



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

(10) **Patent No.:** **US 7,932,923 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **VIDEO SURVEILLANCE SYSTEM EMPLOYING VIDEO PRIMITIVES**
(75) Inventors: **Alan J. Lipton**, Falls Church, VA (US); **Thomas M. Strat**, Pakton, VA (US); **Peter L. Venetianer**, McLean, VA (US); **Mark C. Allmen**, Morrison, CO (US); **William E. Severson**, Littleton, CO (US); **Niels Haering**, Arlington, VA (US); **Andrew J. Chosak**, McLean, VA (US); **Zhong Zhang**, Herndon, VA (US); **Matthew F. Frazier**, Arlington, VA (US); **James S. Seekas**, Arlington, VA (US); **Tasuki Hirata**, Silver Spring, MD (US); **John Clark**, Leesburg, VA (US)

4,737,847 A 4/1988 Araki et al.
4,908,704 A 3/1990 Fujioka et al.
5,448,315 A 9/1995 Soohoo
5,491,511 A 2/1996 Odle
5,515,453 A 5/1996 Hennessey et al.
5,610,653 A 3/1997 Abecassis
5,623,249 A 4/1997 Camire
5,696,503 A 12/1997 Nasburg
5,801,943 A 9/1998 Nasburg
5,802,361 A 9/1998 Wang et al.
5,850,352 A 12/1998 Moezzi et al.
5,860,086 A 1/1999 Crump et al.
5,872,865 A 2/1999 Normile et al.
5,886,701 A 3/1999 Chauvin et al.
5,912,980 A 6/1999 Hunke
5,926,210 A 7/1999 Hackett et al.
5,956,081 A 9/1999 Katz et al.
5,959,690 A 9/1999 Toebes, VIII et al.

(Continued)

(73) Assignee: **ObjectVideo, Inc.**, Reston, VA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

EP 0293189 B1 7/1994

(Continued)

(21) Appl. No.: **12/569,116**

OTHER PUBLICATIONS

(22) Filed: **Sep. 29, 2009**

International Search Report for International Application No. PCT/US08/09073, dated Nov. 3, 2008.

(65) **Prior Publication Data**

(Continued)

US 2010/0013926 A1 Jan. 21, 2010

(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.** **348/143**

(58) **Field of Classification Search** **375/143, 375/144, 145, 148; H04N 7/18**
See application file for complete search history.

Primary Examiner — Tung Vo

(74) *Attorney, Agent, or Firm* — Muir Patent Consulting, PLLC

(57) **ABSTRACT**

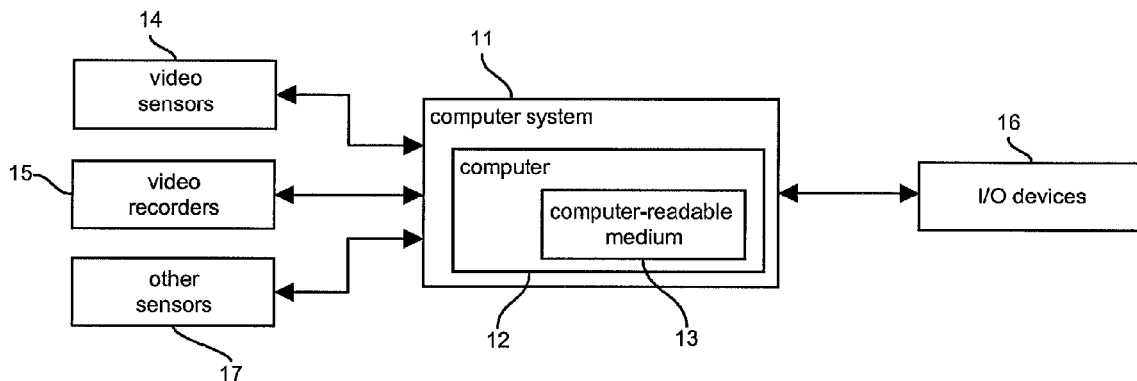
A video surveillance system is set up, calibrated, tasked, and operated. The system extracts video primitives and extracts event occurrences from the video primitives using event discriminators. The system can undertake a response, such as an alarm, based on extracted event occurrences.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,812,287 A 5/1974 Lemelson
4,249,207 A 2/1981 Harman et al.
4,257,063 A 3/1981 Loughry et al.

