



US008160400B2

(12) **United States Patent**
Snavelly et al.

(10) **Patent No.:** **US 8,160,400 B2**
(45) **Date of Patent:** **Apr. 17, 2012**

(54) **NAVIGATING IMAGES USING IMAGE BASED GEOMETRIC ALIGNMENT AND OBJECT BASED CONTROLS**

2002/0113872 A1* 8/2002 Kinjo 348/116
2008/0150890 A1* 6/2008 Bell et al. 345/156
2008/0150913 A1* 6/2008 Bell et al. 345/175

(75) Inventors: **Keith Noah Snavelly**, Seattle, WA (US);
Steven Maxwell Seitz, Seattle, WA (US);
Richard Szeliski, Bellevue, WA (US)

OTHER PUBLICATIONS

TED Talk—"Blaise Aguera y Arcas demos Photosynth" filmed Mar. 2007 at TED conference in Monterey, California, available to view at: http://www.ted.com/talks/lang/eng/blaise_aguera_y_arcas_demos_photosynth.html.*

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

Arya, S. et al., "An optimal algorithm for approximate nearest neighbor searching fixed dimensions," *Journal of the ACM* 45, 1998, 6, 891-923.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1245 days.

Brown, M. et al., "Unsupervised 3D object recognition and reconstruction in unordered datasets," *International Conference on 3D Imaging and Modeling*, Ontario, Canada, Jun. 13-16, 2005, 56-63.

(21) Appl. No.: **11/493,436**

Canny, J., "A computational approach to edge detection," *IEEE Trans. Pattern Anal. Mach. Intell.*, 1986, 8(6), 679-698.

(22) Filed: **Jul. 25, 2006**

(Continued)

(65) **Prior Publication Data**

US 2007/0110338 A1 May 17, 2007

Primary Examiner — Stephen Koziol

(74) *Attorney, Agent, or Firm* — Woodcock Washburn LLP

Related U.S. Application Data

(60) Provisional application No. 60/737,908, filed on Nov. 17, 2005.

(57) **ABSTRACT**

(51) **Int. Cl.**

G06K 9/54 (2006.01)

G06K 9/46 (2006.01)

Over the past few years there has been a dramatic proliferation of digital cameras, and it has become increasingly easy to share large numbers of photographs with many other people. These trends have contributed to the availability of large databases of photographs. Effectively organizing, browsing, and visualizing such seas. of images, as well as finding a particular image, can be difficult tasks. In this paper, we demonstrate that knowledge of where images were taken and where they were pointed makes it possible to visualize large sets of photographs in powerful, intuitive new ways. We present and evaluate a set of novel tools that use location and orientation information, derived semi-automatically using structure from motion, to enhance the experience of exploring such large collections of images.

(52) **U.S. Cl.** **382/305**; 382/100; 382/154; 382/190; 382/201; 382/206; 707/E17.029

(58) **Field of Classification Search** 382/100, 382/154, 190, 201, 206, 214, 216, 305, 325; 707/E17.029

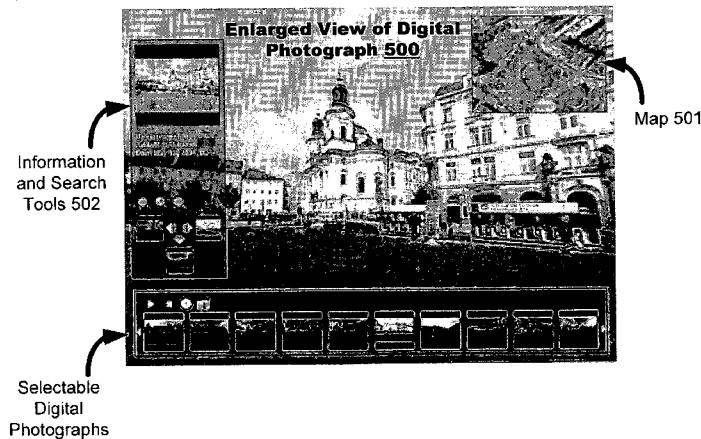
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,263,230 B2* 8/2007 Tashman 382/232
7,353,114 B1* 4/2008 Rohlf et al. 702/5
7,693,702 B1* 4/2010 Kerner et al. 703/22

