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University Attendance and Entrance Control System Using RFID

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Abstract: Because of the increase in terrorist operations in recent times and because of the large numbers of students and auditors in the universities. It is a major goal for terrorists, so, this study propose a system to control the doors of the university and allow only authorized people to enter and save the information of these people and their date of entrance in system database. This system also provides automatic registration of students attendance to avoid errors in the traditional system and to avoid wasting time and easy to calculate the attendance rate of any student with the possibility of sending a warning message to the student's parents when the absence exceeds the legal limit. This system based on Radio-Frequency Identification (RFID), Wireless Sensor Network (WSN), Global System Mobile (GSM) and microcontroller.

Key words: RFID, attendance system, access control, control system, WSN, traditional system

INTRODUCTION

Access control and automatic identification system has become necessary to overcome the security threats faced by many institutes in the world these days. By installing the system at the entrance, it will only allow the authorized people to enter the institutes. The system can also be installed at various points inside the institutes to track the movement and to restrict their access to sensitive areas. In such a way, suspicious persons can be caught which will increase the security level in the institutes (Farooq *et al*., 2014).

RFID is used to identify objects located within a reading range. RFID offers a means of storing and retrieving data through electromagnetic transmission using a Radio Frequency (RF). Today, RFID has various applications such as parking access control, object and supply-chain tracking, retail stock management, health care, super markets and electronic security keys (Liu *et al*., 2008). An RFID system consists of a reader with an antenna and a tag made up of a microchip with an antenna. The tags are embedded or attached in objects that need to be tracked or identified. The reader sends out RF waves which are detected by RFID tags within the reader's range. The RFID reader range depends on the tag type: active, semi-active or passive. It varies from a few meters to hundreds of meters. These tags will respond by sending out their IDs stored in their local memory (Liu *et al*., 2009; Khali *et al*., 2014; Akpynar and Kaptan, 2010).

In a traditional system, the attendance of universities is done through the class list, this list has been prepared by the department for every professor. According to various studies, the traditional attendance system has numerous problems, these can be listed in several formats as per below (Meghdadi and Azar, 2016):

Lost energy of professors: Each professor should check attendance of about 25-30 students per lesson and thus, his energy is lost.

Losing useful time for teaching: Students attendance is associated with the time and spending this time leads to a loss of time that is useful for learning.

Failure to notify parents: Some students give false information to the parents instead of attending classes, they go out for fun elsewhere. The possibility of losing the absence list.

Literature review: Over the last decade, many researchers focused on attendance system or access control as follows. Nainan *et al*. (2013) proposed an RFID technology based attendance management system that system sends data using serial communication. By Yadav and Nainan (2014), a design of RFID based student attendance system with notification to parents using GSM was proposed, the data is also sent using serial communication. The RFID based security and access control system was proposed by Farooq *et al*. (2014). By Khali *et al*. (2014), the researchers were using passive RFID-based technologies to identify moving vehicles. By Azasoo *et al*. (2014), the proposed design makes use of radio frequency as a means of communication between the attendant management data server and the RFID card readers situated in the various classrooms or lecture

halls. Eridani and Widianto (2015) proposed study, this study explained the development of attendance simulation on campus using RFID that connected to the database and attendance information system. Villupuram (2015) proposed a hybrid of student attendance tracking system using RFID device and fingerprint sensor. Developing a Java based RFID application to automate student attendance monitoring was proposed by Kuriakose and Vermaak (2015). RFID-based monitoring and access control system for parliamentary campus was proposed by Htun *et al*. (2015). By Meghdadi and Azar (2016), the researchers were using RFID system to automate and integrate the attendance of professors and students in the classroom. By Konatham *et al*. (2016), the researchers proposed a model for parent alerting and automatic attendance marking using of RFID and GSM.

MATERIALS AND METHODS

The proposed control system: In this study, the proposed control system is explained. In order to ease the reading flow of the study, this study is divided into different subsections as follows.

