Video Surveillance Patrol Robot System in 3G, Internet and Sensor Networks

Fung Po TSO
Department of Computer Science
City University of Hong Kong
posco.tso@gmail.com

Lizhuo Zhang
Department of Computer Science
City University of Hong Kong
lizhuocs@cityu.edu.hk

Weijia Jia
Department of Computer Science
City University of Hong Kong
itjia@cityu.edu.hk

Abstract

We propose to demo a ubiquitous surveillance patrol robot system[1]which can patrol in a candidate site to perform events detection where a wireless sensor network may be deployed. We have enabled the 3G phone controlled patrol robot (over 3G circuit switched network) with integrated access to the WiFi/Internet. Internet is used to provide sensor query, to send control signal to the robot and to request the real time audiovisual data from the robot. The robot can receive the movement instructions from and pull the real-time multimedia data stream to a remote user via WiFi laptop or 3G terminal. We also implemented a gateway which is a key component for the platform in responsible for the interconnection and heterogeneous communication of the networks.

Categories and Subject Descriptors

H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems; I.4.8 [**Image Processing and Computer Vision**]: Scene Analysis

General Terms

Design, Experimentation

Keywords

Video surveillance, Patrol robot, 3G

1 Introduction

This demo presents a novel 3G surveillance patrol system aiming at providing remote surveillance everywhere as long as the area is covered by 3G network and/or WiFi/internet. Our pilot system is formed by five major parts: sensor net with a sink node, 3G phone controlled patrol robot, a normal 3G handset, an internetworking laptop and the central gateway respectively (as shown in Figure. 1). The system uses sensors as the frontline soldiers that are responsible for detecting abnormal events or any intruders and reporting their reading to the central gateway regularly via the sink node. The central gateway is responsible for receiving and analyzing the reports (data) collected from the sensors. If any unexpected event is detected, the central gateway can automatically send a SMS notification to the user, who can choose to dial and dispatch the robot to patrol on site for the specific location to retrieve the real time video via 3G phone or laptop/PC.

[1]The work is supported by RGC Competitive Earmarked Research Grant (CERG), SAR Hong Kong grant no. CityU 113906 and Innovation and Technology Fund (ITF) no. GHP/052/05.

SenSys'07, November 6–9, 2007, Sydney, Australia.
ACM 1-59593-763-6/07/0011

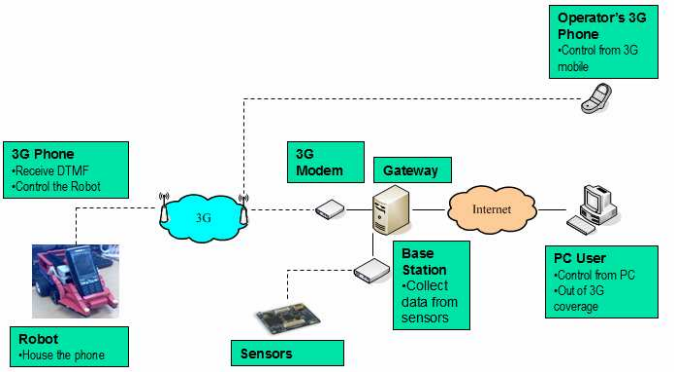

Figure 1. System overview architecture.

2 Configuration of the System

Five parts constitute the system:

(1) *Sensors net* (e.g. heat sensors, voice sensors and light sensor, etc) are distributed randomly in the inspected site. These sensors, upon detection of abnormal events or intrusion, will transmit the readings regularly to the sink node (which is connected to the central gateway).

(2) *3G phone controlled patrol robot:* The patrol robot (see Figure. 1) hosts a 3G terminal (3G phone). The phone plays two roles: (1) to receive control signals from remote 3G phone or laptop/PC and then relay the signals to the robot controlling unit for executing movement instructions, and (2) to transmit real time multimedia stream to the remote user (as the video conversation) over 3G circuit switched network or to the gateway for redirecting this multimedia stream (from 3G CS network) over internet to PC users.

(3) *3G phone* is used to receive SMS notification and acts as a robot remote control, and real time media stream interactive terminal.

