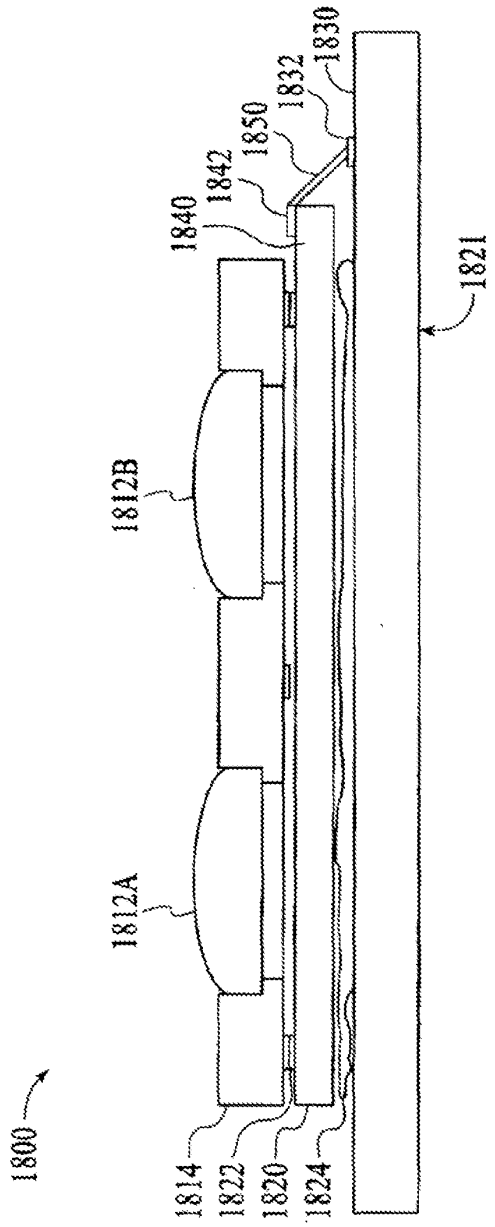

1800
1814
1822
1820
1824
1812A
1812B
1840
1842
1850
1832
1830
1821

FIG.18

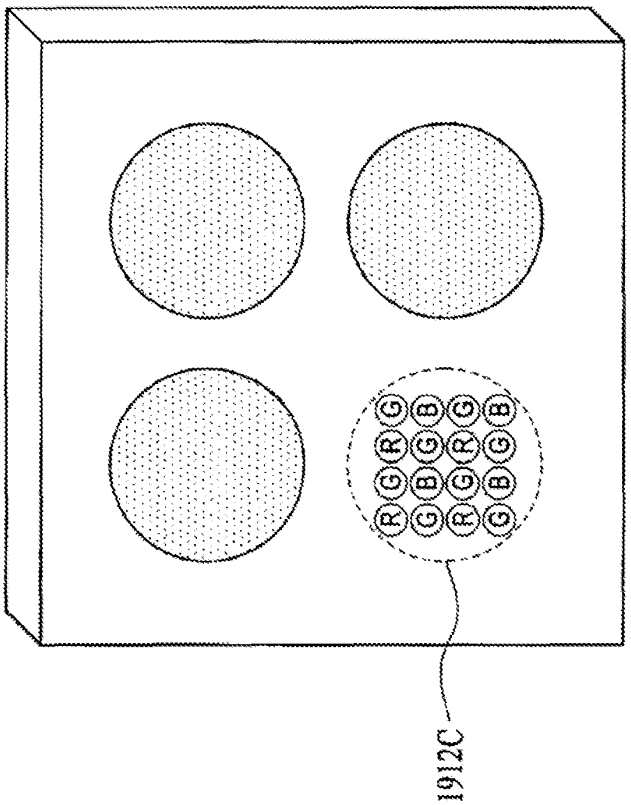


FIG.19

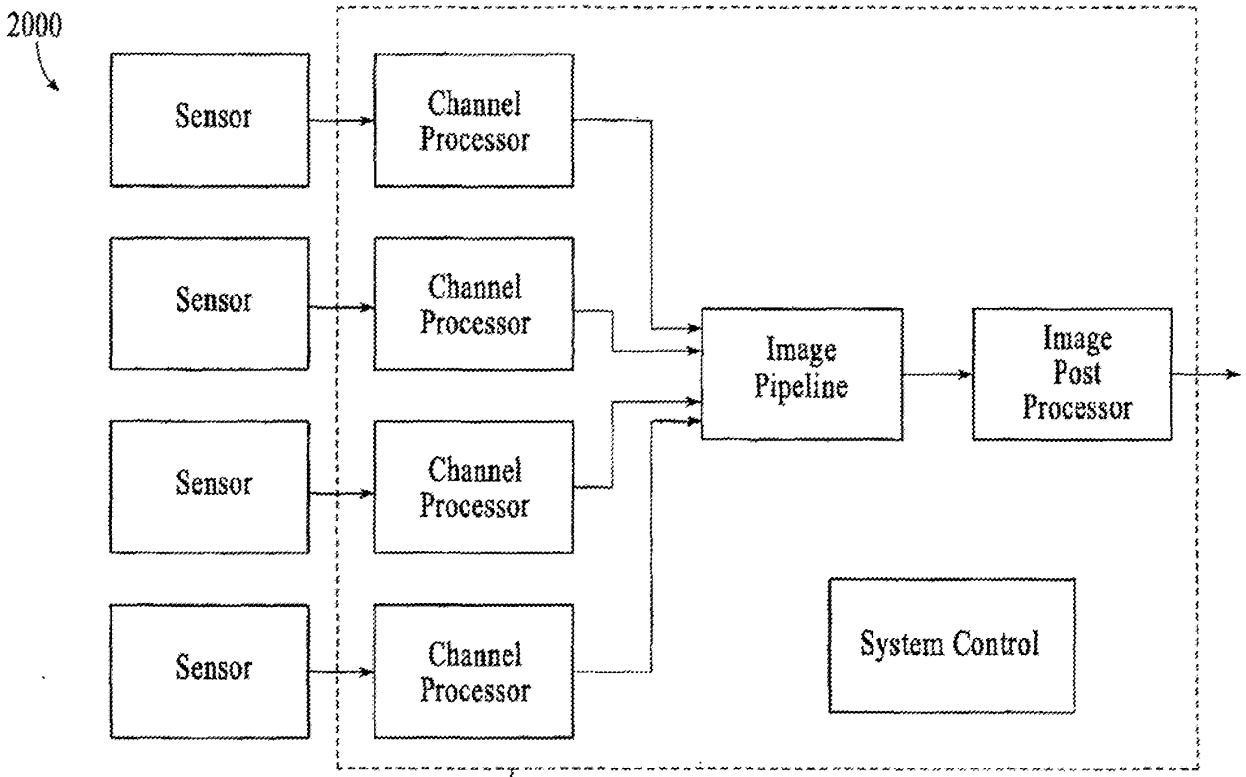

2000
Sensor
Sensor
Sensor
Sensor
Channel Processor
