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Table of Contents

Table of Contents iii

Author Index xi

Foreword xiv

Acknowledgements xvii

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Volume I

Section I — Video Surveillance and Monitoring (VSAM)

Video Surveillance and Monitoring – Principal Investigator Reports

"Advances in Cooperative Multi-Sensor Video Surveillance," Takeo Kanade, Robert T. Collins, Alan J. Lipton, Peter Burt and Lambert Wixson 3

"Extra Sets of Eyes," Kurt G. Konolige and Robert C. Bolles 25

"Forest of Sensors: Using Adaptive Tracking to Classify and Monitor Activities in a Site," W. Eric L. Grimson, Chris Stauffer, R. Romano, L. Lee, Paul Viola and Olivier Faugeras 33

"Image Understanding Research at Rochester," Christopher Brown, Kiriakos N. Kutulakos and Randal C. Nelson 43

"A Multiple Perspective Interactive Video Architecture for VSAM," Simone Santini and Ramesh Jain 51

"Multi-Sensor Representation of Extended Scenes using Multi-View Geometry," Shmuel Peleg, Amnon Shashua, Daphna Weinshall, Michael Werman and Michal Irani 57

"Event Detection and Analysis from Video Streams," Gérard Medioni, Ram Nevatia and Isaac Cohen 63

"Visual Surveillance and Monitoring," Larry S. Davis, Rama Chellappa, Azriel Rosenfeld, David Harwood, Ismail Haritaoglu and Ross Cutler 73

"Aerial and Ground-Based Video Surveillance at Cornell University," Daniel P. Huttenlocher and Ramin Zabih 77

"Reliable Video Event Recognition for Network Cameras," Bruce Flinchbaugh 81

"VSAM at the MIT Media Lab and CBCL: Learning and Understanding Action in Video Imagery," Aaron Bobick, Alex Pentland and Tomaso Poggio 85

"Omnidirectional Vision Systems: 1998 PI Report," Shree K. Nayar and Terrance E. Boult 93

"Image-Based Visualization from Widely-Separated Views," Charles R. Dyer 101

"Retrieving Color, Patterns, Texture and Faces," Carlo Tomasi and Leonidas J. Guibas 107

Video Surveillance and Monitoring – Technical Papers

"Using a DEM to Determine Geospatial Object Trajectories," Robert T. Collins, Yanghai Tsin, J. Ryan Miller and Alan J. Lipton 115

"Homography-Based 3D Scene Analysis of Video Sequences," Mei Han and Takeo Kanade 123

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Event Recognition and Reliability Improvements for the Autonomous Video Surveillance System

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Abstract

This report describes recent progress in the development of the Autonomous Video Surveillance (AVS) system, a general-purpose system for moving object detection and event recognition. AVS analyses live video of a scene and builds a description of the activity in that scene. The recent enhancements to AVS described in this report are: (1) use of collateral information sources, (2) camera hand-off, (3) vehicle event recognition, and (4) complex-event recognition. Also described is a new segmentation and tracking technique and an evaluation of AVS performing the best-view selection task.

1. Introduction

The Autonomous Video Surveillance (AVS) system processes live video streams from surveillance cameras to automatically produce a real-time map-based display of the locations of people, objects and events in a monitored region. The system allows a user to specify alarm conditions interactively, based on the locations of people and objects in the scene, the types of objects in the scene, the events in which the people and objects are involved, and the times at which the events occur. Furthermore, the user can specify the action to take when an alarm is triggered, e.g., to generate an audio alarm or write a log file. For example, the user can specify that an audio alarm should be triggered if a person deposits a briefcase on a given table between 5:00pm and 7:00am on a weeknight. Section 2 below describes recent enhancements to the AVS system. Section 3 describes progress in improving the reliability of segmentation and tracking. Section 4 describes an experiment that quantifies the performance of the AVS "best view selection" capability.

This research was sponsored in part by the DARPA Image Understanding Program.

2. New AVS functionality

The structure and function of the AVS system is described in detail in a previous IUW paper [Olson and Brill, 1997]. The primary purpose of the current paper is to describe recent enhancements to the AVS system. These enhancements are described in four sections below: (1) collateral information sources, (2) camera hand-off, (3) vehicle event recognition, and (4) complex-event recognition.