Design of control scheme: The proposed system can be explained as a block diagram as shown in Fig. 1. It consists of three sides, university gate, classrooms and monitoring center. The university gate includes RFID reader for RFID tag reading and switches to open and close doors. In addition, two microcontrollers connected with ZigBee Model have been considered. The first one collects data from RFID reader while the second one controls the operation of switches depending on a signal from the monitoring center. These switches open and close the involved door at the university gate. Moreover, the ZigBee Model exchanges the information between the university gate, classrooms and monitoring center. At classrooms the RFID reader is distributed at the doors of each classroom to read RFID tag for each student who enters to class and send the information to the monitoring center by the same way explained above. These information are used by the attendance system in the monitoring center. Because reading of tags happen in different time and to reduce the cost of building this system we connect each four classrooms (four RFID readers) by one microcontroller that will collect data and then send it to the monitoring center by ZigBee Model. At the monitoring center, the received information is sent to the Personal Computer (PC) through the ZigBee in a serial transmission information this saved in the database to calculate the student's attendance. Monitoring center

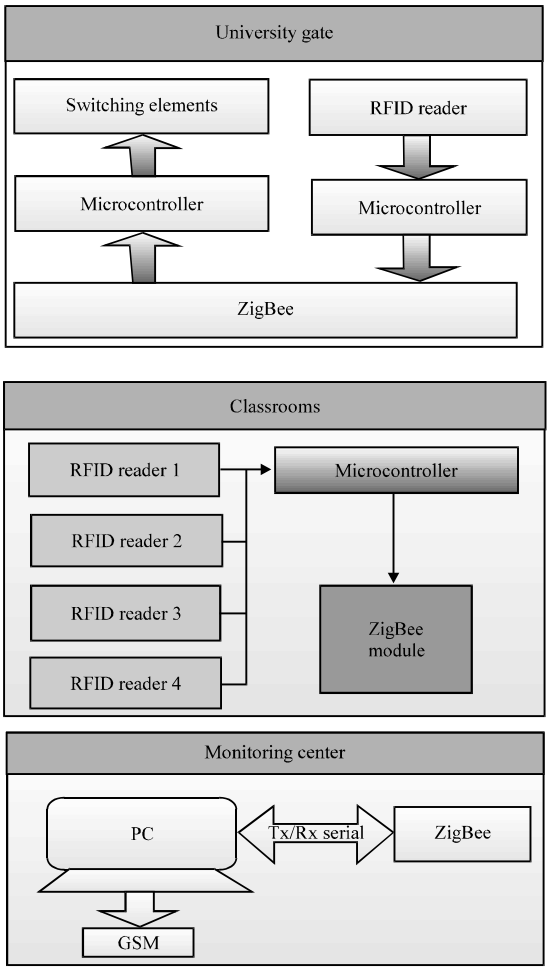

Fig. 1: The block diagram of the proposed system

also has Global System for Mobile (GSM) to send Short Message Service (SMS) to student's parents. The proposed system includes an algorithm installed at the monitoring center and is used to control the operations of the involved door and student attendance.

On the other hand, the designed scheme of the proposed system is introduced as shown in Fig. 2. This figure consists of three sides, university gate (enter, exit), classrooms and monitoring center.

The proposed algorithm: The important thing in designing any system is the algorithm that controls the operation in each part of it. In the proposed system, the message is sent from the monitoring center contains more than one bit each bit has meaning that is used to refer to specific information as shown later when describing the flow chart at university gate. The algorithm of the proposed system is divided to four main parts:

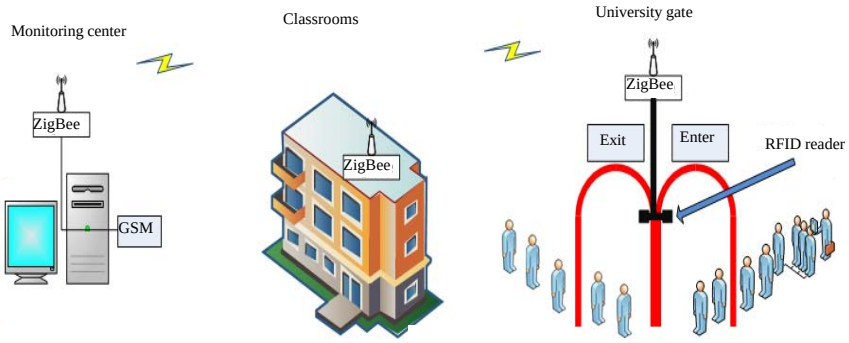

Fig. 2: Designed scheme of the proposed system

In the university gates (enter): When a student tries to enter to university he must go through the gate that is specified for entering. In this part of the system we used two microcontrollers one of them to read RFID tag (student number) from RFID reader then add one to distinguish between student enter to or exit from university then save number after that it must check this number with the old saved number if repeated that means the system read the same number twice and sent it before so that it doesn't do anything if else, it sends the number to the monitoring system. The second one receives decision from monitoring center (the two microcontrollers send and receive data by ZigBee) when decision is received there are two possibilities, when the person is authorized the monitoring center send positive signal (set of one bits) to the gate and allows him to enter the university. When the received signal doesn't begin with one bit, check first bit if zero in this case the received signal must analyse (second set of bits) either the positive signal that means this student is required by the presidency of the university or any other department for any reason for example he did not pay the tuition fees or he did an act that is against the campus laws or the negative signal that means the gate is still closed and doesn't allow him to enter to the university. The flowchart show work at the university gates shown in Fig. 3.

