Indonesian Journal of Electrical Engineering and Computer Science
Vol. 32, No. 2, November 2023, pp. 1206~1214
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v32.i2.pp1206-1214

Implementation of a radio frequency identification and detection technology based digital class attendance system for university students

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Article Info

Article history:

Received Jul 20, 2023
Revised Sep 5, 2023
Accepted Aug 30, 2023

Keywords:

Attendance sysem
Digital class
Radio frequency identification and detection tag
Radio frequency identification and detection technology
University students

ABSTRACT

Class attendance is a key consideration when assigning final marks for courses taught, student attendance is a critical issue for higher institutions. Some institutions choose to regulate attendance with paper sheets, while others prefer to verify students' attendance with paper sheets and then manually enter this information into a computer. This mode of taking students attendance delays time and reduces the time needed for the lecture to be delivered. A system that eases the burden of time delay in taking attendance, promotes the universities, and supports parents is presented in this paper. The radio frequency identification and detection (RFID) student monitoring system has been developed to track student's attendance in the classroom using passive RFID technology. The system uses an RFID reader and a contactless smart card to ensure time management during student's attendance. A reader at a fixed place delivers a signal to a passive RFID chip for detection and identifies a huge number of chips in a short amount of time. The biometric thumb detection module for security was applied to improve the system. The applied enhanced technology sends a message to the parent of any students that fails to attend lectures.

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1. INTRODUCTION

Attendance is a critical criterion that is employed for a variety of purposes in academic institutions. Maintaining records, assessing pupils, and encouraging optimal and continuous attendance in class are all part of these objectives. Most schools in developing countries demand a certain percentage of students to attend class, but this policy has not been implemented due to the numerous obstacles that exists in taking attendance. Taking student attendance on sheets of paper or in books is the standard practice but the method makes impersonation simple, and the attendance sheet can be taken or misplaced. It is difficult to calculate the number of students who have met the required percentage and are thus eligible for the exam because taking attendance takes time. As a result, a system that removes all of these potential sources of problems is necessary [1]. To overcome the aforementioned concerns, this research adopts a radio frequency identification and detection (RFID) technology. RFID is an automatic identification technology that stores and retrieves data using RFID tags or transponders, and it consists of two main components: an RFID reader and an RFID tag. To make the

most of this technology, there are lot of research and development going on, and many new applications and study fields will emerge in the next years. This surge in RFID interest has sparked concerns for the safety of those handling the tags on daily basis [2]. RFID has long been used to regulate access in a range of applications, ranging from asset tracking to limiting entry to restricted places. Although RFID systems at educational institutions are not new, the goal of this research is to show how they can be employed to tackle everyday difficulties in modern universities. In developing countries, RFID, WiFi, Bluetooth, robots, and other cutting-edge technologies have been developed. As a result, we may employ these technologies to improve our everyday routines and make our lives more comfortable and easier. To increase the quality of their students and management, all academic institutions should endeavour to integrate these technologies [3].

RFID is a technology that uses radio frequency data transfer to automatically collect information from a movable object and an RFID reader in order to identify and track it; it contains reader and tag that are widely used to describe them. A typical reader is a device with one or more antennas that transmit and receive radio waves from tags and data stored on an RFID tag must be retrieved via a reader. An RFID reader can be set up to only deliver a radio pulse in reaction to a certain external event. Most electronic toll collecting systems, for example, keep the reader on all the time so that every passing vehicle is logged [4]. RFID scanners in veterinary offices, on the other hand, are usually equipped with triggers that activate only when the trigger is pulled.

