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- (81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
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[Continued on next page]

(54) **Title:** HYBRID PRECISION TRACKING

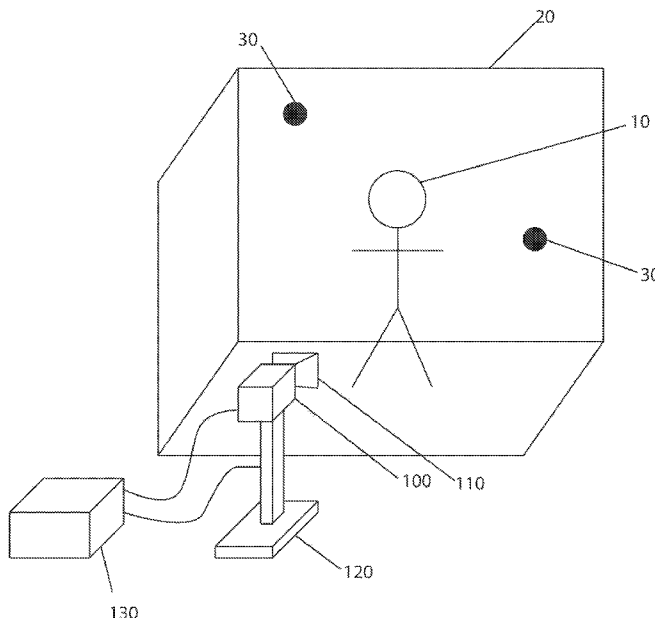


FIG. 1

(57) **Abstract:** Disclosed herein are through-the-lens tracking systems and methods which can enable sub-pixel accurate camera tracking suitable for real-time set extensions. That is, the through-the-lens tracking can make an existing lower precision camera tracking and compositing system into a real-time VFX system capable of sub-pixel accurate real-time camera tracking. With this enhanced level of tracking accuracy the virtual cameras can be used to register and render real-time set extensions for both interior and exterior locations.

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27 December 2013

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/036005

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - G06K 9/00(2013.01) USPC - 345/103 According to International Patent Classification (IPC) or to both national classification and IPC</p>																																					
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) IPC(8) - G06K 9/00; G06T 15/00, 15/10, 15/80; H04N 13/02 (2013.01) USPC - 345/418, 419, 426; 382/100, 103</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched CPC- G06K 9/00; G06T 15/00, 15/10, 15/80; H04N 13/02 (2013.01)</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Orbit, Google Patents, Google Scholar</p>																																					
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td rowspan="2">US 6,064,749 A (HIROTA et al) 16 May 2000 (16.05.2000) entire document</td> <td>9-19</td> </tr> <tr> <td>---</td> <td>-----</td> </tr> <tr> <td>Y</td> <td></td> <td>1-8,10-18,20-29</td> </tr> <tr> <td>Y</td> <td>US 2010/0245593 A1 (KIM et al) 30 September 2010 (30.09.2010) entire document</td> <td>1-8,18,25</td> </tr> <tr> <td>Y</td> <td>US 2008/0075385 A1 (DAVID et al) 27 March 2008 (27.03.2008) entire document</td> <td>6,18,26-29</td> </tr> <tr> <td>Y</td> <td>US 2006/0258938 A1 (HOFFMAN et al) 16 November 2006 (16.11.2006) entire document</td> <td>10-12,15-18,22-24</td> </tr> <tr> <td>Y</td> <td>US 6,014,163 A (HOUSKEEPER) 11 January 2000 (11.01.2000) entire document</td> <td>13,14,20-24</td> </tr> <tr> <td>Y</td> <td>US 2011/0221742 A1 (DEERING et al) 15 September 2011 (15.09.2011) entire document</td> <td>27-29</td> </tr> <tr> <td>A</td> <td>US 2004/0104935 A1 (WILLIAMSON et al) 03 June 2004 (03.06.2004) entire document</td> <td>1-29</td> </tr> <tr> <td>A</td> <td>US 2010/0164862 A1 (SULLIVAN et al) 01 July 2010 (01.07.2010)entire document</td> <td>1-29</td> </tr> <tr> <td>A</td> <td>WO 97/00494 (ROSSER et al) 03 January 1997 (03.01.1997) entire document</td> <td>1-29</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 6,064,749 A (HIROTA et al) 16 May 2000 (16.05.2000) entire document	9-19	---	-----	Y		1-8,10-18,20-29	Y	US 2010/0245593 A1 (KIM et al) 30 September 2010 (30.09.2010) entire document	1-8,18,25	Y	US 2008/0075385 A1 (DAVID et al) 27 March 2008 (27.03.2008) entire document	6,18,26-29	Y	US 2006/0258938 A1 (HOFFMAN et al) 16 November 2006 (16.11.2006) entire document	10-12,15-18,22-24	Y	US 6,014,163 A (HOUSKEEPER) 11 January 2000 (11.01.2000) entire document	13,14,20-24	Y	US 2011/0221742 A1 (DEERING et al) 15 September 2011 (15.09.2011) entire document	27-29	A	US 2004/0104935 A1 (WILLIAMSON et al) 03 June 2004 (03.06.2004) entire document	1-29	A	US 2010/0164862 A1 (SULLIVAN et al) 01 July 2010 (01.07.2010)entire document	1-29	A	WO 97/00494 (ROSSER et al) 03 January 1997 (03.01.1997) entire document	1-29
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<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/></p>																																					
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>“A” document defining the general state of the art which is not considered to be of particular relevance</td> <td>“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</td> </tr> <tr> <td>“E” earlier application or patent but published on or after the international filing date</td> <td>“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</td> </tr> <tr> <td>“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)</td> <td>“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</td> </tr> <tr> <td>“O” document referring to an oral disclosure, use, exhibition or other means</td> <td>“&” document member of the same patent family</td> </tr> <tr> <td>“P” document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			“A” document defining the general state of the art which is not considered to be of particular relevance	“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	“E” earlier application or patent but published on or after the international filing date	“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	“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)	“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	“O” document referring to an oral disclosure, use, exhibition or other means	“&” document member of the same patent family	“P” document published prior to the international filing date but later than the priority date claimed																										
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<p>Date of the actual completion of the international search</p> <p>12 September 2013</p>	<p>Date of mailing of the international search report</p> <p>01 OCT 2013</p>																																				
<p>Name and mailing address of the ISA/US</p> <p>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201</p>	<p>Authorized officer:</p> <p>Blaine R. Copenheaver</p> <p>PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774</p>																																				

