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Lecture Attendance System Using Radio Frequency Identification and Facial Recognition

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ABSTRACT
We propose a nexus of wireless biometric solution to the problem of lecture attendance records in an academic environment. The conventional method of taking attendance records on paper particularly in an environment with lower student/lecturer ratio is not only laborious but robs on the precious time that could be used for an effective learning. We demonstrated the efficacy of our proposed method against conventional methods as being capable of eliminating time wastage.
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Keywords*:* RFID, Facial Recognition, Lecture, Attendance, Tags, Short range reader.

1. INTRODUCTION

The monitoring of attendance in conventional learning environment consists of a number of requirements. The availability of both the learner and the learned usually for a period of not less than seventy percent of entire lecture period and proper record keeping of the learner during the lecture period by the tutor. In most developing countries, lecture attendance is usually noted using paper sheets, file system, surprise quizzes, and roll call of names and/or student identification number etc. These methods have made it so inadequate for the academic department to regularly update and effectively assess the true record of students in a learning environment [16,14].

The current lecture attendance monitoring system in academic environment in developing countries embraces the use of paper based method for taking and usually for computing student's percentage of attendance [14]. This method of attendance monitoring is time consuming and laborious because the valuable lecture time that could otherwise have been used for lectures is dedicated to student attendance taking. This inadequacy in the process of attendance monitoring leads to wrong compilation of student's that were in the class for the entire duration of the course.

Biometric systems have been widely used for the purpose of automatic recognition of objects based on some specific physiological and behavioural features [10].Many biometric systems can be applied for a specific system but the key structure of a biometric system is always the same. In biometric facial recognition, record of the spatial geometry of distinguishing feature of the face is recorded. Because a person's face can be captured from some distance away, the technology has been used to identify card counters or other undesirables in shoplifting and monitoring of criminals and terrorists in some countries with the history of terrorism. Biometric Face recognition is one of the few biometric methods with the merit of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. The technology has drawn the attention of researchers in fields from security, psychology, and image processing up to computer vision [6][7].

Accordingly, there have been proliferations of Radio Frequency Identification (RFID) systems in a number of applications. Successes have been recorded in diverse areas as Healthcare Monitoring [17], Library [15], Home and Business Security Systems [4] and Construction [9] to name a few in Literatures. Radio Frequency Identification (RFID) systems facilitate automatic and identification and tracking of remote components. Research in this field involves improving tags, readers and adapting tags to multiple substrates and function under extreme conditions of temperature, humidity and application of the latest technology to achieve various objectives such as improving traceability, efficiencies, and real-time monitoring system behavior especially in critical health care condition [11][1]. This work seeks to combine value added advantages attributed to these two electronic identity systems: RFID and Facial Recognition in exploring a cutting edge wireless biometric solution to the students' academic attendance monitoring problem in developing countries.

2.0 REVIEW OF RELATED WORKS

A number of related works exists in literature in the application of RFID and Facial Recognition to different areas of attendance monitoring problem. In [12] authors proposed student tracking using RFID. It involves the use of the student identification card to obtain student attendance. The author tried to solve the problem of manual computation of attendance but his work does not eliminate the risk of student impersonation. Consequently, authors in [1] proposed an RFID matrix card based auto identity system to the manual problem of monitoring student in boarding schools. Upon initial study of the three Boarding school in Malaysia, current process of maintaining students records in and out was not only tedious, misinformation always happen as students tend to provide inaccurate information.

The fusion of passive RFID Tags, Wireless local area networking and database management system development helps to ease the monitoring of the availability of boarding students as system RFID reader monitors and recorded student identity through their unique and pre-assigned RFID tag.

Also, authors in [8] reviewed the use of RFID in an integrated-circuit(IC) packaging house to resolve inventory transaction issues. This study suggests that RFID contributes significant improvements to the water receiving process and the inventory transaction process that reduce labour cost and man-made errors. In [5] author proposed the use of finger print to solve attendance monitoring problem. The fingerprint technique verification was achieved using extraction of the fingerprint of students. The proposed system was successful in monitoring attendance but the proposal of [5] lacks the inclusion of a report generation and audit trail system. Similar attendance monitoring solution was developed in [3] to manage the context of the student for the classroom lecture attendance using the Personal Computer of each student.

