Demo: SecureFlex – A Flexible System for Security Management

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Abstract

In this paper, we present a flexible system for security management incorporating different sensor nodes (audio, video, iBeacon/WLAN), a data fusion and analysis center, and mobile units such as smartphones and augmented reality (AR) glasses. The sensor nodes monitor the environment by transmitting low-level measurements and high-level parameters computed on-board such as the number of present persons. The fusion and analysis center summarizes the parameters and this way optimally supports the security personnel and public users in normal as well as in critical situations.

Categories and Subject Descriptors

K.4.1 [**Computers and Society**]: Public Policy Issues—*Human safety*; H.5.5 [**Information Interfaces and Representation**]: Sound and Music Processing—*Signal analysis, synthesis, and processing*; I.4.8 [**Image Processing and Computer Vision**]: Scene Analysis—*Tracking*

General Terms

Security

Keywords

Security management, event security, video tracking, acoustic event detection, wireless sensor network

1 Introduction

Nowadays, sensor networks are applied in a variety of areas including indoor monitoring of environmental parameters (room temperature, humidity), detection of emergency cases (fire, earthquakes), outdoor monitoring for agriculture or in wildlife habitats, and military applications such as target detection [1]. Sensor networks provide the means to increase security by early detecting critical situations and by supporting involved persons, e.g., for emergency evacuation.

In this paper, we present a flexible solution designed to support security management activities at various events. It integrates the following components: different types of sensor nodes (video, audio, and WLAN/iBeacons for positioning), a fusion and analysis center for data management as well as mobile units including smartphones and AR glasses. It is mobile, easily deployable and can be installed for temporary as well as longer lasting events. The system continually monitors defined areas, analyzes parameters in the environment, and sets alerts in case of an emergency. In critical situations, the system supports security personnel and visitors for fast and secure reactions and evacuations.

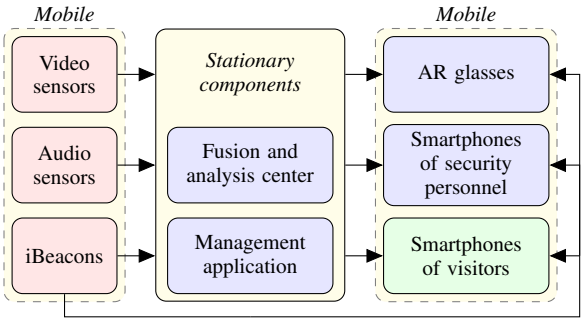

Figure 1. Overview of the system components: Sensor nodes (red), stationary and mobile equipment for security personnel (blue) and for visitors (green).

2 System overview

Figure 1 shows an overview of the SecureFlex modules. The sensor nodes consist of video sensors, audio sensors, and iBeacons for positioning. The video and audio sensors capture data and transmit measurements and on-board computed parameters to the fusion center. The fusion center stores and summarizes the data. The resulting information can be accessed by security personnel over the management application ELSA, over an app for smartphones or by using AR glasses. Visitors of events receive relevant information over a public user app.

2.1 Sensor nodes

2.1.1 Video

The video sensors deliver information about crowd size in the observation area and perform direction-dependent person counting and person motion detection. Video analysis is based on a KLT (Kanade, Lucas and Tomasi) feature point tracker optimized for multi-core CPUs and GPUs [2].

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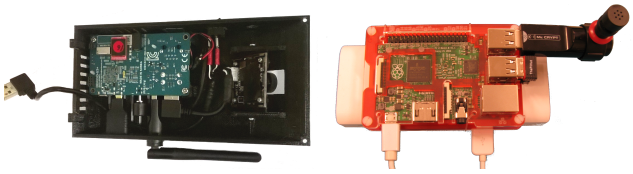

(a) (b)

Figure 2. (a) Video sensor and (b) audio sensor.

The video sensor is composed of a low-power embedded system, a mini USB camera, a WLAN adapter, and a battery pack (see Figure 2 (a)). Different embedded systems (Raspberry Pi 2, Odroid U3, Jetson Tk1) have been tested with regard to processing performance and power consumption. We have decided to use the Odroid 3, which allows processing images with a resolution of 800x600 pixels and an operating time of 12 hours using a battery pack of 15400mAh/5V.

2.1.2 Audio

The audio sensors continually monitor the sound level. If an increased level indicates a critical situation, they send a separate message. Furthermore, they run a voice activity detection algorithm based on the amplitude modulation spectrum [3], which detects talking persons near the sensor.

The audio sensor consists of a Raspberry Pi 2 B, a USB microphone, a wireless adapter, and a battery pack (see Figure 2 (b)). The Raspberry Pi 2 B was chosen due to its computational power and the target hardware support by Matlab/Simulink, which allows easy code deployment.

2.1.3 iBeacons

For indoor positioning, beacons are used which emit a reference bluetooth low energy signal isotropically on a 2.4 GHz carrier. Smartphones and the AR glasses can pick up these signals and compare them to a radio map generated in an initialisation process. Via simultaneous localization and mapping (SLAM) and multilateration the position is derived.

2.2 Fusion Center and Data Management

The data fusion and management is realized as a de-centralized architecture with a central data storage and analysis service as well as multiple de-centralized management clients. The transmission of sensor data is realized over a TCP based communication channel. The data fusion and analysis module combines different kinds of sensor data and events to provide an accurate notification of the users related to critical situations or alerts. In addition to the sensor data, a messaging system allows bi-directional communication between the command room and deployed field staff using smartphones and AR glasses.

A geo-oriented management application provides an up-to-date situation map of relevant areas including available sensors, infrastructure objects, and mobile team members. Each object provides current as well as historical data, which makes it possible to investigate the temporal evolvement of a situation and allows the documentation of the whole event. An attention support system combined with an intuitive visualization of live sensor information enables the operator to effectively supervise large areas. Figure 3 shows a screenshot of the command room management application ELSA.

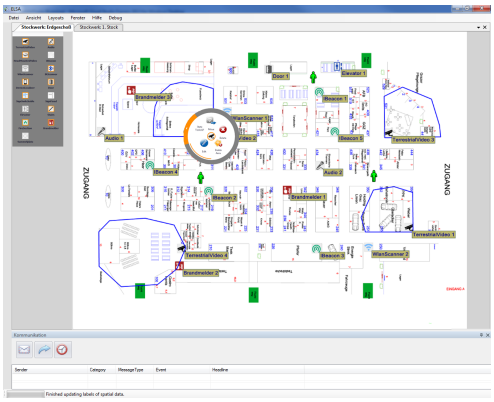

Figure 3. Command room management application ELSA.

2.3 Augmented reality glasses

The Optinvent Ora-1 system is employed as a mobile augmented reality user interface. It provides a transparent display, connectivity through Bluetooth 4.0 and WLAN, GPS, a 9-axis IMU, and a Full HD video camera. Input commands can be issued via a trackpad or a microphone. This allows the user to receive assignments and enables hands-free operation, video streaming, and voice commands.

3 Evaluation

Prototypes of the sensors and the fusion center were evaluated at a congress center with regard to the reliability of the components and the communication. The system is going to be tested in an extensive evaluation including the participation of volunteers and the simulation of defined emergency cases (fire, collapsed visitors, blocked emergency exits, etc.).

4 Conclusion

This paper describes a solution to effectively support security management using a flexible installation at temporary or permanent events. Different sensor nodes monitor the environment, data fusion and analysis algorithms provide condensed information about the current situation. This allows the security personnel to keep track of the scene in normal conditions as well as to quickly react in critical situations. Using the public security app, visitors are provided with information such as the way to the nearest emergency exit.

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