Channel Processor
Channel Processor
Channel Processor
Image Pipeline
Image Post Processor
System Control
2002

FIG.20A

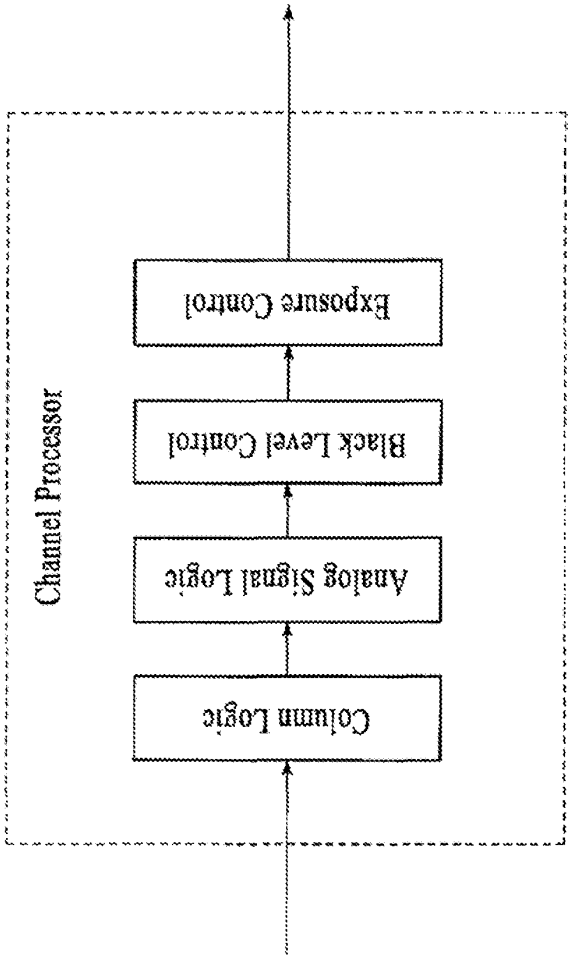

Channel Processor
Column Logic
Analog Signal Logic
Black Level Control
Exposure Control