41 Claims, 7 Drawing Sheets



U.S. PATENT DOCUMENTS

5,963,202 A 10/1999 Polish
 5,963,203 A 10/1999 Goldberg et al.
 5,983,147 A 11/1999 Krumm
 5,987,211 A 11/1999 Abecassis
 5,999,189 A 12/1999 Kajiya et al.
 6,014,461 A 1/2000 Hennessey et al.
 6,031,573 A 2/2000 MacCormack et al.
 6,069,653 A 5/2000 Hudson et al.
 6,075,560 A 6/2000 Katz
 6,088,484 A 7/2000 Mead
 6,091,771 A 7/2000 Seeley et al.
 6,097,429 A 8/2000 Seeley et al.
 6,123,123 A 9/2000 Carder et al.
 6,144,375 A 11/2000 Jain et al.
 6,151,413 A 11/2000 Jang
 6,166,744 A 12/2000 Jaszlics et al.
 6,177,886 B1 1/2001 Billington et al.
 6,025,877 A1 2/2001 Chang et al.
 6,201,473 B1 3/2001 Schaffer
 6,211,907 B1 4/2001 Scaman et al.
 6,226,388 B1 5/2001 Qian et al.
 6,297,844 B1 10/2001 Schatz et al.
 6,307,885 B1 10/2001 Moon et al.
 6,310,916 B1 10/2001 Han
 6,326,964 B1 12/2001 Snyder et al.
 6,351,265 B1 2/2002 Bulman
 6,351,492 B1 2/2002 Kim
 6,360,234 B2 3/2002 Jain et al.
 6,404,455 B1 6/2002 Ito et al.
 6,411,724 B1 6/2002 Vaithilingam et al.
 6,424,370 B1 7/2002 Courtney
 6,504,479 B1 1/2003 Lemons et al.
 6,525,658 B2 2/2003 Streetman et al.
 6,542,075 B2 4/2003 Barker et al.
 6,542,840 B2 4/2003 Okamoto et al.
 6,552,826 B2 4/2003 Adler et al.
 6,570,608 B1 5/2003 Tserng
 6,573,907 B1 6/2003 Madrane
 6,597,800 B1 7/2003 Murray et al.
 6,628,835 B1 9/2003 Brill et al.
 6,646,676 B1 11/2003 DaGraca et al.
 6,696,945 B1 2/2004 Venetianer et al.
 6,707,852 B1 3/2004 Wang
 6,721,454 B1* 4/2004 Qian et al. 382/224
 6,724,915 B1 4/2004 Toklu et al.
 6,727,938 B1 4/2004 Randall
 6,738,424 B1 5/2004 Allmen et al.
 6,741,977 B1 5/2004 Nagaya
 6,801,662 B1 10/2004 Owechko et al.
 6,812,835 B2 11/2004 Ito et al.
 6,816,184 B1 11/2004 Brill et al.
 6,829,371 B1 12/2004 Nichani et al.
 6,844,818 B2 1/2005 Grech-Cini
 6,865,580 B1 3/2005 Bush
 6,924,801 B1 8/2005 Dorbie
 6,940,998 B2 9/2005 Garoutte
 6,954,498 B1 10/2005 Lipton
 6,987,528 B1 1/2006 Nagahisa
 6,987,883 B2 1/2006 Lipton et al.
 7,023,469 B1 4/2006 Olson
 7,167,519 B2 1/2007 Comaniciu et al.
 7,197,072 B1 3/2007 Hsu et al.
 7,215,795 B2 5/2007 Ito et al.
 7,227,893 B1 6/2007 Srinivasa et al.
 7,301,536 B2 11/2007 Ellenby
 7,307,652 B2 12/2007 Broemmelsiek
 7,356,830 B1 4/2008 Dimitrova
 7,436,887 B2 10/2008 Yeredor et al.
 7,447,331 B2 11/2008 Brown et al.
 7,479,980 B2 1/2009 Merheim et al.
 7,653,635 B1* 1/2010 Paek et al. 1/1
 7,660,439 B1 2/2010 Lu et al.
 2001/0019357 A1 9/2001 Ito et al.
 2001/0033330 A1 10/2001 Garoutte
 2001/0035907 A1 11/2001 Broemmelsiek
 2002/0008758 A1 1/2002 Broemmelsiek et al.

