Company attendance and access control system based on radio frequency identification

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Abstract. one of the popular things among succeeded companies is an automated system. The reasons behind using the automated system are to reduce human errors, work and to gain efficiency. The design focused on building an automated system for access control and attendance monitoring by the use of RFID technology. all the companies that still doing mural attendance will get a great help when it used the proposed system. this paper used RFID (tags, reader), microcontroller to collect data, ZigBee technology for transmitting and receiving data wirelessly, computer as a control station. the program at control station was written by using Visual C# and connect with database (DB) MSSQL server to store employees’ numbers (RFID tags) and used for attendance calculations.  The initial results of the proposed system appear a high profit in time-saving and cost when compared with traditional systems. cost divided into two parts, firstly: a price of ZigBee device, secondly: security men

1. Introduction
One of the important factors in human resource management is register attendance of an employee. many things (work performance, salary, productivity or agency progress) can be determined based on employee presence. some drawbacks may occur when attendance recorded manually such as a human error, time-consuming and effort [1,2].

The modern monitoring systems nowadays are established on three main concepts; cost-effective, efficiency and less power consumption. this is to satisfy the growing requirements of the stores, which include companies and other important organizations [3,4].

Automatic identification and Access control system has become very necessary to overcome the security threats faced by many organizations in the world these days. By placing the system at the gateway, it will only allow the authorized persons to enter the organization. The system can also be installed at various locations inside the organization to track the movement and to restrict their access to critical locations. In such a way, dubious persons can be caught which will increase the security in the organizations [5].

2. Related Works
Numerous authors and researchers over the last decade focused on access control and attendance system as follows decennium. attendance system using RFID technology based on GSM network was
introduced by authors [6]. In [7] a system for attendance control based on RFID-technology in Kazakhstan university was introduced. The authors in [8] using RFID technology built a system to control a staff access. The authors in [9] propose a system of a Web application for confirming attendance at company. In [10] the authors proposed an automated student attendance surveillance based on Java and RFID application. Employee attendance tracking based on GPS was developed by authors in [11]. In [12] the classroom attendance and access control biometric fingerprint based on biometric fingerprint were proposed. Payroll system and management attendance based on wireless biometric was proposed by authors in [13].

The authors of [14] made a simple attendance system and software of RFID which is integrated with DB locally based on wired. The attendance system that assists the secretary to fill employee data, then give the reports to the manager, so as to make it easier to give an assessment of the performance of company employees was proposed in [15]. Employee attendance system based on fingerprint, Raspberry Pi and Arduino was proposed by authors in [16]. Access control for laboratory and classroom use Raspberry Pi and a smart card was proposed by authors in [17]. In [18] the staff control system was proposed that allow hands-free access control, monitoring and record the attendance of employees. At the end of the month, a report of a total number of worked hours is print.

3. The Suggested Monitoring System

In this section, the suggested system was explained, this section was divided into multi subsections as follows.

3.1. Design of Monitoring Sketch

The proposed system can be clarified as a block diagram as shown in figure number 1. It consists of three parts, company gate, rooms, and monitoring center. The company gate contains RFID reader, switch to open and close the door and two microcontrollers. The first one collects data from RFID reader while the second one control the operation of switch depending on a signal from the control center. Moreover, the ZigBee model exchanges the information between the company gate, rooms, and monitoring center. At rooms, the RFID reader is spread at the gates of each room to read RFID tag for each employee who comes into room after that the number of RFID tag will send to monitoring center to save in database. The received information is used by the employee attendance system at the monitoring center.

To reduce the price of construction this system we used one microcontroller for each four RFID readers(rooms). The microcontroller will collect data form RFID readers then send it to the monitoring station by ZigBee. At the monitoring station, the received information is saved in the database to calculate the employee attendance. The proposed system involves an algorithm at the monitoring station.it used to control the work of the involved door and employee’s attendance.
3.2. The Suggested Algorithm
The algorithm is the important thing in designing any system. The algorithm used in the system was divided into four parts:

A. In the company door (enter)
when an employee tries to enter to company gate. The algorithm of work was clarified by the flowchart shown below in figure number 3.

**Figure 3.** The algorithm used in the gate to enter to company.

**B. At the company door (exit)**
when an employee tries to exit from the company gate. The algorithm of work was clarified by the flowchart shown below in figure number 4.
C. At the gate of rooms

when RFID reader detect RFID tag (employee number), the detected number immediately delivered to a microcontroller. in the microcontroller, two digits will add to the number to distinguish between employees in different rooms. as clarified below in table number 1. Then it must save the number for 8
hour (the work day) 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. The check is so significant to ensure the precision since the coverage range of RFID reader it could read the same tag (employee number) twice. Each time any new detected number is checked if the result is no that means the employee tag (employee number) is new and was not saved in memory so that the number will send to the monitoring station to saved in a database.

Note: suppose to the work daytime in the company is 10 hours, the microcontroller automatically erases the RFID tag numbers at the end of each day.

| room no. | Code added | Employee number | The Number that will be sent |
|---------|------------|-----------------|------------------------------|
| 1       | 00         | 200E4CB112      | 200E4CB11200                 |
| 2       | 01         | 200E4CB221      | 200E4CB22101                 |
| 3       | 10         | 200E4CB321      | 200E4CB32110                 |
| 4       | 11         | 200E4CB432      | 200E4CB43211                 |

D. In the monitoring station

The algorithm used in the monitoring center is present in figure number 6 below.