The prevailing tags in contemporary times consist of a microprocessor chip known as an integrated circuit with memory. Additional tags are classified as chipless, indicating the absence of an integrated circuit. chipless tags are particularly effective in applications that only necessitate a limited range of functionalities. However, they can still contribute to enhanced accuracy and detection range while being more cost-effective compared to their integrated circuit-based counterparts. In the future, tags will be denoted as integrated circuit-based tags when the term "chip-less tags" is employed [5], [6]. There are two types of RFID tags: passive tags and active tags. The passive RFID system is the most frequently utilized technology on the planet. In a passive RFID system, the reader provides the radio signal to the tag. The tag then activates and communicates with the reader via energy or a signal [7]. The power of the tags, which is less than 10 meters, limits the range of this RFID passive system. Passive tags rely on a tag chip and a reader rather than having their own power source [8]. Active tags in RFID systems have their own power supply and transmitter. A rechargeable battery is usually used to power the tags. To transfer data or information contained on microchips, RFID tags produce their own signal. Transponders and beacons are the two forms of active tags. The objective of the transponder is to save battery life. The transponders will only turn on if and only if they receive a radio signal from the reader. The tag will deactivate and the battery energy will be saved if the transponder does not receive a radio signal. Beacons are used in real-time locating systems (RTLS) and the project, however, uses the passive tag [9].

2. A BRIEF REVIEW OF RECENT RESEARCH WORK

In various universities, several research on the use of RFID for student attendance have been done. Razak and Wen [10], a technique to automate student attendance using RFID technology was developed. A student is issued a tag when he or she registers at Central University of Technology that uses manual recording for student's attendance. To sum up the findings, this system was only tested by employing RFID to track the attendance of five students. The planned study does not address the weaknesses in the RFID tag system. To verify its effectiveness, the suggested system requires additional validation before being tested in a real-time setting. White *et al.* [11] proposed a method to find parallels and contrasts between the two technologies using bar-coding and RFID technology. The quantity and kind of errors connected with the usage of bar-coding and RFID technologies were the factors utilized to report the case study. They concluded that RFID technology outperformed barcoding technology in a real-world setting, with fewer errors and higher performance. In the case of RFID-based technology, data dependability was low, but good in the case of bar-coding technology. Practitioners have proposed that integrating barcode and RFID technology could improve results by removing the constraints of each technology, but that this would be costly and difficult to execute.

Schapranow *et al.* [12] addressed RFID security issues. It is shown that RFID security weaknesses allow hackers to compromise the system. Controlled signal interferences and data encryption can protect RFID technology. Academic institutions use an information management system to track student attendance [13]. A computerised system that uses RFID and biometric technology to track student, instructor, and administrative employee attendance is being developed to eliminate the manual attendance marking method's main drawbacks [14]. Mobile and web versions of the planned system exist. A school requires students to register at all times. Each registered student receives an RFID tag with a code and fingerprints. All classes have RFID readers and scanners, and campus hotspots are available. The RFID reader will read each student's tag and a scanner will match fingerprints to avoid fake attendance. The web-based students attendance management system (SAMS) offers automation, full, summary, and exception reports, time savings, fewer errors, student alert status to management, parents, and guardians via emails and easy mail messages. A system to automate

registration, attendance, question bank uploads, and administrative duties is being developed [15]. Only a use case diagram and graphical user interfaces (GUIs) are included in the report.

The PHP and MySQL-based solution eliminates manual processes and creates a paperless workplace, saving the college time, money, effort, and resources. The study offers to solve the registration and attendance problem by increasing productivity, efficiency, and accuracy without data. Quantitative or qualitative studies must validate the proposed system. The research aims to automate student attendance management to replace manual attendance [16]. A student management information system web service is proposed. The proposed study promotes cannabis dispensaries (CBD) and lowers implementation costs. The web service makes developers language- and platform-agnostic. The development team only needs business logic from customers, not code. Student attendance should be tracked by scanning the quick response (QR) code on each student's identification (ID) card with a QR code scanner. The server will have student attendance data. The server will validate data using application programming interface (API). This will provide accurate information. Validate the web service attendance management system before deciding if it is better than manual attendance methods and emerging automated technologies like RFID, biometrics, and bar code scanners. Sajid *et al.* [17] propose employing face recognition technology to automatically mark student attendance. Each classroom will have a camera to capture all students from different perspectives. Temporal and permanent databases will be used in the automatic attendance system. All lecture photos will be saved in the temporal database. Photographs will be taken at the beginning, middle, and end of a talk. PRESENT-80/128 and PRESENT-256 at electronic codebook (ECB) mode were devised by Ramachandra and Peter for secure RFID tag-reader mutual authentication in internet of things (IoT) applications.

