Tracking Student Movement using Active RFID

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Abstract: - Monitoring students of Universiti Tun Hussein Onn Malaysia (UTHM) movement around the campus is difficult especially for lecturer hall and laboratory access control. By using RFID technology, it is easy to track the student thus enhances the security and safety in selected zone. The application of active RFID in a student monitoring system is to improve faculty and UTHM management system to monitor particular group of students' whereabouts. This paper describes about an ongoing research which is currently in the stage of data collection to measure its' implementation in terms of effectiveness. The focus of the paper is to discuss about the development of the system which is called Student Monitoring System Using Active RFID (SMOSA)

Key-Words: - RFID, student monitoring, active RFID, tracking, security, movement

1 Introduction

Currently, low-cost Radio Frequency Identification (RFID) has been implemented widely in both industry and academic institutes as discussed by [1, 2, 3, 4] where the technology was focused more efficient in terms of processing time. It saves time and money [5]. A contactless transfer of data between the data-carrying device and its reader is far more flexible than smart card and RFID technology provides this contactless ID system solution.

In the Malaysia RFID 2006-2010 Forecast and Analysis by Bizedge (2006), it is stated that the RFID spending in Malaysia is estimated to grow at a compound annual growth rate (CAGR) of 45.84% (nearly US$20.94 million (RM77 million)) in 2010 from US$2.45 million (RM9 million) in 2005. Based on the study, hardware comprises largest portion of the total commercial RFID spending in 2005 (which was 60%), driven primarily by the purchases of readers and tags, followed by software and services (40%).

Knowing this, the SMOSA was developed to ease the university management team to monitor the presence of each student in the interest zone. SMOSA system contains two monitoring tasks; attendance system and tracking system using active RFID. The aim of this paper is to improve attendance data management, reduce administrative error and internal theft.

This section describes briefly about the background of this study. SMOSA architecture is described in the following section. Next, analysis of SMOSA follows. Finally this paper is concluded with an outline of a future work to be carried out

2 SMOSA architecture and technologies

This section explains the high-level design of SMOSA, from the RFID tag to the display data on computer screen.

SMOSA comprises of two graphical user interface (GUI) which is developed for stand alone, online user and data storage; database. The conceptual design of SMOSA is illustrated in Figure 1. First, RFID reader detects if there is RFID tag enters its' active range. Then, data from the RFID tag will be registered and transferred into the database through a stand alone system as the interface. A list of student will be received by the host computer and this data can be accessed directly by the university management using an online system

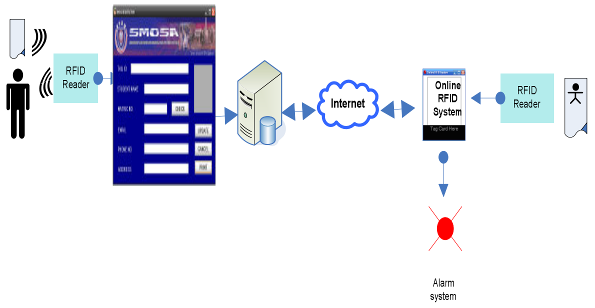

Fig. 1: The operation of the SMOSA.

The criteria of SMOSA are selected based on range, frequency, and technical aspects which are suitable for this project environment and availability of the component. Table 1 lists the property of SMOSA including RFID reader and RFID tag. Meanwhile Figure 2 shows the images of the RFID components.