2002/0082769 A1 6/2002 Church et al.
 2002/0095490 A1 7/2002 Barker et al.
 2002/0135483 A1 9/2002 Merheim et al.
 2002/0163521 A1 11/2002 Ellenby
 2002/0191851 A1 12/2002 Keinan
 2003/0043160 A1 3/2003 Elfving et al.
 2003/0051255 A1 3/2003 Bulman et al.
 2003/0053659 A1 3/2003 Pavlidis et al.
 2003/0085992 A1 5/2003 Arpa et al.
 2003/0231769 A1 12/2003 Bolle et al.
 2004/0113933 A1 6/2004 Guler
 2004/0130620 A1 7/2004 Buehler et al.
 2004/0161133 A1 8/2004 Elazar et al.
 2004/0240542 A1 12/2004 Yeredor et al.
 2005/0146605 A1 7/2005 Lipton et al.
 2005/0157169 A1 7/2005 Brodsky et al.
 2005/0162515 A1 7/2005 Venetianer et al.
 2005/0168574 A1 8/2005 Lipton et al.
 2005/0169367 A1 8/2005 Venetianer et al.
 2005/0198063 A1 9/2005 Thomas et al.
 2006/0232673 A1 10/2006 Lipton et al.
 2006/0279630 A1 12/2006 Aggarwal et al.
 2007/0002141 A1 1/2007 Lipton et al.
 2007/0013776 A1 1/2007 Venetianer et al.
 2007/0052803 A1 3/2007 Chosak et al.
 2007/0127774 A1 6/2007 Zhang et al.
 2008/0100704 A1 5/2008 Venetianer et al.

FOREIGN PATENT DOCUMENTS

EP 0893923 A1 1/1999
 EP 0967584 A2 12/1999
 EP 1024666 A2 8/2000
 EP 1120746 8/2001
 EP 1333682 A1 8/2003
 JP 2009-247654 A 9/1997
 JP 10-048008 2/1998
 JP 10-290449 10/1998
 JP 2000-175174 6/2000
 JP 2000-339923 8/2000
 JP 2000-224542 11/2000
 JP 2001-175868 6/2001
 JP 2001-285681 10/2001
 WO 94/03014 A1 2/1994
 WO 01/62005 8/2001
 WO WO-03/044727 A1 5/2003
 WO WO-2004/006184 A2 1/2004

OTHER PUBLICATIONS

Written Opinion for International Application No. PCT/US08/09073, dated Nov. 3, 2008.
 A. Selinger and L. Wixson, "Classifying Moving Objects as Rigid or Non-Rigid Without Correspondences," Proceedings of DARPA Image Understanding Workshop, 1, Nov. 1998, pp. 341-347.
 Alan J. Lipton, Virtual Postman—An Illustrative Example of Virtual Video, International Journal of Robotics and Automation, vol. 15, No. 1, Jan. 2000, pp. 9-16.
 Alan J. Lipton, Virtual Postman—Real Time, Interactive Virtual Video, IASTED Conference on Computer Graphics and Imaging (CGIM '99), Palm Springs, Oct. 25-27, 1999.
 Robert T. Collins et al., "A System for Video Surveillance and Monitoring," Technical Report CMU-RI-TR-00-12, Robotics Institute, Carnegie Mellon University, May 2000.
 Jemez Technology Corp., Variant iD Web-Site, www.variantid.com, printed Aug. 25, 2003.
 JP Office Action issued in PCT/US2002/22688 dated Oct. 9, 2007.
 A. J. Lipton et al., "Moving Target Classifications and Tracking from Real-time Video," IUW, pp. 159-175, May 1997.
 A. J. Lipton, "Local Application of Optic Flow to Analyze Rigid Versus Non-Rigid Motion," International Conference on Computer Vision, Corfu, Greece, Sep. 1999.
 A. J. Lipton, H. Fujiyoshi and R. S. Patil, "Moving Target Classification and Tracking for Real-time Video," Proceedings of IEEE WACV'98, Princeton, NJ, 1998, pp. 8-14.

