DEVELOPMENT OF A RADIO FREQUENCY IDENTIFICATION BASED ATTENDANCE SYSTEM

BY

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CPE/13/1078

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CERTIFICATION

This project with the title

DEVELOPMENT OF A RADIO FREQUENCY IDENTIFICATION BASED ATTENDANCE SYSTEM

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DEDICATION

This report is dedicated to God Almighty, the Author and Finisher of my faith and to my parents for their guidance and support.

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I wish to express my appreciation to my supportive supervisor Dr. (Engr) I.A. Adeyanju, and co-supervisor Mr T.A. Badmus, the Head of Department Dr. (Engr.) O.M. Olaniyan, the departmental project coordinator Engr. Mrs Esan for her guidance and to all the academic and non-academic staff of the Department of Computer engineering.

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ABSTRACT

The challenges of the manual method of taking attendance include difficulty in keeping the attendance list over a long period of time, time wasting during writing or signing, students forgetting to sign andstudents signing illegally for an absentee.This manual process has a lot of problems which may affect the productivity and management of schools.The aim of this project is to develop a radio frequency identification attendance system.

The RFID attendance system utilises a microcontroller as the processor needed to operate the embedded system. An RFID reader that transmits and receives radio waves in order to communicate with RFID cards. A timing module that supplies current date and time information and a display screen to show information recorded and power supply that supplies energy to work.

The microcontroller is programmed on the Arduino IDE interface using C language. The RFID reader, real time clock, LCD screen and the programmed microcontroller, are all set up on a breadboard and interconnected with each other to ensure they work accurately. Interconnections are done using jumper wires and a multi meter was used to test every component to verify if they are in good conditions. When this is ensured, all components are moved to the development board and are soldered. The soldered components are then coupled together in a casing. The RFID reader module reads information from the cards and sends the data to the Microcontroller. The Microcontroller then analyses the information to determine card data and status. Simultaneously, the microcontroller reads time and date information from the Real Time Clock (RTC) to log the time and date of the card Scan. All the data is then displayed on the LCD Display and sent through the USB port to the attached PC for permanent record of the information. The result gotten shows that the developed system is efficient and can be implemented as a form of attendance taking.

This project provides a convenient method of attendance using RFID tags. An IP camera can be integrated into this system in the future to monitor the actions like buddy-punching wherein a person cheats by scanning for another person.

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CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE

"Attendance can be defined as the state or action of going regularly to or being present at one place or event" (Ling, 2012). In both classroom settings and workplaces, attendance may be mandatory. Poor attendance by a student in a class may affect their grades or other evaluations. Poor attendance may also reflect problems in a students' personal situation and is an indicator that "students are not developing the knowledge and skills needed for later success" (Franklin, Harris & Allen-Meares, 2008). Attendance taking is very helpful in organisations in operations planning as it helps them handle situations when there are absentees and irregularity in attendance records and helps them to maintain their performance standards (Ling, 2012). There are two ways of attendance taking today which are paper-based and technology assisted.

The paper-based method involves using manual approaches to record the attendance of people in an organization like writing names down in a paper. The traditional time cards and punch clocks have also been used as an efficient way to keep track of time after the process of writing down names proved inefficient. In most cases, the process of manual paper based time tracking and attendance method. The situation becomes even more cumbersome if the population is large (Lin, Chen & Tsui-Fang, 2008)

Technology based attendance are various types of attendance systems that make use of electronic equipment or computers. This technology based or automated attendance system has various advantages allowing schools and organizations take attendance easily and manage time effectively. Some of the main advantages include quick and simple time tracking process, cost efficiency due to lower maintenance cost, as well as reduced time theft and ineffectiveness (Uddin *et al.*, 2014)

1.2 STATEMENT OF THE PROBLEM

Most educational institutions are concerned with students' attendance. The conventional methods of attendance taking by calling names is quite time consuming, encourages truancy on the students' part and insecurity, therefore, institutions are constantly in search of more efficient and error free ways to take attendance. The methods currently used in attendance taking include paper-based and technology assisted methods (Franklin, Harris & Allen-Meares, 2008).

The paper based method for attendance taking may be inefficient, hard to read, easily damaged, lost and most of all a waste of resources. In most universities, lecturers take attendance by calling out the names and surnames of students, and then marking them, while, in others, lecturers pass around a sheet of paper asking students to sign in attendance just next to their names (Lin, Chen & Tsui-Fang, 2008). Both practices have their drawbacks. In the first case, if numerous groups attend the lesson, checking all of these students by name or surname might take precious time of each lesson; in the second case, friends of absent students may write down their names and surnames. These practices place university teachers and their institutions at considerable disadvantages when it comes to taking attendance. This manual process has a lot of problems as stated and this could be a big problem in the school and might affect the productivity and management of said school.

The recent technology based method for attendance taking includes biometrics, barcode, magnetic stripe, web-based, etc. while these methods may be effective in producing results, they are costly to implement, less secure and difficult compared to radio frequency identification (Olanipekun & Boyinbode, 2015).

The ability of radio frequency identification attendance system to deliver a system that can automatically capture student's attendance by flashing their student card at the RFID reader can save all the mentioned troubles, provide precise and accurate data about tagged items will improve efficiency.

1.3 AIM AND OBJECTIVES

The aim of the project is to design an attendance system that is based on radio frequency identification. The specific objectives are:

1. To design a radio frequency identification attendance system
2. To implement the designed RFID system using a hardware prototype.
3. To evaluate the effectiveness of the developed RFID system.

1.4 SCOPE OF STUDY

The project will develop a radio frequency identification attendance system. The project emphasizes the use RFID for attendance taking although it might also be applicable to security and access control.

1.5 SIGNIFICANCE OF STUDY

This project is focused in the area of radio frequency identification. There are several application areas of RFID including:

- **Access control:** RFID can be used to limit access to a secure area of system that is only those that have their biometric details in the system are allowed to gain access, RFID system is used to authorize the tag holder to enter a secure area. It reads the data present on the tag and compares with the data on the microcontroller. Access control process is usually in two steps which are identification and authentication (Elisabeth, Zsolt, Peter & Laszlo, 2006).
- **Product tracking and inventory control:** Tracking assets on the item level is beneficial across a broad cross-section of industries, but the retail sector has one of the highest ceilings in terms of opportunity from the use of RFID. It uses electromagnetic fields to automatically identify and track tags attached to items. The tags contain electronically stores information. Passive tags collect energy from nearby RFID readers interrogating radio waves (Huang, 2009).
- **Public transit (bus, rail, subway):** In South Korea, t-money cards can be used to pay for public transit. It can also be used in most convenience stores and vending machines in subways as cash. 90% of cabs in Seoul accept card payment, including

most major credit cards and the T-money card. T-money replaced UPASS, first introduced for transport payments in 1996 using MIFARE technology (O'Connor, 2008). Also, in Hong Kong, mass transit is paid for almost exclusively through the use of an RFID technology, called the octopus card. This has also been used in various other countries like Canada, Russia etc. (O'Connor, 2008).

- **Human Implants:** Implantable RFID chips designed for animal tagging are now being used in human beings. An early experiment with RFID implants was conducted by British professor of cybernetics Kevin Warwick, who implanted a chip in his arm in 1998. In 2004, Conrad chase offered implanted chips in his night clubs in Barcelona and Rotterdam to identify their VIP customers, who in turn use it to pay for drinks. In 2004, the Mexican Attorney General's office implanted 18 of its staff members with the verichip to control access to a secure data room (O'Connor, 2008).
- **Toll roads:** The tags, which are usually the active type, are read remotely as vehicles pass through the booths, and tag information is used to debit the toll amount from a prepaid account. The system helps to speed traffic through toll plazas as it records the date, time, and billing data for the RFID vehicle tag. This has been introduced in some places in Nigeria.
- **Retailing:** This is similar to product tracking. In June 2003, Wal-Mart Corporation issued a mandates for its top 100 suppliers to adopt passive RFID tag to all the shipments sent to three of its Texas distribution centres by January 2005. One month after the deadline, the CIO of Wal-Mart stated that more than 5 million tag reads had been taken. Adopting RFID technology has benefited Wal-Mart in a 16 per cent reduction in out-of-stock items. Moreover, replenishment for out-of-stock items is three times faster than using bar code system, and stores equipped with RFID are more effective at replenish out-of-stock items. Overall, an estimation shown by Research firm Sanford C. Bernstein & Co. stated that annually over $8 billion could be saved once Wal-Mart has fully deployed RFID through all its locations (Thornton, Haines, Das, Bhargabva, Campbell & Kleinschmidt, 2006).

1.6 METHODS OF STUDY

a. Review of relevant literature through online resources and the library. All materials related to radio frequency identification, attendance systems and processing programming language.
b. Design of the RFID based attendance system.
c. Investigate the RFID cards that will suit the design specification and the number of cards to suit the prototype
d. Construction and implementation of the design on a solderless breadboard
e. Construction and implementation of the design on a veroboard
f. Test the prototype and debug every code until it works as desired.
g. Evaluate functionality of the developed system.

CHAPTER TWO

LITERATURE REVIEW

2.1 ATTENDANCE SYSTEMS

Attendance is very important in many organizations; industries and the education sector, because of this importance different attendance taking systems have been developed. Attendance is a fundamental factor in ameliorating student achievement in classes (Lin, Chen & Tsui-Fang, 2008) Existing methods of attendance taking can be categorized as paper based or technology assisted.

Paper-based attendance taking: This involves using manual methods to record the attendance of people in an organization. The traditional time cards and punch clocks have long been used as an efficient way to keep track of time after the process of writing down names proved inefficient. In most cases, the process of manual paper based time tracking and attendance method. The situation becomes even more cumbersome if the population is large.

The punch clock replaces the writing of names with the slotting in of a paper card called a time card, into a time clock. The time clock would then print day and time information on the card once contact is made with the card. This system does not solve impersonation and is still difficult to process and keep record of because they are done manually. Buddy punching is another drawback associated with this traditional approach in which colleagues take advantage of the system by 'punching' for their co-workers.

Technology based attendance taking: Technology based attendance are various types of attendance systems that make use of electronic equipment or computers. This technology based or automated attendance system has various advantages allowing schools and organizations take attendance easily and manage time effectively. Some of the main advantages include quick and simple time tracking process, cost efficiency due to lower maintenance cost, as well as reduced time theft and ineffectiveness.

Other benefits associated with technology based include greater accuracy and reduced or even eliminated "buddy punching". Technology based attendance systems include barcode attendance system, web-based attendance system, magnetic stripe attendance system, GSM-GPRS attendance system, smart card technology, etc.