9 Claims, 10 Drawing Sheets



OTHER PUBLICATIONS

- Debevec, P. E. et al., "Modeling and rendering architecture from photographs: a hybrid geometry- and image-based approach," *SIG-GRAPH '96: Proceedings of the 23rd annual conference on Computer graphics and interactive techniques*, ACM Press, New York, NY, USA, 1996, 11-20.
- Yahoo, Inc., "Popular Tags on Flickr Photo Sharing," *Flickr*, <http://www.flickr.com/photos/tags>, 2006, 2 pages.
- Hartley, R. I. et al., *Multiple View Geometry in Computer Vision*, second ed. Cambridge University Press, 2004.
- Johansson, B. et al., "A system for automatic pose-estimation from a single image in a city scene," *IASTED Int. Conf. Signal Processing, Pattern Recognition and Applications*, Crete, Greece, Jun. 25-28, 2002, 68-73.
- Lourakis, M. I. et al., "The design and implementation of a generic sparse bundle adjustment software package based on the levenberg-marquardt algorithm," *Tech. Rep. 340, Institute of Computer Science—FORTH*, Heraklion, Crete, Greece, Aug. 2004.
- Mikolajczyk, K. et al., "A performance evaluation of local descriptors," *IEEE Transactions on Pattern Analysis & Machine Intelligence*, 2005, 27(10), 1615-1630.
- Rubner, Y. et al., "A metric for distributions with applications to image databases," *Int'l Conf. on Computer Vision (ICCV)*, 1998, 59-66.
- Schaffalitzky, F. et al., "Multi-view matching for un-ordered image sets, or 'How do I organize my holiday snaps?'" *Proceedings of the 7th European Conference on Computer Vision*, Copenhagen, Denmark, May 28-31, 2002, 1, 414-431.
- Sutherland, I. E., "Sketchpad: a man-machine graphical communication system," *Proceedings—Spring Joint Computer Conference*, 1963, 329-346.
- Szeliski, R., "Image alignment and stitching: A tutorial," Tech. Rep. MSR-TR-2004-92, Microsoft Research, 2004, 1-57.
- Werner, T. et al., "New techniques for automated architecture reconstruction from photographs," *Proceedings of the 7th European Conference on Computer Vision*, Copenhagen, Denmark, May 28-31, 2002, 2, 541-555.
- Microsoft Co., "What can you do with a gazillion photos on a single database indexed by their locations?" *World-Wide Media eXchange: WWWX*, <http://www.wwmx.org>, Apr. 7, 2005, downloaded Sep. 27, 2006, 2 pages.
- Yeh, T. et al., "Searching the web with mobile images for location recognition," *CVPR (2)*, 2004, 76-81.