- C. R. Wren et al., "Pfnder: Real-time Tracking of the Human Body," *Vismod*, 1995.
- CN Office Action for CN 02822772.7 on Oct. 14, 2005.
- D. M. Gavrilu, "The Visual Analysis of Human Movement: A Survey," *CVIU*, 73(1):82-98, Jan. 1999.
- F. Bartolini et al., "Counting People Getting in and Out of a Bus by Real-time Image-sequence Processing," *IVC*, 12(1):36-41, Jan. 1994.
- H. Fujiyoshi and A. J. Lipton, "Real-time Human Motion Analysis by Image Skeletonization," *Proceedings of IEEE WACV'98*, Princeton, NJ, 1998, pp. 15-21.
- International Search Report for International Application No. PCT/2001/32614 on May 6, 2002.
- International Search Report for International Application No. PCT/2006/25196, mailed Jan. 16, 2008.
- International Search Report for International Application No. PCT/US06/45625, mailed on Sep. 24, 2007.
- International Search Report for International Application No. PCT/US2002/22688 on Dec. 11, 2002.
- International Search Report for International Application No. PCT/US2006/012556, mailed on Feb. 12, 2008.
- International Search Report for International Application No. PCT/US2006/02700 dated Apr. 13, 2007.
- J.P. DeParis et al., "A Device for Counting Passenger Making Use of Two Active Linear Cameras: Comparison of Algorithms," *IEEE*, pp. 1629-1634, 1996.
- L. Khoudour et al., "Real-time Pedestrian Counting by Active Linear Cameras," *JEI*, 5(4):452-459, Oct. 1996.
- L. Wixson et al., "Detecting Salient Motion by Accumulating Directionally-Consistent Flow," *IEEE* 1999.
- L. Wixson et al., "Detecting Salient Motion by Accumulating Directionally-Consistent Flow," *IEEE Trans Pattern Anal. Mach. Intell.*, vol. 22, pp. 774-781, Aug. 2000.
- M. Rossi et al., "Tracking and Counting Moving People," *ICIP94*, pp. 212-216, 1994.
- M. Allmen et al., "Long-Range Spatiotemporal Motion Understanding Using Spatiotemporal Flow Curves," *Proc. IEEE CVPR*, Lahaina, Maui, Hawaii, pp. 303-309, 1991.
- M. Isard et al., "BraMBLE: A Bayesian Multiple-Blob Tracker," *ICCV*, 2001.
- N. Haering et al., "Visual Event Detection," *Video Computing Series*, Editor Mubarak Shah, 2001.
- Notification for IL Application No. 161777 issued Feb. 21, 2008.
- R. T. Collins, Y. Tsin, J. R. Miller and A. J. Lipton, "Using a DEM to Determine Geospatial Object Trajectories" *CMU-RI-TR-98-19*, 1998.
- S. Ioffe et al., "Probabilistic Methods for Finding People," *IJCV*, 43(1):45-68, Jun. 2001.
- Shio et al., "Segmentation of People in Motion," *Proc. IEEE*, 1991, vol. 79, pp. 325-332.
- T.J. Olsen et al., "Moving Object Detection and Event Recognition Algorithm for Smart Cameras," *IUW*, pp. 159-175, May 1997.
- W.E.L. Grimson et al., "Using Adaptive Tracking to Classify and Monitor Activities in a Site," *CVPR*, pp. 22-29, Jun. 1998.
- Written Opinion for International Application No. PCT/US2006/25196, mailed on Jan. 16, 2008.
- Written Opinion issued in PCT Application No. PCT/US2006/012556, mailed on Feb. 12, 2008.
- Written Opinion of the International Searching Authority issued for PCT Application No. PCT/US2006/45625, mailed on Sep. 24, 2007.
- A. J. Lipton et al., "Moving Target Classifications and Tracking from Real-time Video," *IUW*, pp. 129-136, 1998.

