DEVELOPMENT OF A SURVEILLANCE SYSTEM WITH MOTION DETECTION AND SELF-LOCATION CAPABILITY

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Abstract

A surveillance system with the motion detection and the location measurement capability has been in development for the additional surveillance of the facilities in our institute. Each remote box, which consists of a surveillance camera, a GPS unit and a Wi-Fi unit, sends the motion picture along with its location data over the network. The server analyzes such information to detect the unwanted access and sends the status or alerts to the clients. The system is about to be installed for the actual surveillance.

INTRODUCTION

Surveillance cameras and sensors are widely used for the security control in various types of institutes and facilities. Our institute also has surveillance cameras and sensors, which have the primary responsibility for detecting unwanted accesses to our institute. One of the problems in the present surveillance cameras is the lack of the motion detection capability, therefore security agents are required to watch the display throughout the day to find such unwanted accesses. Another problem is the fixed positioning of units because the devices used for the surveillance system are based on hardwiring connections for analog signal of video transmissions. This restriction prevents us from adding temporary cameras for increased securities or for subsidiary purposes. Even worse, the old-fashioned hardwiring system requires locating the position of surveillance cameras by hand. To eliminate such problems, we are constructing a surveillance camera system with motion detection and self-locating features based on a server-client scheme. A monitoring unit consisting of a network camera, Wi-Fi and GPS modules, acquires its location by use of GPS or the radio wave from surrounding Wi-Fi access points (AP), then sends its location to a remote server along with the motion picture over the network. The server analyzes such information to detect any unwanted accesses and serves the status or alerts on a web-based interactive map for the easy access to such information. We report the current status of the development and expected applications of such self-locating system beyond this surveillance system.

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SYSTEM OUTLINE

The present system is based on a conventional serve-client scheme. A typical configuration of the present surveillance system is shown in Fig. 1. The surveillance is performed by a remote box, which consists of a network camera, a GPS module, a single board computer, and a Wi-Fi access point. All the devices inside the remote box are basically operated by either 5 V DC or 12 V DC, expecting the battery-driven operation. The network connection between the remote box and the server is managed by the local area network in our institute and Wi-Fi connection.

A conventional network camera is in a waterproof housing and placed outside the remote box. This camera can be connected by Power-over-Ethernet technology (PoE) to realize the data transmission and power supply by a single wire. A USB-type GPS module is also implemented in this waterproof housing to ensure the detection of the exact place of the network camera. The USB connection required for this GPS module is prepared by a pair of USB - RJ-45 conversion adapters, which can extend a USB connection up to 50 meters, almost the same distance as that a PoE connection. Therefore, the camera can be placed up to several tens meters away from the remote box, which gives a greater flexibility for the installation.

A linux-based single board PC is embedded in the remote box. The GPS module placed in the camera housing is finally connected to this single board PC for the analysis of GPS location. The NMEA sentences of GPRMC and GPGGA are interpreted to obtain the coordinates of the camera and the time and date of GPS measurement. Obtained location data is sent to the server and used as the position of the camera. This single board PC is also expected to be used as the interface to the devices, such as the control of the floodlight and making sounds for the alert etc.

As for the self-locating feature, the cases that the GPS signals from satellites are not available(e.g. inside or behind the building) should be assumed. To deal with such cases, a self locating technique by using the Wi-Fi signals of surrounding AP is also developed as the alternative way to determine the location. In this technique, the locations of APs are previously determined as the reference points. The number of reference APs varies depending on the places, but at least three reference APs are expected with in the radius of 50 meters. In theory, the intensity of radio wave should follow the inverse squares law, but such simple cor-