Authors in [11] proposed design and prototype implementation of a secure and portable embedded reader system for reading biometric data from an Electronic passport(E-passport) using Electronic Product Code (EPC) RFID tags. The passport holder is authenticated online by using GSM network. Secure communication through Advance Encryption Standard (AES) encryption technique between server and the proposed e-passport reader helps to provide comprehensive system to create, manage and monitor identity data online.

In [14], authors proposed a simplified and cost effective model of embedded computer based solution to the manual method of managing student lecture attendance problem in higher institutions in developing countries. The developed system is capable speeding up the process of taking students lecture attendance and allows for error free and faster verification process of authenticating student lecture attendance policy required for writing examination in a campus environment but could not provide absolute solution to the problem of impersonation by erring students.

In [2] Artificial Neural Networks and Facial Recognition were used to develop a security door system where authorization of facial appearance of privilege users in the database is the only guarantee for entrance. In the system, the personal computer processes the face recognized by the system digital camera and compares data with privileged users in the database. The system control program either sends a signal to open the electromechanical door upon facial existence or deny entry.

In this paper, we proposed a nexus wireless biometric solution to the problem of lecture attendance problem in academic environment. The current process of taking student particularly in an environment with lower student/lecturer ratio is not only laborious but robs of the precious time that could be used for an effective learning. The amalgamation of these technologies to student attendance monitoring problem as demonstrated in this study is capable of eliminating time wasted during classical/manual collection of attendance, provide solution to the problem of impersonation liable to similar solution as proposed in [1, 14,5,12] and an avenue for proper academic monitoring of students performance by University administrators.

3.0 MATERIALS AND METHOD

3.1 System overview

The system was developed for Lecture Attendance Management Scenario of Bells University of Technology, Ota, Nigeria for each lecture period. The system manages the student lecture attendance using a Windows Application system and the developed RFID and Face Recognition based attendance model. The application system contains a module known as the administrator module. The function of the administrator module is to handle the entire administrator task: Adding, editing and deleting classes, subject and college/department. Only the administrator can view, add and delete data in the attendance system. Figure 1.0 shows the general block diagram of the system. The developed model consists of an RFID Reader incorporated with a µRFID Reader board, RS232 to USB converter cable

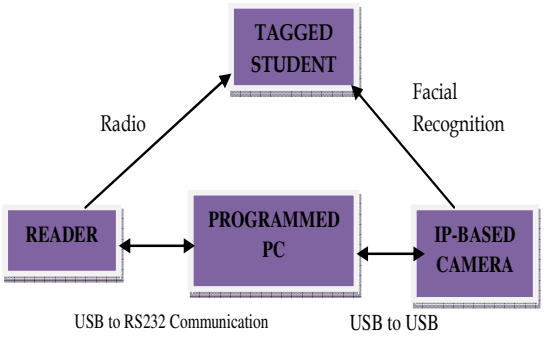

Fig 1: System Block diagram

3.2 Design Considerations

The proposed attendance management system in this work consists of the following considerations:

Hardware Design Considerations

Considering RFID systems shown in Figure 2.0, electronic tags communicate with the reader through radio waves. RFID Tags can be one of three types: active, semi active or passive. Because these tags do not supply their own power, communication with them needs to be short and usually does not transmit much data usually just an ID code. The range for transmission is from 10mm to 5 meters. There are four different kinds of tags in use, categorized by their radio frequency: low frequency (between 125 to 134 KHz), high frequency (13.56MHz), UHF (868 to 956 MHz), and microwave (2.45 GHz).The tag has a unique set of numbers which makes every card unique, in each case a reader must scan the tag for the data it contains and then the information is sent to the database.

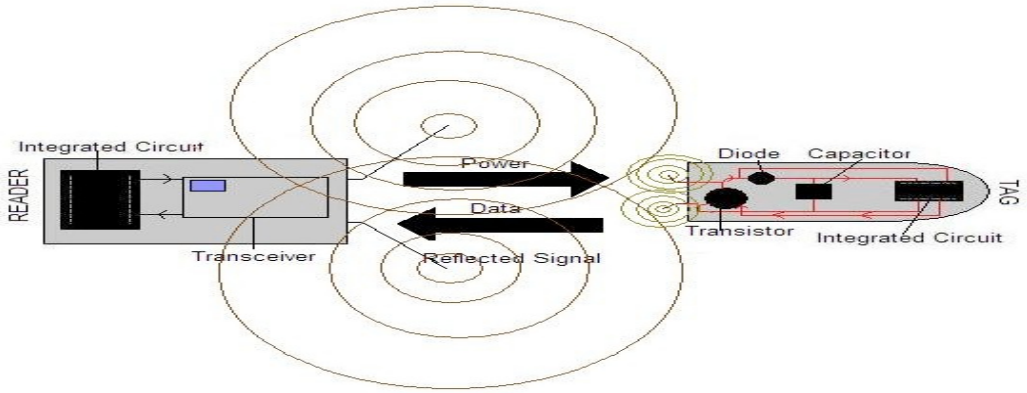

Fig 2: Basic RFID System

In the foregoing we shall described the hardware consideration:

The Electronic Tag:
The study exploited popular wide range of EM4100 transponder available for the Micro RFID Reader (µRW) as the low frequency Electronic RFID tag. The tag electronic is mapped with student information (Name, Matriculation number, level and Department) available in the system database. For the lecture attendance management scenario of Bells University of Technology, Ota, Nigeria considered in this study, the RFID tag for four students and untagged card is shown in figure 3:

Fig 3.0: Electronic Tag

RFID READER –µRW
For this study, the µRW RFID Reader was chosen for cost reason. It was designed to read from EM4100 transponder used as electronic access card at frequency of 134 kHz. In operation the reader continually scan for EM4100 transponder pre-defined at 134 kHz to respond to C# program commands via the UART Receive line (Rx) serially connected through the RS232 to USB converter to the USB port of the PC. The overall circuit of the RFID subsystem is shown in Figure 4:

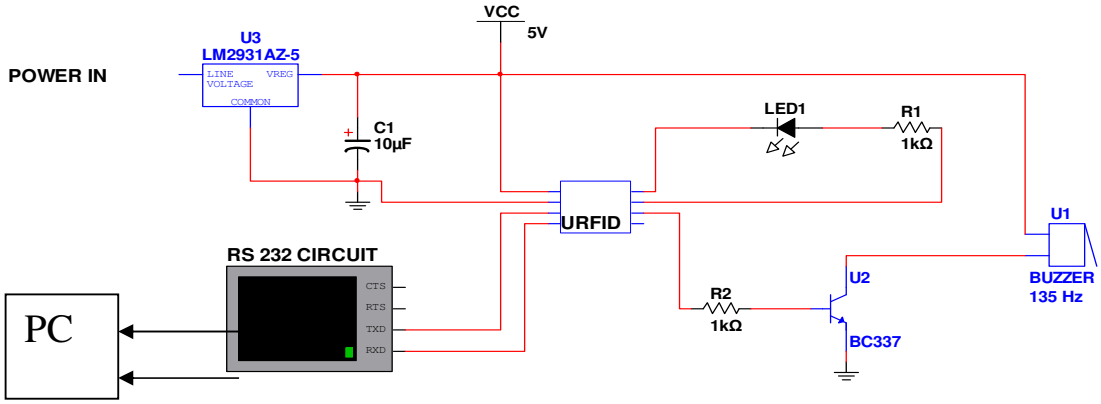

Fig 4:. Overall Circuit diagram of the RFID system

POWER SUPPLY

Most TTL (Transformer-Transfer Logic) digital circuit uses 5V to operate. A 5V source needs to be regulated to power for the µRW RFID Reader circuit. Through 9V to 24V DC unregulated supply, this part was developed by using LM2931AZ5 as the voltage regulator.

Facial Recognition/Comparison

Due to cost reasons, this stage face capture and comparison session was accomplished through a simple web camera. Once a reader badges his card in for attendance the web camera automatically takes a picture of the person holding the tag and compares it with the enrolled in the system database during initial registration of the student.