* cited by examiner

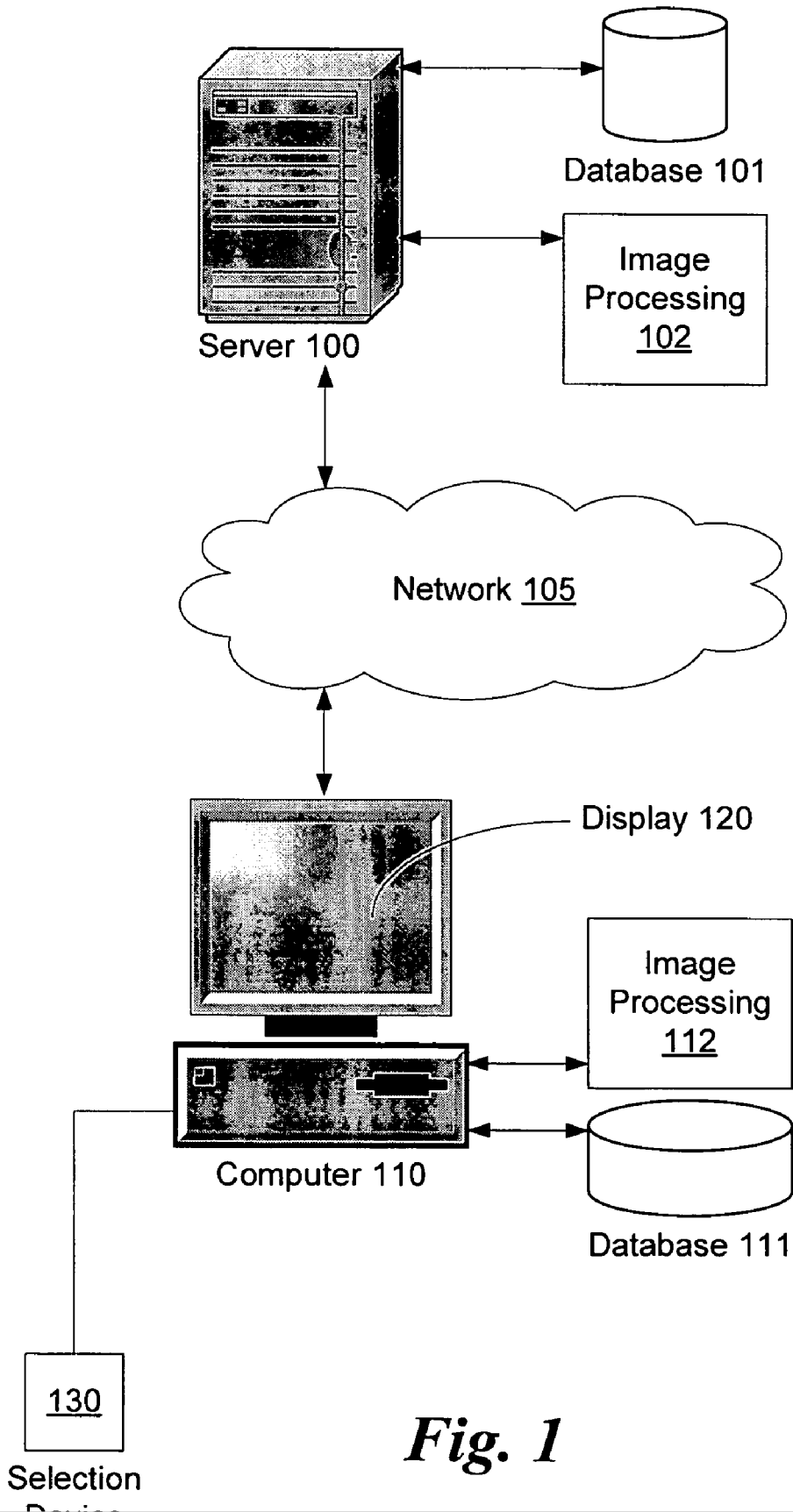


Fig. 1

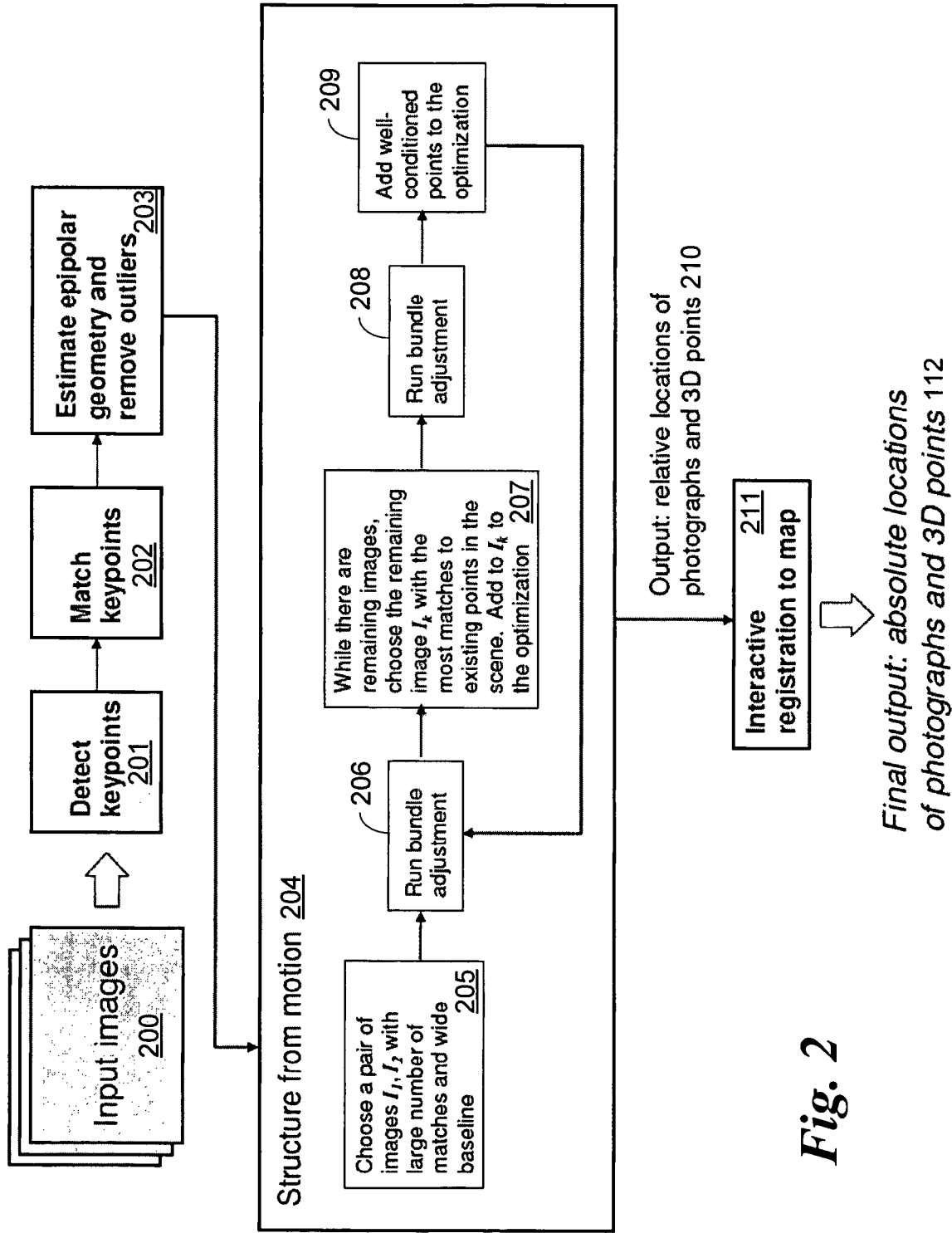


