



- (51) **International Patent Classification:**
G06T 19/00 (2011.01) *G05D 1/00* (2006.01)
- (21) **International Application Number:**
PCT/US2014/013497
- (22) **International Filing Date:**
29 January 2014 (29.01.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
13/754,795 30 January 2013 (30.01.2013) US
- (71) **Applicant:** INSITU, INC. [US/US]; 118 East Columbia River Way, Bingen, Washington 98605 (US).
- (72) **Inventors:** DAVIDSON, Darcy, Jr.; P.O. Box 130, Dallesport, Washington 98617 (US). TROWBRIDGE, Theodore T.; 1540 Solar Lane, Hood River, Oregon 97031 (US).
- (74) **Agents:** POOLE, James M. et al.; The Boeing Company, P.O. Box 2515, MC 110-SD54, Seal Beach, California 90740-1515 (US).
- (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, IR, IS, JP, KE, KG, 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, SA, 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.

- (84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- 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))

- (88) **Date of publication of the international search report:**
24 September 2015

(54) **Title:** AUGMENTED VIDEO SYSTEM PROVIDING ENHANCED SITUATIONAL AWARENESS

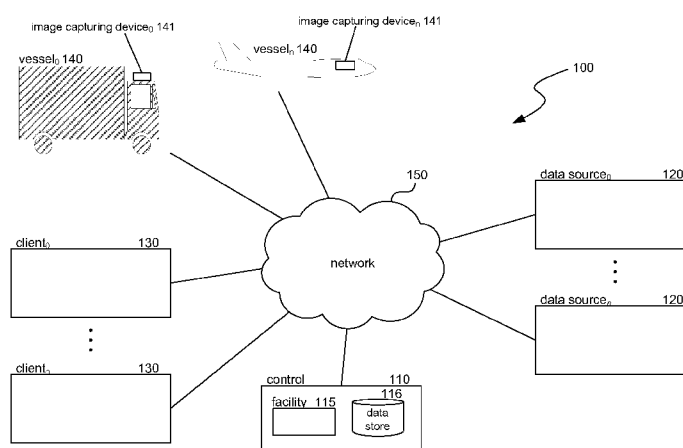


FIG. 1

(57) **Abstract:** A facility, comprising systems and methods, for providing enhanced situational awareness to captured image data is disclosed. The disclosed techniques are used in conjunction with image data, such as a real-time or near real-time image stream captured by a camera attached to an unmanned system, previously captured image data, rendered image data, etc. The facility enhances situational awareness by projecting overlays onto captured video data or "wrapping" captured image data with previously-captured and/or "synthetic world" information, such as satellite images, computer-generated images, wire models, textured surfaces, and so on. The facility also provides enhanced zoom techniques that allow a user to quickly zoom in on an object or area of interest using a combined optical and digital zoom technique. Additionally, the facility provides a digital lead indicator designed to reduce operator-induced oscillations in commanding an image capturing device.

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/013497

A. CLASSIFICATION OF SUBJECT MATTER
 INV. G06T19/00 G05D1/00
 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)

G05D G06T H04N

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, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GLORIA L CALHOUN* A ET AL: "Synthetic vision system for improving unmanned aerial vehicle operator situation awareness", 1 May 2005 (2005-05-01), ENHANCED AND SYNTHETIC VISION, SPIE, PAGE(S) 219 - 230, XP009168010, ISBN: 0-8194-5787-6	1-4,6-8, 18-20
Y	title, abstract, section "1. OVERVIEW", therein pgph. 1-3; section "2.1 SmartCam3D Synthetic Vision System" therein e.g. pgph.1-4; section "3.2 Presentation of synthetic vision symbology: scene-linked or not." section "3.3.2 Terrain overlay" section "3.10 Adequacy of the performance of the synthetic vision system" fig.1-5 with captions; ----- -/-	5,14-17



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

"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

14 July 2015

Date of mailing of the international search report

28/07/2015

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Ellerbrock, Thomas

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/013497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUIYAO WU ET AL: "Vison-based auxiliary navigation method using augmented reality for unmanned aerial vehicles", INDUSTRIAL INFORMATICS (INDIN), 2012 10TH IEEE INTERNATIONAL CONFERENCE ON, IEEE, 25 July 2012 (2012-07-25), pages 520-525, XP032235230, DOI: 10.1109/INDIN.2012.6300922 ISBN: 978-1-4673-0312-5 sections "A. Computer vision-based registration", "B. The transformation based on registration algorithm to get distance and direction information" -----	1-3,6-8
A	CAMPION D C ET AL: "Direct geo-referencing technique for rapid positioning of targets and environmental products using tactical grade airborne imaging data", OCEANS 2002 CONFERENCE AND EXHIBITION. CONFERENCE PROCEEDINGS (CAT. NO.02CH37362) IEEE PISCATAWAY, NJ, USA, vol. 3, 2002, page 1603, XP002732531, ISBN: 0-7803-7534-3 abstract -----	3
A	INANC T ET AL: "Nonlinear trajectory generation for unmanned air vehicles with multiple radars", PROCEEDINGS OF THE IEEE CONFERENCE ON DECISION AND CONTROL - 2004 43RD IEEE CONFERENCE ON DECISION AND CONTROL (CDC) 2004 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS INC. US, vol. 4, 2004, pages 3817-3822, XP002732532, first 5 lines of section "1. Introduction" -----	8
X	US 2012/307042 A1 (LEE HOU-HSIEN [TW] ET AL) 6 December 2012 (2012-12-06) pgph. 9-10, 16-17 -----	4,13-17
X	WIXSON L ET AL: "Image alignment for precise camera fixation and aim", COMPUTER VISION AND PATTERN RECOGNITION, 1998. PROCEEDINGS. 1998 IEEE COMPUTER SOCIETY CONFERENCE ON SANTA BARBARA, CA, USA 23-25 JUNE 1998, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC, US, 23 June 1998 (1998-06-23), pages 594-600, XP010291695, DOI: 10.1109/CVPR.1998.698666 ISBN: 978-0-8186-8497-5 p.3, left col., pgph.3; right col., pgph.2 ----- -/--	4,13-17

