Chapter 3.29
Automated Object Detection and Tracking for Intelligent Visual Surveillance Based on Sensor Network

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ABSTRACT

The aim of this research was to apply an agent approach to a wireless sensor network in order to construct a distributed, automated scene surveillance. A wireless sensor network using visual nodes is used as a framework for developing a scene understanding system to perform smart surveillance. Current methods of visual surveillance depend on highly trained personnel to detect suspicious activity. However, the attention of most individuals degrades after 20 minutes of evaluating

monitor-screens. Therefore, current surveillance systems are prompt to failure. An automated object detection and tracking was developed in order to build a reliable visual surveillance system. Object detection is performed by means of a background subtraction technique known as Wronskian change detection. After discovery, a multi-agent tracking system tracks and follows the movement of each detected object. The proposed system provides a tool to improve the reliability and decrease the cost related to the personnel dedicated to inspect the monitor-screens.

THE NEED FOR AUTOMATED SURVEILLANCE SYSTEMS

Automated visual surveillance is becoming an increasingly interesting topic for the scientific community because of the changing security needs. The need for developing computer systems that can provide enough information to take rapid action against security threats is greatly felt. Typically, visual surveillance systems consist of several cameras distributed through an area connected to monitors in a central operator room, where highly qualified personnel are in charge of reviewing and analyzing the video stream of each camera to observe suspicious activities. A high-level sketch of such a system is illustrated in Figure 1a. However, with the increasing number of cameras to monitor a huge number of installations of interest, there is simply not enough pairs of eyes to keep track of all information. Moreover, a recent study concludes that after 20 minutes of evaluating monitor-screens, the attention of most individuals degrades to below acceptable levels (Green, 1999). Another factor to be considered is the cost because cameras are cheap and ubiquitous but the personnel required to analyze them are highly expensive. Therefore, the video captured by the cameras serves more as an archive to refer to after an event has occurred. A current trend in the research is to design *smart surveillance systems* capable of preventing untoward incidents rather than investigating after the incidents have occurred. However, there are many challenges to be overcome before a reliable automated surveillance system is realized (Dick, 2003). These technical challenges include system design and configuration, architecture design, object identification, tracking and analysis, restrictions on network bandwidth, physical placement of cameras, installation cost, privacy concerns, reliable object detection, and trustworthy identification of individual.

There are several events that a smart surveillance system has to detect in real-time such as motion, abandoned object alert, object removal, and observation of any other abnormal activity or behavior. Motion detection alerts when objects are moving in the specified zone. Also, the system must identify the characteristics of the motion such as velocity, acceleration, and direction of movement. Another event of interest is an abandoned object that constitutes a potential threat such as bombs. It is also of interest to investigate when an object has been removed from the area under surveillance such as expensive equipment being stolen. The system must be capable of alerting against behavior that deviates from the norm such as a vehicle going over or under the speed limits in a parking lot.

Two core issues for *automated surveillance* are *object detection* and *tracking.* Surveillance cameras provide video stream that suffer from low resolution and low frame rate. Moreover, the quality of the video depends on the lighting conditions. Also, suspicious activity must be detected at the time of occurrence, therefore, object detection must be performed in real-time. These characteristics make object detection a challenge. Object detection may be performed by *background subtraction* and *optical flow* techniques. The optical flow is capable of detecting object movement even when the background is also moving. However, this technique is computationally complex and resource demanding, hence,