Near-field communication (NFC) enabled devices are in contact or within a short distance of one other as they communicate. Ramachandra and Peter [18] is to find a way to overcome the constraints of the manual attendance marking system. An NFC tag, an NFC enabled mobile device, and a web server are the three main components of the proposed automatic attendance system. There are three ways to implement the proposed system. In the first scenario, the lecturer is using a mobile device with NFC capabilities in the classroom. An NFC tag is attached to each student's identification card. Each student's ID card must make physical touch with the instructor's mobile device to be counted as present. In the second scenario, each student has an NFC-enabled mobile device, and each classroom has an NFC smart tag affixed to a poster paper. The technological components of developing an RFID-based smart attendance system are discussed by [19]. The goal is to replace the current manual attendance marking system with a computer assisted approach. RFID technology is a more cost-effective technique to automatically indicate attendance when compared to other options such as NFC, biometric, and QR code scanners. Instead of installing RFID scanners in each classroom, the authors suggest a less expensive RFID based attendance system that is portable and can be taken to the classroom. It can store data in the microcontroller using electrical erasable programmable read only memory. The suggested smart attendance system is to put the test from multiple angles, including top, side, corner, and bottom. The maximum detecting range for cards is 5 cm. Real-time validation is required for the proposed smart attendance system [20], [21]. The RFID system presented is a bespoke solution that is challenging to build and install for an institution. In the work done by [9] an embedded computer-based lecture attendance management system was presented. An improvised electronic card and card reader is serially connected to the digital computer system as part of the system. A smart attendance system based on real-time face recognition was proposed in [19]. It suggested that smart attendance system uses principal component analysis (PCA) and the cascade technique to reliably detect faces in a real-time context. The suggested real-time facial recognition system can detect several faces to identify employees or pupils as they enter the office or classroom. The key advantage of the suggested approach is that it eliminates the requirement for staff or students to take any action or pay attention in order to register attendance. Cheng *et al.* [22] created and implemented a system that uses passwords to authenticate users; nevertheless, because passwords may be exchanged or modified with impersonation is possible. Passwords can also be forgotten, restricting access to the system for the user.

Sharma *et al.* [19] employed a wireless attendance management system that uses iris recognition to authenticate people. The system makes use of an off-line iris recognition management system that can handle the full process, from iris recognition image capture to minute extraction, storage, and matching. A smart attendance system is presented by [23] using machine learning with a camera, a facial recognition algorithm, and a database are all part of the proposed smart attendance system. Every classroom has a camera with which students can shoot images. To identify individual students' faces and compare them to previously recorded photos, the study uses a histogram of oriented gradients. The student is marked absent if the facial recognition does not match. Each student is represented by many photos taken from various angles in the database. The proposed method is said to have several advantages, including being cost-effective, rapid, and error-free.

However, the suggested technology has never been tested in a real-time setting in any institution, no conclusions can be drawn. The suggested system is a customized solution that involves both supervised and unsupervised training to effectively recognize faces. An RFID-based attendance management system was

proposed by [24] The proposed framework could give a new, more precise, and less time-consuming mechanism for assessing understudy engagement in school and improving the way understudy address participation in the classroom. An RFID based authentication system model that is simple and inexpensive has been successfully advantages. This framework will aid in the anticipated capacity for participation, and guardians will be contacted if their children do not show up. An online attendance management system using RFID with object counter, according to [6], [25], [26]. The student attendance system, which uses RFID technology and an object counter to record and track student attendance, will dramatically improve the existing manual method, especially in a university context. The technology encourages a fully automated approach to recording student attendance and keeping track of their whereabouts on campus. attendance system is safe and accurate. The system is straightforward to use, with easily accessible switches and communication interfaces. It is possible to save and retrieve attendance records.

In this paper, we developed an RFID student monitoring system to track student attendance in the classroom using passive RFID technology. The system deployed RFID reader and a contactless smart card to ensure time management during student's attendance. It also has inherent technology that is capable of sending a text message to the parent of any students that fails to attend lectures.

3. SYSTEM DESIGN AND IMPLEMENTATION

The system design and implementation were focused separately in terms of system block diagram, and the system circuit operation. Before carrying out any project, the block diagram must be drawn and fully understood. Block diagram gives a pictorial understanding of any work. The block diagram of the system is as shown in Figure 1.

