

US 8,824,833 B2

Sep. 2, 2014

(12) United States Patent

Dagher et al.

(54) IMAGE DATA FUSION SYSTEMS AND **METHODS**

(75) Inventors: **Joseph C. Dagher**, Boulder, CO (US);

Amit Ashok, Boulder, CO (US); David Tremblay, Boulder, CO (US); Kenneth

S. Kubala, Boulder, CO (US)

Assignee: OmniVision Technologies, Inc., Santa

Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this

patent is extended or adjusted under 35

U.S.C. 154(b) by 380 days.

Appl. No.: 12/865,343

(22) PCT Filed: Jan. 30, 2009

(86) PCT No.: PCT/US2009/032683

§ 371 (c)(1),

(2), (4) Date: Nov. 29, 2010

(87) PCT Pub. No.: WO2009/097552

PCT Pub. Date: Aug. 6, 2009

(65)**Prior Publication Data**

US 2011/0064327 A1 Mar. 17, 2011

(51) Int. Cl.

G06K 9/32 (2006.01)G06T 5/00 (2006.01)G06T 5/50 (2006.01)

(52)U.S. Cl.

> CPC . G06T 5/50 (2013.01); G06T 5/004 (2013.01); G06T 2207/20221 (2013.01); G06T 2207/10148 (2013.01)

CPC G06T 2207/20221 See application file for complete search history.

Field of Classification Search

(56)References Cited

(10) **Patent No.:**

(45) Date of Patent:

U.S. PATENT DOCUMENTS

5,130,794	Α	sķ.	7/1992	Ritchey 348/39
5,172,236	Α		12/1992	Takemoto et al.
5,282,045	Α		1/1994	Mimura et al.
5,771,416	Α	*	6/1998	Mukai et al 396/378
6,128,416	Α	*	10/2000	Oura 382/284
6,201,899	В1		3/2001	Bergen
6,654,013	В1	*	11/2003	Malzbender et al 345/426
6,856,708	В1		2/2005	Aoki
7,274,830	B2		9/2007	Bacarella et al.

(Continued)

OTHER PUBLICATIONS

Snavely et al., "Photo Tourism: Exploring photo collections in 3D," ACM Transactions on Graphics, 25(3), Aug. 2006.*

(Continued)

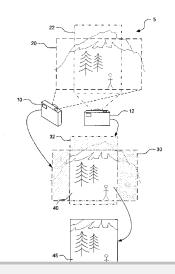
Primary Examiner — Bhavesh Mehta Assistant Examiner — Andrew Moyer

(74) Attorney, Agent, or Firm — Lathrop & Gage LLP

(57)**ABSTRACT**

Systems and methods for image data fusion include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes at least partially overlap in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data subsets such that each of the subsets is based on at least one characteristic of the second collection, and each subset spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data subsets.

39 Claims, 18 Drawing Sheets





(56) References Cited

U.S. PATENT DOCUMENTS

2001/0045982 A1 2002/0140823 A1 2003/0026588 A1* 2004/0047518 A1	10/2002 2/2003 3/2004	Okisu et al. Sakurai et al. Elder et al
2004/0080661 A1 2004/0105569 A1* 2004/0234154 A1* 2005/0248590 A1*	6/2004 11/2004	Afsenius Sharma et al
2006/0050338 A1* 2006/0061678 A1 2007/0188601 A1*	3/2006 8/2007	Hattori
2007/0247517 A1 2008/0056612 A1* 2008/0218613 A1* 2011/0019048 A1	3/2008	Zhang et al. 382/284 Park et al. 348/262 Raynor et al. 348/262

OTHER PUBLICATIONS

Bao and Xu, "Complex wavelet-based image mosaics using edgepreserving visual perception modeling," Computers & Graphics 23.3 (1999): 309-321.*

Brown and Lowe, "Recognising panoramas," Proceedings of the Ninth IEEE International Conference on Computer Vision, vol. 2, No. 1218-1225, 2003.*

Klarquist and Bovik, "Fovea: A foveated vergent active stereo vision system for dynamic three-dimensional scene recovery," Robotics and Automation, IEEE Transactions on 14.5 (1998): 755-770.*

Kuhnlenz et al., "A multi-focal high-performance vision system," Robotics and Automation, 2006. ICRA 2006, Proceedings 2006 IEEE International Conference on, IEEE, 2006.*

Scassellati, "A binocular, foveated active vision system," No. AI-M-1628, Massachusetts Inst of Tech Cambridge Artificial Intelligence Lab. 1999.*

Zhao et al., "Broadband and wide field of view foveated imaging system in space," Optical Engineering 47.10 (2008): 103202-103202.*

Wikipedia, http://en.wikipedia.org/wiki/Image_scaling, Jan. 29, 2007.*

Drori, Iddo, and Dani Lischinski. "Fast multiresolution image operations in the wavelet domain." Visualization and Computer Graphics, IEEE Transactions on 9.3 (2003): 395-411.*

Hill, Paul R., Cedric Nishan Canagarajah, and David R. Bull. "Image fusion using complex wavelets." BMVC. 2002.*

International Search Report and Written Opinion issued in related PCT patent application PCT/US2009/032683, dated Jan. 30, 2009, 14 pages.

Kiyoharu, et al., "Producing Object-Based Special Effects by Fusing Multiple Differently Focused Images," IEEE Transactions on Circuits and Systems for Video Technology, IEEE Service Center, vol. 10, No. 2, Mar. 1, 2000.

