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(71) Applicant (for all designated States except US): **TK HOLDINGS INC.** [US/US]; 2500 Takata Drive, Auburn Hills, Michigan 48326 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **SHEN, Shi** [CN/US]; 30155 Southampton Lane, Farmington Hills, Michigan 48331 (US).

(74) Agents: **SHIPLEY, Howard** et al.; Foley & Lardner LLP, 3000 K Street NW, Suite 600, Washington, District of Columbia 20007 (US).

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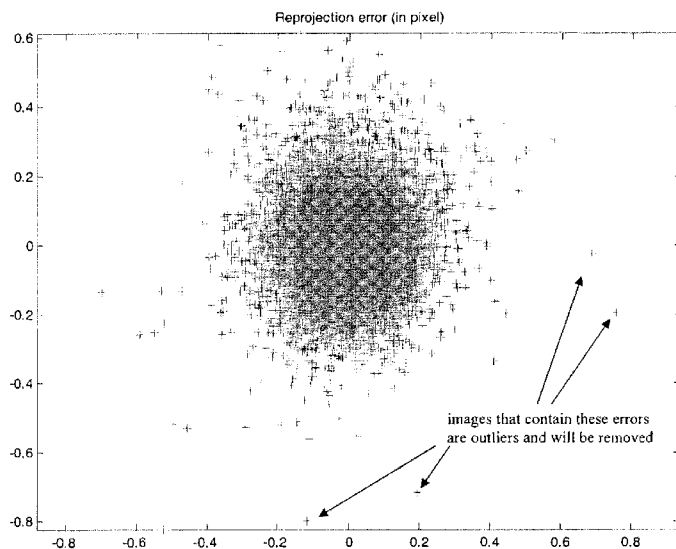
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: IMAGE SENSOR CALIBRATION SYSTEM AND METHOD

FIG. 8



(57) Abstract: A calibration apparatus includes a calibration target such as a checkerboard, a frame configured to hold the checkerboard in place, a rotatable socket connected at one end to the frame, a stand which is connected to another end of the rotatable socket, a height adjusting portion connected at one end to the stand, and a platform connected to another end of the stand. The checkerboard can be tilted and moved to a particular distance and orientation with respect to an image system to be calibrated by the calibration apparatus. A method of identifying outlier images in the camera parameter estimation process, by using estimated 3D positions of the checkerboard compared with ground truth values.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/030325**A. CLASSIFICATION OF SUBJECT MATTER*****H04N 3/14(2006.01)i, H04N 5/335(2011.01)i, G01N 21/956(2006.01)i***

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N 3/14; G01B 11/24; G06K 9/46; G06T 17/00; G06K 9/00; H04N 17/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: Calibration, Pattern, Frame, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002-0057832 A1 (MARC R.A.B. PROESMANS et al.) 16 May 2002 See abstract, paragraph[0006] - paragraph[0035], figures 1 - 3b.	1-17
A	US 2004-0042649 A1 (KAZUHIKO ARAI et al.) 04 March 2004 See abstract, paragraph[0006] - paragraph[0018], paragraph[0050] - paragraph[0058], figures 1 - 3b.	1-17
A	US 2009-0059011 A1 (SUN JUNHUA et al.) 05 March 2009 See abstract, paragraph[0010] - paragraph[0024], paragraph[0032] - paragraph[0047], figures 1 - 2.	1-17
A	US 2009-0122058 A1 (TSCHESNOK ANDREW J.) 14 May 2009 See abstract, paragraph[0012] - paragraph[0016], paragraph[0041] - paragraph[0049], figures 3 - 4.	1-17

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

* Special categories of cited documents:

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"&" document member of the same patent family

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Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan
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Authorized officer

PARK, SANGCHEOL

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002-0057832 A1	16.05.2002	AT 253721 T	15.11.2003
		AU 1997-30852 B2	28.10.1999
		AU 3085297 A	07.01.1998
		AU 712090 B2	28.10.1999
		BR 9709679 A	11.01.2000
		CA 2256587 A1	18.12.1997
		DE 69726025 D1	11.12.2003
		DE 69726025 T2	16.09.2004
		EP 1009969 A1	21.06.2000
		EP 1009969 B1	05.11.2003
		IL 127534 A	26.08.2001
		IL 127534 D0	28.10.1999
		JP 2000-512012 A	12.09.2000
		JP 2000-512012 T	12.09.2000
		KR 10-2000-0016663 A	25.03.2000
		NO 985746 A	12.02.1999
		NO 985746 D0	08.12.1998
		US 6510244 B2	21.01.2003
		WO 97-47942A1	18.12.1997
US 2004-0042649 A1	04.03.2004	DE 60316645 D1	15.11.2007
		DE 60316645 T2	31.01.2008
		EP 1394501 A2	03.03.2004
		EP 1394501 A3	25.01.2006
		EP 1394501 B1	03.10.2007
		JP 03-635539 B2	06.04.2005
		JP 2004-093216 A	25.03.2004
		US 7286698 B2	23.10.2007
US 2009-0059011 A1	05.03.2009	CN 100491903 C	27.05.2009
		CN 101109620 A	23.01.2008
		US 8180101 B2	15.05.2012
US 2009-0122058 A1	14.05.2009	AU 2008-222933 A1	12.09.2008
		CA 2717485 A1	12.09.2008
		CN 101681438 A	24.03.2010
		EP 2135197 A2	23.12.2009
		JP 2010-520565 A	10.06.2010
		JP 2010-520565 T	10.06.2010
		KR 10-2009-0130003 A	17.12.2009
		WO 2008-109567 A2	12.09.2008
		WO 2008-109567 A3	12.09.2008
		WO 2008-109567 A3	13.11.2008
		WO 2008-109567 A4	12.09.2008
		WO 2008-109567 A4	19.02.2009