Area Surveillance Using RFID System

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Abstract: - This paper proposes a method of tracking and monitoring activities of individual (or objects) in designated areas using RFID technology. In common practice, area surveillances are done by having security personnel guarding the areas or by using observation cameras. However as the number of individuals or objects in the particular area increases, monitoring may become more challenging as there would be too many activities to watch out for. Moreover, if anyone (or an object) vacates the area, there is no system to identify them and hence becoming difficult to trace their whereabouts. The proposed system is implemented by tagging the individuals or objects with RFID tags that has unique identification. RFID readers will be placed at strategic locations which would be monitored by security personnel in the control room. The personnel will be able to identify which individual or objects that are out of zone based on the tags that has been detected by the reader. The tags are also equipped with tamper proof feature that will generate alarm if they were to be removed. All the activity transactions are kept in a database for future references or actions. The capability of the proposed system is demonstrated with a case study.

Key-Words: - Radio Frequency Identification (RFID), area surveillance, RFID reader, RFID tags

1 Introduction

Monitoring of activities in designated areas could be done using various techniques. One typical example is the use of baby monitor that allows parents or caretakers to hear when an infant is awake while out of the hearing range of the infant. The sounds made by the infant will be picked up by the microphone and sent via the transmitter to the receiver that is held by the person taking care of the baby [1].

Another common method of area surveillance is by using observation cameras. These cameras will transmit visual signals to the receiver that could be watched by personnel working in the control room. However monitoring using this method becomes troublesome when the number of activities in the monitored area increases. Sharp observation by the personnel on every activity would be highly required. On top of that, as highlighted by [2], occlusions of monitored people by crossings and shading of other people would definitely occur in a crowded area. This means some views would be obstructed and hence surveillance becomes less efficient. To overcome this problem, it was proposed by [2] to have matching algorithm of spatio-temporal image from multiple cameras that could track objects against occlusions.

Another powerful technique for area surveillance is by using night vision whereby it increases the in-the-dark visibility without using visible light source [3]. Using thermography technique, activities are detected through human or living temperature. However the disadvantages of this particular technique are that the temperature could only be detected on the surface and the cameras are very costly [4].

Realizing many limitations on the surveillance methods, we are proposing a surveillance system using the Radio Frequency Identification (RFID) technique. RFID technology is a wireless sensor technology, which is based on the detection of electromagnetic signals. It is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags which carry data on transponders, antenna

which collects the transmitted data, RFID reader that receives and reads the collected details and host computer that keeps the software base data collection and manages the system [5]. Like broadcast television and radio, RFID system uses four major frequency bands: low frequency (LF), high frequency (HF), ultrahigh frequency (UHF) and microwave frequency. The systems that are coming up in the market today operate in UHF band whereas old RFID systems typically use LF and HF bands [6].

Typical utilization of RFID technology is e-passport that contains particular details of the traveler as well as the date, time and destination of travel. Works by [7] proposes a smart parking application while [8] highlights the capability of this technology in pharmaceutical supply chain.

In the proposed method of area surveillance, individuals or objects are labeled with RFID tags that have unique identification. RFID readers will be placed at designated areas allowing activities within the areas to be monitored by security personnel in the control room. The personnel will be able to identify which individual or objects that are out of zone based on the tags that has been detected by the reader. If the tags are removed without authorization, alarm will be generated. All the activity transactions are kept in a database for future references or actions. A case study of inmate tracking system is conducted and demonstrated to prove the workability of the proposed method.

2 Approach and Methods

The project involves RFID tags and readers for detection of activities, Graphical User Interface (GUI) for monitoring purpose as well as the use of MySQL software for data storing.

2.1 RFID Tags and Readers

RFID tags are classified into three different types, which are passive, active and semi passive. Each type of tags has its own operating characteristics and the means by which it receives the power for transmission determines the type [9]. For this project, active tags are opted for its capability to be detected at a distance up to 30 m from RFID reader [10].

RFID reader is a transceiver that has combination of transmitter and receiver. Its role is to query the tag and receive data from it. In executing this project, the long-range RFID system is applied. The long-range implies that the gap between the reader and tag is greater than 1m.

2.2 Database and Graphical User Interface (GUI)

Database of this system was developed using MySQL and its set up and design was done using phpMyAdmin interface. MySQL database, the open source Relational Database Management System (RDBMS) is known for its flexibility for many usages [11].