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/013497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 168 830 A1 (WELLS & VERNE INVEST LTD [GB]) 2 January 2002 (2002-01-02) pgph.11, particularly penultimate sub-pgph. -----	4,13-17
X	WO 97/13357 A1 (SENSORMATIC ELECTRONICS CORP [US]) 10 April 1997 (1997-04-10) p.3, L20-39; p.10, L1-28; fig.2 -----	13
Y		5,14-17
A	US 2004/189830 A1 (POLLARD STEPHEN BERNARD [GB]) 30 September 2004 (2004-09-30) pgph.5 -----	3,13-17
A	NELSON E D ET AL: "Zoom techniques for achieving scale invariant object tracking in real-time active vision systems", PROCEEDINGS OF THE SPIE - THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING SPIE - THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING USA, vol. 6569, 27 April 2007 (2007-04-27), pages 65690F-1-12, XP002741769, ISSN: 0277-786X abstract; p.3, section "3. HYBRID ZOOM" -----	3,13-17
X	Abrams Austin, Fridrich Nick, Jacobs Nathan, Pless Robert: "Participatory integration of live webcams into GIS", Proceedings of the 1st International Conference and Exhibition on Computing for Geospatial Research & Application, COM.Geo '10; 23 June 2010 (2010-06-23), XP002741770, Retrieved from the Internet: URL:http://research.engineering.wustl.edu/~abramsa/papers/comgeo_camera.pdf [retrieved on 2015-07-03] section "3. SCALABLE INTEGRATION OF LIVE VIDEO WITH GIS", therein pgph.1-2; section "3.1 Integration of Webcams into 2D Satellite Imagery", therein pgph.1-5 section "3.2 Integration of Webcams into 3D Imagery", therein pg.1; fig.3-4 ----- -/--	9-12

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/013497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SAWHNEY H S ET AL: "VIDEO FLASHLIGHTS - REAL TIME RENDERING OF MULTIPLE VIDEOS FOR IMMERSIVE MODEL VISUALIZATION", RENDERING TECHNIQUES 2002. EUROGRAPHICS WORKSHOP PROCEEDINGS. PISA, ITALY, JUNE 26 - 28, 2002; [PROCEEDINGS OF THE EUROGRAPHICS WORKSHOP], NEW YORK, NY : ACM, US, vol. WORKSHOP 13, 26 June 2002 (2002-06-26), pages 157-168, XP001232389, ISBN: 978-1-58113-534-3 section "1. Introduction", therein e.g. pgph.1 section "4. Video Flashlight Rendering Algorithm & Implementation", therein, pgph.1-2; section "4.1. Flashlight Rendering Results", therein pgph.1; p.8, left col., pgph.2 fig.5+9 with captions -----	9-12
A	KIHWAN KIM ET AL: "Augmenting aerial earth maps with dynamic information from videos", VIRTUAL REALITY, SPRINGER-VERLAG, LO, vol. 15, no. 2 - 3, 11 January 2011 (2011-01-11), pages 185-200, XP019911651, ISSN: 1434-9957, DOI: 10.1007/S10055-010-0186-2 abstract -----	9-12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/013497

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.:

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.

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

1. claims: 1-3, 6-8

First invention (claims 1-3, 6-8):

Augmenting the live video images captured by an unmanned aerial vehicle (UAV) by overlaying a variety of different virtual / metadata (depending on the embodiment) to enhance the situational awareness.

The overlaid virtual data comprises:

- some object of interest (from claim 1)
- geographic / topographic / terrain / map data (from claim 2)
- bathymetric data (= sea floor topography) (claim 3)
- flight path, groundspeed, etc. (claim 6)
- building, city block overlay (claim 7)
- detectability overlay (claim 8)

2. claims: 4, 18-20

Second invention (claims 4, 13-17):

The second invention is related to changing the orientation of a camera (claims 13-17) of the UAV (claim 4).

3. claims: 5, 13-17

Third invention (claims 5, 18-20):

Combining an optical and a digital zoom (claim 18-20) of a UAV (claim 5).

4. claims: 9-12

Fourth invention (claims 9-12):

Rendering a hybrid environment by combining two different image streams of two (real) different cameras, transforming the images frames of both streams with respect to some geographic region and with respect to the position of a virtual camera.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/013497

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012307042 A1	06-12-2012	TW 201249713 A US 2012307042 A1	16-12-2012 06-12-2012
EP 1168830 A1	02-01-2002	AU 7442401 A EP 1168830 A1 EP 1297690 A1 US 2004105010 A1 WO 0201856 A1	08-01-2002 02-01-2002 02-04-2003 03-06-2004 03-01-2002
WO 9713357 A1	10-04-1997	AR 003814 A1 AU 705512 B2 AU 7205396 A BR 9611113 A CA 2231095 A1 EP 0853855 A1 JP H11513549 A US 5684532 A WO 9713357 A1	09-09-1998 27-05-1999 28-04-1997 13-07-1999 10-04-1997 22-07-1998 16-11-1999 04-11-1997 10-04-1997
US 2004189830 A1	30-09-2004	GB 2400253 A JP 2004304798 A US 2004189830 A1	06-10-2004 28-10-2004 30-09-2004