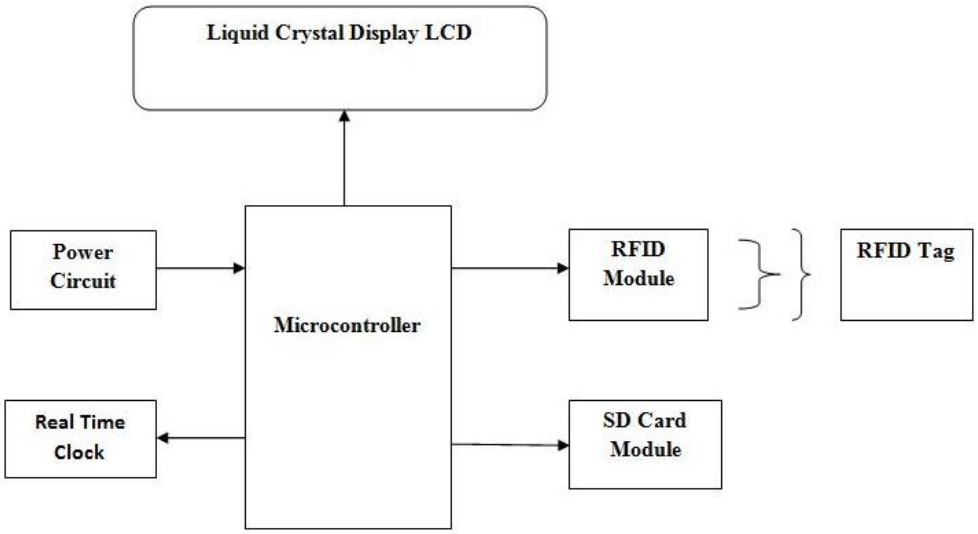

Figure 1. The system block diagram or flow chart

3.1. The system circuit diagram

The main microcontroller in this system is the Arduino Mega; it controls almost everything in the circuit. Power from the power circuit is used to energize the microcontroller, which then communicates with the real time clock (RTC) module to obtain the correct time and date. It also communicates with the RFID module to interpret the information contained in the RFID tag, which is required to sign in attendees. The microcontroller, via the secure digital (SD) card module, establishes a connection with the storage card, which stores all attendance records. There is no way to know what is going on in the system without a display, which is why a liquid crystal display (LCD) is required, which is also linked to the microcontroller. In a nutshell, the RFID Attendance system is designed using a Proteus software. As shown in Figure 2 from power circuits to the microcontroller to the RTC module to the LCD to the RFID module to the SD card module and back to the microcontroller.