(4) *Laptop/PC* can be used to query sensors data/status from the internet and can also be turned into a robot remote control and a real time media stream receiving

terminal.

(5) *Central gateway* is the core part of the ubiquitous platform and it interconnects with wireless sensor network, 3G network and internet. The gateway collects and processes the data from sink node of sensor net and notifies the user using SMS if any event is detected. Moreover, the gateway also accepts query for the sensor data from the internet and supports the calls from internet (PC users) to 3G phone enabled patrol robot.

3 Demo Scenario

In our pilot deployment, four sensors are located in each corner of the inspected room. We artificially introduce an abnormal event to the sensor, say, the sudden change of light intensity. The reading of this sudden change is detected and transmitted to the central gateway (via sink node first). The gateway notifies user by sending a SMS on this event with the contents: Sudden change of light intensity detected from Sensor (ID: 001). Dial +852 60143869 to see the real time video. The user can use the 3G phone or laptop to directly dial the patrol robot and to instruct it to run to the location where sensor 001 locates and to watch (actually the user watches) what is happening. However, dialing directly to the robot using a 3G phone can only take place when the current location of user has 3G service overage. If that location has no 3G service coverage, the user can still access to the patrol robot using an internetworking laptop through our special Internet client to connect to the central gateway. The central gateway bridges the internet to the 3G circuit switch network. After the video call is setup, the internet user can also control the robot and retrieving on site real time video through internet.

Figure 2. Client interface.

4 Extended Applications

The architecture supports a number of video applications that involve 3G phone and PC (with internet access) users. We now describe two possible application scenarios.

Remote Diagnosis. In this scenario, sensors are deployed to monitor the patients' (or elders at home) health status. The sensors are responsible to collect these data and report the data to the central gateway. Central gateway is capable of analyzing the data according to predefined reading threshold. A warning message will be sent immediately to the hospital (or doctor) by SMS/email when an abnormal reading is obtained. The concerned party can then dial a number to give a remote diagnosis and log onto the central gateway to adjust the reading threshold, or add some more monitoring parameters (if necessary).

Real-time video surveillance. In this scenario, camera sensors are installed in the home/office of a 3G user for security surveillance. We assume that a camera sensor is capable of analyzing the videos captured (e.g., detecting human motions). When a camera sensor detects an event, it transmits the real-time video (through a wired/wireless LAN) to a base station, e.g., a PC connected to the Internet. The PC then initiates a UDP connection with the central gateway and sends the real-time video recorded by the camera. The gateway dials the number of the 3G user (or notifies the 3G user by sending a SMS), establishes a video call connection with the 3G phone, and sends the video stream through 3G circuit-switched cellular network.

5 Conclusion

In this proposal, we present the patrol robot, a surveillance architecture that requires the interaction between sensor network, 3G network as well as TCP/IP network. In such architecture, we novelly introduce an central gateway for interconnecting these three nets and it is also fully transparent to the end users. Moreover, A range of applications such as health status monitoring in medical field can be developed as the extension of this architecture.

6 References

[1] ITU-T Recommendation H.324: Terminal for low bitrate multimedia communication.

[2] 3GPP TR 26.111 V5.0.0, Codec for circuits witched multimedia telephony service; Modifications to H.324. 2002

[3] SIP: Session Initiation Protocol, RFC 3261. June 2002

[4] J. Burke, D. Estrin, M. Hansen, A. Parker, N. Ramanathan, S. Reddy, and M. B. Srivastava. Participatory Sensing. In *ACM Sensys World Sensor Web Workshop*, 2006.

[5] Sensorplanet, http://www.sensorplanet.org/.

[6] Mobile landscapes: Graz in real time. http://senseable.mit.edu/projects/graz/.

[7] O. Iwasak, T. Uenoyama, A. Ando, T. Nishitoba, T. Yukitake, M. Etoh. Video Transcoding Technology for Wireless Communication Systems Vehicular Technology Conference Proceedings, Tokyo, 15-18 May 2000. vol.2, pp. 1577 - 1580.

[8] F Yang, Q. Zhang, W. Zhu, Y.Q. Zhang. Bit Allocation for Scalable Video Streaming over Mobile Wireless Internet In Proceeding of INFOCOM'2004, Hong Kong, March 2004.