Kazuya, et al., "All-in-Focus Image Generation by Merging Multiple Differently Focused Images in Three-Dimensional Frequency Domain" Advances in Multimedia Information Processing—PCT 2005 Lecture Notes in Computer Science, vol. 3767, pp. 303-314, Jan. 1, 2005.

Hong, Sahyun, et al. "Data Fusion of Multiple Polarimetriv SAR Images Using Discrete Wavelet Transform (DWT)" IEEE, 3323-3325, 2002.

Office Action issued in related Taiwanese Patent Application 098103287 dated Jan. 9, 2013, 29 pages.

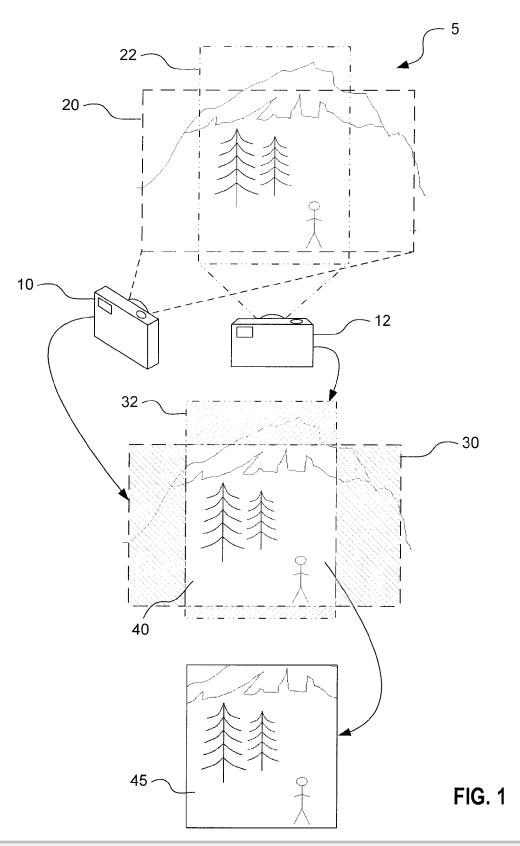
U.S. Appl. No. 13/281,674 Office Action issued Sep. 10, 2013, 28 pages.

U.S. Appl. No. 13/281,674 Response to Office Action filed Dec. 10, 2013, 9 pages.

* cited by examiner



Sep. 2, 2014



Sep. 2, 2014

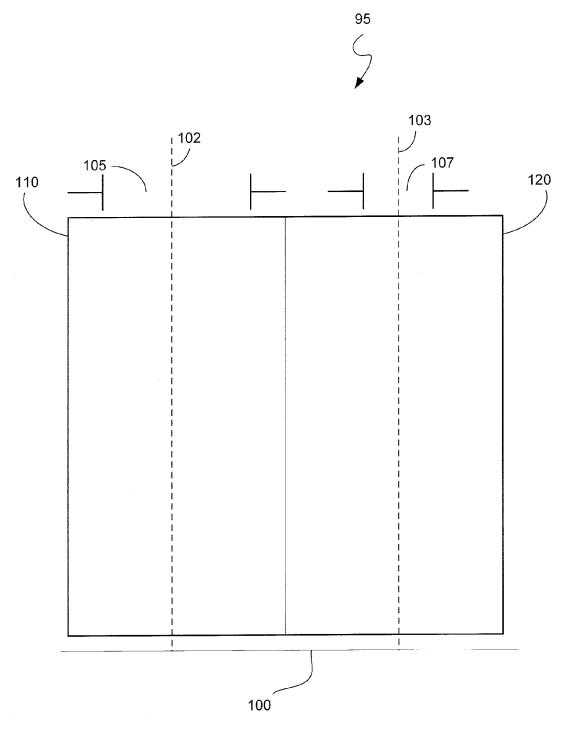


FIG. 2A

Sep. 2, 2014

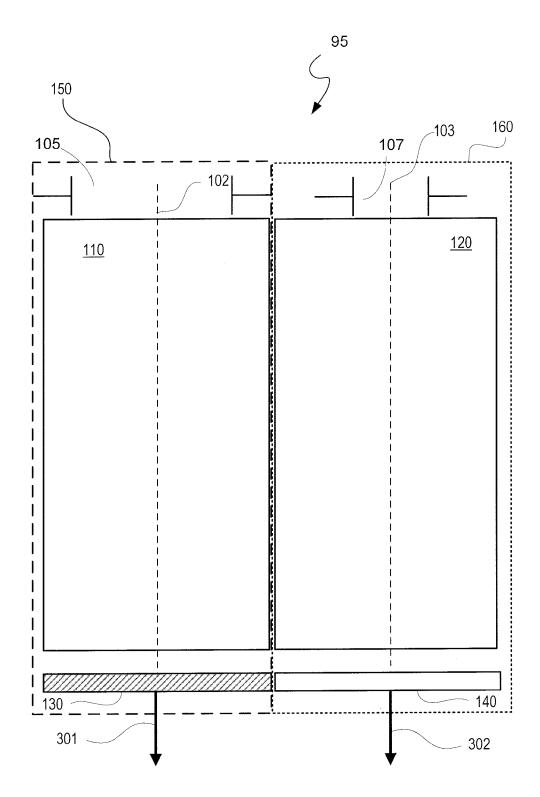


FIG. 2B



DOCKET A L A R M

Explore Litigation Insights



Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time** alerts and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