Fig. 2

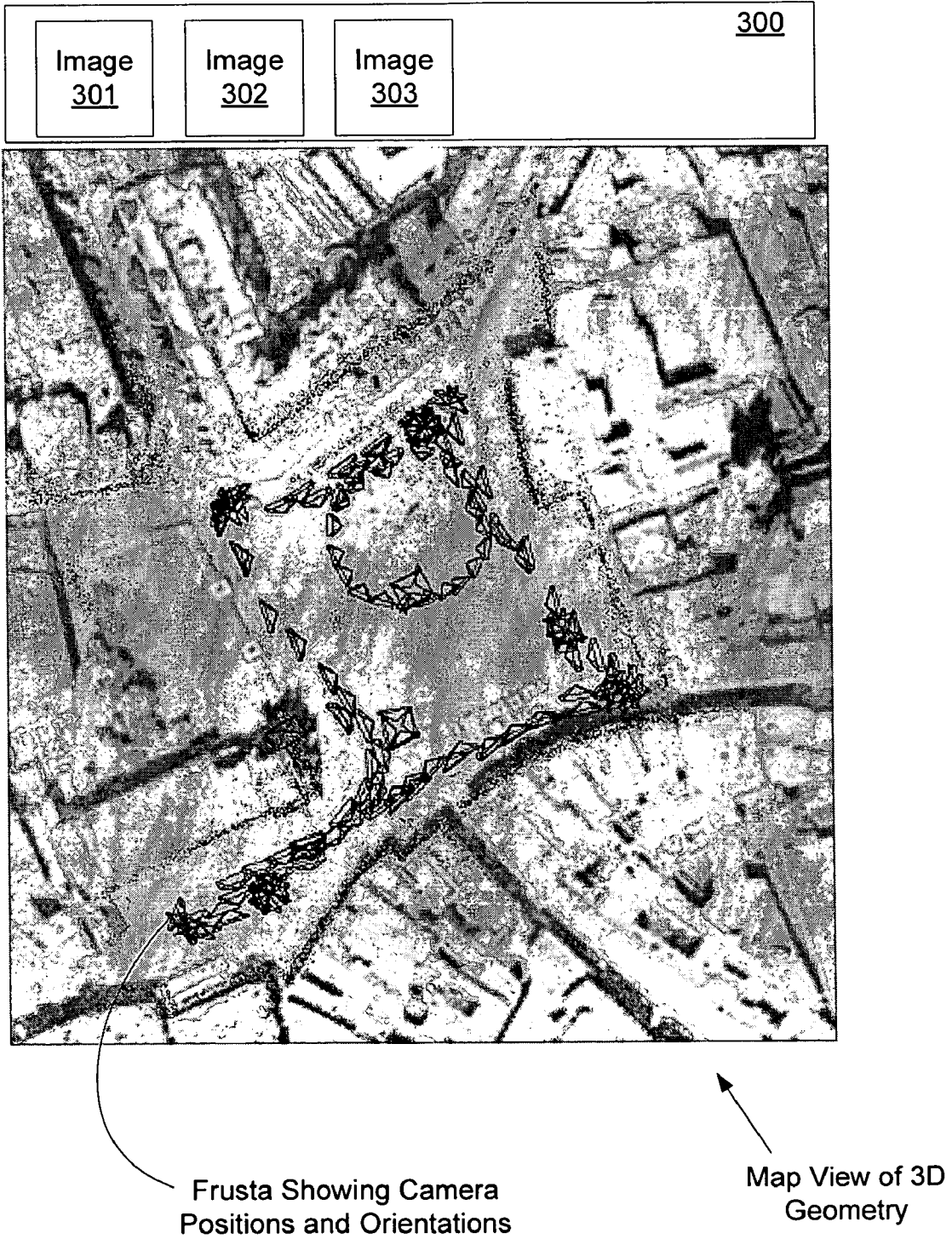


Fig. 3

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.