Design and Development of Portable RFID for Attendance System

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Abstract—**This paper describes an ongoing project for recording examination attendance using Radio Frequency Identification (RFID). The project is carried out to test in a university, where the system which is named Portable Examination Attendance System (PEAS) is integrated with the existing system for record extraction. The use of RFID technology enables the university management to avoid attendance forms from damages such as tear, lost, and misplaced. This paper describes about the design and development of PEAS in terms of hardware technology and software. In addition, some related works are reviewed and addressed to support this project. As a conclusion, this paper states some future works of this project.**

Keywords-RFID, PDA, attendance system, RFID tag

I. INTRODUCTION

Nowadays, smart card identification has been used widely in many services industries, purchasing and distribution logistics, manufacturing companies, material flow systems, and security. It offers significant benefits for individuals, businesses, and governments. The purpose of this type of identification is to provide information about people, animals, goods and products in transit [1].

Most learning institutions are implementing the final examination for each taught subject at the end of each semester to measure students' performance. Thus, students attending examinations are required to fill the attendance sheet before the examination begins. The examination officers then collect the attendance paper manually. However, within a large hall full with students in different section and subjects, the attendance forms may lose, tear, or damage in other forms.

A. Smart Card

The smart cards were invented with security and portability in mind. The ability to communicate with other systems gives the smart card the ability to be used as an ID card, payment card, SIM card for mobile phones, credit card, and retail loyalty program card. Generally, the smart cards can be divided into two types: whether contact or contactless. The contact card must be inserted into a smart card reader. It has a small chip on the front pane of the card. When the card is inserted into a smart card reader, the reader makes a contact with electrical connectors allowing the transfer of data to and from the chip.

In contrast, the contactless card only needs to be passed within 10 cm of the reader to perform a transaction by using the Radio Frequency Identification (RFID) technology. An RFID technology is a non-touch recognition system that transmits and processes the information on events and environments using a wireless frequency and small chips [2, 3].

Typical RFID systems are made up of 2 major components, i.e. the readers and the tags. The reader, which is also called the interrogator, sends and receives radio frequency data to and from the tags via antennas. A reader may have multiple antennas that are responsible for sending and receiving the radio waves. The tag or transponder is made up of the microchip that stores the data, an antenna, and a carrier to which the chip and antenna are mounted. The tag antenna is the conductive element that enables the tag to send and receive data. For passive card, lower frequency is about 135 kHz and high-frequency 13.56 MHz. The tags usually have a coiled antenna that couples with the coiled antenna of the reader to form a magnetic field. Then, the RF energy from the reader antenna is harvested by the antenna and used to power up the microchip, which then

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changes the electrical load on the antenna to reflect back its own signals. The smart cards are becoming more and more ubiquitous and the trend to integrate a card reader in all kind of equipment such in personal computers, personal digital assistants, or even mobile phones [4]. This paper presents about the design and development of a Portable Examination Attendance System (PEAS) using RFID in which each student who attends for examination can be recorded effectively. The system can be executed either on computers or mobile devices. An overview of PEAS is discussed in the next section.

B. The System overview

PEAS consist of software and hardware as illustrated in Figure 1. In overall, the contact less card using the RFID is used to identify unique items using radio waves. In this project, PEAS is developed and implemented on a Personal Digital Assistant (PDA).

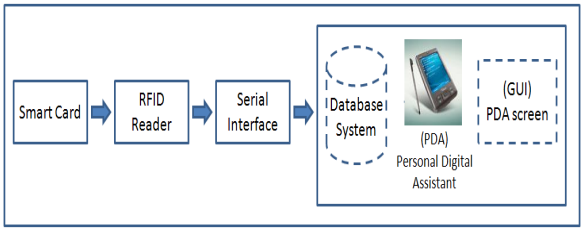

Figure 1. The reader and transponder of RFID system

In Figure 1, the three small boxes on the left are hardware, while the big box on the right contains software. Hardware set was setup without hard programming. But, for the software, all functions need to be programmed.

This paper does not intend to discuss about software design in detail, but more on the hardware design. Next section discusses about the hardware design and development.