2.2 BARCODE ATTENDANCE SYSTEM

The barcode system is a common type of time and attendance system through which the efficiency of measuring and tracking employees' time could be increased to a great degree. With the automation through barcode technology, the errors previously made in the manual payroll or attendances are eliminated. As a result, the system provides high levels of accuracy and reliability in tracking of employee attendance. In addition, the costs associated with the installation of the system are not too much relative to the cost of payroll or attendance errors (Thomas, 2004). The implementation of the barcode system is easy. Every employee is issued a badge/card in which there is a barcode. In order to check into or out of the company, the badge/card is swapped on the time clock, and the data is captured by the clock. This data from the clock can be downloaded by the manager or the administrator and then used for updating and maintaining time and attendance records (Ononiwu & Okorafor, 2012).

AB12345678910

Figure 2.1 an example of a barcode

Source: (International barcodes, 2018)

2.3 BIOMETRIC ATTENDANCE SYSTEM

Biometric technology involves the identification and verification of individuals by analyzing the human body characteristics such as finger prints, palm vein, iris and the likes has been widely used in various aspects of life for different purposes, most importantly for students' attendance (Falohun, Oke & Gbadamosi, 2015). The computer uses any of these biometric identification schemes to determine who you are, and based on your identity authorize your different levels of access (O'Connor & Catherine, 2009). When a biometric system is used as an authentication system then its purpose is to verify if the individual is actually who he or she claims to be, it does this by searching the database for a match to the biometric data gotten from the individual (Shoewu, Makanjuola & Olatinwo, 2014). Biometric identifiers are the distinctive measurable characters used to label and describe individuals (Adeyanju, Omidiora & Oyedokun, 2015). The biometric traits include: face, fingerprint, palm vein, finger vein, iris and speech. There are two modes of operation for biometric systems which are unimodal in which just one physiological trait is used and multimodal in which more than one physiological trait is used. Most of the biometric systems in use are unimodal (Raghavendra, Ashok& Hemantha, 2010). The mode of operation used by a biometric system depends on the available funds and the purpose for developing the system. Multimodal biometric systems are more efficient but costlier to implement than unimodal biometric systems.

2.3.1 Face Recognition

A face is a unique anatomical feature which contains the eyes, nose and mouth etc. Human beings have been using the face as a means of recognition for ages. The human brain has developed highly specialized areas dedicated to the analysis of the facial images (Anila & Devarajan, 2012).Figure 2.2 shows the human face. Over the years advancement in computing capability has enabled face recognition to become automated. It can now be used for both verification and identification (open-set and closed-set) (Committee on Technology, 2006).

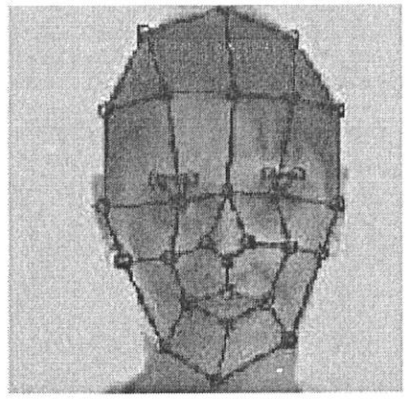


Figure 2.2 a face recognition system processing the image of a human face.

Source: (Jain, Ross & Prabhakar, 2004)

2.3.2 Fingerprint Recognition

A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. The endpoints and crossing points of ridges are called minutiae. The upper skin layer segments of the finger are the ridges while the lower segments are the valleys (Shoewu, Makanjuola& Olatinwo, 2014). It is a widely accepted assumption that the minutiae pattern of each finger is unique and does not change during one's life. Ridge endings are the points where the ridge curve terminates, and bifurcations are where a ridge splits from a single path to two paths at a Y-junction (Mishra & Trivedi, 2011). Figure 2.3 shows the human fingerprint and its different parts.

Figure 2.3: The Human Fingerprint and its different part.

Source: (Chaurasia, 2012)

2.3.3 Iris Recognition

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The iris is perforated close to its center by a circular aperture known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The iris' unique epigenetic pattern remains stable throughout adult life making very good biometric traits for biometric systems (Masek, 2003). Figure 2.4 shows the image of an iris. The stages of iris recognition can be divided into three stages and these stages are segmentation (locating the iris region in an eye image), normalization (creating a dimensionally consistent representation of the iris region), and feature encoding (creating a template containing only the most discriminating features of the iris). The segmentation stage can be carried out using Hough Transform, Daugman's Integro-differential Operator or Active Contour Models. Normalization can be carried out using Daugman's Rubber Sheet Model, Image Registration or Virtual Circles. Feature encoding can be carried out using Laplacian of Gaussian Filters, Haar Wavelet, Zero-crossings of the 1D wavelet, Log-Gabor Filters, Gabor Filters or Wavelet Encoding (Masek, 2003). Although iris recognition is very reliable, it is considered intrusive by most end users (Raghavendra, Ashok & Hemantha, 2010).

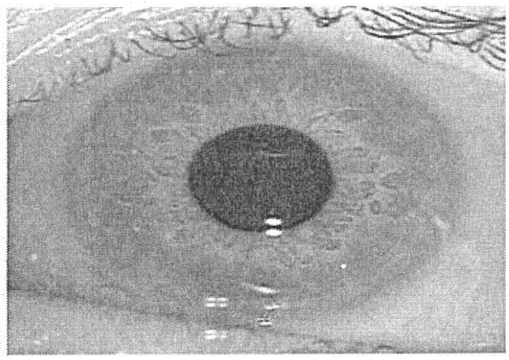


Figure 2.4 The Human Iris (Jain, Ross & Prabhakar, 2004).

2.4 MAGNETIC STRIPE/SMART CARD ATTENDANCE SYSTEM

In the magnetic stripe attendance system, data is encoded in the magnetic stripe of the card. When the card, is swiped through the time clock, the information in the card's magnetic stripe is recorded by the time clock. This system also reads one card at a time and also requires contact with the reader. Figure 2.2 is a pictorial diagram of a card embedded with magnetic strip. Smart card based attendance technology: Smart cards are electronic cards which consist of processor and memory (Jain & Shukla, 2014). Its system function is based on microcontroller. Companies that use smart card attendance system provide their employees a special card called smart card in which employees' information along with the access code is stored. They are required to enter the card into a smart card reader where the assigned code is generated to enroll attendees (Chandramouli & Lee, 2007).

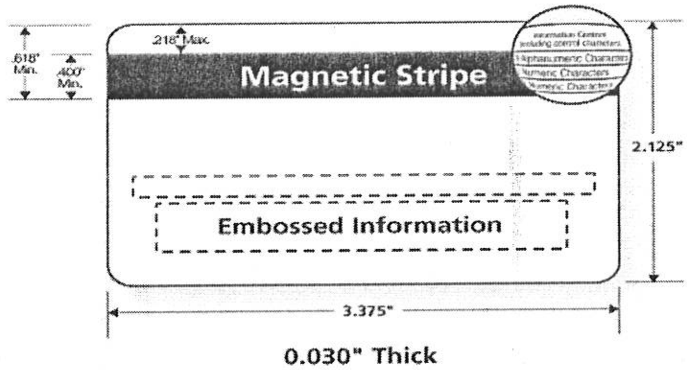


Figure 2.5: Magnetic stripe card

Source: (Qcard the Lab Authority, 2018)

2.5 RFID SYSTEMS

It is generally said that the roots of radio frequency identification technology can be traced back to World War II. The Germans, Japanese, Americans and British were all using radar which had been discovered in 1935 by Scottish physicist Sir Robert Alexander Watson-Watt to warn of approaching planes while they were still miles away. The problem was there was no way to identify which planes belonged to the enemy and which were a country's own pilots returning from a mission. Radio Frequency Identification (RFID) research and discovery began in earnest in the 1970s. RFID is commonly used to transmit and receive information without wires. RFID readers and tags communicate through a distance using radio waves. There are a lot of advantages in RFID system, included their price, size, memory capacity and their capability. Advances in radar and RF communications systems continued through the 1950s and 1960s (Mahyidin, 2008).

Radio-frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag or label, attached to an object, through a reader for the purpose of identifying or tracking the object (Karmakar, 2008). Radio-frequency identification (RFID) technology incorporates the use of electromagnetic spectrum to uniquely identify an object, animal or person. They are grouped under the automatic identification (Auto-ID) technologies (Nwaji, 2012). The RFID attendance system offers an organization the efficiency and convenience associated with RFID technology at low cost.

The RFID attendance system is an automatic embedded system used in taking attendance of registered persons in a particular organization. The RFID attendance system offers an organization, the efficiency and convenience associated with RFID technology at a low cost. Each student uses an RFID card and the reader records the data when the student enters the classroom. RFID devices and system must be supported by sophisticated software architecture that enables the collection and distribution of location based information in near real time. A complete picture of the RFID attendance system combines the RFID Tags and readers with access to global standardized database, ensuring real time access to up-to-date information on the card. The card contains a unique identification number called an Electronic Product Code (EPC) (Tiwari, Tiwari, Ade, Sana, Patel & Khan, 2014).

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data for the purposes of automatically identifying and tracking tags attached to objects. Similar to other identification systems such as barcodes, fingerprints or eyes' iris, the reader (RFID reader) reads from some source of identification data (RFID tag). Then, the identification data are usually processed by a data processing subsystem or server. However, RFID systems outstand from other identification systems because they may be nearly as cheap as barcode systems, use a wireless channel like GPS or GSM, and have some computational capabilities like magnetic cards. That is why more and more attention has been paid to this technology in recent years(Trujillo-Rasua, 2013). A general RFID system contains three major components, the tag, the reader, and the backend system (Huang, 2009). In technical terms, an RFID system consists of three key elements:

- The RFID tag, or transponder, that contains information and identification data.
- The RFID reader, or transceiver, that queries transponders for information stored on them. This information can range from static identification numbers to user or sensory data.
- The data processing subsystem or server, which processes the data obtained from readers.

2.5.1 RFID Tags

An RFID tag is a microchip combined with an antenna in a compact package; the packaging is structured to allow the RFID tag to be attached to an object to be tracked.

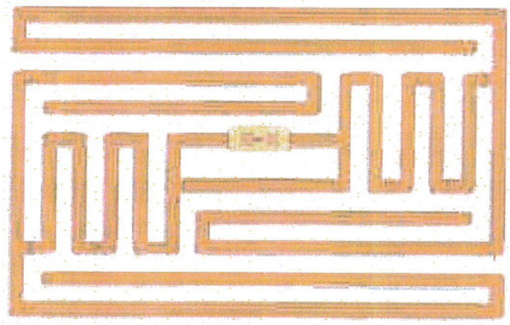


Figure 2.6: An RFID tag (Jechlitschek, 2013).