At the university gates (exit): The research at this part id clarified as shown in Fig. 4. RFID reader at the exit gate reads RFID tag for each student pass from this gate, the microcontroller reads the number then add zero to each number this mean the student went out of the university then save the number. After that it must check this number with the old saved number, if repeated that means the system has read the same number twice and sent it before, so, it doesn't do anything if else it sends the number to the monitoring system.

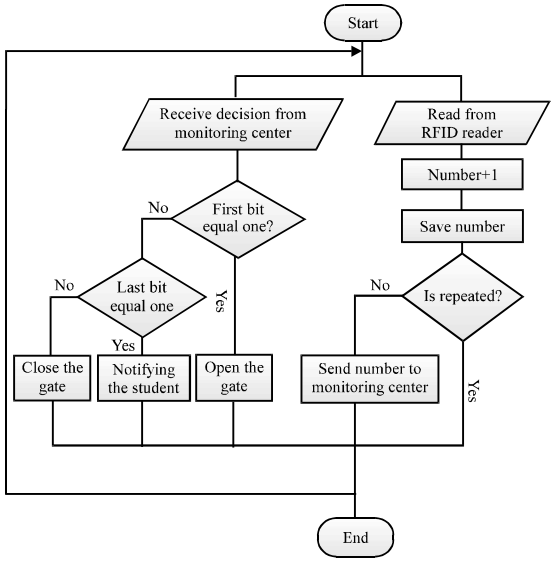

Fig. 3: Flowchart of enter through the gate of the university

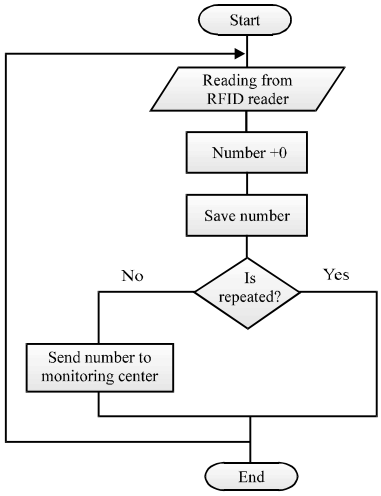

Fig. 4: Flowchart of the exit gate in the university

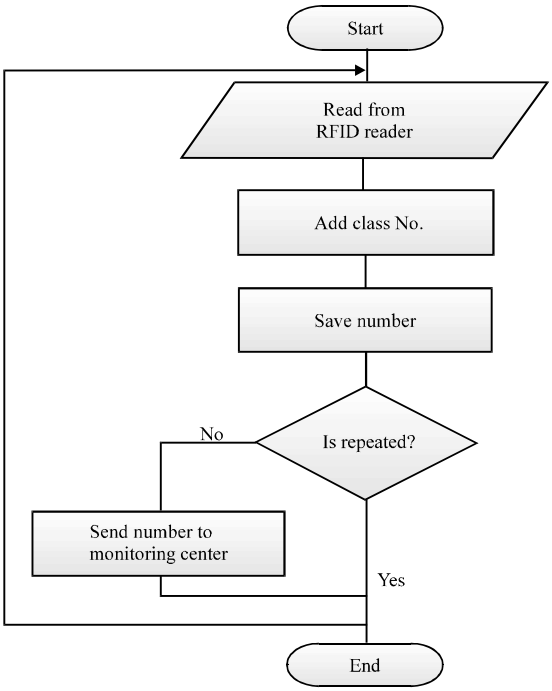

Fig. 5: Flowchart of the gate of classroom

Table 1: Add two bits to RFID tag number

Classroom No.	Code added	Student No.	The number that will be sent
1	00	200E4CB112	200E4CB11200
2	01	200E4CB221	200E4CB22101
3	10	200E4CB321	200E4CB32110
4	11	200E4CB432	200E4CB43211