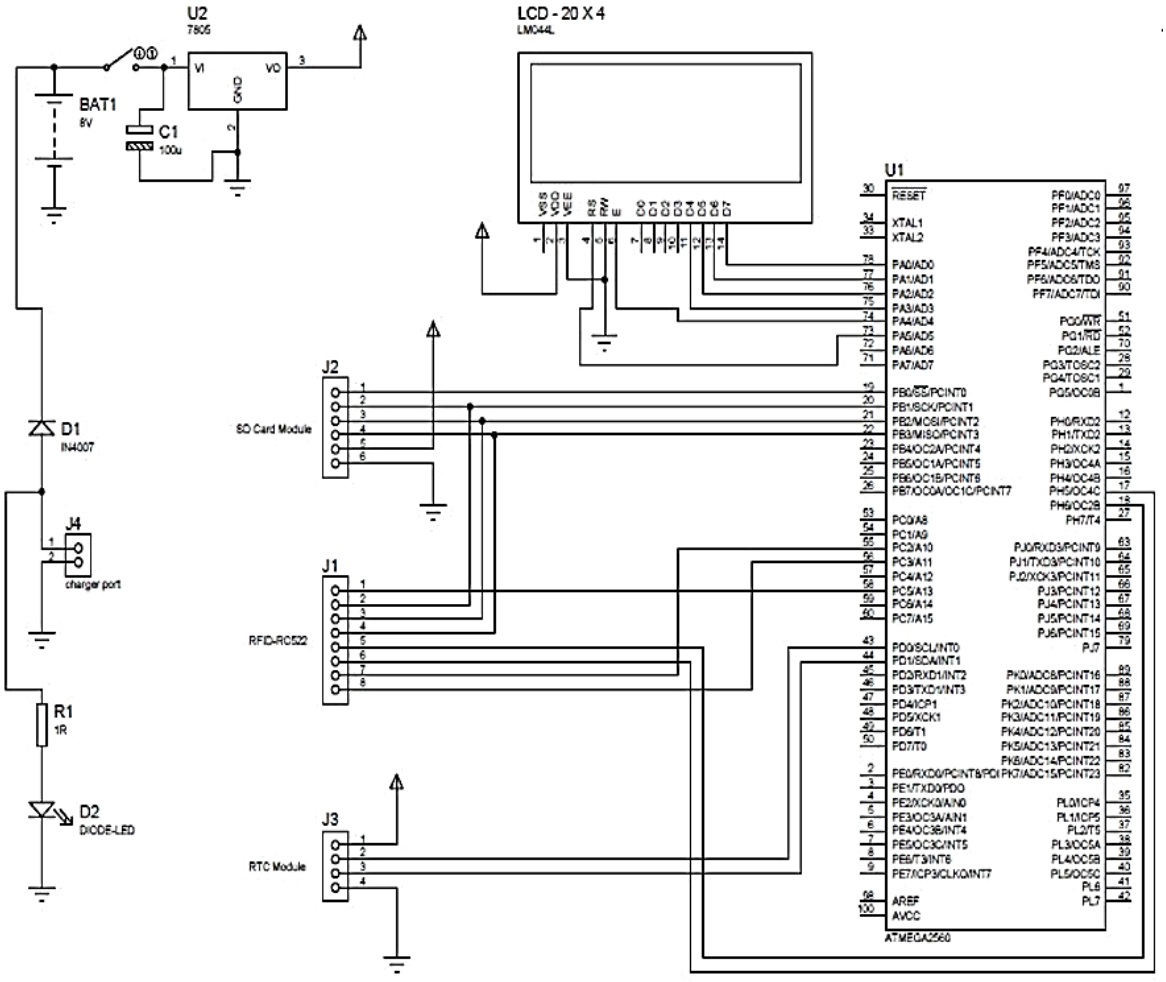

Figure 2. The RFID attendance system circuit diagram

3.1. System components description

The following components were assembled together to achieve proper functionality of the proposed system. The components are: i) power circuit; this is an electronic circuit that controls the flow of power from the charging port (source) to the battery. It consists of the integrated circuit (IC) regulator (LM7809), 100 µf 16V, 1kΩ resistor and diode IN4007; ii) liquid crystal display (Alpha numeric): this is a flat panel display where the system conditions are displayed; iii) Arduino Mega 2560: this is the base microcontroller of this system, it provides the interface for the relation between the RFID module and the rest of the system. It can be said to be the engine block of the system; iv) RFID module (MRC 522): this is a radio frequency identification reader used to gather information from and RFID tag; v) RFID tag 13.56 MHz: this is the type of student identification used in this project, each tag is peculiar to a particular student and contains specific information about the students that will be read by the microcontroller once the tag is within proximity of the RFID module; vi) SD card module: this is the module that makes it possible to write and or read the information on the memory card; and vii) battery: two 4V rechargeable batteries connected in series was used to provide constant 8V power to the system.

4. RESULTS AND DISCUSSION

The implementation of this project follows the following procedures; i) purchasing of the entire materials/components needed; ii) resistance checks of the components bought with the help of ohmmeter before making the necessary connection with the components; iii) continuity checks of all connectors used in the project; iv) drafting out a schematic diagram on how to arrange the materials/components; v) testing the completed system to see if the design works; and vi) finally, implementation of design of the project. Having satisfied the above, we proceeded with the arrangements of the components into the case. Hardware design and

packaging are critical components of any engineering design. It is the appearance of the completed project. We do not leave the work unfinished after soldering and connecting it, it must be cased and packaged. Packaging could be used to protect the design components while also making the finished project look nice. Figure 3 depicts the internal system architecture of the prototype attendance RFID system, highlighting the activity function of each component. The packaging is made of portable plywood with perforations at the appropriate corners for the LCD, RFID module, power switch, charging port, and SD card module. It is very light in weight and was designed to not add to the weight of the components while still providing adequate protection to the components.