There are three fundamental components, the antenna, the integrated circuit, and printed circuit board/substrate, in all RFID tags. The antenna mainly is responsible for transmitting and receiving radio waves and sometimes collecting the energy from radio waves if the tag is a passive tag (types of tag will be explained shortly.) The main purpose of integrated circuit (IC) is to transmit the tag's unique identifier and the printed circuit board (PCB) is used to hold the tag together (Thornton, Haines, Das, Bhargabva, Campbell & Kleinschmidt, 2006). In modern RFID technology, there are 4 types of tag, passive tag, semi-passive tag and active tag.

i. **Passive tag:** A passive tag is an RFID tag that does not contain a battery; the power is supplied by the reader. When radio waves from the reader are encountered by a passive RFID card, the coiled antenna within the tag forms a magnetic field. The tag draws power from it, energizing the circuit in the tag. The tag then sends the information encoded in the tags memory. Because of the lack of a battery, these tags are the smallest and cheapest tags available; however it also restricts its reading range to a range between 2mm and a few meters. As an added benefit those tags are also suitable to be produced by printing. Furthermore their lifespan is unlimited since they do not depend on an internal power(Jechlitschek, 2013).

ii. **Semi-passive tags:** A semi passive tag uses a battery to run the microchip's circuitry but communicate by harvesting power from the reader signal (Trujillo-Rasua, 2013). They are quite similar to the active tags; the main difference is how the battery is used. Batteries in this tag are used to power only the internal circuitry. The advantage of semi-passive tags is longer read ranges than passive tags because the energy they absorb from Near Field is fully used to transmit data only.

iii. **Active tags:** Unlike passive tags, this type of tags comes with power supplied on board such as battery. Since they have their own power supply, they don't need to be powered by the RFID readers' antennas. Therefore, passive tags have longer read range than passive tag. The drawbacks are that they are more expensive and bigger in size (Banks, Hanny, Pachano & Thompson, 2007). An active tag's range can be tens of meters, making it ideal for locating objects or serving as landmark points. The lifetime is up to 5 years (Jechlitschek, 2013).

2.5.2 RFID Reader

An RFID reader is the brain of the RFID system and necessary for any system to function. Readers, also called interrogators, are devices that transmit and receive radio waves in order to communicate with RFID tags. An RFID reader can be in any forms such as pricing gun in store, toll plaza in highway, and so on. An RFID reader is considered as a middle man in between tags and backend systems. It interrogates (usually called "read") the data encoded in tag and sends the data to backend system for application wirelessly or through wire (Huang, 2009). Therefore, an RFID reader should contain an antenna and an RS-232 serial port or an Ethernet jack. Generally, there are two types of RFID readers, read-only readers and read/write readers. A read-only reader only can read tag's data. A read/write reader can read tag's data and also write data to tag if the tag contains a read/write memory, also RFID readers fall into several classes – fixed RFID readers, handheld RFID readers, and integrated RFID readers. A fixed RFID reader stays in one specific location when encoding and reading tags, while a handheld RFID reader is mobile and can be carried around while scanning various items. An integrated RFID reader is a reader with a built-in antenna and usually has another port to support up to one additional antenna.

Integrated readers are a great fit if you are only looking for a lower cost solution and only need one or two antennas (Atlas RFID solutions, 2016).

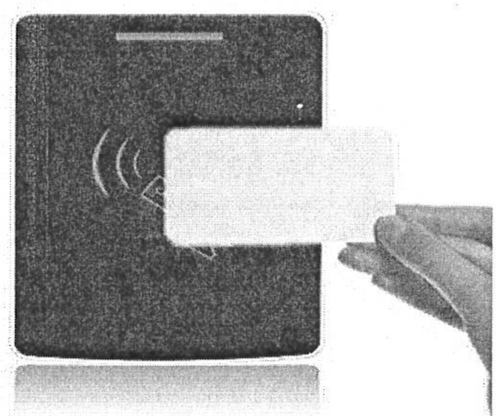


Figure 2.7: RFID card and reader
Source: (UniTech Security, 2017)

2.5.3 The Backend System

The RFID reader serves as a middle man between tags and backend systems. Once a backend system receives data transmitted by a RFID reader, the system runs application based on the data it received (Royer, 2016). The backend system is where the data is manipulated and stored, and forms the data resource for the system users. Typically, the backend system incorporates some sort of database which allows the linking of the RFID data to other stored information or storing of the tag details themselves. For example, a given bit string RFID tag code is essentially useless as a piece of data in isolation, but if this unique code is associated with a given product or person, then the backend system can be used to cross reference the code and thus reveals the identity of the tagged item. Equally, a backend system may simply record the occurrences of RFID tags in specific locations, and thus tracking of tags becomes possible even if the identity of the tagged item is unknown (Royer, 2016).

2.5.4 Frequency ranges in RFID tags

RFID tags fall into three regions in respect to frequency (Jechlitschek, 2013)

i. **Low frequency (LF, 30 - 500 kHz):** Low frequency tags are cheaper than any of the higher frequency tags. They are fast enough for most applications, however for larger amounts of data, the time a tag has to stay in a readers range will increase. Another advantage is that low frequency tags are least affected by the presence of fluids or metal. The disadvantage of such tags is their short reading range. The most common frequencies used for low frequency tags are 125 - 134.2 kHz and 140 - 148.5 kHz (Jechlitschek, 2013).

ii. **High frequency (HF, 10 - 15MHz):** High frequency tags have higher transmission rates and ranges but also cost more than LF tags. Smart tags are the most common member of this group and they work at 13.56MHz.

iii. **Ultra high frequency (UHF, 850 - 950MHz, 2.4 - 2.5GHz, 5.8GHz):** UHF tags have the highest range of all tags. It ranges from 3-6 meters for passive tags and 30+ meters for active tags. In addition the transmission rate is also very high, which allows to read a single tag in a very short time. This feature is important where tagged entities are moving with a high speed and remain only for a short time in a readers range. UHF tags are also more expensive than any other tag and are severely affected by fluids and metal. Those properties make UHF mostly useful in automated toll collection systems. Typical frequencies are 868MHz (Europe), 915MHz (USA), 950MHz (Japan), and 2.45GHz.

Frequencies for LF and HF tags are license exempt and can be used worldwide; however frequencies for UHF tags differ from country to country and require a permit (Jechlitschek, 2013). The different frequency bands and their operating range are shown in Table 2.1.

Table 2.1 RFID Frequency bands and characteristics (Jechlitschek, 2013).

Frequency band	**Operating range**	**Applications**
125kHz – 134kHz (LF)	~ 0.5meters	Access control and object identification
13.56MHz (HF)	~ 1meters	Library books and smart cards
860MHz to 930MHz (UHF)	~ 3 meters	Logistics and parking access
2.4Ghz (microwave)	~ 10 meters	Electronic toll collection and airline baggage tracking

2.5.5 RFID Standards

Nowadays, most technologies used are governed by standards. Basically, these define the minimum requirements of some technology in order to achieve interoperability. Developing international standards for RFID technology can bring up three major benefits. First, an international standard will make sure that interoperability among RFID readers and tags manufactured by different venders and improve interoperation across national boundaries. Secondly, having an international standard will decrease the cost due to compatibility and exchangeability. Third, an international standard will help dramatically on proliferation of RFID technology worldwide (Wu, Nystrom, Lin& Yu, 2006)

In this globalized world, such material or item, presumably attached to an RFID tag, could travel around the world more than most people in their whole life (e.g. from manufacturers to warehouses, from warehouses to points of sale, from points of sale to retailers, from retailers to customers, from customers to customers or second-hand retailers, etc.) (Huang, 2009). This means that RFID tags should be correctly read by everyone and everywhere, in the present and in the future, and without any restricted access or implementation, i.e. RFID systems should be interoperable.

Currently, there are four major organizations involving in developing standards for RFID technology. There are International Standard Organization (ISO), EPC global, European

Telecommunication Standards Institute (ETSI), and Federal Communication Commission (FCC). Among them, the International Standard Organization (ISO) and EPC global have done an incredible job over the past few years.

i. **EPC Global:** EPC Global is leading the development of industry-driven standards for the Electronic Product Code (EPC) to support the use of RFID systems (EPC Global, 2004) . Their task has been to specify frequencies, coupling methods, types of keying and modulation, information storage capacity, and modes of interoperability (Bill & Himanshu, 2006). Table 2.2 shows the classification of RFID tags according to the EPC Global organization.

Table 2.2 EPC Global tag classes (Huang, 2009).

Class	**Description**
Class 0	Passive, read-only.
Class 0+	Passive, write-once but using class 0 protocols.
Class I	Passive, write-once.
Class II	Passive, write-once with extras such as encryption
Class III	Rewritable, semi-passive, integrated sensors
Class IV	Rewritable, active, may communicate with other actions
Class V	Rewritable, active, can power and read other tags.

ii. **ISO standards:** ISO has been working on RFID applications in several areas such as proximity cards, RFID air interface, animal identification, supply chain (Huang, 2009).

ISO Standards for Proximity Cards:

- ISO 14443 proximity cards – Offering a maximum range of only a few inches. It is primarily utilized for financial transaction such as automatic fare collection, bankcard activity and high security application. These applications prefer a very limited range for security.

- ISO 15693 vicinity cards or smart cards – Offering a maximum usable range of out to 28 inches from a single antenna or as much as 4 feet using multiple antenna elements and high performance reader systems.

ISO Standards for RFID Air Interface:

- ISO 18000 – 1 part 1 – Generic Parameters for Air Interface Communication for Globally Accepted Frequencies.
- ISO 18000 - Part 2 – Parameters for Air Interface Communication below 135 KHz
  ISO standard for Low Frequency
- ISO 18000 - Part 3 - Parameters for Air Interface Communication at 13.56 MHz
  ISO standard for High Frequency
  Read/Write capability
- ISO 18000 - Part 4 - Parameters for Air Interface Communication at 2.45 GHz
  ISO standard for Microwave Frequency
  Read/Write capability
- ISO 18000 - Part 5 - Parameters for Air Interface Communication at 5.8 GHz
- ISO 18000 - Part 6 - Parameters for Air Interface Communication at 860 – 930 MHz
  ISO standard for UHF Frequency
- ISO 18000 - Part 7 - Parameters for Air Interface Communication at 433.92 MHz
  Manifest tag for Department of Defence

ISO Standards for Animal Identification:

- ISO 11748 / 11785 - Standard for Animal Identification

ISO Supply Chain Standards:

- ISO 17358 – Application Requirements, including Hierarchical Data Mapping
- ISO 17363 – Freight Containers
- ISO 17364 – Returnable Transport Items
- ISO 17365 – Transport Unit

- ISO 17366 – Product Packaging
- ISO 17367 – Product Tagging
- ISO 17374.2 – RFID Freight Container Identification