At the door of classroom: The research at this part is clarified as shown in Fig. 5. The operation is done in the microcontroller as shown in Fig. 1. The microcontroller read data (student number) from RFID reader that is connected with it to distinguish between students in classroom 1 (RFID reader 1) and student in classroom 2 (RFID reader 2), etc., add two bit as shown in Table 1. Then it must save the number for 2 h (the time of lecture) this saved number is very important in the next step when checking if the number is repeated or not (the same number is saved) that means it has already been read and sent to the monitoring center. The check is very important to insure the accuracy because of the coverage range of RFID reader it could read same tag twice. If the check result is no that mean the number is new and is not saved in memory, so, it send to the monitoring center to register it in the database system.

According to the lectures time table (lectures could be 2 or 3 h or more), the microcontroller automatically erases the saved numbers at the end of each lecture.

In the monitoring center: The operation at this part is clarified by Fig. 6. This flowchart starts with reading data received by ZigBee then checks if this data came from the university gate if not, that means it came from classroom so that firstly extract the class number this data is used by the attendance system that will save student number and classroom number and time. For each student, if the absence is more than the legal limit then the system will send an SMS to the parents number that is saved in the system when the student has registered in the university. On the other hand if the check result is yes then in this case the data go in sequence of process the first one is to check whether the student has came out or came in if the result is no that means the student came out, so, it must save the student number and time. If the result is yes, so that, the data must pass to the second check to decide if the student is authorized or not if the result is yes then send one to the university gate and save the student number and time. If the result is no then send zero. After that it must check if the student number is locked or not (if student is required by the presidency of the university or any other department for any reason) if the result is yes then send one to university gate if else send zero.

Hardware design of the proposed system: This study explains the design and implementation of the proposed system in the hardware form. A block diagram of the implemented system (at the university gate) is shown in Fig. 7. It consists of two micro controllers (AT89C51) one of them collects data of RFID reader sequentially and sends them to the monitoring center using ZigBee technology. The second micro controller is used to control the switching element (transistor and LED) operation that gives ON/OFF signals to open/close doors based on the received control signals from the monitoring center.

The hardware implementation of the university gate is shown in Fig. 8. It includes RFID reader connected to the first microcontroller while the second microcontroller is connected to the switching element (the transistor as a door in reality under test). The transistor controls their operation.

A block diagram of the implemented system (at the classrooms) is shown in Fig. 9. It consists of microcontroller (Arduino Uno) connected with four RFID readers. Arduino collects data from RFID readers then send it to the monitoring center by using ZigBee. The RFID reader are distributed at the doors of each classroom to read RFID tag for each student who enters to the class and send the information to the monitoring center by the same way explained above. This information is used by the attendance system in the monitoring center because