Table 1 The property of SMOSA

Criteria	Solution
Type of RFID	Active
Reader	2.4GHz ISM Band (High Frequency)
Range	70 meters
Size of RFID tag	(31 x 21.5 x 7)mm – without enclosure (40 x 40 x 15)mm
Life	Unlimited
Source of power supply	- 8-28 V DC/400mA(RFID reader) - Lithium battery CR2032(RFID tag)
Type of software	- Microsoft Visual Basic 2008 - SQL - Macromedia Dreamweaver 8
Others Typical application	Access control, item level tracking, smart card,
Networking	LAN

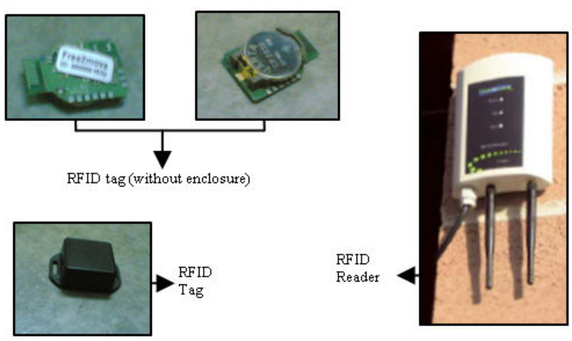

Fig. 2 Active RFID component

To design and develop the SMOSA, a list of software and hardware were involved and described in the followings:

2.1 RFID Tag

RFID tag is a small object that can be attached to or incorporated into a product [6]. It contains antennas to enable them to receive and transmit radio-frequencies to and from transceivers. There are two basic types of RFID tags: passive, and active. Passive tags require no internal power source, and are commonly used with issues relating to security. In contrast, active tags require a power source, and are more expensive. In addition, there is another type of tag which is called Semi-passive RFID which is similar to passive tags except for the addition of a very small battery allowing it to have a small amount of constant power. Table 2 addresses the differences between passive and active RFID technologies

Table 2 The differences between passive and active RFID technologies

Criteria	Active	Passive
Tag Power Source	Internal to tag	Energy transferred from the reader via radio frequency.
Tag Battery	Yes	No
Availability of Tag Power	Continuous	Only within field of reader
Required Signal Strength from Reader to Tag	Low	High (must power the tag)
Available Signal Strength from Tag to Reader	High	Low
Communication Range	Long range (100m or more)	Short or very short range (3m or less)
Multi-Tag Collection	-Collects 1000s of tags over a 7 acre region from a single reader -Collects 20 tags moving at more than 100 mph	-Collect's hundreds of tags within 3 meters from a single reader -Collects 20 tags moving at 3 mph or slower.
Sensor Capability	Ability to continuously monitor and record sensor input; data/time stamp for sensor events	Ability to read and transfer sensor values only when tag is powered by reader; no date/time stamp
Data Storage	Large read/write data storage (128KB) with sophisticated data search and access capabilities available	Small read/write data storage (e.g. 128 bytes)

Area Monitoring (e.g. warehouse, terminal, yard)	Yes	No
High-Speed, Multi-Tag Portal	Yes	Limited

Savi Technologies [6] discusses about the RFID technology processes, which starts with a tag that is made up of a microchip with an antenna, and a reader with an antenna. Active RFID uses an internal power source (battery) to continuously power the tag and its radio frequency (RF) communication circuitry. Active RFID allows very low-level signals to be received by the tag (because the reader does not need to power the tag), and the tag can generate high-level signals back to the reader, driven from its internal power source. Additionally, the Active RFID tag is continuously powered, whether in the reader field or not. As discussed in the next section, these differences impact communication range, multi-tag collection capability, and ability to add sensors and data logging, and many other functional parameters.

2.2 RFID Reader

RFID reader is a device that is used to interrogate an RFID tag [8]. The reader has an antenna that emits radio waves; the tag responds by sending back its data. A number of factors can affect the distance at which a tag can be read (the read range). The frequency used for identification, the antenna gain, the orientation and polarization of the reader antenna and the transponder antenna, as well as the placement of the tag on the object to be identified will all have an impact on the RFID system's read range

3 SMOSA Design

An experiment has been conducted to test the functionality and performances of SMOSA; a spectrum analyzer was used to capture the output for the RFID tag. The RFID reader utilized 12V batteries and 2.4 GHz frequency. Figure 3 shows the detail of hardware analysis obtained from the experiment. An experiment was conducted in order to test the functionality and performances of the SMOSA with minimum disturbance of people and electronic appliances; such as mobile phone, television and radio.