2.5.6 RFID Applications

RFID technology has been characterized by its growing popularity. Consequently, a large and diverse number of RFID solutions are being used by more and more business companies. Not surprisingly, national governments have also noticed the benefits of RFID systems in their ordinary tasks, namely for passport control and document tracking. The very first commercial usage of RFID technology was introduced in the late 1960s to the early 1970s. The system is called the Electronic Article Surveillance (EAS). Its primary function is to avoid shoplifting by using the simplest form of RFID with 1-bit tags. Moreover, both Wall-Mart Corporation and US Department of defence (DOD) had issued the requirement for their suppliers to adopt RFID technology in June 2003 and October 2003 respectively (Thornton, Haines, Das, Bhargabva, Campbell & Kleinschmidt, 2006). These actions were considered as the reason for the vast use of RFID commercially. Nowadays RFID is being used in many areas such as:

i. **Identification:** Since the very beginning of the RFID technology during the Second World War, identification was its primary goal. Nowadays, the scenario is not so different; animal identification, inventory systems, human implants for identification of patients and drug control, are just a few examples of identification by radio frequency. Indeed, other RFID's features like tracking implicitly identify their target; otherwise it would not be possible to track them (Jechlitschek, 2013).

ii. **Tracking:** Tracking assets on the item level is beneficial across a broad cross-section of industries, but the retail sector has one of the highest ceilings in terms of opportunity from the use of RFID. It uses electromagnetic fields to automatically identify and track tags attached to items. The tags contain electronically stores information. Passive tags collect energy from nearby RFID readers interrogating radio waves. There exist several scenarios in which RFID systems are the most suitable for tracking (e.g. indoor environments or for animal surveillance). Also, in comparison with other tracking systems like GPS or GSM, the RFID technology is considered much less costly. That is why tracking, together with identification, is considered one of the primary goals of RFID systems (Thornton, Haines, Das, Bhargabva, Campbell & Kleinschmidt, 2006). For tracking, tags operating at high frequency are usually required because they have a larger reading range. Those types of tags are used for tracking in libraries or bookstores, pallet tracking, building access control, airline baggage tracking and apparel and pharmaceutical items tracking, for example, in February 2008, the Emirates airline started a trial of RFID baggage tracking at London and Dubai airports (Webster, 2008).

iii. **Automobile Industry:** Perhaps, one of the most common RFID applications in automotive industry is vehicle immobilizer. A vehicle immobilizer is basically a system that prevents a vehicle from being driven if a wrong RFID tag is provided. Almost over 40 per cent of new cars produced in North America are equipped with some sort of RFID-enable immobilizer. Besides this antitheft system, RFID technology is also applied to the inventory management in automotive industry to maintain inventory status (Jechlitschek, 2013).

iv. **Electronic passports:** Electronic passports (e-passports) or passports with an embedded RFID tag have been introduced in many countries, including Malaysia (1998), New Zealand (2005), Belgium & The Netherlands (2005), Norway (November 2005), Ireland (2006), Japan (2006), Pakistan (2006), Germany, Portugal & Poland (2006), Spain (August 2006), the United Kingdom, Australia and the United States (2007), Serbia (July 2008) and Republic of Korea (August 2008) (Nithyanand, 2009). Contrary to most RFID applications, RFID tags on passports are a sort of smart card rather than a low-cost tag. They are able to execute computationally complex public key cryptosystems with large key size and are tamper-proof. Also, plenty of information may be stored on the tag's memory such as, name, birthdate, biometric information, photo, etc. Such information may be contrasted with the information available on paper, thereby reducing the risk of passport forgery and fraud (Elisabeth, Zsolt, Peter & Laszlo, 2006).

v. **Payment transactions:** In the United States, many RFID-based payment systems can be found in marketplaces such as Speedpass offered by ExxonMobil and

ExpressPay conducted by American Express. In addition, RFID-based payment systems can also be found in transportation areas around the world such as SmarTrip used in Washington D.C. Metro system, EasyCard for Taipei Metro in Taiwan, Nagasaki Smart Card system in Japan, Oyster Card for London Transportation, and so on. Perhaps, the most remarkable RFID-based payment system in the world is the Octopus system in Hong Kong. The Octopus system allows users to use just a single smart card to pay for not just transportation fares but almost everything around users(Banks, Hanny, Pachano& Thompson, 2007)

vi. **Healthcare:** The healthcare industry has been heavily investing in RFID. The healthcare supply chains, prevention of drug counterfeiting or patient safety, are just some examples of critical processes monitored by RFID. By doing so, patients of a hospital in England might avoid exposure to diseases caused by infected equipment that was not properly tracked and classified. Furthermore, discarded drug packaging will not be reusable by companies attempting to sell counterfeit pharmaceuticals, as noted by Colombian pharmacy chain Medicarte (RFID journal, 2016). Indeed, it is expected that investments in RFID technology by the healthcare industry rise from $90 million in 2006 to $2.1 billion in 2016 (IdTechEx, 2016).

2.5.7 RFID Problems and Challenges

RFID has been implemented in different ways by different manufacturers; global standards are still being worked on. It should be noted that some RFID devices are never meant to leave their network (as in the case of RFID tags used for inventory control within a company). This can cause problems for companies. Consumers may also have problems with RFID standards. For example, ExxonMobil's SpeedPass system is a proprietary RFID system; if another company wanted to use the convenient SpeedPass (say, at the drive-in window of your favourite fast food restaurant) they would have to pay to access it - an unlikely scenario. On the other hand, if every company had their own "SpeedPass" system, a consumer would need to carry many different devices with them (Trujillo-Rasua, 2013).

i. **RFID systems can be easily disrupted:** Since RFID systems make use of the electromagnetic spectrum (like WiFi networks or cell phones), they are relatively easy to jam using energy at the right frequency. Although this would only be an inconvenience for consumers in stores (longer waits at the checkout); it could be disastrous in other environments where RFID is increasingly used, like hospitals or in the military in the field. Also, active RFID tags (those that use a battery to increase the range of the system) can be repeatedly interrogated to wear the battery down, disrupting the system (Stephan, Morten & Christian, 2004).

ii. **RFID Reader Collision:** Reader collision occurs when the signals from two or more readers overlap. The tag is unable to respond to simultaneous queries. Systems must be carefully set up to avoid this problem; many systems use an anti-collision protocol (also called a singulation protocol. Anti-collision protocols enable the tags to take turns in transmitting to a reader (Trujillo-Rasua, 2013).

iii. **RFID Tag Collision:** Tag collision occurs when many tags are present in a small area; but since the read time is very fast, it is easier for vendors to develop systems that ensure that tags respond one at a time.

iv. **The contents of an RFID tag can be read after the item leaves the supply chain:** An RFID tag cannot tell the difference between one reader and another. RFID scanners are very portable; RFID tags can be read from a distance, from a few inches to a few yards. This allows anyone to see the contents of your purse or pocket as you walk down the street. Some tags can be turned off when the item has left the supply chain; see zombie RFID tags (Atlas RFID solutions, 2016).

v. **RFID tags are difficult to remove:** RFID tags are difficult to for consumers to remove; some are very small (less than a half-millimetre square and as thin as a sheet of paper) - others may be hidden or embedded inside a product where consumers cannot see them. New technologies allow RFID tags to be "printed" right on a product and may not be removable at all (Jechlitschek, 2013).

vi. **RFID tags can be read without your knowledge:** Since the tags can be read without being swiped or obviously scanned (as is the case with magnetic strips or barcodes), anyone with an RFID tag reader can read the tags embedded in your clothes and other consumer products without your knowledge. For example, you could be scanned before you enter the store, just to see what you are carrying. You might then be approached by a clerk who knows what you have in your backpack or purse, and can suggest accessories or other items. (For retail stores).

vii. **RFID tags can be read a greater distance with a high-gain antenna:** For various reasons, RFID reader/tag systems are designed so that distance between the tag and the reader is kept to a minimum. However, a high-gain antenna can be used to read the tags from much further away, leading to privacy problems

viii. **RFID tags with unique serial numbers could be linked to an individual credit card number:** At present, the Universal Product Code (UPC) implemented with barcodes allows each product sold in a store to have a unique number that identifies that product. Work is proceeding on a global system of product identification that would allow each individual item to have its own number. When the item is scanned for purchase and is paid for, the RFID tag number for a particular item can be associated with a credit card number (Jechlitschek, 2013).

2.6 MICROCONTROLLER SYSTEMS

A microcontroller is a small, inexpensive computer, usually used for sensing input from the real world and controlling devices based on that input. Most electronic devices used today have a microcontroller in them in some form or another. Microcontrollers are used with simple sensors and output devices, and they can communicate with desktop computers fairly simply as well (Tigoe, 2014).

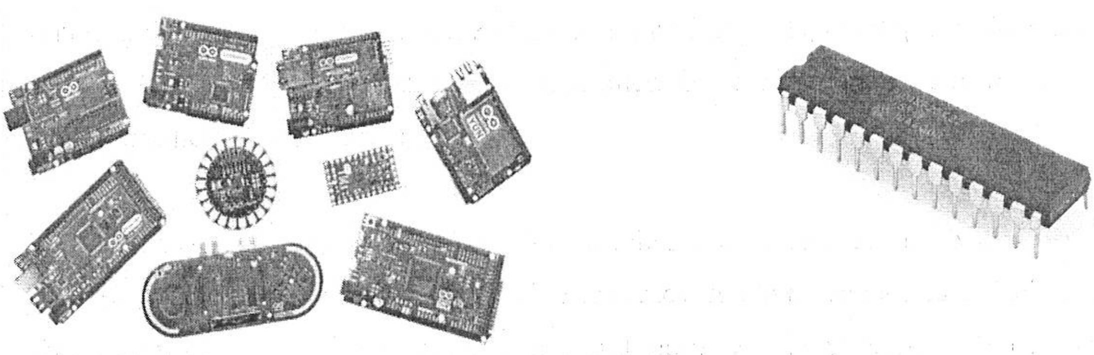
Microcontrollers contain a CPU, Random access memory (RAM), special function registers, program ROM memory, data ROM memory, parallel input/output ports and can have a host of on-chip peripherals including analogue-to-digital converter (ADC), digital-to-analogue converter (DAC), serial UART, one of several timers, comparators, etc. (Wilder, 2015).

CPU: CPU stands for central processing unit. It is basically the brain of the microcontroller. It is what fetches the instructions from the code memory and executes the instructions that it fetches.

Data RAM: the space used for storing constant and variable values that are used by the microcontroller during normal program execution. The amount of physical RAM space on a given microcontroller varies from one to the next. The data RAM on a microcontroller is organized into several registers each with its own unique address.

Special Function Registers: They are just like the registers in a data RAM. Data can be written to and read from them. Some SFRs directly controls the on-chip hardware on the microcontroller while the others are controlled by the on-chip hardware on the microcontroller (Wilder, 2015).

There are several different levels of microcontrollers and microcontroller systems. Some are very small, chip-size devices to which electronics should be connected to. Others are larger, composed of several components and ports for input/output. Higher level microcontrollers have a simple hardware interface to other devices (usually a plug or a couple of wires) and a simpler programming language. High level controllers must be attached to a personal computer via serial or USB to operate(O'Sullivan, 2016). Lower level controllers require more work in terms of hardware connections and programming, however lower level processors are generally cheapest and the most flexible.