II. DESIGN AND DEVELOPMENT

The system development was focused separately in terms of i) Hardware Design ii) Software Development. Figure 2 illustrates the design flow.

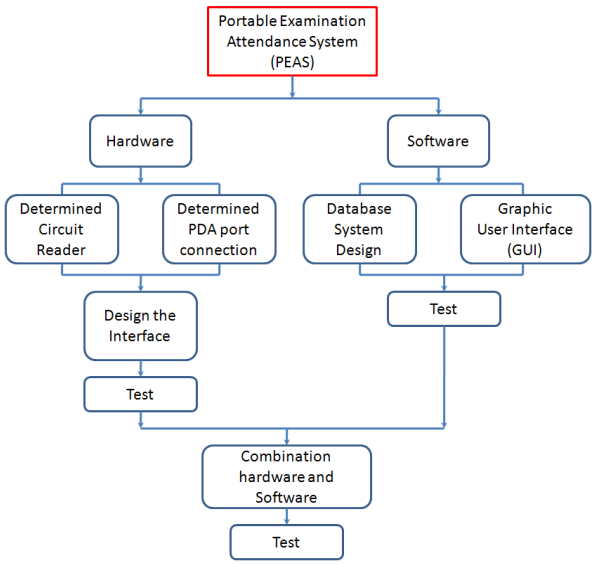

Figure 2. The design flow of the system

Figure 2 depicts that the hardware and software were developed separately, and were tested before combined to fully implement the PEAS. There were three testing altogether. The test of hardware was carried out to ensure that the setup was successful. The software was tested to ensure that all functions work as intended. In the final test, the system was already integrated into the portable hardware, and it was aimed at testing all functions on mobile device. The design and development of hardware and software are described in the following subsections. They involve RFID tag, RFID reader, PDA, PDA-RFID Reader Connection, and software part.

A. RFID Tag

Locating RFID tags (Figure 3) is the basic building block of an RFID-based communication system. It consists of integrated circuit devices containing the RF circuitry and information to be transmitted via air interface when interrogated. There are two types of tags; passive and active which reflect to the power source. Active tags which work using internal energy source, i.e. battery can have longer read and response range than passive ones and tend to be more reliable because it does not need a continuous radio signal to power [5]. But it imposes more cost to the manufacturers. As a result, passive tags are more commonly invited for deploying RFID systems in spite of their vulnerabilities.

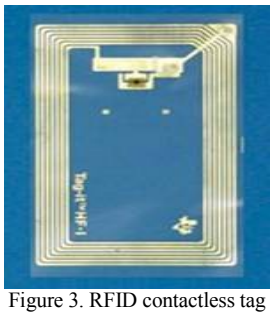

Figure 3. RFID contactless tag

B. *RFID Reader*

Mobile RFID readers are user-friendly devices which are capable of being interrogators to transmit radio energy to tags and to listen to the tags' responses. Using produced energy in an electro-magnetic coupling, tags would be able to compute pre-defined processing logics and to respond to pre-defined data containing tag's identification code and add initial information. Mobile readers can be designed to read in the mode of either only a particular kind of tags or different kinds of tags at a single time.

The tag and the reader must comply with the same standard in order to communicate. If a tag is based on a proprietary design, a reader must support the same communication protocol to communicate with that tag. Reader characteristics that are independent of tag characteristics include:

i. Power output and duty cycle.
ii. Enterprise subsystem interface.
iii. Mobility, and antenna design and placement.

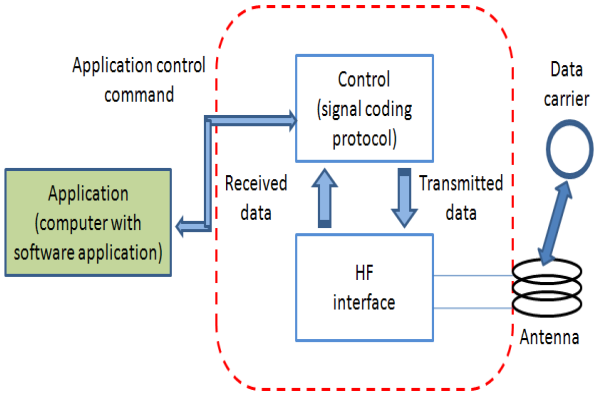

Figure 4. Block diagram of a reader consisting of control system and High Frequency (HF) interface.