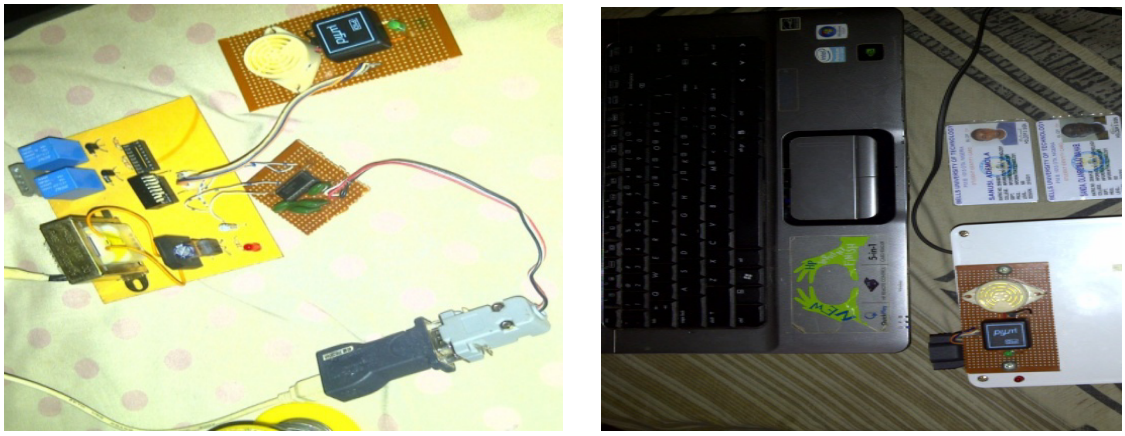

Fig 5: The RFID Student Attendance Monitoring Hardware Prototype

Software Design Consideration

In the development cycle of the proposed RFID system, decisions are made on the part of the system to be realized in the hardware design and the parts to be implemented in the software. This software module consists of modules that can be easily decomposed and tested as individual units; this was done to make sure software meets design considerations. The attendance monitoring program was written in Microsoft visual C# programming language in a Visual studio development environment. Figure 6.0 shows the overall flowchart of the system for both RFID and Facial Recognition sub systems.

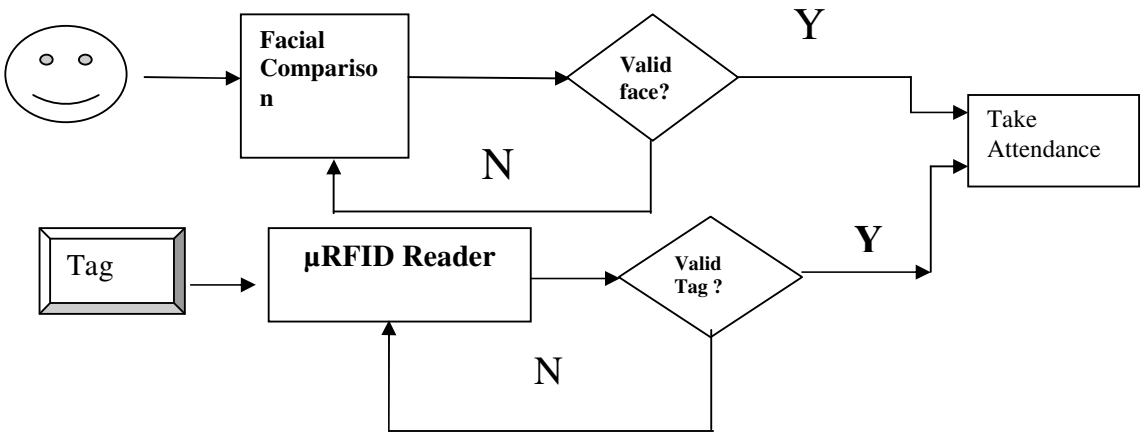

Fig 6: Overall Flowchart of the student RFID and Facial Recognition based Attendance System

4. SYSTEM OPERATION/TESTING & DISCUSSION

Considering figure 6.0 every student with a pre-programmed EM4100 transponder RFID tag has a privilege to attend lecture through the entrance door, a serial number of tag is associated with the student database entry on the Programmed PC. Each time a student flips his/her card/RFID tag, the µRFID reader responds wirelessly through the pre-defined commands via the UART Receive line of the URFID. The availability of EM4100 transponder RFID tag selected in range of 135kHz makes its serial number to be read, set the LED color from red to green, buzzer to function and associated data transmitted on the UART Tx line in serial ASCII format.

This corresponding ASCII format code is then decoded by the programmed PC through the RS232 to USB converter shown in figure 5.0 Since two-level authentication and verification is required for acknowledgement of student attendance for each lecture, equal facial comparison of the student at the entrance with pre- enrolled facial appearance of the student stored in the database by the intelligent IP camera justify the biometric verification of the student and thus acknowledged the student attendance for the lecture automatically by the Programmed PC. This mutual exclusiveness of the wireless radio waves monitoring between the EM4100 RFID tag and µRFID reader and facial comparison of the real time student facial appearance with facial appearance in the database is shown in Figure 7.0.