(a) Arduino microcontrollers

(b) PIC microcontrollers

Figure 2.8 Different types of microcontroller

2.7 RELATED WORK

A number of related works exist in literature, application of RFID Technology to different areas and specifically to the area of academic attendance monitoring problem.

A biometric system using fingerprint identification for attendance automation of employees in an organization was proposed by Maltoni *et al.* (2003). Consequently, authors proposed student wolf pack club tracking system to simplify and speed up the process of student wolf pack club ticket distribution for athletic event. The proposition emphasizes a simple, reliable and cost effective model for face classrooms' attendance management that uses existing student ID card chip as the passive tag with additional short message services to parents as weekly summary.

RFIDSensNet Lab (2005) implemented an automated attendance management system both in electronic and mobile platform using stationary matrix AR 400 RFID reader with four circulatory polarized antennae and handheld RFID reader respectively. In the electronic platform, the attendance management system depicts a simple client/server system. Students can visually see their names as they entered class on the screen and they are assured that their presence has been entered in the instructor's database. However, one important drawback about this system is the RFID tag read rates degrade tremendously as it comes closer to electronic devices.

An automatic attendance system using fingerprint verification technique was proposed. The fingerprint technique verification was achieved using extraction of abnormal point on the ridge of user's fingerprint or minutiae technique. The verification confirms the authenticity of an authorized user by performing one to one comparison of a captured fingerprint templates against the stored templates in the database. The proposed automatic attendance system signals either true or false based on logical result of previous one to one verification of persons authenticity (Chitresh and Amit, 2010).

An RFID based library management was implemented which saves the library staff time and energy by automating their task Mahajan *et al.* (2010). Borrowing and returning of books are automated using the check-in, check-out system which is RFID based. The limitation of the system is that it is costly to implement as inserting a tag in all books in the library may not be cost effective.

Parvathy *et al* (2011) resolves the problem of students searching for their examination halls and seating arrangements. The card reader is provided at the entrance of the building. A student needs to swipe his tag in front of the reader at any hall and his hall and seat number would be displayed on the LCD.

An automatic access control system which evolves to prevent illegal entry of people into a building and preventing unauthorized people from gaining access to certain organization resources was implemented. The door locking system functions in real time, the door open as soon as the user scans the tag. The system also stores the login and logout information of the user. A webcam can be integrated into the system to monitor the person who swaps the card, thus avoiding the problem of a person scanning in for another person (Geoffrey, 2012).

A web based attendance system was designed by Kassim *et al.* (2012) in which a website for taking attendance and computing attendance records was developed using any of the web programming language. Students and lectures were given usernames and passwords thereby ensuring those without usernames cannot access the system. However, the developed system can be improved and upgraded further, e.g. by extending the system with new features and modules or by improving the web-interface layout with new display style.

An SMS and RFID based notification system which enables parents monitor the presence of their children at a specific time was proposed. The time in and out of every student is generated through scanning of their ID card at the gate followed by the sending of SMS notification of attendance to their parents. Limitation of the system is that there is no acknowledgement between sender and receiver (Mojares *et al.*, 2013).

An RFID based students monitoring system was implemented by Arulogun *et al.* (2013) to keep track of attendance in business organizations and firms. Similar project was undertaken by (Saparkhojayev & Guvercin, 2012). However, the project can be improved by incorporating a facial recognition application that would serve to further increase the biometric security of the system against impersonation by erring workers.

Shoewu *et al.* (2014) proposed a biometric attendance system using fingerprint as the biometric trait and they compared it results with manual attendance taking methods. They found that the system recorded a 94% success rate for eight students who participated in the study. The biometrics based attendance system produced approximately 3.8 seconds execution time on the average while the manual method of attendance produced approximately 17.8 seconds execution time on the average. Results of the biometric based attendance system confirm improved performance as compared to the manual method of attendance.

A barcode based student attendance system was proposed by Lakshmi *et al* (2015) for recording or marking the student's attendance. It was implemented using computerized software system. Each student is issued a barcode tag which is swiped in the reader to store in a database. A Java application was further developed which helped marking attendance using the barcode scanner.However, the project can be improved by incorporating a facial recognition application to increase security.

An attendance management system for students in college was proposed, it is used determine those who will sit for examination. The system was implemented using a fingerprint sensor and raspberry pi. GSM/GPRS module was used to send the attendance of each student to their parents or guardian (Divya, 2016).

Moharil and Dandare (2016) proposed a microcontroller based Attendance Management System (AMS) in which the student's bio-data (name, date, time, RFID card identification number and finger identification number) are enrolled firstly in the database of raspberry pi. When a student enters into the class, this RFID reader reads the student's ID number and identifies his fingerprint. When all are identified the GSM module sends attendance detail as a message to the parents of student.

A biometric attendance system was designed by Adewale (2017); the attendance system developed was based on unimodal biometrics. The biometric attendance system used one physiological trait, face recognition. The processes involved in the unimodal biometric attendance system includes data acquisition, biometric image preprocessing, feature extraction, matching and evaluation using accuracy, false accept rate (FAR) and false reject rate (FRR).

In Olufeyimi (2017), a microcontroller based door access system was developed using Radio Frequency Identification. The developed system reads and responds to both registered and unregistered tags, but grants access to only registered tags. The system can be adapted to securing various kinds of doors such as in libraries, laboratories and office buildings.

CHAPTER THREE

DESIGN METHODOLOGY

3.1 OVERVIEW OF THE RFID BASED ATTENDANCE SYSTEM

The attendance system will be developed using radio frequency identification. Figure 3.1 shows a block diagram which describes the proposed RFID attendance system. This consists of the RFID transmitter, RFID reader, power supply, microcontroller, timing module and display screen.

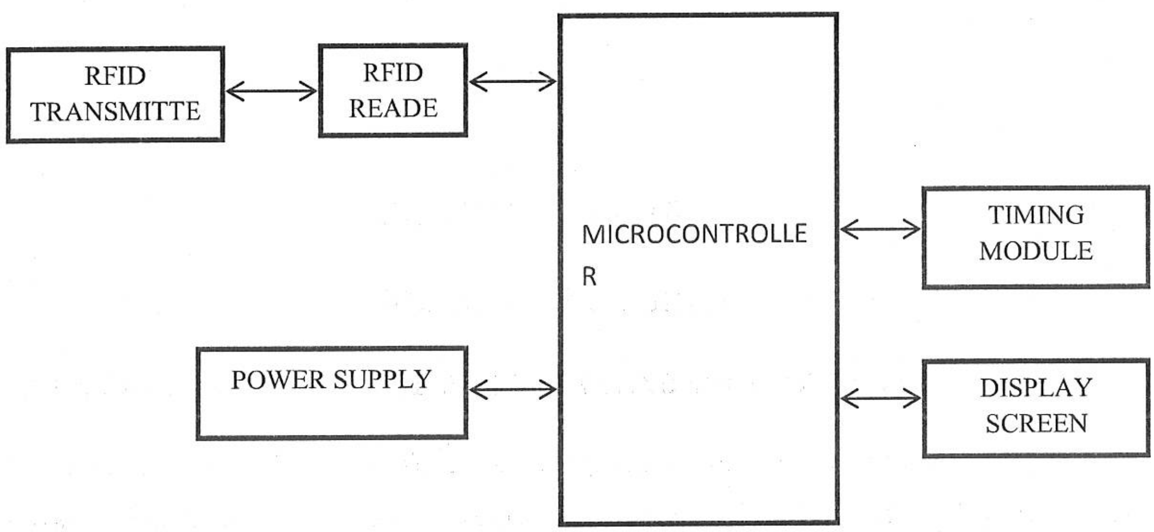


Figure 3.1: Overview of the RFID based attendance system.

3.2 RFID TRANSMITTER

RFID transmitter refers to an identification tag or card that transfers its content to the reader via radio frequency. It uses electromagnetic fields to automatically identify and track tags attached to objects. The tag contains electronically-stored information. Figure 3.2 shows the RFID tag and its antenna. Each tag contains unique ID information and possibly other information; there are active and passive tags. When tags are put near the reader it creates a small charge that is enough to cause the tag to transmit its unique ID. The tag ID is what sets one apart from the others. The project will make use of RCC 522 module.

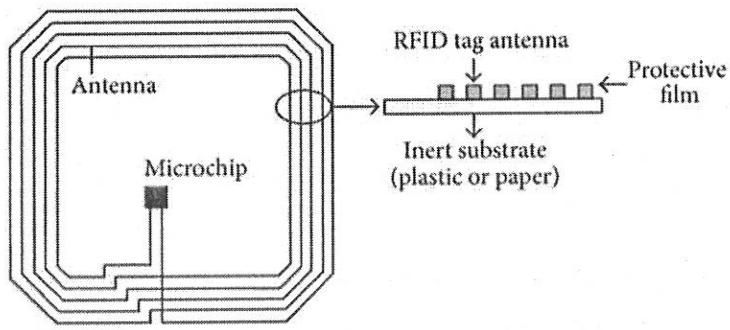


Figure 3.2 Schematic representation of RFID tag

Source: (Elisabeth, Zsolt, Peter& Laszlo, 2006).

Table 3.1 shows the specification of the RFID transmitter used.

Table 3.1 Specification of RCC 522 module (Tucker, 2017)

Working current	13 – 26mA/DC 3.3V
Standby current	10 - 13mA / DC 3.3V
Working frequency	13.56MHz
Reading distance	0-60mm
Protocol	SPI
Data communication speed	10Mbit/s
Working temperature	-20 – 80 degrees

3.3 RFID READER

An RFID reader is the brain of the RFID system and necessary for any system to function. Readers, also called scanners, are devices that transmit and receive radio waves in order to communicate with RFID tags. An RFID reader is considered as a middle man in between tags and backend systems. It scans (usually called "read") the data encoded in tag and sends the data to backend system for application wirelessly or through wire. The reader specification for this project is the RDM630. Figure 3.3 shows the RDM630 scanner.

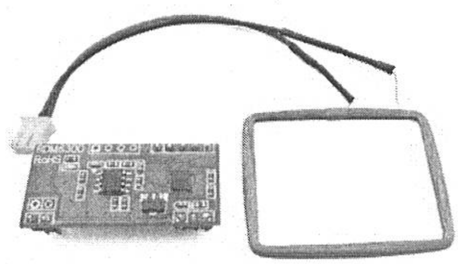


Figure 3.3: RFID Reader
Source: (Karmakar, 2008)

The 125KHz RFID Reader is a module used to read uem4100 RFID card information with two output formats: Uart and Wiegand. It has a sensitivity of 7cm maximum sensing distance. There is also the electronic brick version of this module. Table 3.2 highlights the specifications of the RFID reader used

Table 3.2 Specification of RFID reader (Tucker, 2017)

Selectable output formats	UART or Wiegand
Interface pins	4pins
Supply voltage	5V
Maximum sensing distance	7cm
UART output	9600 baudrate, 8 data bits, 1 stop bit
Wiegand output	26bitd, 1 even verify bit, 24 data bit

3.4 MICROCONTROLLER

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. The arduino nano is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Table 3.1 highlights the features of ATmega328

Table 3.3 Features of ATmega 328 (Emmanuel, 2012).