FIG.20B

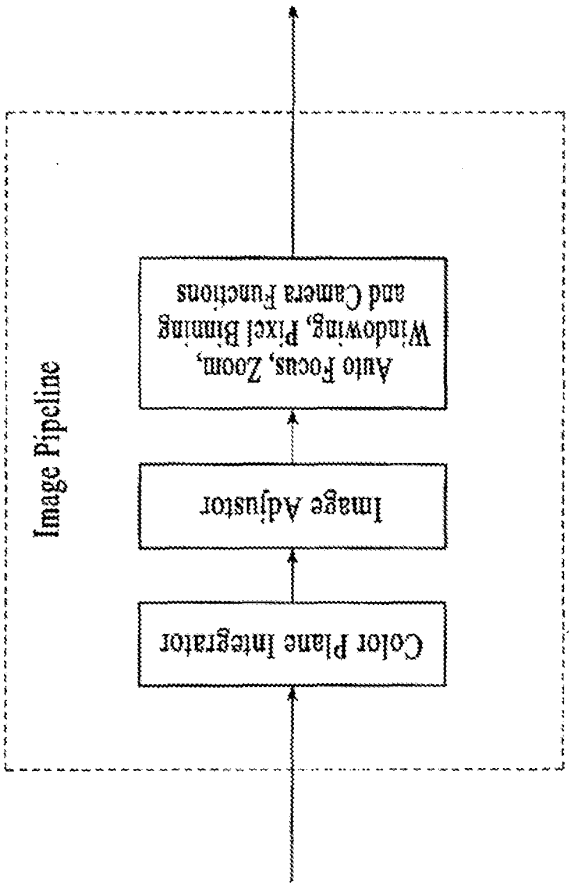

Image Pipeline
Color Plane Integrator
Image Adjustor
Auto Focus, Zoom,
Windowing, Pixel Binning
and Camera Functions

FIG.20C

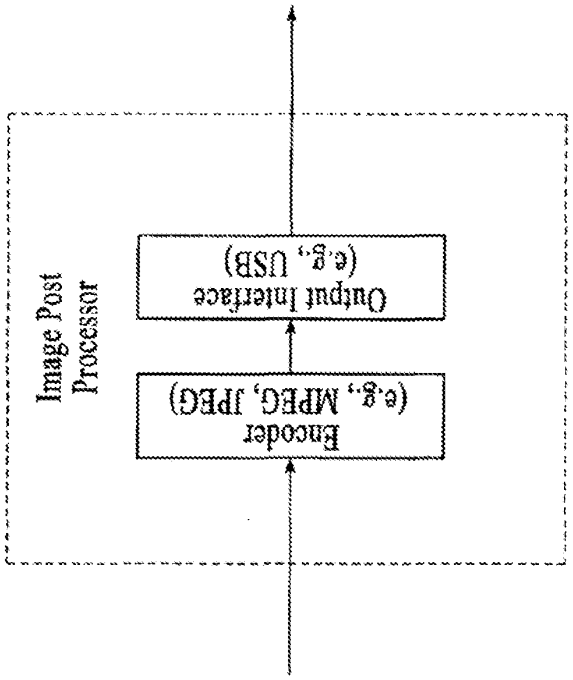
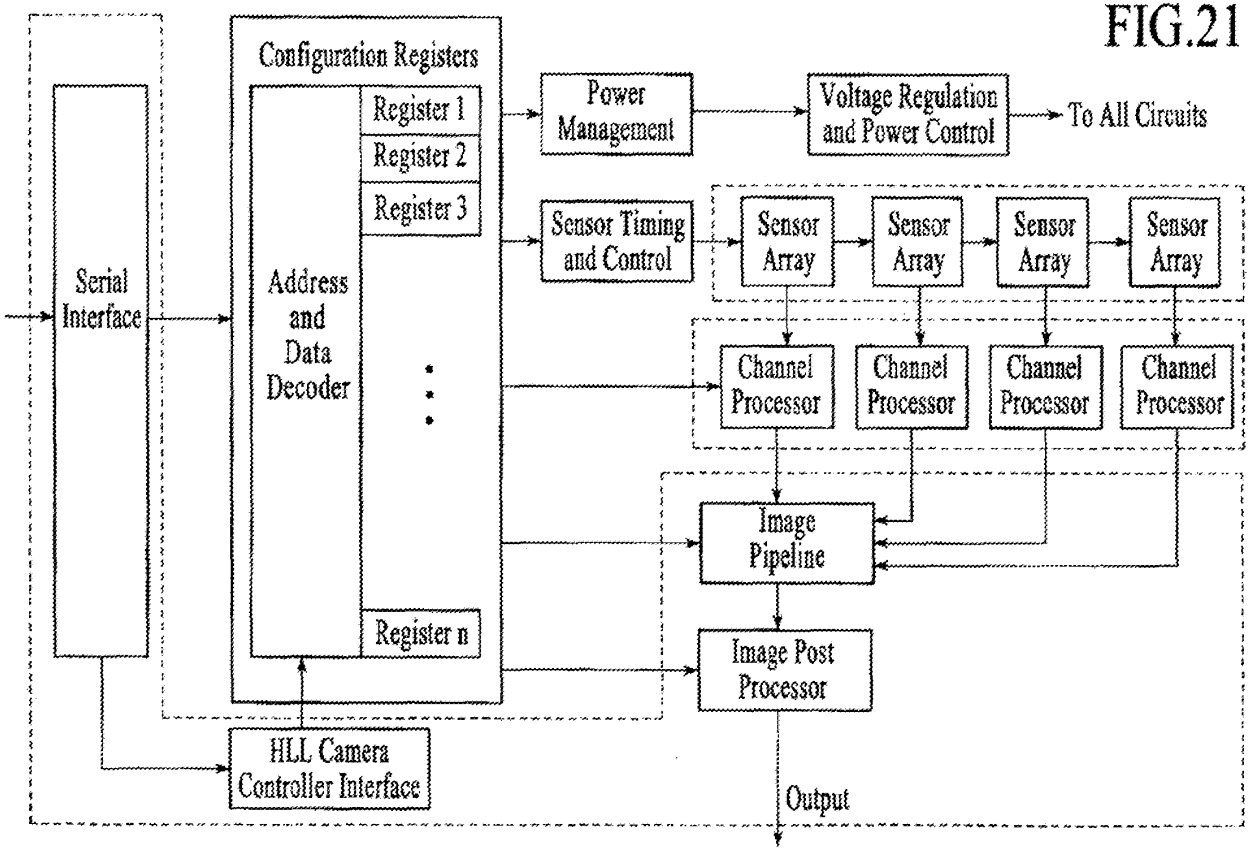