![Flowchart of the monitoring station](image)

**Figure 6.** Flowchart of the monitoring station.

3.3. Design of the Proposed System

In this subsection the hardware implementation of the proposed system was explained. A diagram of the proposed system (at the company door) is clarified in Figure number 7. It contains two
microcontrollers (AT89C51) one of them collects data from RFID reader then sends it to the monitoring station by ZigBee module. The second microcontroller control the operation of switching element (transistor and LED) that gives signals (ON/OFF) used to open/close doors based on signals that received from the monitoring station.

![Diagram of the university gate.](image)

**Figure 7.** A block diagram of the university gate.

The implementation of the company door in hardware is present in figure number 8. It contains RFID reader that connected with the first microcontroller while the second one is connected with a switching element (transistor) represent a door in real life (under test).

![Image of the hardware implementation of the company gate.](image)

**Figure 8.** The hardware implementation of the company gate.

A diagram of the system at the rooms is clarified in the figure number 9. It contains a microcontroller (Arduino Uno) connected with RFID reader (four readers), the microcontroller gathers tag numbers from readers then send it to the monitoring station through ZigBee. the RFID reader was spread at the door of each room to read tag number of the employee who enters the room then sends the data to the monitoring station.
The attendance system in the monitoring station used a received information. reading tags operation will not occur in same time so that each four room (RFID reader) was connected with one microcontroller to reduce the cost of a system. the Serial Peripheral Interface (SPI) protocol was used to RFID readers with Arduino. The connection way was presented in figure number 10.

Figure 9. A block diagram of the rooms

Figure 10. Connecting Arduino with RFID reader by SPI protocol.

The hardware building at room is shown below in figure number 11. (as a case study we used only one RFID reader).

Figure 11. The hardware implementation of system in the room.

The implemented system diagram (monitoring station) is clarified in the figure number 12. It contains computer connected to the ZigBee through USB based XBEE Explorer board as shown in the figure number 13. The computer receives data from the monitoring field (company gate and
rooms) and then returns the appropriate decision through ZigBee about which door must open or save employee number in a database system. The proposed algorithm was written in Visual C# and SQL server.

**Figure 12.** A diagram of the monitoring station.

**Figure 13.** XBEE Explorer USB.

Figure 14 clarifies that the Graphical User Interface (GUI) of the suggested system is viewed and the computer connected with ZigBee.

**Figure 14.** The control station the program at the monitoring station shown in figure number 15.
4. Extending of the Suggested System

The suggested system can be extended to accommodate any company or institute with any geographic state. Based on the company size (number of rooms and gate) the hardware component must provide. On the other hand, the monitoring station remains the same. For example, the company has 40 rooms, one major gate (4 gates to exit and 4 to enter), consequently, we need 8 RFID readers, 4 microcontrollers, 2 ZigBee at the company gate.

at rooms, we need 10 microcontrollers, 40 RFID readers, 10 ZigBee modules, one ZigBee at the monitoring station and one PC. For data transmission between the proposed system parts, the mesh network is used to connect the ZigBee devices together.

5. Results of Simulation

To ensure the work of the project, it was applied to the sample. two major parts in the research firstly the employee attendance secondly gate control. for the first part by experiments the operation of reading the tag and save it in a database system took a less time.

Suppose time calculation is 0.5 second when compared with the traditional ways for attendance based on manual entry. For the manual attendance recording, it was taken approximately 10 seconds per employee. this period involves notarial and visual authentication [5]. the suggested system advantages of time-saving was presented in table number 2

| Method         | Number of Employee in Room |
|----------------|---------------------------|
| Manual Entry   | 10 seconds | 300 seconds | 600 seconds | 900 seconds |
| Suggested system | 0.5 seconds | 15 seconds | 30 seconds | 45 seconds |
The profit in a time saving when compare the proposed system with traditional method clarify in figure number 16.

![Graph showing comparison of total time taken to record the attendance of students.](image)

**Figure 16.** A linear graph showing the comparison of total time taken to record the attendance of students.

when compared the new proposed system with manual human work we see the work efficiency improved because the error was eliminated.

The proposed system reduces the security men. In the traditional way, the check operation was done by security man we need a man for each gate in the company gate if it has 10 gates that mean 10 security men. with the proposed system only one man enough this lead to reduce the cost effectively.

In the rooms, as we aforesaid earlier every 4 readers are connected with one ZigBee, the ZigBee price is 25$ [19] and XBee Explorer is 10$ [20]. so the suggested system minimizes the cost as clarify in table 3 compared with the oldest methods which use one ZigBee module for each reader.

**Table 3. Saving Money**

| No. of Rooms | Total price in $ | Saved Money in $ |
|--------------|------------------|------------------|
|              | traditional system | proposed system |                  |
| 4            | 140              | 35              | 105              |
| 16           | 560              | 140             | 420              |
| 64           | 2240             | 560             | 1680             |
| 128          | 4480             | 1120            | 3360             |
| 256          | 8960             | 2240            | 6720             |
| 512          | 17920            | 4480            | 13440            |

**6. Conclusions**

An effective system of employee attendance and company doors control using RFID and database system(SQL Server) has been proposed. ease attendance calculation and automatically control the access through the company doors is the main objective of the suggested system. the system work controlled by a suggested algorithm at the monitoring station. the results of the simulation show a prominent performance in terms of saving money and time. Compared with other traditional systems.
the implementation of the suggested system in real area as the future work using real gates instead LEDs.

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