Input Voltage (limits)	6-20
Operating voltage	5V Input voltage (recommended) 7-12V
Microcontroller	ATmega 328
Flash memory	32KB (ATmega 328) of which 0.5KB used by bootloader
Digital I/O pins	14 (of which 6 provide PWM output) Analog Input pins
DC current per I/O pin	40mA DC current for 3.3V pin 50mA
SRAM	2KB (ATmega 328)
EEPROM	1KB (ATmega 328)
Clock speed	16MHz

The Arduino nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL(5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX).An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). Figure 3.4 shows the schematic representation of the arduino microcontroller and figure 3.5 shows the pin mapping of ATmega328. The ATmega328 also supports I2C (TWI) and SPI communication.

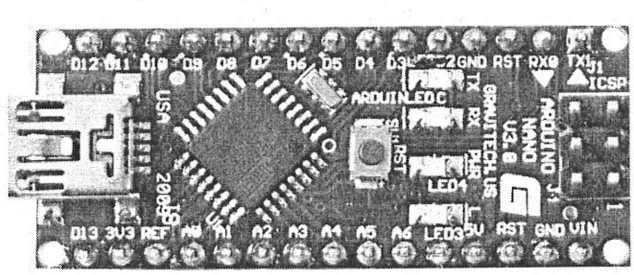


Figure 3.4: Arduino Nano microcontroller

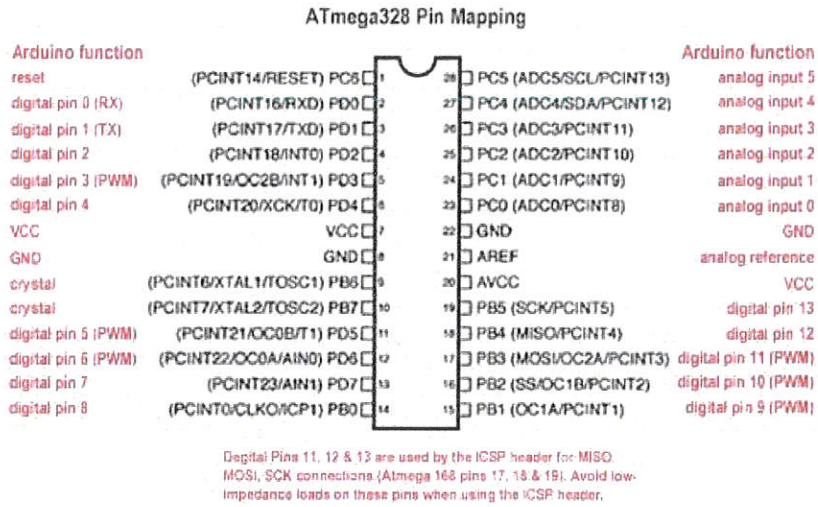


Figure 3.5ATmega 328 pin mapping (Reichelt, 2018)

3.5 POWER SUPPLY

A Lithium-ion battery is made up of an anode, cathode, separator, electrolyte, and two current collectors. The anode and cathode store the lithium. The electrolyte carries positively charged lithium ions from the anode to the cathode and vice versa through the separator. The movement of the lithium ions creates free electrons in the anode which creates a charge at the positive current collector. The lithium ion used for this project is the 12V – 100Ah. Figure 3.6 shows the battery and Table 3.4 highlights its specification

Figure 3.6 Lithium ion battery

Table 3.4 Lithium ion battery specification (Tucker, 2017)

Model no.	012-00002GF
Nominal capacity	100Ah
Nominal battery voltage	12VDC
Operation voltage discharge	9.2VDC
Operation voltage charge	15VDC
Cell voltage min cut-off	2.3VDC
Cell voltage max cut-off	4.2VDC

3.6 TIMING MODULE

The real time clock(RTC) is a module that supplies current date and time information and retains the a record of time even when the system's power is down; this is possible because it has an internal power source(battery) for maintaining the clock when power is down. This module is very crucial for keeping a record of the time. The DS1302 RTC is used in this work and it is shown in Figure 3.7 with schematic diagram in Figure 3.8. Table 3.5 shows the technical specifications of the DS1302 RTC.

Although keeping time can be done without an RTC, using one has benefits:

- Low power consumption
- Frees the main system for time critical tasks

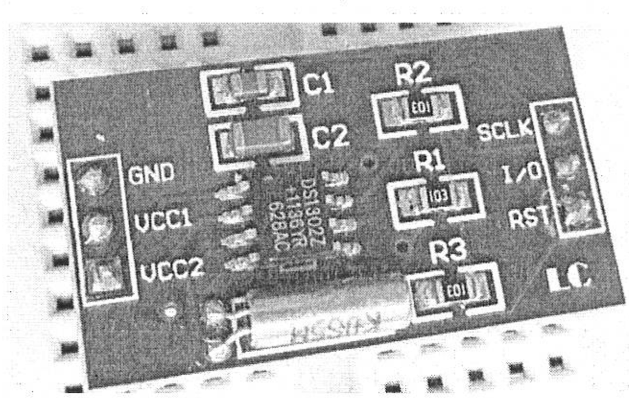


Figure 3.7 RTC module

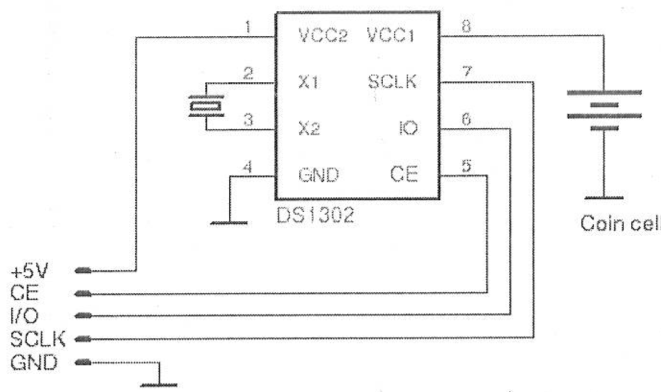


Figure 3.8 DS1302 Real time clock and wiring

Table 3.5 Specification of DS1302 RTC (Tucker, 2017)

Supply voltage	3.3V
Voltage range on any pin	-0.5V to 7V
Operating temperature	0 – 70 degrees
Soldering temperature	260 degrees
Operating temperature (industrial)	-40 to 85 degrees
Storage temperature	-55 to 125 degrees

3.7 DISPLAY SCREEN

A 16x2 liquid crystal display (LCD) is used as the display screen in this project. The serial and parallel pins are defined which makes interfacing easier with microcontrollers. 16x2 LCD is named so because: it has 16 Columns and 2 Rows. Its specifications are listed in Table 3.6.

Table 3.6 Specification of 16x2 LCD (Tucker, 2017).

Supply voltage	3V
Duty cycle	1/16
Interface	SPI/I2C (RW1063 IC)
Controller	HD44000

Figure 3.9 shows the Pin-out and pin description of 16x2 LCD Module.

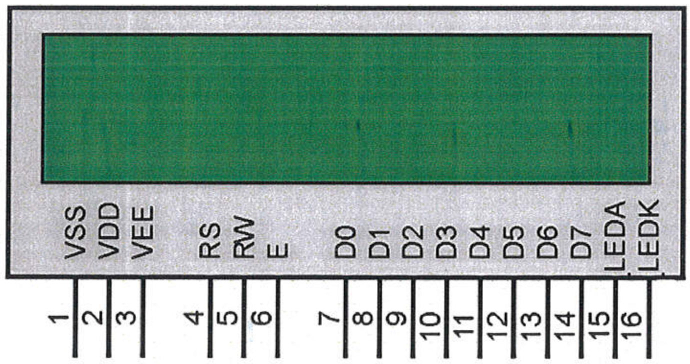


Figure 3.9 LCD screen

3.8 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the processing programming language and the wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. Figure 3.10 shows a screenshot of code written in the arduino IDE.

Figure 3.10 Arduino IDE

3.9 OPERATIONAL FLOW CHART

A user's card is first preregistered for the class in question. This is done by swiping the master card to preregister and grant access to the card. Subsequently, every time the card is swiped, access is granted and a log of the time and date is entered and printed to the computer. A card can also be removed from the list of registered cards by swiping the Access Denial master card. Thus various cards and thus various individuals can be registered or de-registered for a course. These processes are depicted clearly by the flow chart diagram in Figure 3.11

