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(54) **VIDEO SURVEILLANCE SYSTEM EMPLOYING VIDEO PRIMITIVES**
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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)

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FOREIGN PATENT DOCUMENTS

EP 0293189 B1 7/1994

(Continued)

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OTHER PUBLICATIONS

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

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

(58) **Field of Classification Search** **375/143, 375/144, 145, 148; H04N 7/18**

(57) **ABSTRACT**

See application file for complete search history.

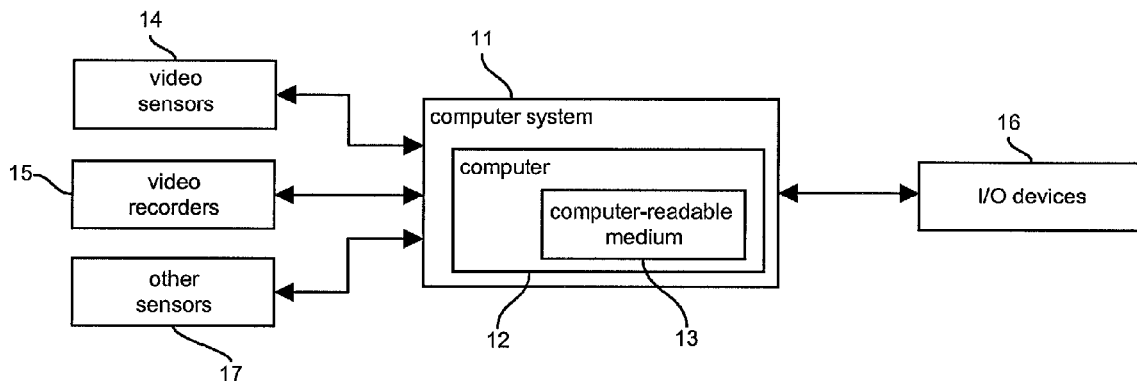
A video surveillance system is set up, calibrated, tasked, and operated. The system extracts video primitives and extracts event occurrences from the video primitives using event discriminators. The system can undertake a response, such as an alarm, based on extracted event occurrences.

(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 Comanicu 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