Figure 4 shows the HF interface according to ISO 14443 standards which can be used to simulate the data transmission from the smart card to a reader by load modulation. The HF interface forms the interface between the analogue, high frequency transmission channel from the reader to the transponder and the digital circuitry of the transponder. The modulated HF signal from the reader is reconstructed in the HF interface by demodulation to create a digital serial data stream for reprocessing in the address and security logic. A clock pulse generation circuit generates the system clock for the data carrier from the carrier frequency of the HF field. The HF interface incorporates a load modulator or backscatter modulator such as frequency divider controlled by the digital data being transmitted to return data to the reader. Since the passive transponder does not have their own power supply, thus it is supplied with energy via the HF field of the reader. To achieve this, the HF interface draws current from the transponder antenna which is rectified and supplied to the chip as a regulated supply voltage.

C. *Personal Digital Assistant (PDA)*

PDA used in PEAS is HP iPAQ hx2000 series Pocket PC (Figure 5). The PDA acts as the storage medium and the application. The card reader is plugged at the charger port for communication connection. In addition, the database was designed to read and show the content of the reader on the screen.

Figure 5. HP iPAQ hx2000 series Pocket PC

D. *PDA-RFID Reader Connection*

The most critical part in PEAS is to make the connection between the reader and the PDA port. The PDA serial interface uses the special Himalaya connector which contains 22 pin male. The descriptions of each pin are provided in Table 1.

TABLE I
PIN MATCHING AND SIGNALS

Pin	Signal	Description
1,2,3,4	V_ADP	
5	Reserved	Do Not Use
6	DCD	RS-232 Data Carry Detect
7	RXD	RS-232 Receive Data
8	TXD	RS-232 Transmit Data
9	DTR	RS-232 Data Terminal Ready
10,15,22	GND	Ground
11	DSR	RS-232 Data Set Ready
12	RTS	RS-232 Request To Send

13	CTS	RS-232 Clear To Send
14	RING	RS-232 Ring
16,18,20	N.C.	Do Not Use
17	USB Detect	Detect
19	UDC+	USB positive data signal
21	UDC-	USB negative data signal

E. Software

A software part containing modules was designed to read from a contactless tag (transponder) or write data to a contactless data carrier using the reader as the interface. Write and read operations involving a contactless data carrier was designed based on master-slave principle as shown in Figure 6. PEAS contains an application as the master while the reader acts as the slave and is only activated when write or read commands are received from the application master.

The database is developed using Microsoft Access which is integrated with the system and data communicator.

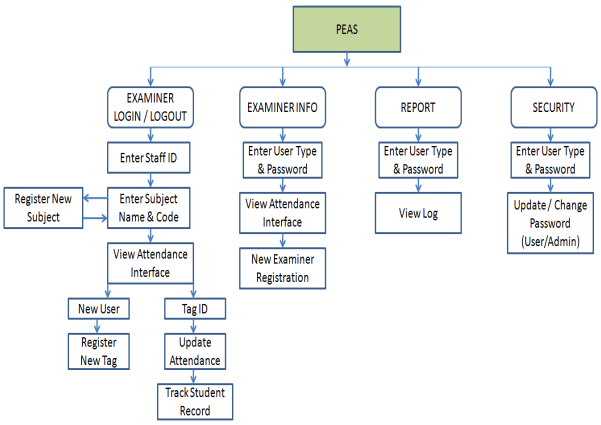

Figure 6. Modules of PEAS

Figure 6 illustrates the modules involved in PEAS which are examiner module, examiner info, report, and security. All these modules are integrated with the main Student Course Registration portal, which is already developed and used in the faculty. Integrating PEAS with the existing portal will make the data extraction easier.