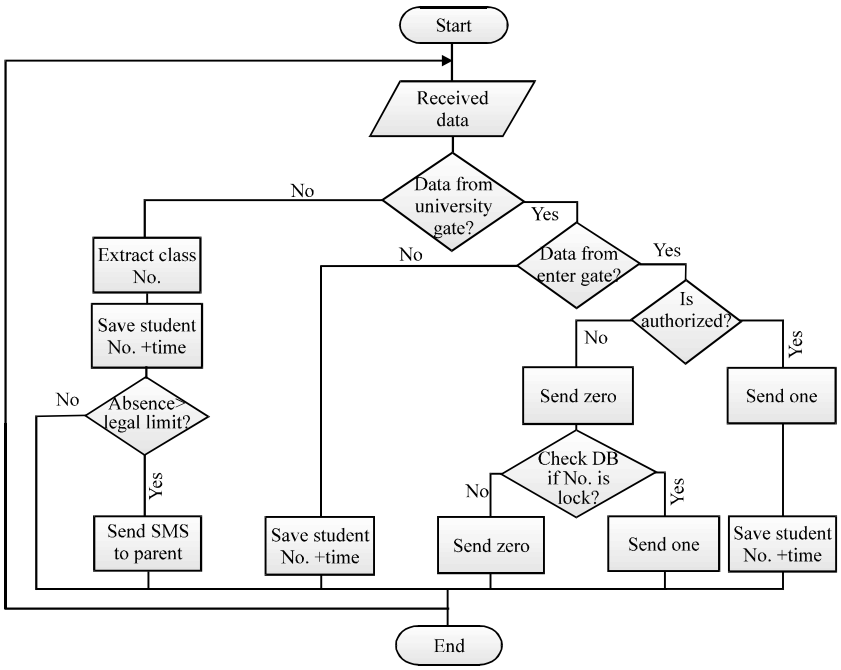

Fig. 6: Flowchart of the monitoring center

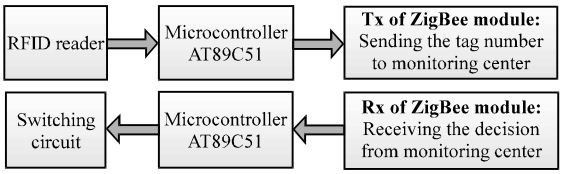

Fig. 7: A block diagram of the university gate

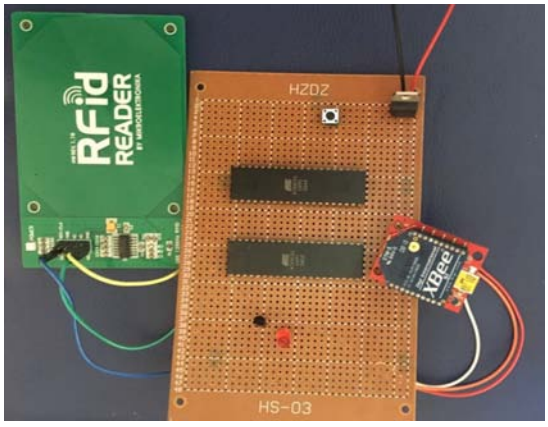

Fig. 8: The hardware implementation of the university gate

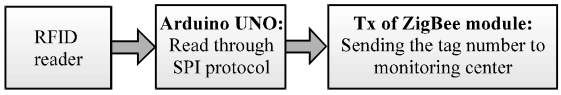

Fig. 9: A block diagram of the classroom

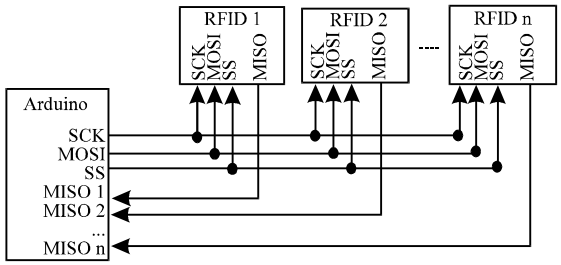

Fig. 10: Connecting Arduino with RFID reader by SPI protocol

the process of reading tags happen in different times and to reduce the cost of building this system, we connected every four classrooms (RFID reader) by one microcontroller that will collect data and then send it to the monitoring center using ZigBee Model. Arduino connects with RFID readers by Serial Peripheral Interface (SPI) protocol. The way of connection is shown in Fig. 10.

The hardware implementation of system in the classroom is shown in Fig. 11. We used one RFID reader in hardware as a case study.

The block diagram of the implemented system (monitoring center) is shown in Fig. 12. It consists of PC connected to ZigBee Model through the adapter of USB based XBEE Explorer board as shown in Fig. 13. This board includes (3.3 V) voltage regulator to adapt the ZigBee Model voltage. The PC receives data from covered

