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[Continued on next page]

(54) Title: APPARATUS FOR USE OF MULTIPLE OPTICAL CHAINS

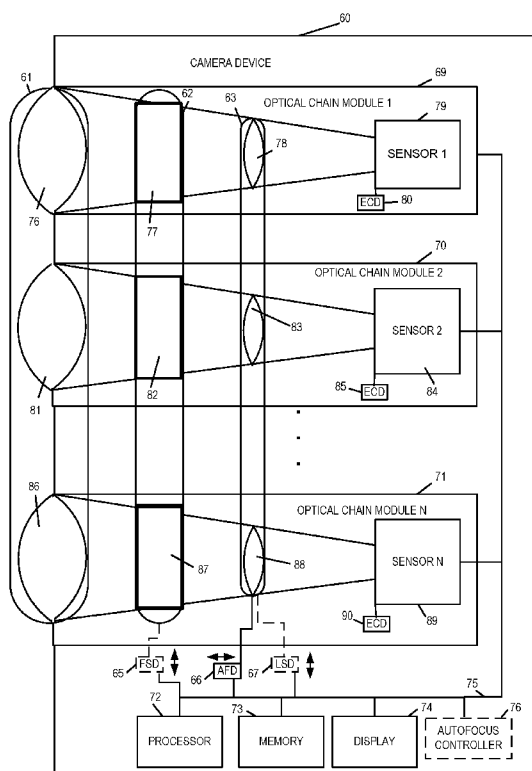


FIGURE 4

(57) Abstract: Methods and apparatus for capturing or generating images using multiple optical chains operating in parallel are described. Pixel values captured by individual optical chains corresponding to the same scene area are combined to provide an image with at least some of the benefits which would have been provided by capturing an image of the scene using a larger lens than that of the individual lenses of the optical chain modules. By using multiple optical chains in parallel at least some benefits normally obtained from using a large lens can be obtained without the need for a large lens. Furthermore in at least some embodiments, a wide dynamic range can be supported through the use of multiple sensors with the overall supported dynamic range being potentially larger than that of the individual sensors. Some lens and/or optical chain configurations are designed for use in small handheld devices, e.g., cell phones.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Published:

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INTERNATIONAL SEARCH REPORT

014/010267 08.07.2014

International application No.

PCT/US14/10267

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 27/10; H04N 5/225 (2014.01)

USPC - 348/335

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classification(s): H01L 27/10; H04N 5/225; G02B 13/16 (2014.01)

USPC Classification(s): 348/335, 340, 345; 257/291

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google/Google Scholar; ProQuest; IEEE;
Keywords Used: compound, superimposed, lens array, combined

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8,237,841 B2 (TANIDA, J et al.) August 7, 2012; figures 1, 2, 7; column 5, lines 11-15, 22-23; 28-33; column 6, lines 7-10, 29-33, 64-67; column 7, lines 1-4, 60-61; column 8, lines 1-10	1-9, 11, 13, 18, 20-28, 30, 32, 35
----- Y		10, 12, 14-17, 19, 29, 31, 33-34, 36-37, 39-80
Y	US 8,194,169 B2 (TAMAKI, S et al.) June 5, 2012; column 6, lines 53-54; column 16, lines 15-20	10, 29, 44-48, 50-52, 59-62, 64-80
Y	SEGAN, S. "Hands on with the 41-Megapixel Nokia PureView 808", February 27, 2012, PC Mag, [online], [retrieved on 2014-04-16]. Retrieved from the Internet: <URL: http://www.pcmag.com/article2/0,2817,2400773,00.asp >; first paragraph	12, 14, 31, 33
Y	US 5,982,951 A (KATAYAMA, T et al.) November 9, 1999; column 1, lines 9-10; column 6, lines 29-33	15-17, 34
Y	US 7,551,358 B2 (LEE, S et al.) June 23, 2009; column 4, lines 31-37	19
Y	US 5,078,479 A (VUILLEUMIER, R et al.) January 7, 1992; abstract; column 2, lines 6-8; column 3, lines 1-7; claim 2.	36-37, 39-52, 63



Further documents are listed in the continuation of Box C.



* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 June 2014 (09.06.2014)

Date of mailing of the international search report

08 JUL 2014

Name and mailing address of the ISA/US

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

-Please see Supplemental Page-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-80

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

2014/010267 08.07.2014

International application No.

PCT/US14/10267

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ROBERTSON, M et al "DYNAMIC RANGE IMPROVEMENT THROUGH MULTIPLE EXPOSURES". 1999. [online] [retrieved on 2014-4-16]: <URL: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=817091&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D817091 >; figure 1; introduction	37, 39-62
Y	US 5,781,331 A (CARR, W et al.) July 14, 1998; column 3, lines 58-65	53-62

-Continued from Box III: Observations where unity of invention is lacking-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-80 are directed toward a method of producing at least one image of a first scene area comprising a plurality of three or more optical chain modules, a first scene area, a first image, a second image, a third image, a first combined image, a plurality of lenses.

Group II: Claims 81-90 are directed toward an apparatus comprising a plurality of lenses, non-circular apertures, a first aperture, a plurality of light capture areas, the entire area of said first aperture, one or more semiconductor sensors, and optical chains.

Group III: Claims 91-98 are directed toward a plurality of at least three optical chain modules, a lens, an image deflection element, optical rays, an optical axis, a sensor.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features. Group I has at least a first scene area, a first image, a second image, and a third image that Groups II and III do not have. Group II has at least non-circular apertures, a first aperture, a plurality of light capture areas, the entire area of said first aperture, and one or more semiconductor sensors that Groups I and III do not have. Group III has at least an image deflection element that Groups I and II do not have.

The common technical features of Groups I and II are at least a plurality of optical chain modules, lenses, a sensor, and combined images. The common technical features of Group I-III are at least optical chain modules, lenses, and a sensor. These common features are disclosed by US 8,237,841 B2 to Tanida, J et al. (hereinafter "Tanida"). Tanida discloses optical chain modules (nine integrally arranged imaging units U (optical chain modules), figures 1-6, column 5, lines 11-15, 32-33), lenses (optical lenses L11, L13 ... L33, figures 1-6, column 5, lines 28-31), and a sensor (solid-state imaging element 5, figures 1-6, column 5, lines 28-31).

Since the common technical features are previously disclosed by the Tanida reference, these common features are not special and so Groups I-III lack unity.