2.1. Collateral information sources

Figure 1 shows a diagram of the AVS system. One or more "smart" cameras process the video stream to recognize events. The resulting event streams are sent to a Video Surveillance Shell (VSS), which integrates the information and displays it on a map. The VSS can also generate alarms based on the information in the event streams. In recent work, the VSS was enhanced to accept information from other sources, or "recognition devices" which can identify the objects being reported on by the cameras. For example, a camera may report that there is a person near a door. A recognition device may report that the person near the door is Joe Smith. The recognition device may be a badge reader, a keypad in which a person types their PIN, a face recognition system, or other recognition system.

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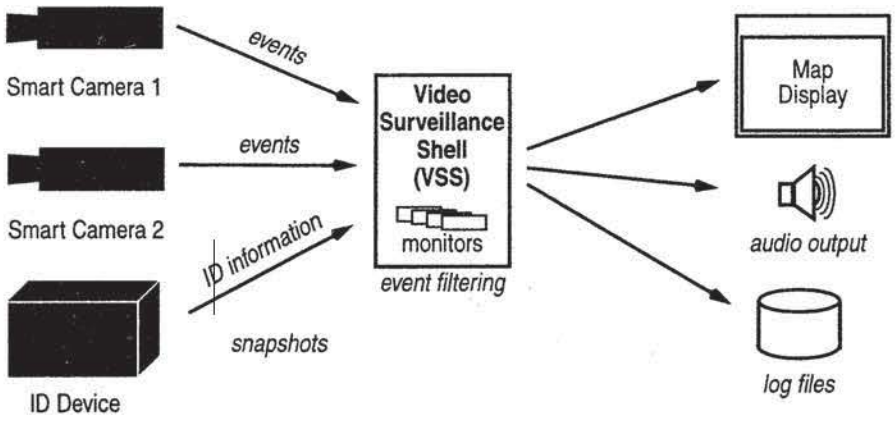

Figure 1: AVS system diagram

The recognition device we have incorporated is a voice verification system. The user stands in a predefined location in the room, and speaks his or her name. The system matches the utterance to previously captured examples of the person speaking their name, and reports to the VSS if there is a match. The VSS now knows the identity of the person being observed, and can customize alarms based on the person's identity.

A recognition device could identify things other than people, and could classify actions instead of objects. For example, the MIT Action Recognition System (MARS) recognizes actions of people in the scene, such as raising their arms or bending over. MARS is trained by observing examples of the action to be recognized and forming "temporal templates" that briefly describe the action [Davis and Bobick, 1997]. At run time, MARS observes the motion in the scene and determines when the motion matches one of the stored temporal templates. TI has obtained an evaluation copy of the MARS software and used it as an recognition device which identifies actions, and sends the result to the AVS VSS. We successfully trained MARS to recognize the actions of opening a door, and opening the drawer of a file cabinet. When MARS recognizes these actions, it sends a message to the AVS VSS, which can generate an appropriate alarm.

2.2. Camera hand-off

As depicted in Figure 1, the AVS system incorporates multiple cameras to enable surveillance of a wider area than can be monitored via a single camera. If the fields of view of these cameras are adjacent, a person can be tracked from one monitored area to another. When the person leaves the field of view of one camera and enters another, the process of maintaining the track from one camera view to another is termed *camera hand-off*. Figure 2 shows an area monitored by two cameras. Cam-

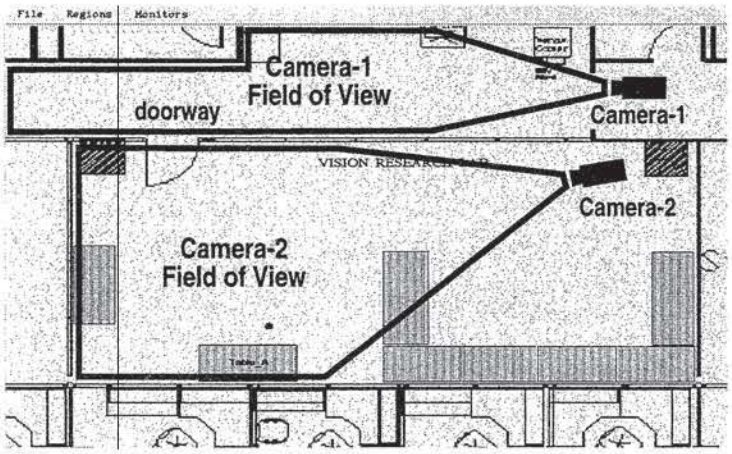

Figure 2: Multiple cameras with adjacent fields of view

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