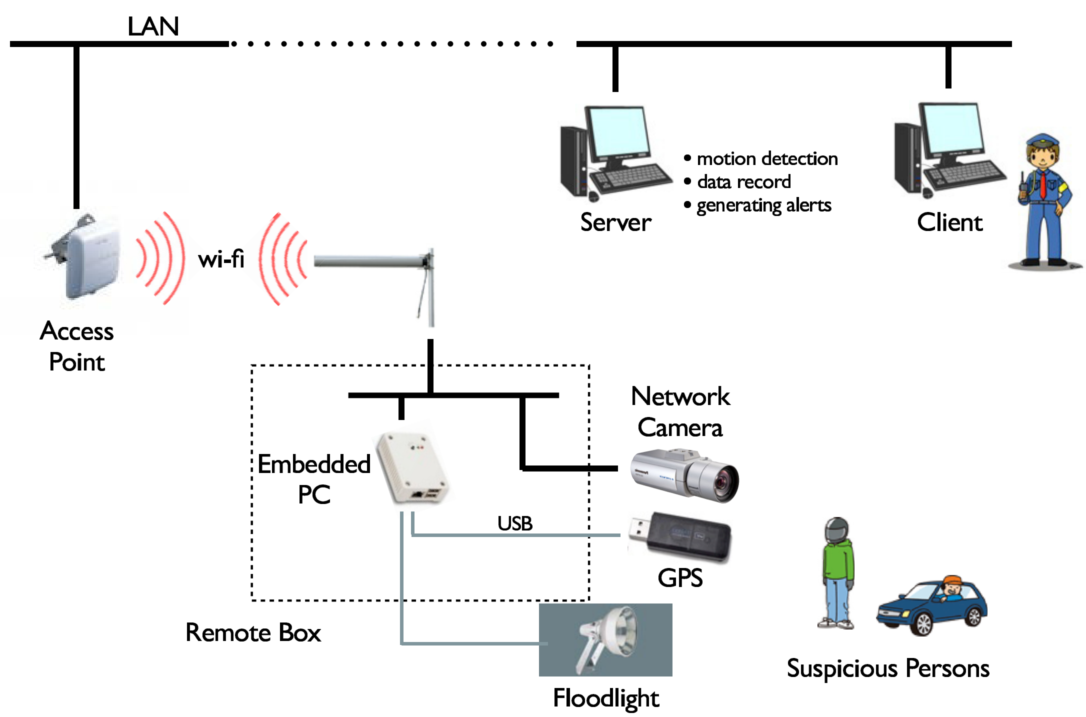

Figure 1: Configuration of the surveillance system.

relation is largely disturbed in real cases by the multipath propagation or reflections caused by the surrounding obstacles. Therefore, the correlation between the signal intensity vs distance are measured and empirically approximated to simple functions (Fig. 2). In the remote box side, the Wi-Fi signals detected are identified by their BSS-IDs, and respective distances among reference APs are determined from their respective signal intensities. The location is obtained as the weighted mean of the coordinates of detected reference APs with distance as weights. In the trials for the cases inside the building, approximate positions of the remote box can be determined in the accuracy of 10 meters.

The visual data obtained by the network camera is continuously sent to the server as streaming data. The server is responsible to detect any unwanted accesses and manages the alerts and responses to such accesses. The motion detection is based on motion[1] and kmotion[2] is used as the default front-end for this system as well as archiving the obtained activities. Additionally, each alert is shown on GIS softwares such as Google Earth in client PCs as an icon at the position corresponding to the latitude and longitude data obtained by the GPS module implemented inside the camera housing. Other responses to an unwanted access can be arranged with the combination of a single board PC in the remote box, such as turning on a floodlight at the camera as a warning to suspicious persons.

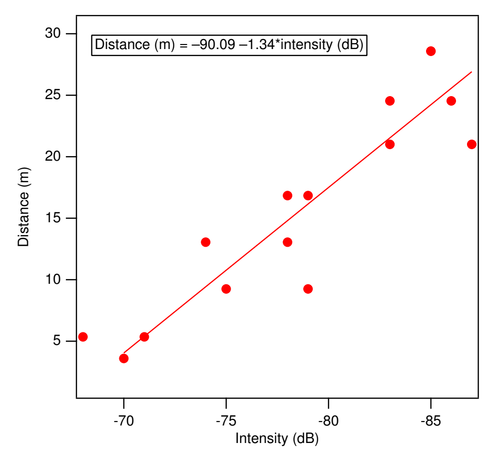

Figure 2: A typical correlation between the distance and wave intensity measured for a reference AP. The correlation is well approximated by a simple linear function. This kind of correlations are measured for every reference AP.