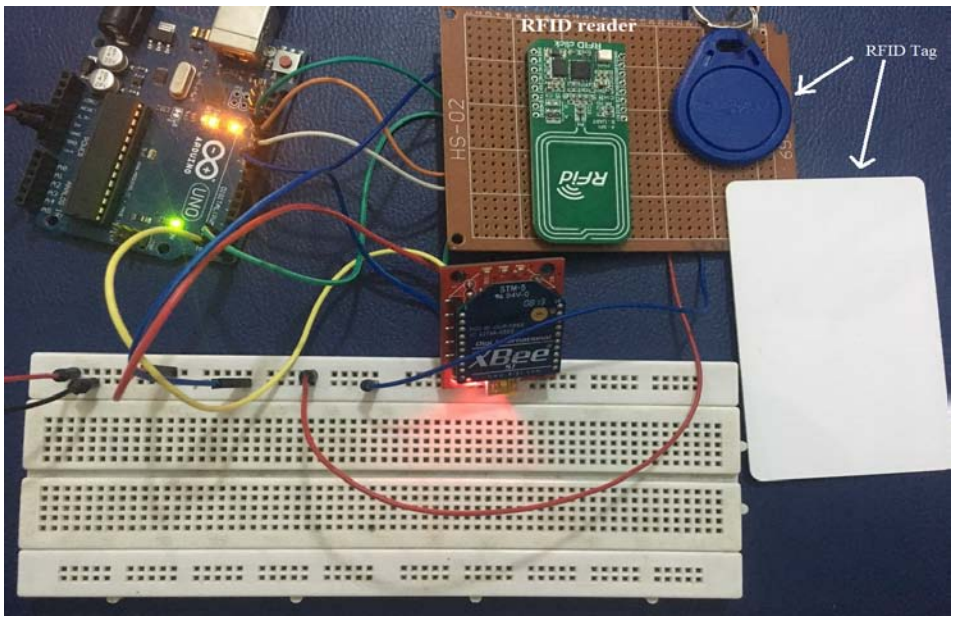

Fig. 11: The hardware implementation of system in the classroom

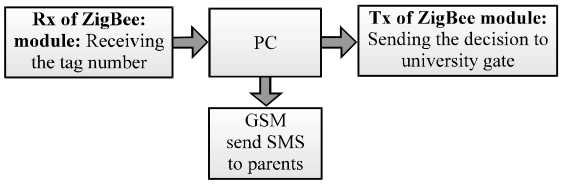

Fig. 12: A block diagram of the monitoring center

Fig. 13: XBEE Explorer USB

area (university gate and classrooms) to process it and then returns the appropriate decision through ZigBee about which door must open or save ID number in attendance system. The process of the received data is done using the proposed algorithm that has been written in visual C# and SQL server as explained.

Figure 14 illustrates that the Graphical User Interface (GUI) of the proposed system is viewed and connected with ZigBee through XBEE explorer and GSM (mobile device through AT commands).

Figure 15 shows the program in pc at the monitoring center this program is written in C# by using it you can show students attendance for any class. This program show the total number of students entering or exiting the university.

If you want to add a new student or update information you can press students information button to show new window as shown in Fig. 16. Additionally you can delete any student by entering the RFID tag number that represents the student id.

When a department in university needs any student this operation can be done easily by pressing requested student button. The requested student window is shown in Fig. 17. You can request any student by entering the student id and reason also can update the reason or delete the request.

Expansion of the proposed system: The proposed system can be expanded to accommodate any university or company with most of the geographic conditions. We need more components based on the university size (number of gate and classrooms). On the other hand, the control center remains the same. For example, to cover university in real life and this university has 40 classrooms, one major gate (four doors to enter and four to exit), thus, we need 8 RFID readers, 4 microcontrollers, 2 ZigBee modules at the university gate, at class rooms we need 10 microcontrollers, 40 RFID readers, 10 ZigBee modules, one ZigBee at the monitoring center and one PC. In addition, based on the university size and the