PEAS is almost complete and ready for final testing. Next section elaborates the implementation of PEAS.

III. IMPLEMENTATION

This section describes the implementation of PEAS. The software has been integrated into the mobile device. In terms of functions, everything works well, as intended. However, systematic evaluation will be discussed in another paper, including results of user test. Four screen shots are captured to picture the process of how the system works. Figure 7 illustrates the main interface for PEAS.

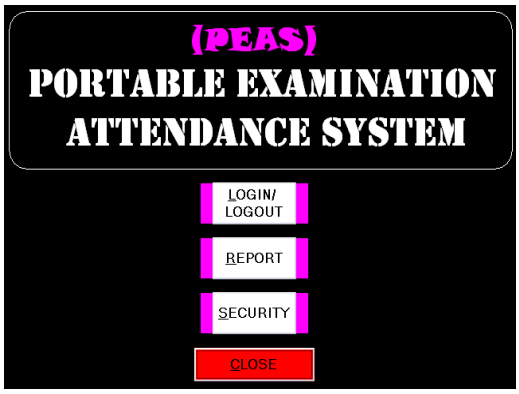

Figure 7. Main screen

First, login page is used to authenticate the authorized person (Figure 8).

Figure 8. Login page

Prior to attendance recording, examination officer need to provide course information to link with the Student Course Registration Portal (Figure 9).

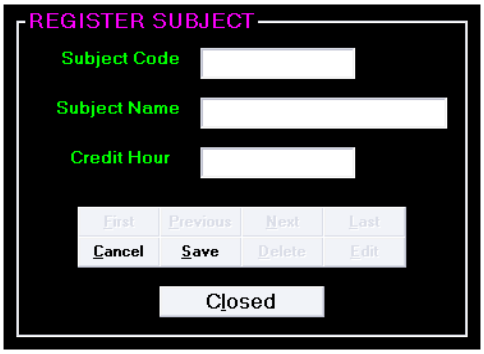

Figure 9. Course Information

The purpose of course information is to ensure the number of students registered in the Course Registration System and the current attendance is equal. Thus, any absent students can be identified. A sample of records tracking is illustrated in Figure 10.

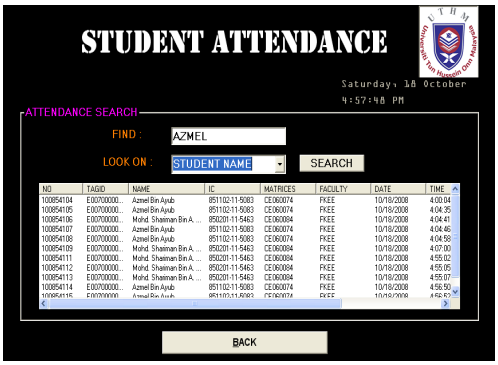

Figure 10. Tracking record

This project has good supports from previous works, which have implemented RFID in similar applications, as outlined in the next section.

IV. Related Work

This section describes previous projects regarding attendance records. Attendance records are necessary to determine and validate student eligibility during the class or examination day. Thus, many researches have been discovered in this area to improve and replace the traditional way using paper with the current RFID technology. In relation, there are many kinds of development that are related to RFID utilization to maximize potentials and application in the daily life.

Zhang Yongqiang and Liu Ji [6], designed a wireless fingerprint-based attendance system to record and obtain the attendance data using finger prints or known as biometric.

Man and Kyng [7] designed a time management and access monitoring system using microprocessor card to monitor students' or staffs' movement with the records that are kept in the database for administrator reference in campus, office or certain area. All data captured by this system could be accessed by teachers; headmaster and parents by fully utilizing Mykad features via the Internet and intranet facilities.

However Jonathan Sidi, Syahrul N. Junaini and Lau S. Ling (2007) proposed a system that was capable to record students' attendance using interactive input, generating reports, viewing students' and lecturer' profiles, and providing students timetable [8]. The system records attendance using barcode scanner. In addition, the system generates automatically, the lecturers are able to count students attendance easily and quickly.

