

Introduction of Smart Monitoring and Tracing System Using GPS Information

Choong-Soo Lim, Hwan-Chul Kim, Sang-Kyun Cha, and Jung-Hoon Choi

Abstract—SMTS(Smart Monitoring and Tracing System)is the ideal monitoring & tracking system that can configure organic networks composed of Portable Smart Surveillance Terminals, Intelligent Monitoring & Tracing System and Real-time Surveillance Application. Also it can do real-time tracing the location of target objects by automatic camera control using location information. We will develop the SMTS based on wireless network access control for efficient data relay, automatic tracing of a moving object using position recognition, and map based position display. The development of SMTS will change current surveillance systems which are partial and passive into active and perfect surveillance systems. In this paper, we introduce the system configuration, service scenarios, design concepts, and the reasons why develop the SMTS.

Index Terms—Relay network, two channels, GPS, camera, tracking, location sensor.

I. INTRODUCTION

Despite of unprecedented global economic recession, the importance of security and surveillance equipments is growing more and more, and the relevant market is growing rapidly for the satisfaction of market requirements such as crime prevention, access control and intrusion detection. Specially, the demand of video surveillance equipments is increasing on buildings, apartments, financial institutions, public agencies, military facilities, and so on. According to the change of services demand, the surveillance market is evolving as below:

1) Services Environment

- Isolated and passive environment → Active environment based on network
- Indoor environment using sensor → Outdoor environment using GPS information

2) Information Type

- Analog video → Integrated information(video, audio, text) based on location

3) Applied Technology

- Analog → Digital
- Passive control by a control center → Automatic control via object position recognition

- Video surveillance by a control center → Automatic video tracking and surveillance based on Map via private wireless network

Currently, the most active ongoing researches about intelligent video surveillance are motion detection, region detection and region tracking technology using image processing. However, it is predicted that the current video surveillance technology using image processing is not able to overcome the limit of recognition performance due to lighting, weather, shadows, etc. So, appropriate solutions are unlikely to be developed in the near future.^[1]

Another part of research is a location tracking technology for a moving object. It is possible to track the location of moving objects outdoors using GPS, but a GPS does not work indoors. So, most of the researches have been focusing on the indoor application. For the research of the indoor location tracking, researches based on RFID^[2], UWB^[3], RADAR^[4] are being studied.

TABLE 1: APPLIED TECHNOLOGIES

Applied technology	Descriptions
Location identification and presentation	- Identification of target object's location in both indoors and outdoors - Presentation of location information through the dedicated interface - Visualization of location and status information on the map screen
Location tracking	- Automatic camera control using location information - Real-time location tracking of multiple targets by automatic control of cameras - Video recording and managing about a tracking information
Private relay network configurations	- Wireless access control using two channels - Active network topology update - Transmission of various data type (voice, text message, location data, ..) - Simultaneous transmission of both voice and data

In this paper, we introduce the “Smart Monitoring & Tracing System” using GPS Information to meet the above change of services demand and overcome the services degree of existing surveillance systems. The suggested system in this paper is able to support both of a real-time indoor and outdoor video surveillance and tracking operations. For the cost effective and efficient surveillance services, we apply the wireless network access control on services area, multiple object tracking via automatic control

Manuscript received March 13, 2012; revised May 9, 2012.

Choong-Soo Lim are with Comesta, Inc. #714 Gwanpyoung-Dong, Yusung-Gu, Daejeon, 305-509, Korea (e-mail: {lcs1472, hkim, skcha}@comesta.com).

Korea Polytechnic Univ. #2121 Jeongwang-Dong, Siheung, Gyeonggi-do, 429-793, Korea (e-mail: jhchoi@kpu.ac.kr).

of network cameras, a map based object tracking using location information, and communication with audible and textual information.