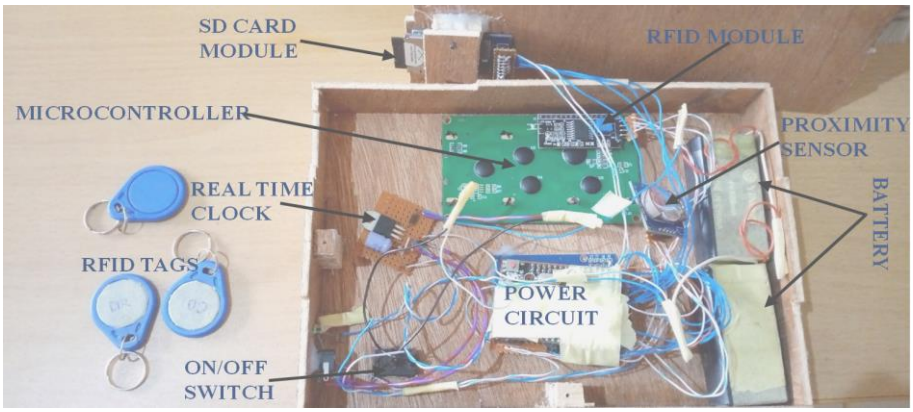

Figure 3. Internal architecture of the attendance system

4.1. Operations of the attendance system

The results obtained during testing states after necessary troubleshooting were satisfactory. The system was able to respond to its operation; when switched ON the system will take exactly 5 seconds to boot and get ready to sign in tags as shown in Figure 4. The student's information such as names, age, name of parents and their mobile phone contact is collected and stored in the database. When a preregistered tag is brought close to its RFID sensors, the RFID module reads the information contained in the tag and the system will sign in the appropriate name. For example, when Ohanu Peter C signs in, the system will acknowledge receipt as shown in Figure 5.

Figure 4. System switch ON

Figure 5. Preregistered RFID tag sign in mode

The Figure 6 shows when the tag is not registered on its database, the system displays "not registered" as such the student unable to sign in. In the case where a student wants to sign in twice the system will return a message stating that you have already signed in as shown in Figure 7. The system is designed to store student's attendance in the order of their punctuality, the first student to sign in will have his name on the top of the register while the last to sign in will likewise be the last on the list. The information is stored in the SD card which the lecturer can take after his own period is exhausted. The system is designed not to sign in anybody if the SD card is missing which means that if the lecturer goes with his SD card no student can sign in shown in Figure 8.

The system is equipped with RTC module which makes it impossible for the system time not to be correct no matter how long the system has been dead or not in use. The RTC module preserves the correct time and date and provide backup power source for the system time to be always correct. When a student loses the RFID card, the two-factor authentication method, randomized attendance checks and monitoring and auditing method could be used to verify or clear the students for class attendance.

Figure 6. Unregistered RFID tag sign in mode

Figure 7. Registered RFID tag sign in mode

Figure 8. RFID tag sign in mode with no SD card

5. CONCLUSION

During the course of this study, it was proved that a new, accurate, and less time-consuming technique of recording student attendance in school is possible. A prototype of a low-cost RFID-based attendance system has been successfully created. The old approach of taking class attendance is time-consuming, capable of human error, lacks real-time data, easy to manipulate and has limited monitoring capabilities. The developed

system prototype has various advantages over the old approach of attendance tracking. This method will help with the automatic storage of attendance and will make it simple to determine which students have met the minimum number of attendance criteria to sit for the university examinations.

ACKNOWLEDGEMENTS

The authors wish to express their profound gratitude to the African Centre of Excellence for Sustainable Power and Energy Development (ACE-SPED), University of Nigeria, Nsukka, for providing the necessary facilities. The authors would also like to thank the University of Nigeria and Universitas Ahmad Dahlan for supporting this collaborative research. The authors of this paper certify that they have no conflict with any organization or entity.

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