Image Post Processor
Encoder (e.g., MPEG, JPEG)
Output Interface (e.g., USB)

FIG.20D

FIG.21


Configuration Registers
Register 1
Register 2
Register 3
Register n
Address and Data Decoder
Serial Interface
Power Management
Voltage Regulation and Power Control
To All Circuits
Sensor Timing and Control
Sensor Array
Sensor Array
Sensor Array
Sensor Array
Channel Processor
Channel Processor
Channel Processor
Channel Processor
Image Pipeline
Image Post Processor
HLL Camera Controller Interface
Output

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Filer:	Paul S. Hunter/Linda Anderson
Attorney Docket Number:	088245-9946
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	380	380
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1250**

Electronic Acknowledgement Receipt

EFS ID:	12713145
Application Number:	13465229
International Application Number:	
Confirmation Number:	5599
Title of Invention:	LARGE DYNAMIC RANGE CAMERAS
First Named Inventor/Applicant Name:	Richard Ian Olsen
Customer Number:	23524
Filer:	Paul S. Hunter/Linda Anderson
Filer Authorized By:	Paul S. Hunter
Attorney Docket Number:	088245-9946
Receipt Date:	07-MAY-2012
Filing Date:	
Time Stamp:	13:33:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1250
RAM confirmation Number	10380
Deposit Account	
Authorized User	

File Listing:

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

1		transPOAdec.pdf	262515 b50b96693ae032ec527c6fc48c8b7459ec83ab3d	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal of New Application	1	3
	Assignee showing of ownership per 37 CFR 3.73(b).	4	4
	Power of Attorney	5	5
	Oath or Declaration filed	6	8

Warnings:

Information:

2	Application Data Sheet	ADS.pdf	62103 2950ea848eb86a6995f2cd32a8b639d8026b773f	no	5

Warnings:

Information:

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3		spec.pdf	205667 e949e82df4fbd0816b5037ee805ab049deb2fa15	yes	43

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	39
	Claims	40	42
	Abstract	43	43

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Information:

4	Drawings-other than black and white line drawings	Drawings.pdf	6503463 dafb92b4e022e713748847e01864d58d6a794dac	no	24

Warnings:

Information:

5	Fee Worksheet (SB06)	fee-info.pdf	32952 7f30e2b9a42bf9a00961ccb8d88fbc9d39da346c	no	2

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

DocCode - SCORE

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Application Number: 13465229 Document Date: 5/7/2012

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- Drawings

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Form Revision Date: May 1, 2009