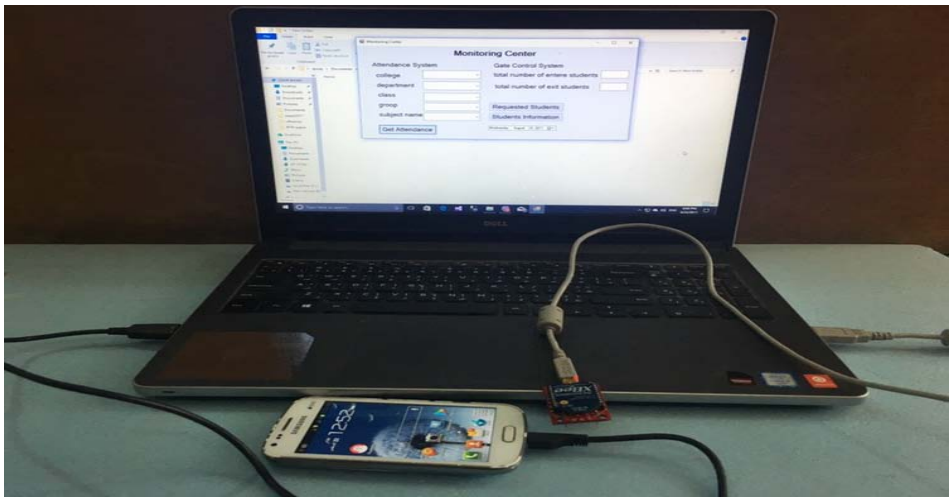

Fig. 14: The monitoring center

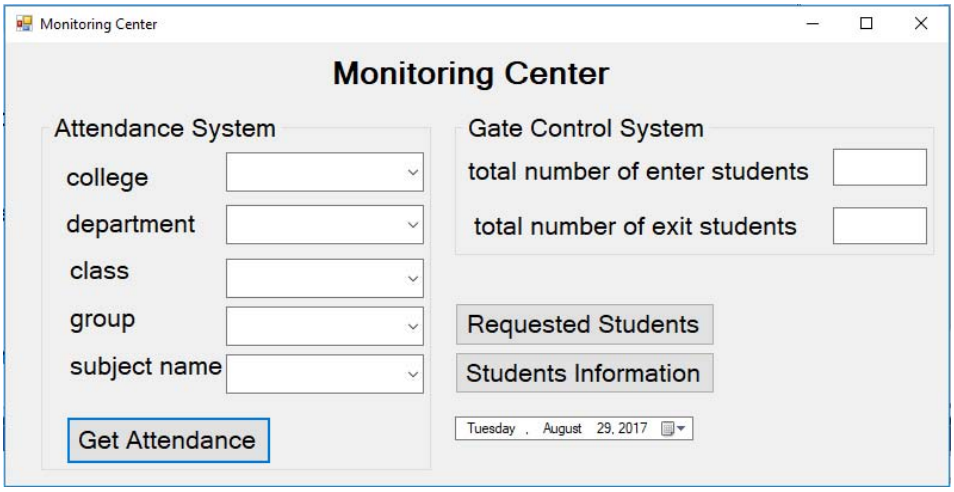

Fig. 15: GUI of monitoring program

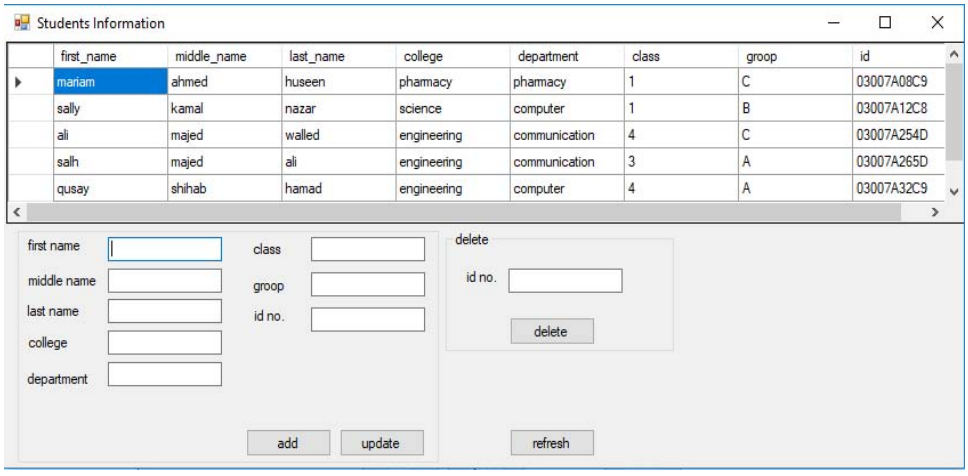

Fig. 16: GUI of student information

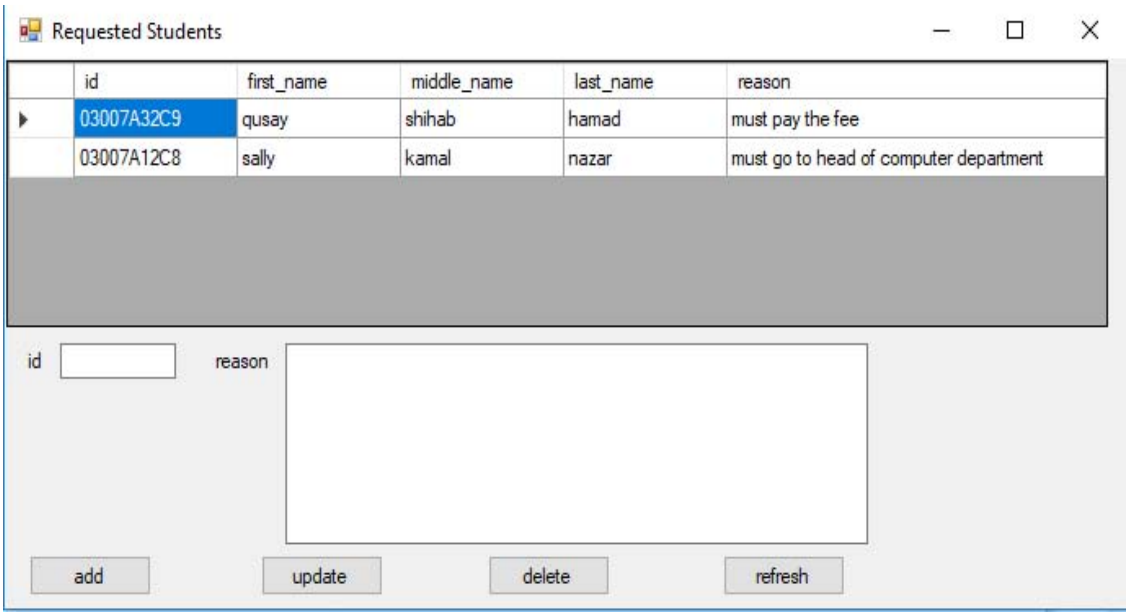

Fig. 17: GUI of requested student window

distance between project parts, so that, mesh network methodology is used to connect the ZigBee technologies together for data transmission.

RESULTS AND DISCUSSION

The research was conducted on a sample to ensure it works. As you know this project contains two main parts gate control and student attendance, so, firstly we talked about attendance by experiments, we found that the reading the tag by RFID reader then send it to the monitoring center and save it in database takes a short time, so, we assume this time is 0.5 sec to make a time calculation when compared with the traditional method of recording attendance involves individual manual entry.

On average, the time taken to record the attendance by manual entry method took approximately 10 sec per student. This time duration includes written and visual authentication (Nainan *et al*., 2013). The advantage of the proposed system can saw in Table 2 by compared between 1, 10, 50 and 100 students in class and show the saved time when using this system as shown in Table 2. Figure 18 shows a graph of the saved time when using the system compared with the traditional method.

The proposed system saves a considerable amount of time and greatly improves the efficiency of work. Also, the quality can be improved due to the reduction in entry errors by the manual human operations. Additionally,

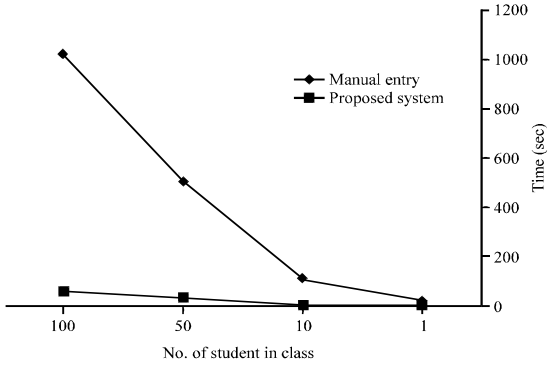

Fig. 18: A linear graph showing the comparison of total time taken to record the attendance of students

Table 2: Results of the study

	No. of student in class			
Methods	1	10	50	100
Manual entry (sec)	10.0	100	500	1000
Proposed system (sec)	0.5	5	25	50