In another spectrum, Pala and Inanc [9] applied RFID technology for check in and check-out at parking lots quickly without need to stop car and it definitely avoids traffic jam during parking hours. This type of system is used in detecting vehicles through internet facilities by comparing the previous information in the database.

Another case study referred to was a nursing documentation involving data collection on user perceptions by comparing the usability between PDA and the laptop as storage media. The work describes that the nurses must rely on their memory on paper and pencil methods to collect information and transfer it to the patient's record [10]. At the point of care, PDA technology help to overcome the collecting and entering patient's data due to its small size and their wireless connection capability. Within the conventional methods that based on paper and pencil, the information collected may take a considerable amount of time to be placed on the patient's record. There is also the possibility that by the time a nurse sits down to write the information on the patient's record some may not be recalled. Therefore, these methods for collecting data at point of care delay the update of the patient record and may result in loss of information.

Based on a literature, it indicates that most of the implementation of Attendance system are using computer integrated with RFID or other devices. Thus, the development of Portable RFID attendance system gives an option to the user using the wireless devices e.g. PDA.

V. Conclusion

This study finds that integration of mobile device with software for recording examination attendance is sufficient. In a pilot test, it was found that it reduces time, manpower, long-term cost (of printing and paper), and eases the examination procedures. In future, PEAS will be implemented in a larger scale to determine its robustness, i.e. whether it can work stably with large number of data. Besides, the GUI will be redesigned by implementing user-centered design method, and need further user evaluation so that it can be commercialized.

Acknowledgement

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References

[1] F. Klaus. RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification, Munich Germany, John Wiley & Sons, 2003.

[2] H. Lim, B. Choi and J. Lee. An Efficient Localization Algorithm for Mobile Robots based on RFID System, SICE-ICASE International Joint Conference 2006 Oct. 18-21, Bexco, Busan, Korea. pp.5945-5950, 2006.

[3] D. Hahnel, W. Burgard, D. Fox, K. Fishkin, and M. Philipose, Mapping and localization with RFID 1.42 technology," Proc. IEEE International Conference on Robotics and Automation, Vol. 1, pp. 1015-1020, 2004

[4] Abrial A., Jacky B., Marc R., Patrice S., and Vivet P. A New Contactless Smart Card IC Using an On-Chip Antenna and an Asynchronous Microcontroller". IEEE Journal of Solid-State Circuits, Vol. 36, No. 7, pp. 1101-1107. 2001

[5] Scheuermann, D. The Smartcard as a Mobile Security Devices, Electronics & Communications Engineering Journal, Vol. 14, pp. 205-210, 2002.

[6] Yongqiang Z., Ji L.The Design of Wireless Fingerprint Attendance System, International Conference on Communication Technology, ICCT '06, Handan, Hebei, China, 27-30 November 2006, pp. 1-4, 2006

[7] Man M, Kyng L.Y. Utilizing MYKAD Touch N Go features for Student Attendance System (TITO)". Proceeding of 1st International Malaysian Educational Technology Convention 2007, 2-5 November 2007, Johor Bahru, Malaysia, pp.114-120. 2007.

[8] Sidi, Jonathan, Syahrul N, Junaini, and Lau, S. Ling. ISAMS: Tracking Student Attendance using Interactive Student Attendance management System. Third Malaysian Software Engineering Conference (MySEC'07), 3 – 4 December 2007, Selangor, Malaysia, pp. 1-5. 2007

[9] Z. Pala and N. Inanc. Smart Parking Applications Using RFID Technology, Proceedings of 1st Annual RFID Eurasia, Istanbul, Turkey, 5-6 September 2007, pp.1 – 3, 2007

[10] Rodriguez, N.J. Borges, J.A. Soler, Y. Murillo, V. Colon-Rivera, C.R. Sands, D.Z. Bourie, T. PDA vs Laptop A Comparison of Two Versions of a Nursing Documentation Application", Proceedings of the 16th IEEE Symposium on Computer-Based Medical Systems (CBMS'03), 26-27 June 2003, Puerto Rico University Mayaguez, Puerto Rico, pp. 201-206. 2003