The flowchart of the RFID tracking and monitoring system is as shown in the following Figure 1.

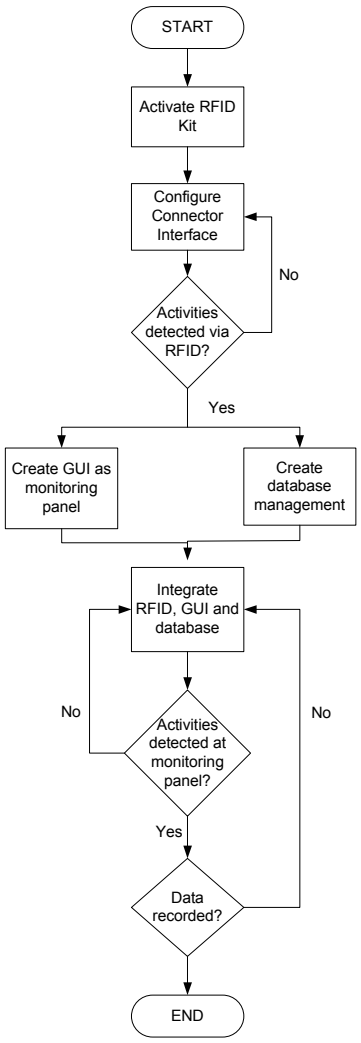

Figure 1: RFID Tracking and Monitoring System

3 Hardware Configuration

ActiveWave RFID products were chosen in developing the prototype. It is an ultra high frequency (927MHz) active RFID hardware and communicates with computer through USB interface. The active RFID reader is designed for fast and easy system integration without losing performance, functionality or security. This active RFID reader consists of a real time processor,

operating system, virtual portable memory, and transmitter/receiver unit in one small self-contained module that is easily installed in the ceiling or in any other convenient location. The ActiveWave RFID reader has two modes of operating ranges which are 30 meter (100 feet) from the tag at 433MHz and 85 meter (280 feet) from the tag at 916MHz, 927MHz, or 868MHz. One of the outstanding features of the ActiveWave RFID system is its true anti-collision capability. This feature ensures data integrity, when several RFID tags are read simultaneously.

The ActiveWave RFID reader field strength can be configured ranging from 0 to 20, so that we can estimate the RF field by setting the strength ratio as shown in Table 1.The working frequencies of the ActiveWave system are based on the international platform of RFID systems. The long read range ActiveWave RFID system employs a midrange frequency, and a unique complex software algorithm to provide noise immunity and error-free operation in high-interference environments.

Table 1: ActiveWave Reader field strength ratio to estimate distance

Field Strength Ratio	Estimated Distance (m)	Field Strength Ratio	Estimated Distance (m)
1	4.25	11	46.75
2	8.50	12	51.00
3	12.75	13	55.25
4	17.00	14	59.50
5	21.25	15	63.75
6	25.50	16	68.00
7	29.75	17	72.25
8	34.00	18	76.50
9	38.25	19	80.75
10	42.50	20	85.00

The ActiveWave active wristband tag is the size of a wristwatch, yet much lighter. This tag is designed to be worn around the wrist. The wristband is secured such that if it is unfastened or cut, then the tag will immediately send an alert to the system. These wristband tags are used to tag all the inmates and each tag has a unique ID. Figure 2 shows the Active Wave active RFID reader and active wristband tag used in the prototype.

Figure 2: ActiveWave RFID Reader and Wristband Tag

4 Software Configuration

Four tables were created to store data which are an alarm or alert history table, inmate table, officer table and readers table. These tables are created to cater for our case study which is the tracking of inmates. Figure 3 shows all the tables that have been created.

Figure 3: Inmate Tracking Database

All the alarm current status and history will be stored in alarm table. It has five fields that are acknowledged, id, name, zone, and progress time. The field of acknowledged indicates the current status of the particular inmate, if it's OK then the inmate is in the right zone otherwise it becomes Alert status which shows that conflict occurred. The inmates profile and information are stored in inmate table. It has seven fields which are id, name, room, house, bed, tag_id, and enroll date. For the room field, it stores in which zone the particular inmate belongs to. As for this prototype, there are only two zones created due to hardware constrained, which we classified as 10 for first zone and 20 for second zone. For the enroll field it stores date of inmate enrollment at the prison.Officer table is to store all officers or operators information in the inmate tracking system. The table consists of three fields which are id, name and password. The last table is readers, where it only has two fields which are reader id and reader number. The purpose of this table is to assigned one zone for one reader.