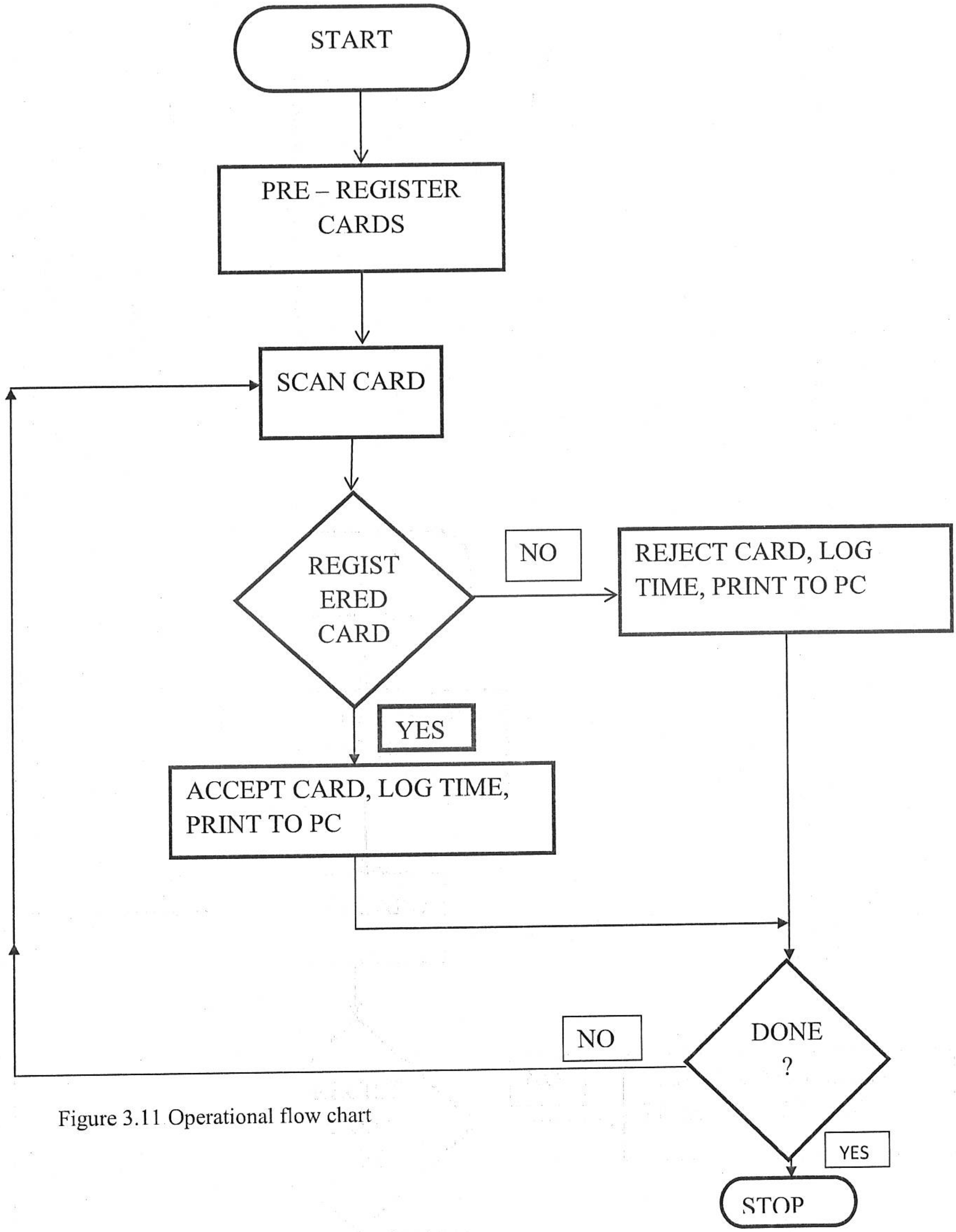


Figure 3.11 Operational flow chart

3.10 CIRCUIT DIAGRAM OF RFID ATTENDANCE SYSTEM

The Schematic Diagram that underpins all this operation is shown in figure 3.11 along with a description of the various parts.

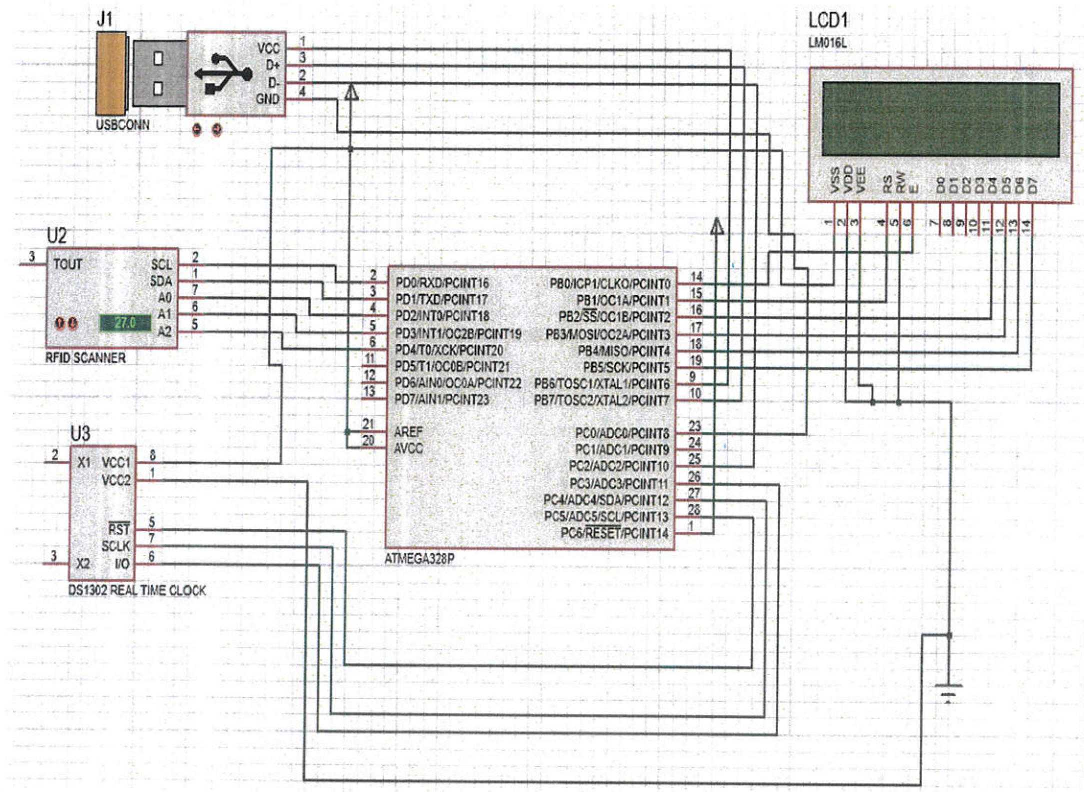


Figure 3.12 Circuit diagram of RFID attendance system

The RFID scanner is connected to the microcontroller which is in turn connected to the LCD to display information processed by the microcontroller. In this circuit, the RFID module sends data to the controller in serial. The serial communication is enabled using a command. The communication is done by a baud rate of 9600bps.

The real time clock is connected to both microcontroller and LCD. All components used in this project are connected to the microcontroller and the LCD, which are both connected to the ground.

The RFID reader module reads information from the cards and sends the data to the Microcontroller. The Microcontroller then analyses the information to determine card data and status. Simultaneously, the microcontroller reads time and date information from the Real Time Clock (RTC) to log the time and date of the card Scan. All the data is then displayed on the LCD Display and sent through the USB port to the attached PC for permanent record of the information.

Since this project uses prefabricated modules which have all been designed for electrical compatibility, there is not much electrical analysis that needs be done. The whole system operates on a 5-volt supply. The project as implemented meets all the design objectives and performs satisfactorily.

CHAPTER FOUR
IMPLEMENTATION AND RESULTS

4.1 SYSTEM IMPLEMENTATION

The construction of this project was done in four different stages: Firstly, the implementation of the components in the system design onto a solderless experiment board (breadboard).

Next is the transfer of components from the solderless experiment board to the development board, and then soldering the components permanently on the development board. Finally, the entire project was coupled together into a casing. The Bill of Engineering Measurement and Evaluation (BEME) which highlights all the components used for the system implementation are listed in Appendix A.

4.2 COMPONENTS IMPLEMENTATION ON SOLDERLESS BREADBOARD

The microcontroller, after it has been programmed using the universal programmer, the RFID scanner, the real time clock, LCD screen, are all set up on a breadboard and interconnected with each other as seen in the circuit diagram in Figure 3.9 of this report.

Interconnections were done using jumper wires and a multi meter was used to test every component to verify if they are in good conditions. During the breadboard testing some problems were encountered with the Real Time Clock Module and the SD Library. This allowed catching compatibility issues between SD Card Library and the RFID Library.

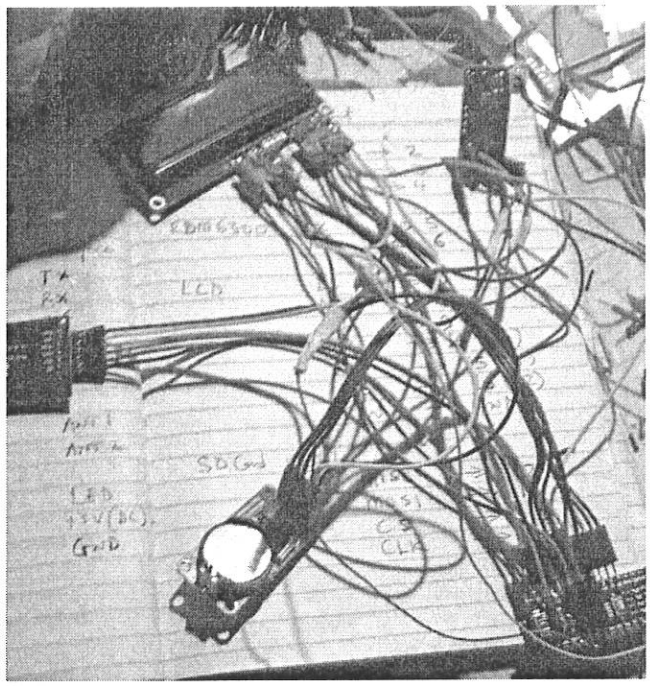


Figure 4.1 Interconnection of components

4.3 COUPLING OF PROTOTYPE COMPONENTS ON VEROBOARD

After a successful component interconnection, the whole connection is tested to check whether or not it is good working condition. If the connections perform the desired operation, then there is need to couple the components together into a casing. For this project, the casing used is a plastic box and the components were well laid and screwed to the box. The lithium battery is well placed into the box and the power button is fixed outside the box for reachability. First, connecting wires were soldered to the RFID Module. These wires feed power to the module and bring out the signals to the Microcontroller. Next, the wires to the RTC were soldered and finally wires to the LCD Display were soldered. These various wires were then soldered to the Microcontroller and the power supply. Electrical continuity testing was carried out to ensure full functionality. Figure 4.2 shows the project prototype indicating the power button, USB port and swipe card area.