II. SMTS(SMART MONITORING & TRACING SYSTEM)

A. System & Service Configuration

SMTS consists of three main components, PSST(Portable Smart Surveillance Terminal), IMTS(Intelligent Monitoring & Tracing System) and RSA(Real-time Surveillance Application). Its overall configuration is shown in Fig1, and brief descriptions of each component are as follows.

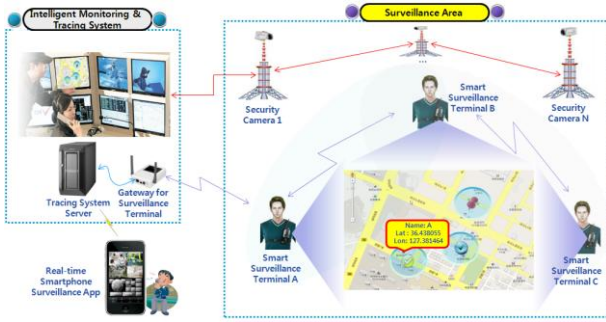


Fig. 1. System & Service Configuration

1) PSST(Portable Smart Surveillance Terminal)

- Open system architecture using Android
- Processing location information
- Configuring wireless relay network using two channels
- Providing end-to-end communication by radio
- Interfacing with IMTS by radio
- Displaying target location on the map screen using LCD and GPS

2) IMTS(Intelligent Monitoring & Tracing System)

- Processing the location information of all PSST in real time
- Providing smart camera control based on intelligent tracking algorithm
- Saving monitoring & tracing data
- Displaying target location on the map screen

3) RSA(Real-time Surveillance Application)

- Monitoring application for Android smartphone
- Providing remote monitoring on target site and remote camera control in real time
- Displaying target location on the map screen

There are two types of surveillance service.

The first is called passive surveillance service: PSST sends its own location information to all other terminals over the network periodically. It makes a security man having the PSST be able to see the location of all other security men on its screen. PSST also sends its own location information to IMTS. When a security man with a PSST detects an intruder, he can propagate the location of intruder by marking on the LCD screen of the PSST. Then, IMTS finds the nearest surveillance camera and controls it automatically for the purpose of displaying and saving images of the target area.

The other is called active surveillance service: If the position recognition sensor of IMTS detects a moving object, IMTS starts tracking the target object by controlling surveillance cameras and propagates the location of target object to all PSST.

SMTS provides both surveillance services. Each service flow is as follows:

4) Flow of passive surveillance service

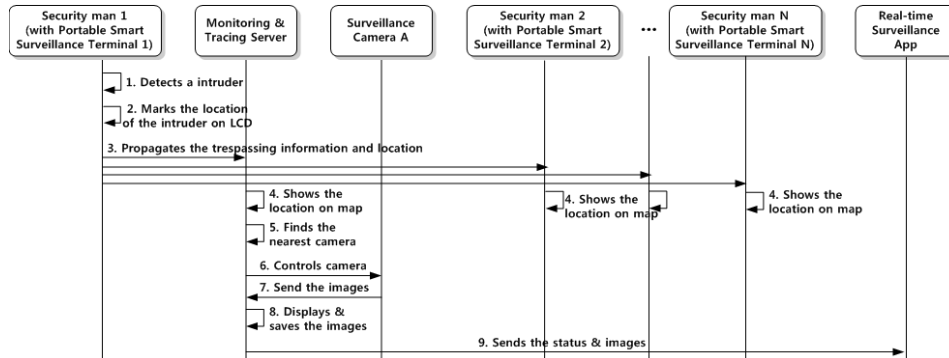


Fig. 2: Flow of passive surveillance service

5) Flow of active surveillance service

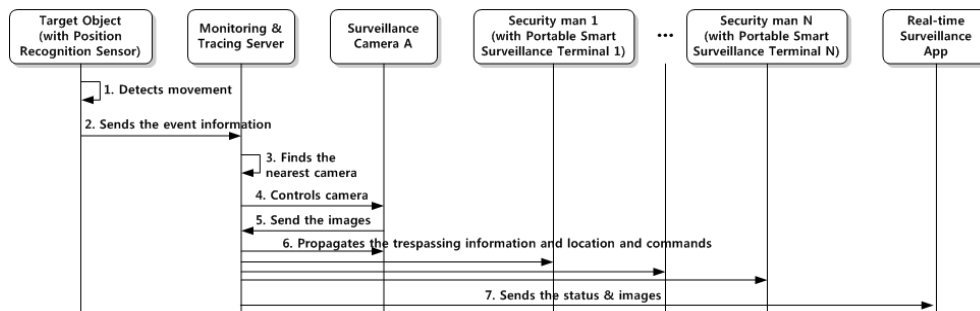


Fig. 3: Flow of active surveillance service

These paired surveillance services suggested in this paper can provide ideal surveillance services.

B. PSST(Portable Smart Surveillance Terminal)

PSST is able to configure wireless relay network on ISM frequency band using two channels, and we design it based on the scheme of open platform to acquire cost effective communication network, wide range of service area, effective monitoring service, and so on.

For the purpose of providing efficient monitoring services, PSST equips a variety of peripherals(GPS, Camera, LCD, etc.). It makes possible to transmit voice and data simultaneously. The system configuration and specification of PSST is as follows.

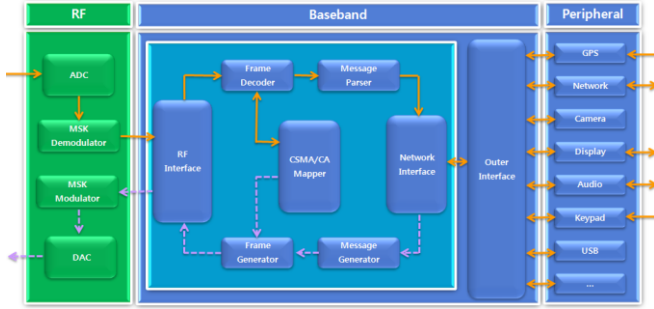


Fig. 4. System configuration of PSST

TABLE 2: SPECIFICATION & PERFORMANCE OF PORTABLE SURVEILLANCE TERMINAL

Classification	Specification & Performance
OS/Platform	Embedded Linux/Android
Frequency/Modulation	ISM Band/ FSK/MSK
Transmission Protocol	2hops relay protocol based on CSMA
Distance/Speed	300meter/Max 384kbps
Data Types	Voice, data, voice & data
Maximum Node Count	24 nodes
Peripheral	GPS, LCD, Camera, Audio, WiFi, USB,

Each PSST manages its own routing table and propagates the network configuring information to all terminals periodically. In this way, it is able to do network topology update.

We design PSST to transmit voice and data simultaneously by efficient configuration of transmission frame and relay scheme. In addition, we adopt the MIL-STD-188-220^[5] specification as a network transmission frame in order to apply to both military and civilian industry.

C. IMTS(Intelligent Monitoring & Tracing System)

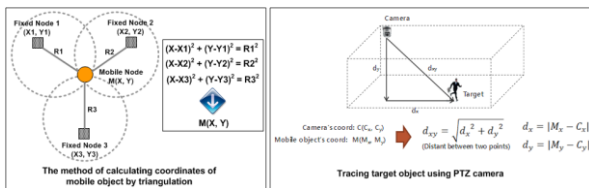


Fig. 5. Basic theory for calculating coordinates by triangulation

IMTS is a movement tracking and monitoring system based on object tracking and automatic camera control technology. It configures wireless sensor network^[6] with

location sensor nodes to detect the movement of target object.

Triangulation is used as basic theory to calculate the location of moving target object in IMTS. Using the calculated location information, IMTS calculates horizontal and vertical angles for pan-tilt control.