Cont. Box No. III

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 fees must be paid.

Group I, claims 1-25, drawn to hybrid through-the-lens tracking system, comprising using a calibrated look-up table to modify search locations for scene markers when using adjustable lenses, predicting locations of the scene markers and using a high speed scene marker detection scheme to calculate the predicted locations of the markers, and calculating necessary angular corrections to correct the angular position of camera.

Group II, claims 26-29, drawn to finding the center of a circle comprising detecting the edge or slope of an image luminance or color, and storing this information in a derivative image, removing parallel lines from the resulting derivative image by searching along the normal of the current derivative slope to select for circular markers, searching along the direction of the current slope for the opposite side of the circle, and thereby determining a candidate for the center point of the circle, voting for the most likely center point, using the accumulation of all of the center points and reading out the highest weighted point to a CPU with a fast data transfer.

The inventions listed as Groups I-II 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 for the following reasons: the special technical feature of the Group I invention: hybrid through-the-lens tracking system, comprising using a calibrated look-up table to modify search locations for scene markers when using adjustable lenses, calculating the predicted locations of the markers, and calculating necessary angular corrections to correct the angular position of camera as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: detecting the edge or slope of an image luminance or color, and storing this information in a derivative image, removing parallel lines from the resulting derivative image by searching along the normal of the current derivative slope to select for circular markers, searching along the direction of the current slope for the opposite side of the circle, and thereby determining a candidate for the center point of the circle, voting for the most likely center point, using the accumulation of all of the center points as claimed therein is not present in the invention of Groups I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of tracking a marker and predicting the location of a center of the marker, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2004/0104935 A1 (WILLIAMSON et al) 03 June 2004 (03.06.2004), abstract, para 151, 272-273, 317; US 2010/0164862 A1 (SULLIVAN et al) 01 July 2010 (01.07.2010), para 27, 44-47 and WO 97/00494 (ROSSER et al) 03 January 1997 (03.01.1997), abstract, page 6, para 3, page 7, paras 3-4, page 13, para 2.

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/036005

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 extra 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 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.:

- 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.