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61/452,840 15 March 2011 (15.03.2011) US(71) Applicant (for all designated States except US): **BOARD OF TRUSTEES OF MICHIGAN STATE UNIVERSITY** [US/US]; 246 Administration Building, East Lansing, Michigan 48824 (US).

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(88) Date of publication of the international search report:

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(54) Title: REAL-TIME OPTICAL 3D SHAPE MEASUREMENT SYSTEM

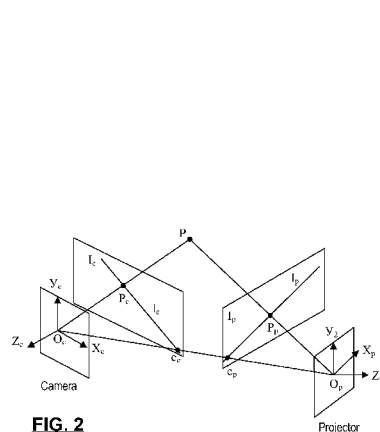


FIG. 2

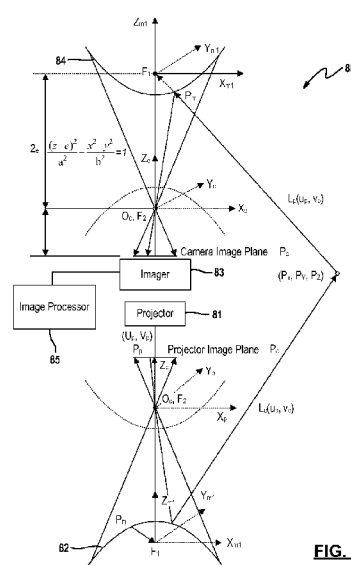


FIG. 8

(57) Abstract: Improved method and system for performing three-dimensional shape inspection by: projecting a pattern of light onto an object of interest with a projector, the pattern of light being constituted by a plurality of symbols of different shapes; capturing an image of the illuminated object with an image capturing device; determining the 3D shape of the object from the image data and the projected light pattern with a processor using triangulation. The pattern of light is projected in an omnidirectional plane by means of a first mirrored surface having hyperbolic shape to provide an alternative to traditional monochromatic light based patterns.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/029048

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01B11/25
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01B

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 38 727 A1 (RUBBERT RUEDGER DIPL ING [DE]) 19 March 1998 (1998-03-19) column 1, lines 3-9 column 3, lines 7-57 column 5, lines 3-52; figures 1,2	1-19
X	US 2008/118143 A1 (GORDON EYAL [IL] ET AL) 22 May 2008 (2008-05-22) paragraphs [0031], [0037], [0044], [0113], [0191], [0206]; figures 3, 6A, 7, 8, 9A, 9B,10 paragraphs [1309] - [0326], [0335], [0337], [0343] - [0349], [0360] - [0368], [0371] - [0374] paragraphs [0379], [0382], [0444] ----- -/--	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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"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

28 August 2012

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/010825 A2 (COGNITENS LTD [IL]; ALBECK DAN [IL]; SEGEV AVNER [IL]; SHALOM TAMIR [I] 3 February 2005 (2005-02-03) page 10, line 25 - page 12, line 14; figures 1-4 page 14, line 19 - page 15, line 6; figure 9 -----	1-19
A	WO 2004/001332 A1 (CANESTA INC [US]) 31 December 2003 (2003-12-31) page 1, lines 12-14 page 13, line 1 - page 14, line 6; figure 3 page 16, line 4 - page 17, line 26; figure 6 figures 7-10 -----	1-19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/029048

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

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

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

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

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

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search 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.:

1-19

Remark on Protest

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

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-19

Method and system for performing three-dimensional shape inspection by: projecting a pattern of light onto an object of interest with a projector, the pattern of light being constituted by a plurality of symbols of different shapes; capturing an image of the illuminated object with an image capturing device; determining the 3D shape of the object from the image data and the projected light pattern with a processor using triangulation.

The projected pattern of light is constructed by generating a pseudo-random sequence of values and it projected onto the object along an epipolar line which results in significantly accelerating the algorithm compared with the conventional strategies.

2. claims: 20-36

Method and system for performing three-dimensional shape inspection by: projecting a pattern of light onto an object of interest with a projector, the pattern of light being constituted by a plurality of symbols of different shapes; capturing an image of the illuminated object with an image capturing device; determining the 3D shape of the object from the image data and the projected light pattern with a processor using triangulation.

The pattern of light is projected in an omnidirectional plane by means of a first mirrored surface having hyperbolic shape to provide an alternative to traditional monochromatic light based patterns.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/029048

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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