this system sends SMS message to parenst when the absence is accessed the legal threshold, therefore, labour cost is reduced to perform the value added functions.

Secondly, we talked about controlling the university gate, the proposed system facilitates work and reduce the number of security personnel. In the traditional method when checking is done by human we need security man for each entrance in the university gate if it has 10 entrances that means 10 people but with the system in

Table 3: Saving money

No. of classrooms	Total price ($)		
	Traditional system	Proposed system	Saved money ($)
4	140	35	105
8	280	70	210
16	560	140	420
32	1120	280	840
64	2240	560	1680

this study one security man is enough to control all entrances in gate and still enough when increasing that number which will reduce the cost effectively.

In the classrooms as, we mentioned earlier each 4 RFID readers are connected with one ZigBee module (XBee), the price of ZigBee module is 25$ (Anonymous, 2015a) and XBee Explorer is 10$ (Anonymous, 2015b). So, the proposed system reduces the cost of design as shown in Table 3 when compared with the traditional system which uses one XBee module for each RFID reader.

CONCLUSION

In this study, an efficient hybrid system on student's attendance and university gates control based on RFID has been proposed. The main objective of the proposed system is to access control through the university gate and student attendance automatically based on RFID technology and microcontrollers. This can be obtained by using the proposed algorithm at the monitoring center that controls the system operation. The simulation results showed the superior performance of the proposed system in comparison with a conventional method in terms of time and money saving.

RECOMMENDATION

For future research, we are planning to implement the proposed system in real monitoring area and using the real doors instead of LEDs.

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