CURRENT STATUS

The developments of each component are almost finished and now the installation of the remote box is now on the way for the surveillance towards unlawful dumping in the premise border of our institute. In such applications, the surveillance system is often in danger of the destructive behaviors by the suspicious persons who are about to dump the refuses. To avoid such destructive behaviors, the remote box will be placed at a safe place inside the premise of our institute, and only the camera unit will be placed about 30 meters away from the remote box with the help of implemented PoE and USB extension features. Since the camera is set outdoors, the self-locating feature by GPS is used in the present case. Now the adjustment of parameters for the motion detection is on the way because the malfunction caused by the rain drops is not negligible.

KURAMA - A SPIN-OFF OF THIS SYSTEM

The magnitude-9 earthquake in the east Japan and the following massive tsunami resulted in the severe damage at Fukushima daiichi nuclear power plant, i.e., the worst nuclear disaster Japan has never experienced before. One of the contribution of our institute to the recovery from the disaster is to develop KURAMA (Kyoto University RAdiation MApping system) for the carborne γ-ray survey in Fukushima and surrounding regions. KURAMA is installed in an automobile and records the readout of γ-ray survey meter along with the location data obtained by GPS while driving around the region. The readouts are simultaneously transmitted to the observation base in a remote place over the mobile phone network and displayed on Google Earth in realtime (Fig. 3). KURAMA is used as the standard system for the carborne γ-ray survey by Fukushima prefectural government and the Ministry of Education, Culture, Sports, Science and Technology in Japan. Results are available to the public from their websites[3] [4].

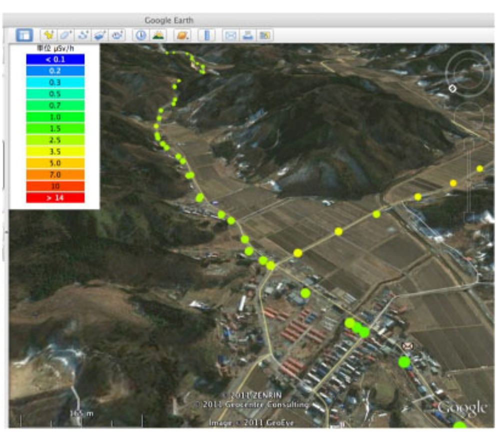

Figure 3: A typical radiation data obtained by KURAMA. The readout of radiation are displayed on Google Earth along with the geographical features.

In the development of KURAMA, some of the techniques which stem of the present surveillance system are introduced. For example, the GPS handling technique used in KURAMA is based on the one in the present surveillance system. Also some techniques developed for KURAMA are imported to the present surveillance system. In KURAMA, the radiation intensity and location of each measurement point are displayed as icons with the respective color on Google Earth. This feature is realized by the dynamic generation of a KML file with the combination of Apache and PHP, which will be used as one of the schemes for the alert in the surveillance system.

REFERENCES

[1] K. J. Lavrsen, *motion*; `http://www.lavrsen.dk/foswiki/bin/view/Motion/WebHome`.

[2] Robert E, *kmotion*; `http://www.kmotion.eu/`

[3] *Results of carborne γ-ray surveys in Fukushima prefecture(in Japanese)* `http://www.pref.fukushima.jp/j/soukoukekka.htm`.

[4] *Radiation map by the Ministry of Education, Culture, Sports, Science and Technology in Japan(in Japanese)* `http://denshikokudo.jmc.or.jp/test/mext110628/`.