By mapping to virtual coordinate system, IMTS already knew the exact coordinates of the target area where fixed sensor nodes are installed in. On detecting intrusion event, it tracks the target object by controlling network cameras using the calculated vertical and horizontal angle.

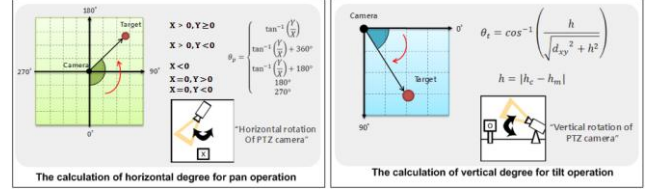


Fig. 6. Basic theory for calculating vertical and horizontal angle

D. RSA(Real-time Surveillance Application)

When an intrusion event is occurred, the manager in remote site can receive the current status information of target area, and is able to watch the images of target site by connecting to IMTS using RSA. So, the manager can know the status of target site immediately.

RSA is a smartphone application providing many functions; real-time video display, saved video display, remote camera control.

The software architecture of RSA is designed for processing location, status, and multimedia data received from IMTS. The software architecture of RSA is shown in Fig. 7.

- 1) Network Message Managing Block
- 2) Map based Location Information Managing Block
- 3) Multimedia Managing Block

Graphic User Interface Block

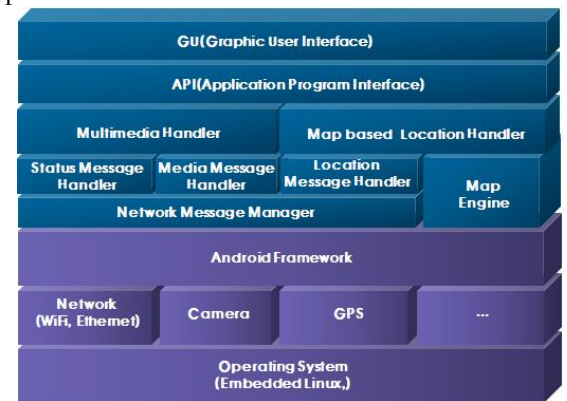


Fig. 7. SW Architecture of RSA.

III. CONCLUSIONS

SMTS(Smart Monitoring & Tracing System) proposed in this paper is the ideal surveillance system technology combining both passive and active surveillance technologies. We are confident that SMTS and its technology will spread all over the world and contribute to public safety.

In this paper, we show the overall system configuration, basic technologies, architecture of major components, and service flows.

We are going on developing major components of SMTS now. Based on the result of development, we will write and submit additional papers about the performance and reliability of SMTS including its major components hereafter.

REFERENCES

- [1] J. H. Yoo, K. Moon, and H. S. Cho, "Trends in Intelligent Video Surveillance," *Electronics and Telecommunications Trends*, 2008, vol. 8, pp. 23-4.
- [2] K. Finkenzeller, *RFID Handbook: Fundamentals and Applications in Contactless Smart Card and Identification* 2 edition, John Wiley & Sons, May 2003.
- [3] J.-Y. Lee and R. A. Scholtz, "Ranging in a Dense Multipath Environment Using an UWB Radio Link," *IEEE JSAC.*, vol.20, no. 9, Dec 2002.
- [4] P. Bahl and V. Padmanabhan, "RADAR: An In-Building RF-Based User Location and Tracking System," in *Proc. IEEE Infocom 2000*, IEEE CS Press, Los Alamitos, Calif, 2000.
- [5] S.-W. Han and B.-S. Kim, "Research on Performance Improvement of MIL-STD-188-220 Protocol for Tactical Wireless Networks," The Institute of Electronic Engineers of Korea: IEEK Autumn Conference, 2010.
- [6] J.-E. Kim and J. Kang, "IEEE 802.15.4a CSS-based Localization System for Wireless Sensor Networks," *Mobile Adhoc and Sensor Systems*, 2007. MASS 2007. IEEE International Conference, 2007.