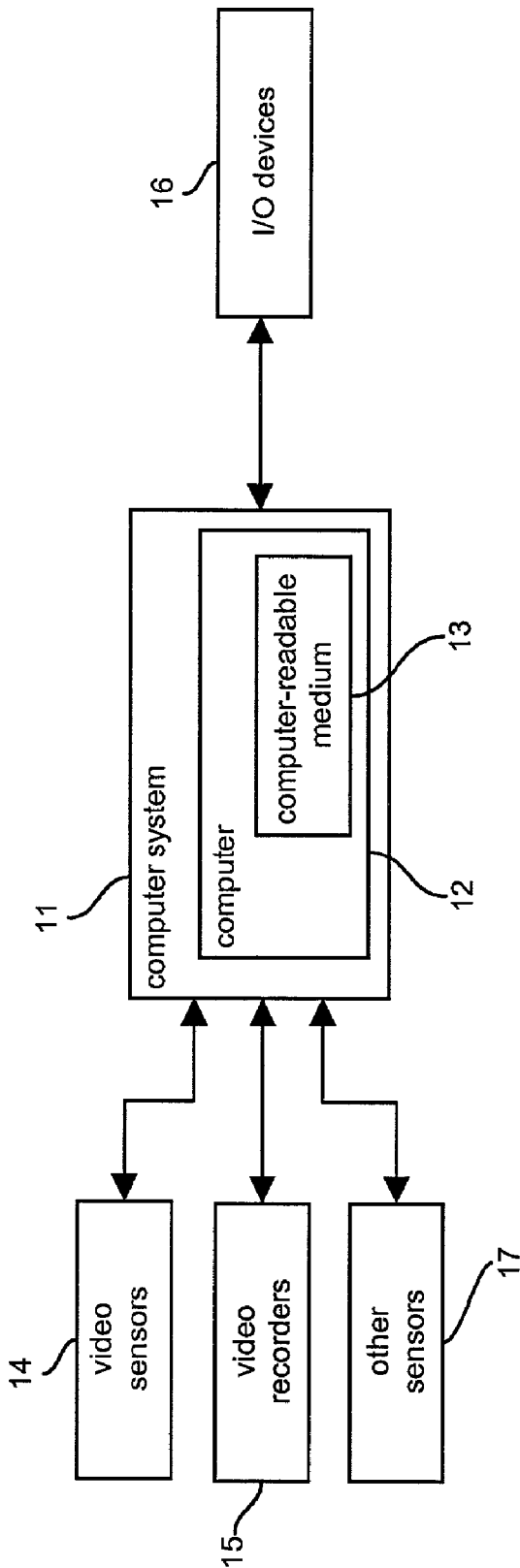


FIG. 1

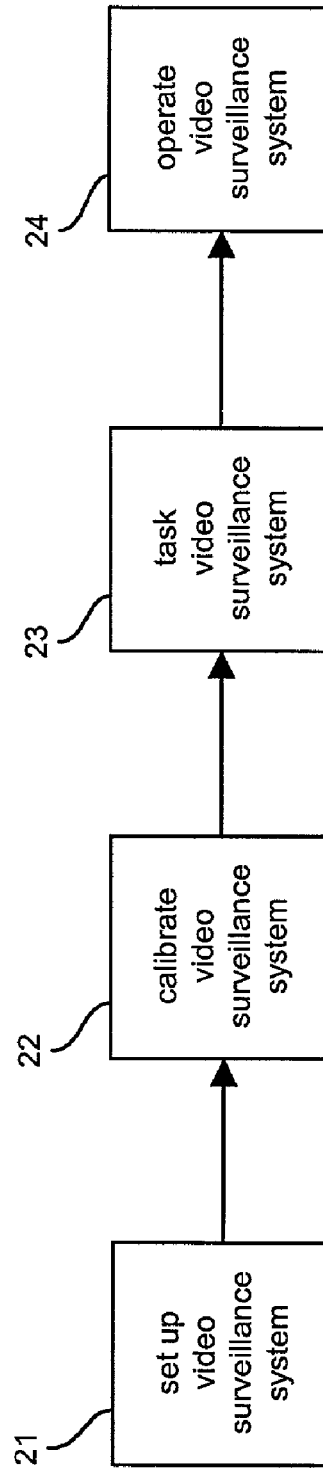


FIG. 2

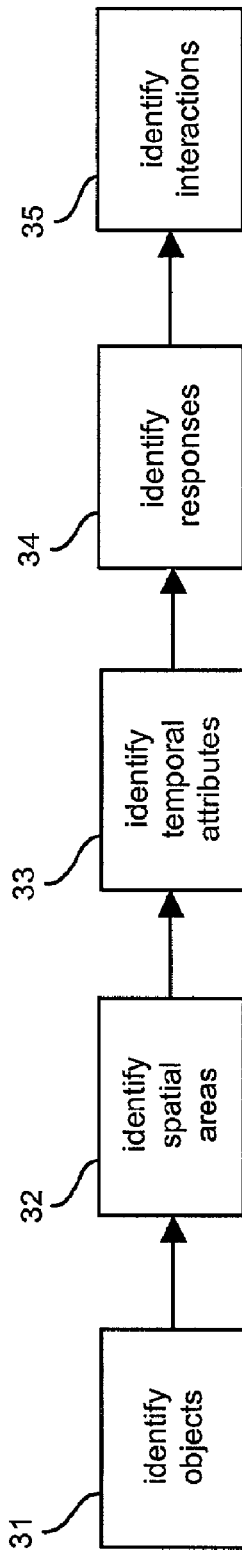


FIG. 3

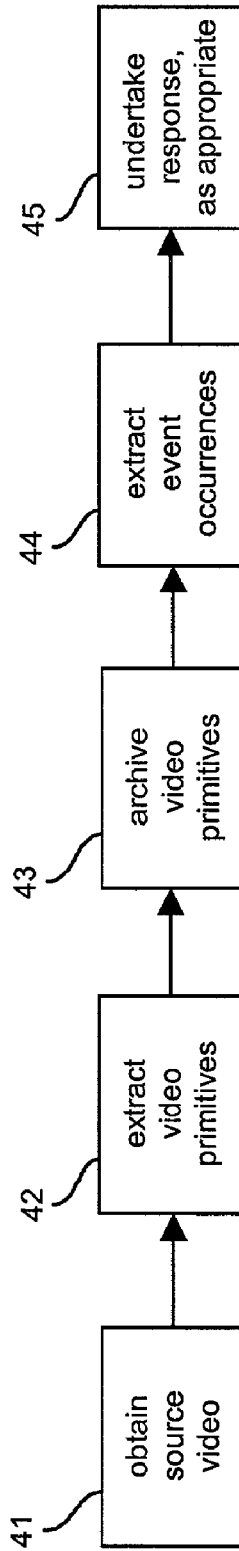


FIG. 4

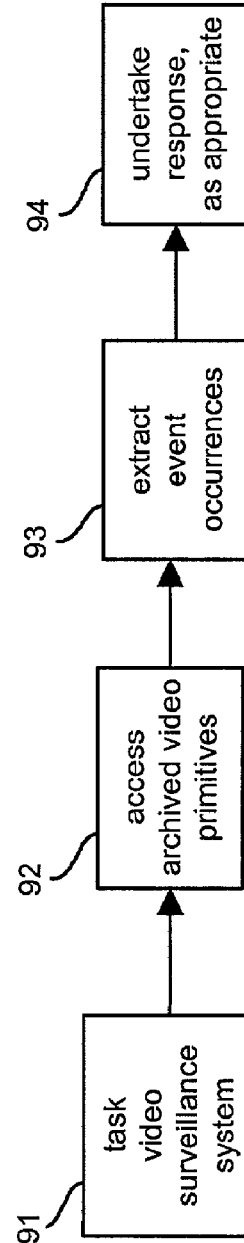


FIG. 9

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