* cited by examiner

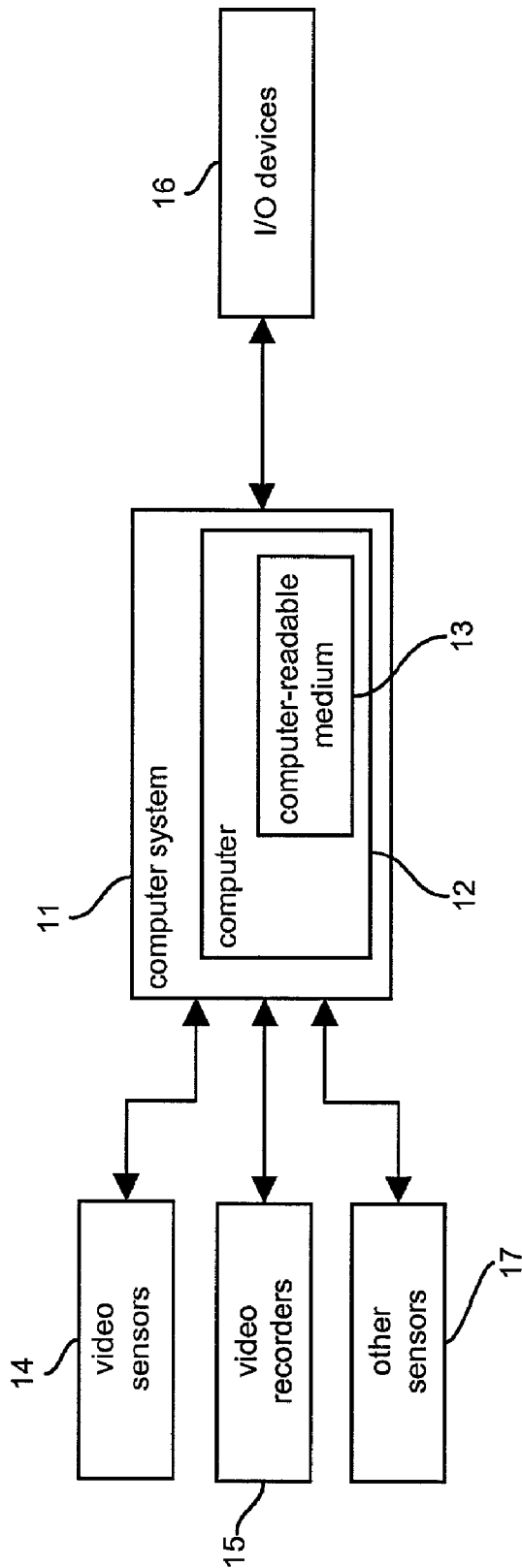


FIG. 1

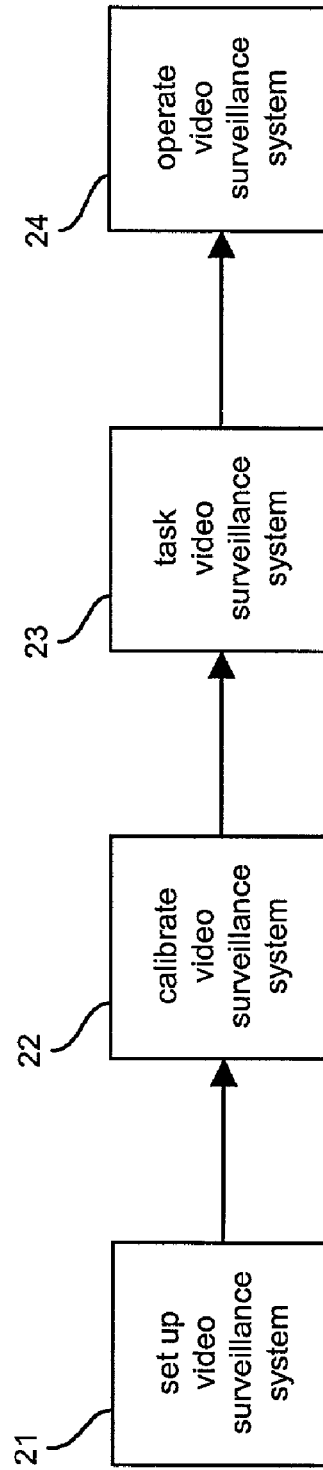


FIG. 2

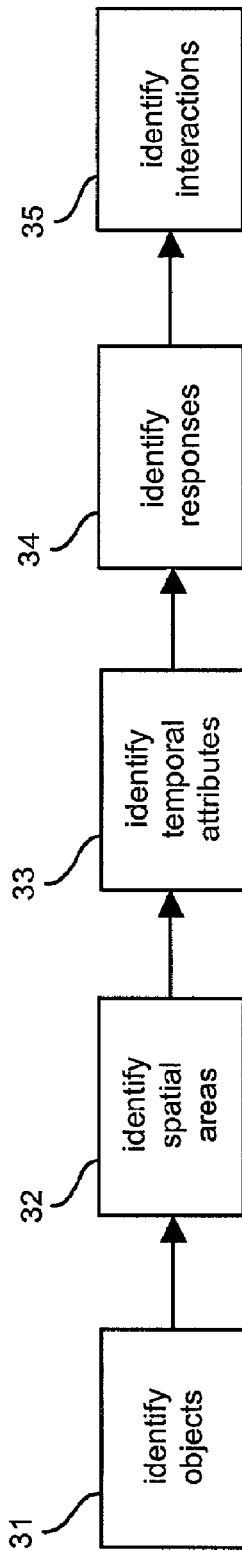