5 System Integration

The Inmate Tracking System was developed by using all the hardware and software development as discussed in the previous sections. Tests have been conducted to ensure that all hardware is functioning as required and software is producing the desired outputs. To demonstrate the system, a total of six wrist tags are divided into two different areas around respective reader.

Figure 4 shows the block diagram of movement of inmates with tag IDs 200 and 203 being tracked at respective locations. Two readers are being placed at the two specified zones.

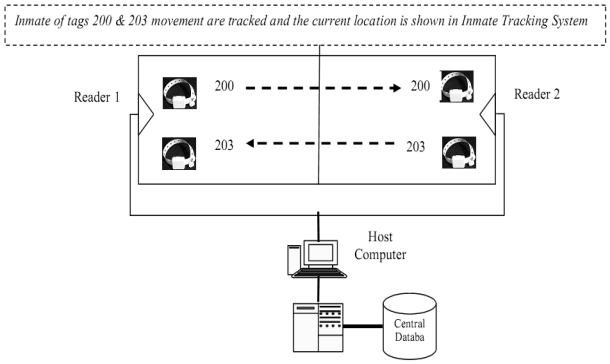

Figure 4: Inmate Tracking System

5.1 System Authorization

To login to the system the officer needs to enter his assigned ID and password as in Figure 5.

Figure 5: Inmate Tracking System login

Once allowed to access the system, the officer will be shown with the main window interface as in Figure 6. Using this main window the officer is allowed to access or update the database system and at the same time monitor the inmates. This window also shows the current locations of all the inmates and total number of inmates in each zone.

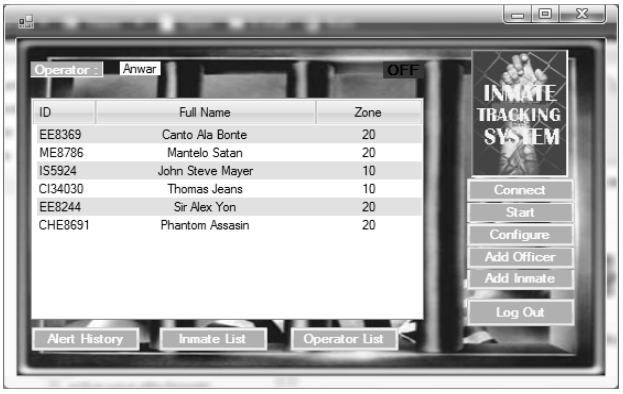

Figure 6: Main window of Inmate Tracking System

5.2 System Monitoring

To activate the monitoring system, the officer needs to click the connect icon on the right side of the menu to turn on the RFID reader. The ON sign on the top right side of the screen shall be seen as shown in Figure 7.

Figure 7: The Tracking System is in monitoring mode

If there is a need to increase or decrease the coverage area or connected with more or less RFID reader, the officer just need to click on configure button. This is to add new or remove IP address of the particular reader(s). This is shown in Figure 8.

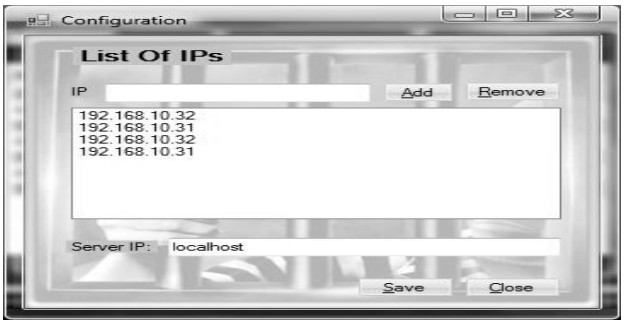

Figure 8: Readers IP Configuration

5.3 Data Management

The officers also are able to add inmate and officer profiles by clicking the add officer and add inmate

buttons respectively and the forms as in Figures 9 and 10 will appear. As all the required information is being filled and submitted, the data will be stored in MySQL database.

Figure 9: Add Inmate Profile

Figure 10: Add Officer Profile

The system will give an error message if duplicating data is being entered as shown in Figure 11.