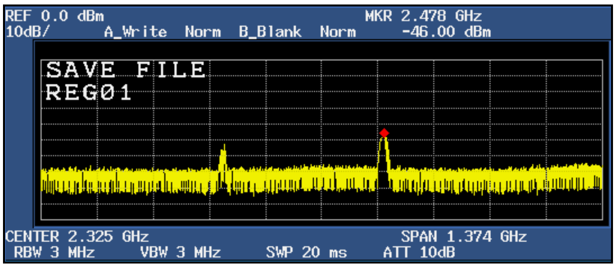

Fig. 3 Output signal of RFID reader within 3.5 meter radius

It can be noticed that the operating maximum power was 46 dBm with frequency of 2.35 GHz; affected by minimum environment producing the electromagnetic (EM) noise and normal moisture levels within the air. The pattern of power decreases as distance gets larger due to the effected of the environment interferences.

For the interfacing part, SMOSA were divided into two part : (1) stand alone system (2) online system. The stand alone system comprises of four modules: attendance, login, register, and search. The database was developed to store data using SQL. A web server was utilized to assist the management system to monitor the students' movement in preferred places. The function of the web server is to register the students' information and monitor the students' attendance lists using networking via either Local Area network (LAN) or Wireless.

3.1 Database Design

The database has three tables that are attendance, registration and users. The detailed information in every table is shown in Table 3.

Table 3: Attributes of Tables

Table	Function	Field Name	Data Type
Attendance	Save student attendance	No (Primary Key)	Auto Number
		Matric_No	Text
		Name	Text
		Time	Date/Time
		Date	Date/Time
		Status	Text
Registration	Save student information	Matric_No (PrimaryKey)	Text
		Tag ID	Text
		Student Name	Text
		Email	Text
		Phone No.	Text
		Address	Text
Login	Save UserID and Password	User ID	Text
		Password	Text

3.2 Interface Design

Figure 4 shows the flow chart of SMOSA. First, the RFID tag should be assigned to user (student). Then RFID tag is turned ON and the tag must be placed in a reading range. The antenna will generate the radio frequency field to the tag. Then, RFID will be detected after the reader receives signals from the tag and uses to record attendance and saves it in the database or to search student's details in the database. Although these steps sound simple but the most important key is to register the tag first. Secondly if problems still occur, some maintenance work would be required to identify the status of the tag and the reader. This process will repeat if a student with a tag enters the antenna reader region.