FIG. 3

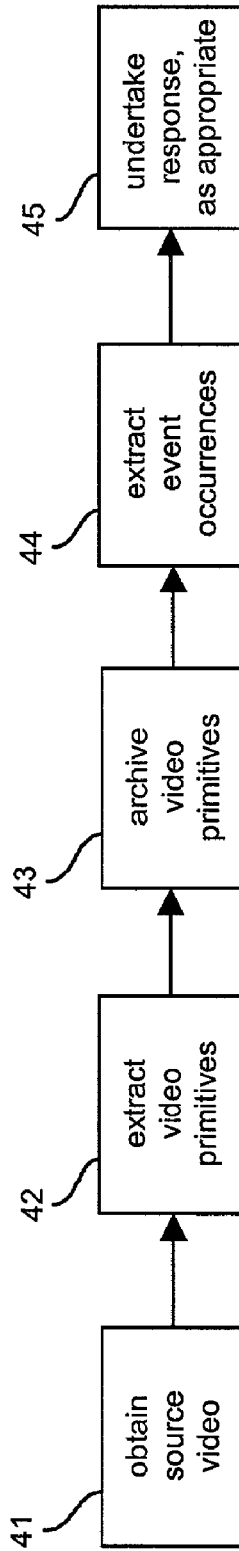


FIG. 4

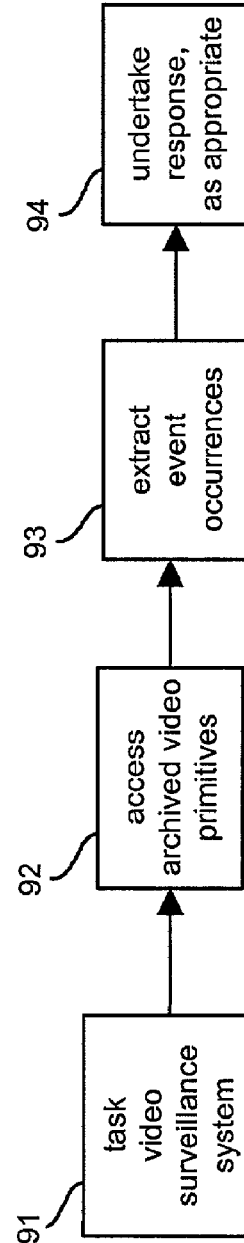


FIG. 9

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.