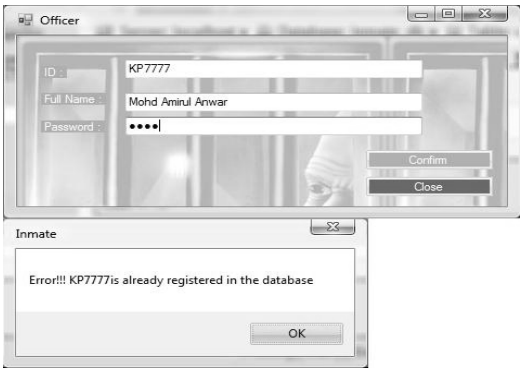

Figure 11: Error Message for Duplicating Data

5.4 System Alert

If there is a conflict such as inmate crossing beyond his zone, an alert signal will be popping up on the host computer where the officer is monitoring and inmate name will be shown as well his present location as shown in Figure 12.

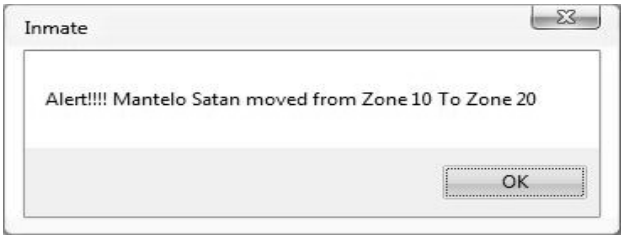

Figure 12: Alert Pop up for Moving out of Zone

If the tag has been tampered, the alert signal will pop up as well as in Figure 13. The inmate name will be displayed.

Figure 13: Alert alarm pop-up for tag tampered

5.5 Data History

All the conflict that has happened can be viewed by clicking alert history icon and the history will be displayed as in Figure 14.

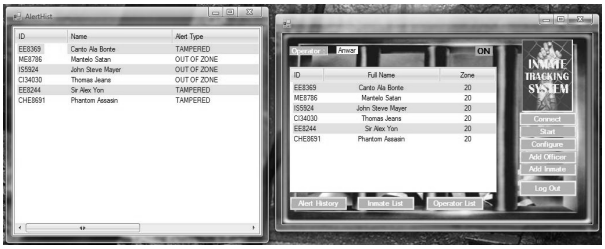

Figure 14: Records of Alert History

Table in Figure 15 shows list of inmates at the assigned locations and each inmate is assigned with unique ID. The system also managed to show when they entered the prison. Table in Figure 16 shows all the registered officers who are allowed to access the system.

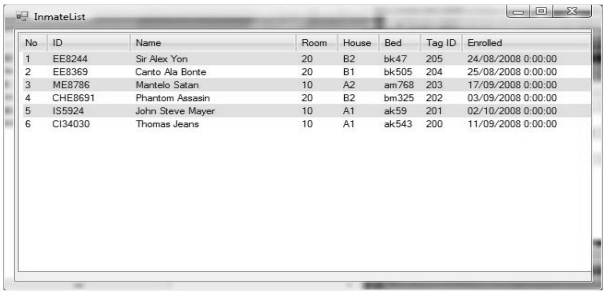

Figure 15: List of all Registered Inmate

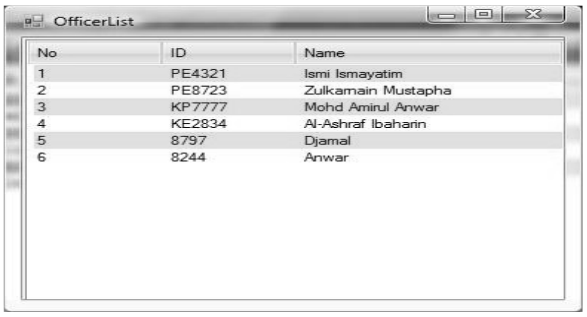

Figure 16: List of all Registered Officer

6 Conclusion

As conclusion, the objectives of this project have been achieved. The active RFID systems have been integrated with Graphical User Interface (GUI) for detection, monitoring and tracking of activities within the designated areas. The prototype of inmate tracking system had confirmed the capability of the system to conduct area surveillance effectively. Activities as well as identification of people (or object) were captured effortlessly. In the event of the person or object crosses over the area border or if the RFID tags were removed without authorization, the alarm system were triggered and alerted at the monitoring panel. Database management is also incorporated with the system for the purpose of data storing and could be retrieved for later use. The designed system could be applied to various other applications due to its ease of usage and effectiveness.

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