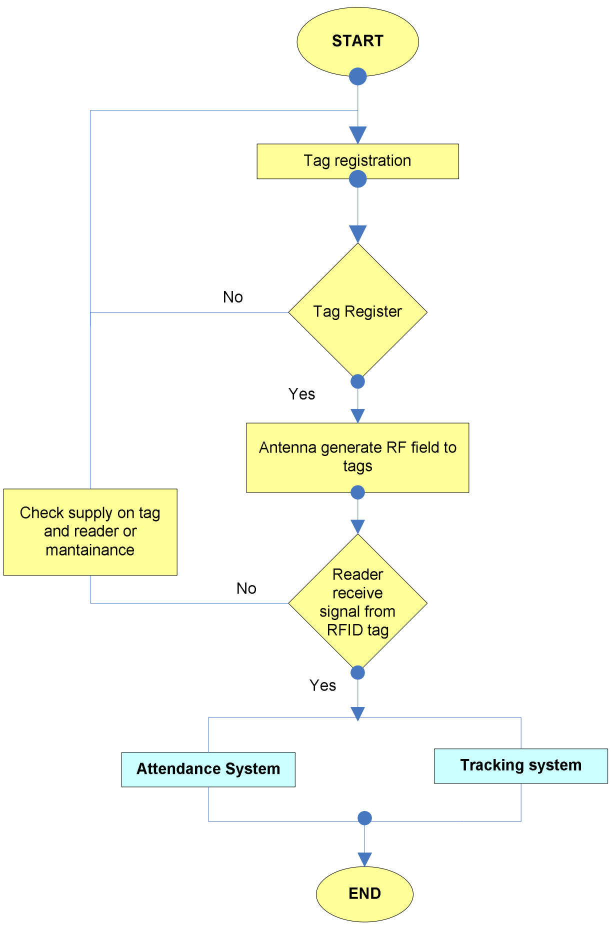

Fig. 4: SMOSA system flow chart

Figure 5 depicts three snapshots of SMOSA. The Figure 5(a) displays the main page of SMOSA, where it asks for user id and password. This is to ensure that only authorized persons can enter into the system. Figure 5(b) displays a form to register a new tag. Each student is assigned to a specific RFID tag, and the tag will always keep his/her information, including tag id, student's name, metric number, email address, phone number, and address. This information can always be updated. The management staffs can also find where a specific student located at any current time as indicated by Figure 5(c). They can search using either matric number or subject code

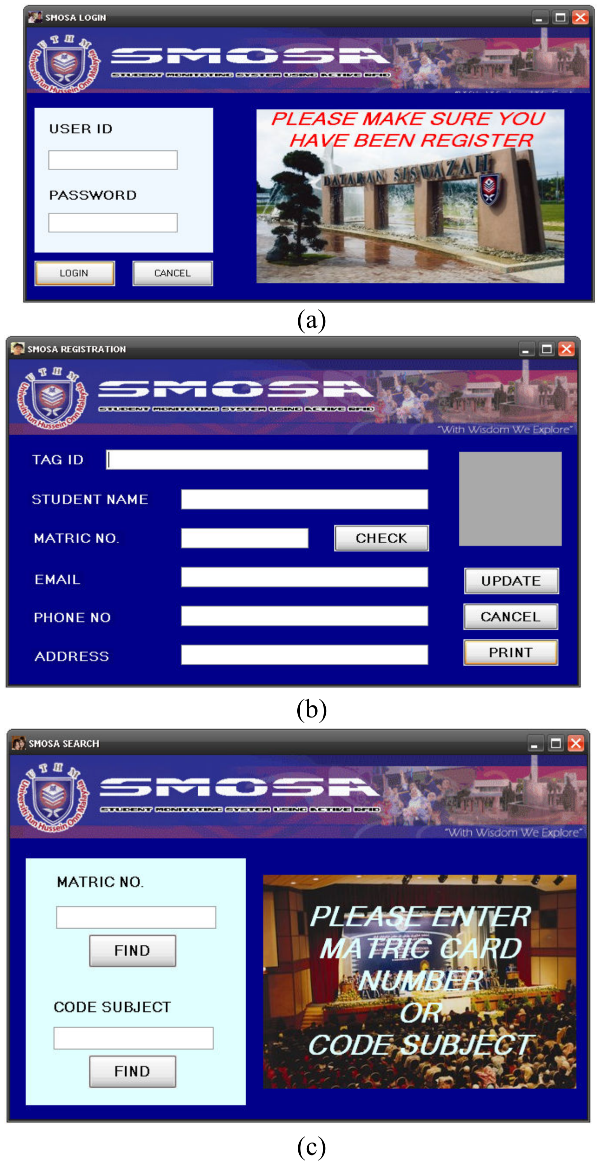

Fig. 5: SMOSA snapshots (a) Main page (b) Attendance module (c) Tracking module

4 Conclusion

RFID has been an important technology both in industry and in human life. RFID systems provide automated responding signals to identify physical objects without the need for line-of-sight communication. In our next research we will consider the security issue of the system to enabling the system to be immune from any attack and also combining RFID systems with biometric technology

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