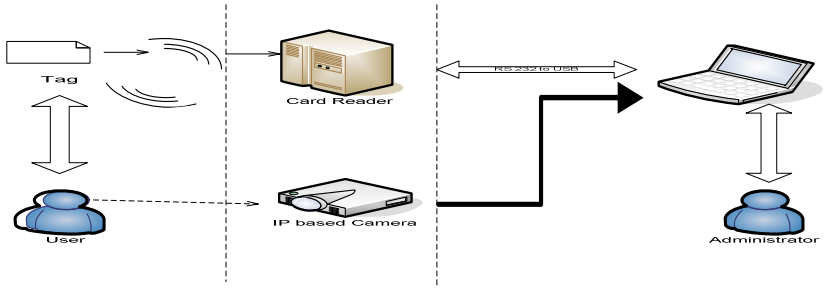

Fig 7: Illustration of the RFID and Facial Recognition Operational Principle

The buzzer is activated when a valid RFID tag passes through a radio frequency of the µRFID reader. If the tag and the captured face is similar to the captured face in the system database, then the system register the student as present in the class. Due to cost and flexibility reasons, this RFID attendance system uses passive tags and thus for every class, students needs to swipe their tags close to the reader (about 15mm from the reader). The reader reads the tag and the application reads check-in time and when the student is leaving the same process is repeated and the application reads check-out time. Also the facial recognition is accomplished with a web camera. If an invalid EM4100 RFID tag is used, the program will give a notification that the tag has not been registered to any student and requires a valid tag. The database contains the name of student, Matric number, Address, E-mail, Course duration and Course Information. Figure 8-figure 12 shows the Graphic User Interfaces (GUI's) of the system application control program developed with Visual C# programming Object Oriented Programming Language:

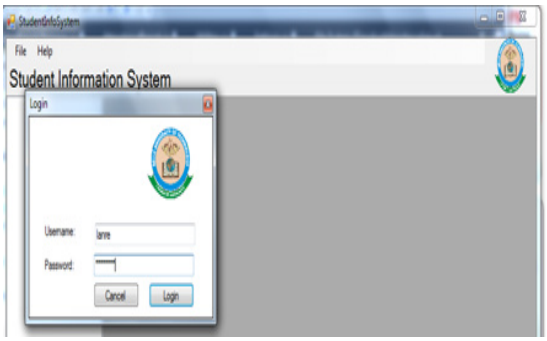

Fig 7: Student Information Enrollment Interface

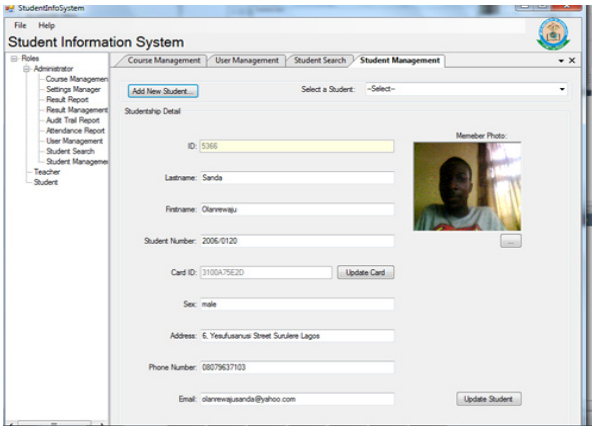

Fig 8 : Home page

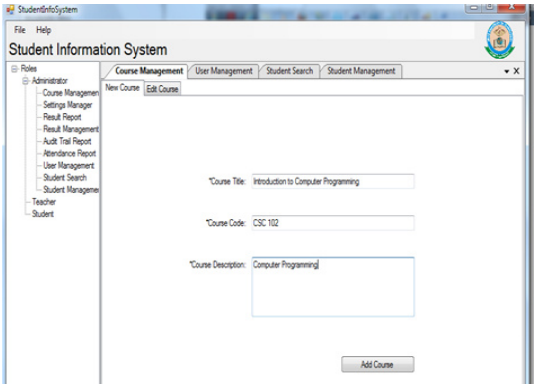

Fig 9 : Course Registration Interface

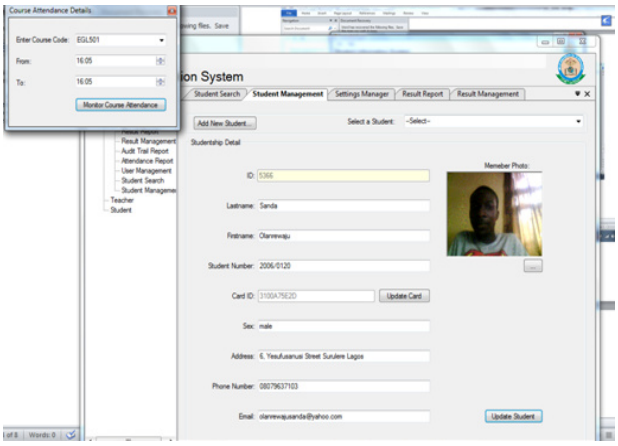

Fig 10: Attendance Monitoring Interface

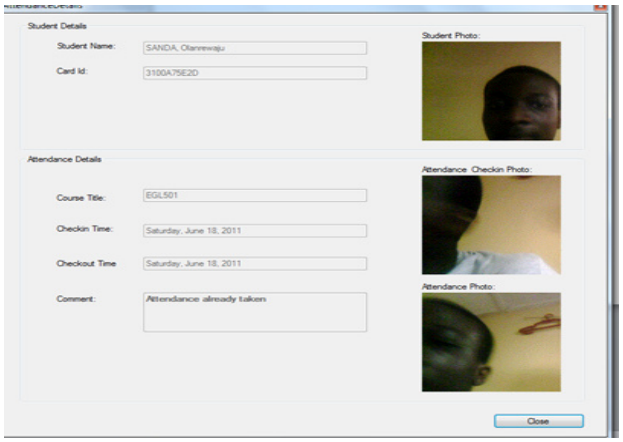

Fig 12. Attendance Facial Comparison

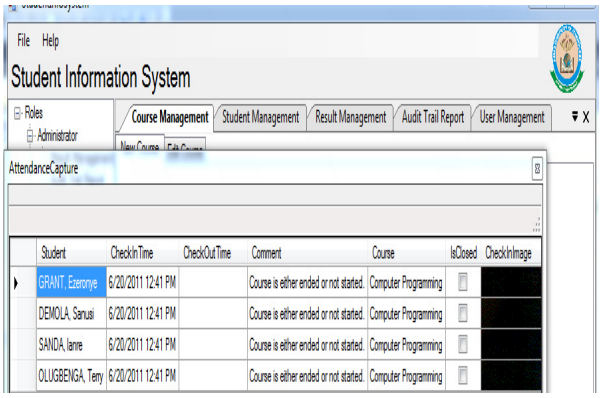

Fig 11: Attendance Check-in and Check-out

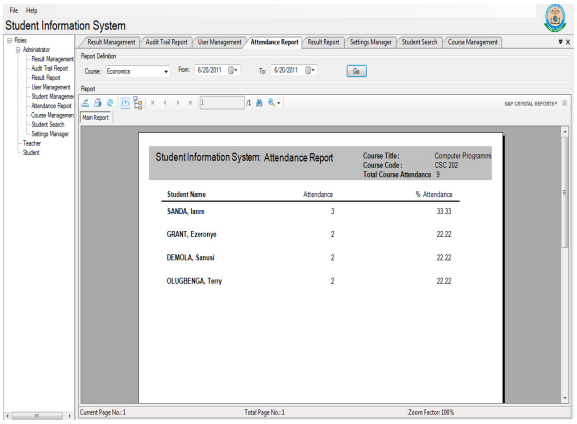

Fig 13: Attendance Report Page

5.0 CONCLUSION

This paper has successfully presented a simplified, low cost wireless biometric solution to the problem of lecture attendance records in an academic environment in developing countries. The prototype implementation of RFID and Facial recognition in attendance taking and the objectives stated on previous section has been achieved. The major strength of the system lies in its portability and high scalability but with less flexibility in programming as compared to the previous design and implementation in [1, 14, 5, 12]. By careful examination, it can be inferred that the proposed system could not only speed up the process of taking attendance, it also solves the problem of impersonation which was encountered in previous solutions.

6. FUTURE WORK

The developed system is not without exceptions. Hence the following recommendations could be made for improvement in the immediate future:

(1) Incorporation of Iris and IP camera for secured Facial Recognition that would further increase the efficiency and security of the system against impersonation in distributed Network of different real time lecture room monitoring respectively.

(2) Application of an active reader for effective RFID performance.

(3) Browser testing and extended wireless testing must be conducted for possible deployment situations.

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