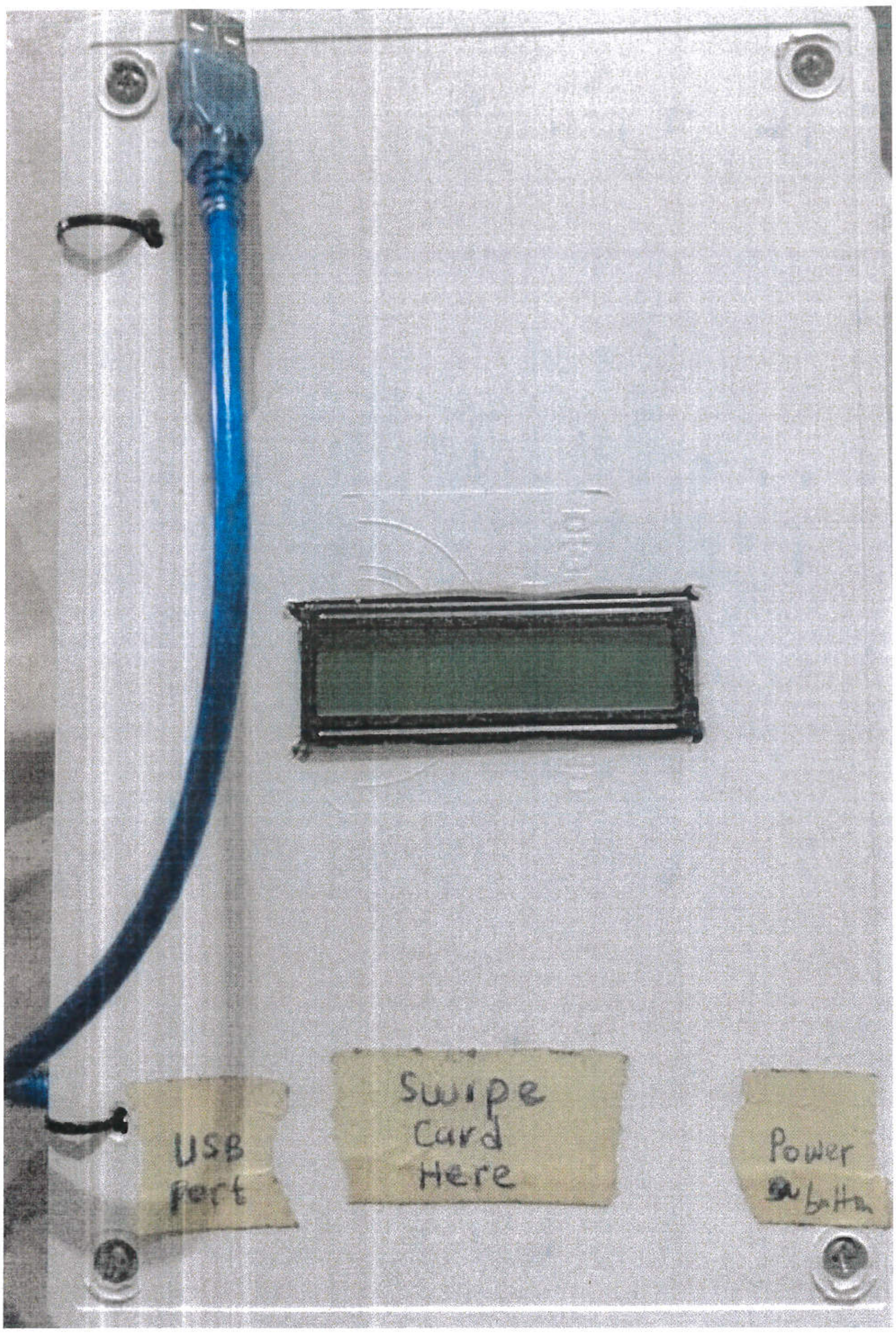


Figure 4.2 the prototype of the Radio frequency identification based attendance system

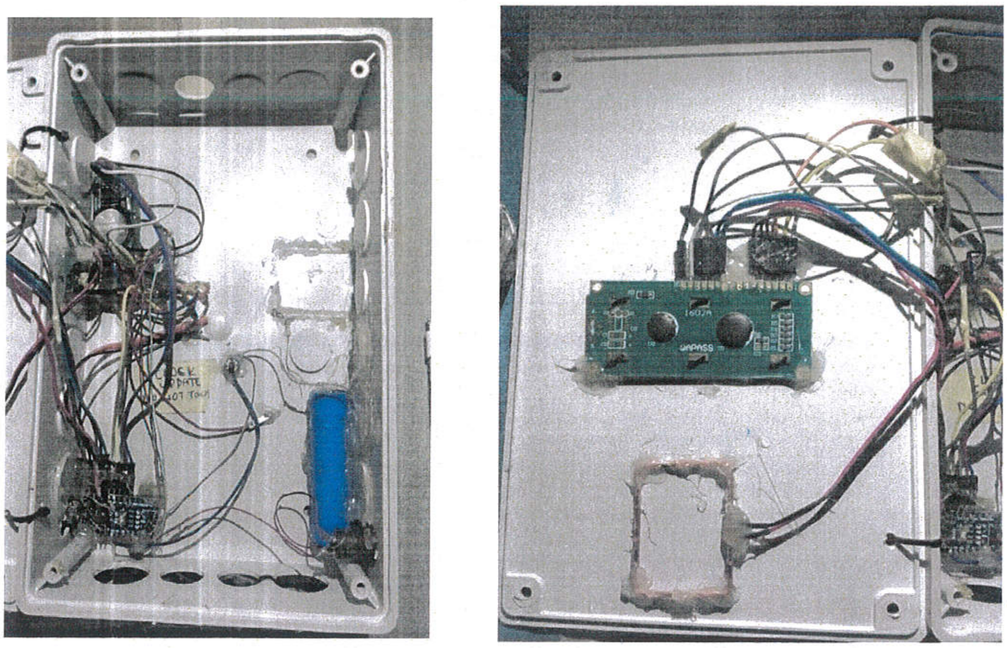


Figure 4.3 Components assembly inside plastic case

4.4 MODE OF OPERATION

1. The system power button is turned on and all the attached modules are tested by the microcontroller.

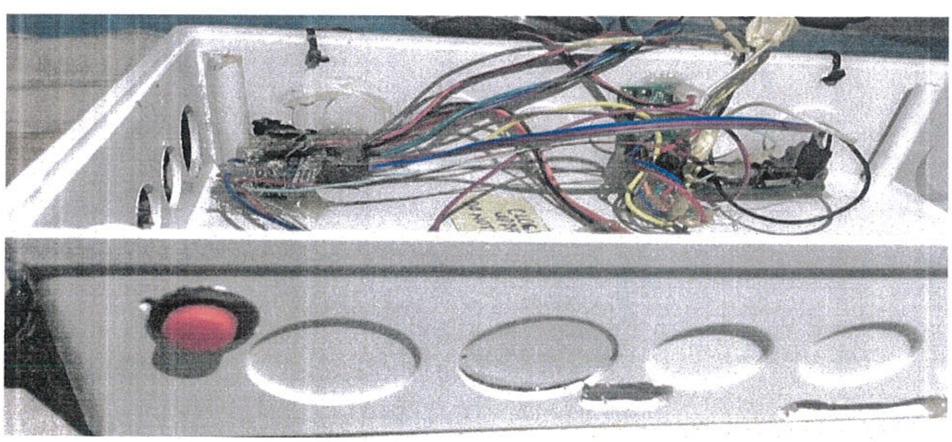


Figure 4.4 Power button illustration

2. Next, the system enters the card programming mode to add or remove cards from the database and either grants or denies access to selected cards using the Master tags. While doing this, it provides visual prompts to the user on the LCD Display. Figure 4.5 shows the system response while booting.

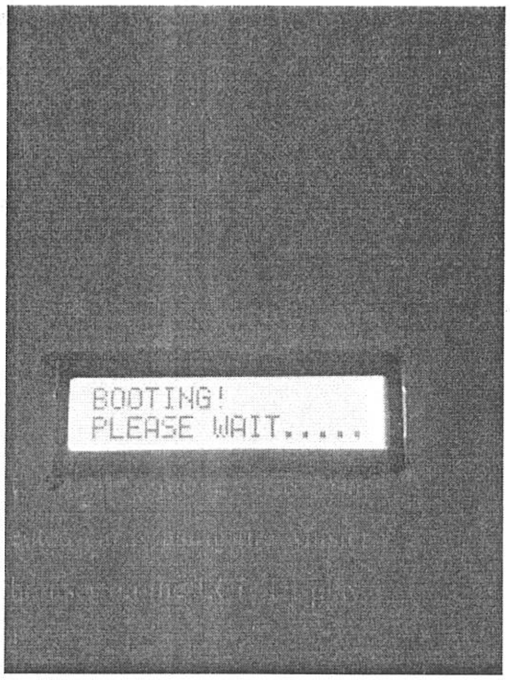


Figure 4.5 System booting

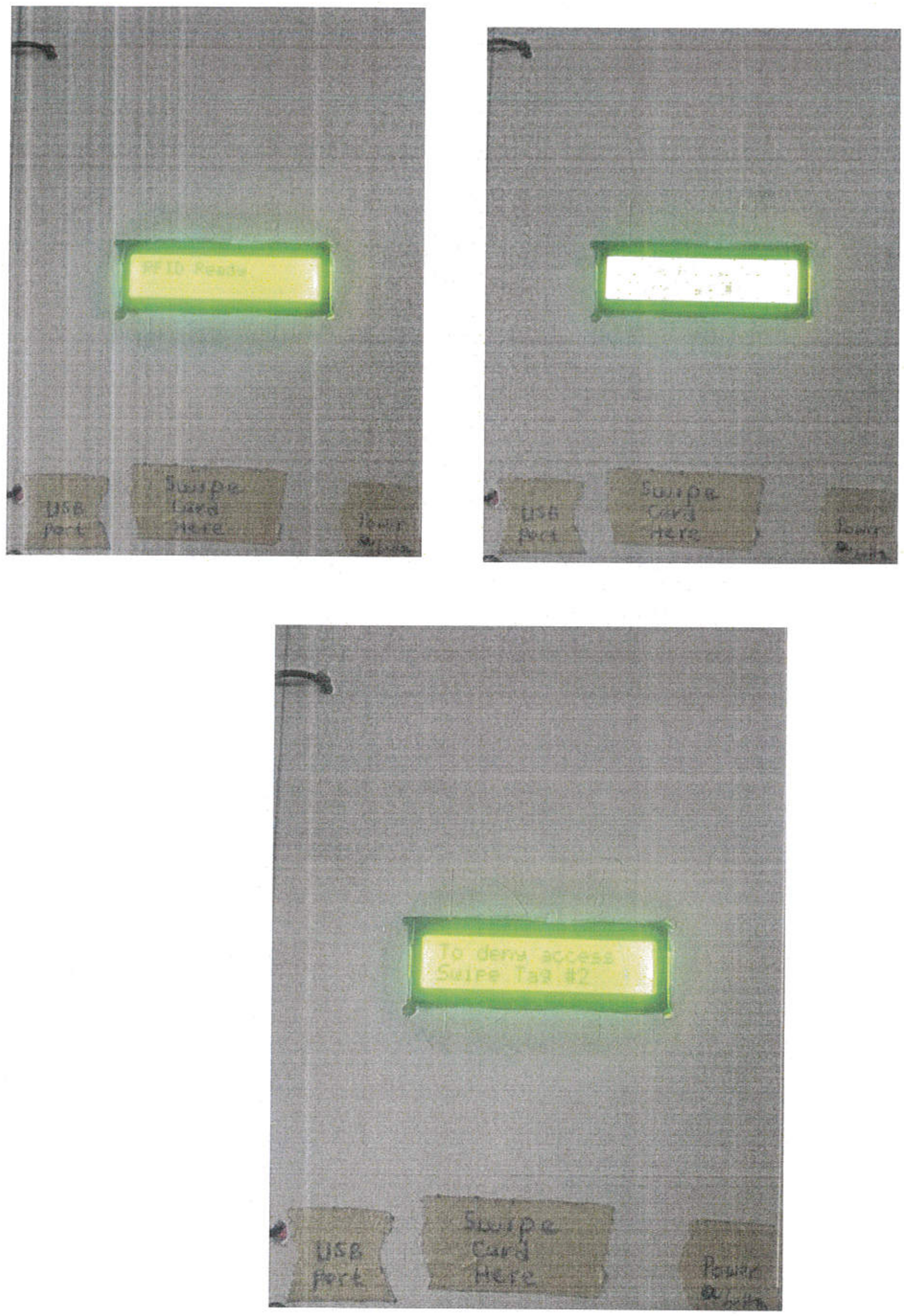


Figure 4.6 System responses after booting

3. Once the desired cards have been programmed, it then begins logging all card activities to the attached PC using a terminal program (Terminal.exe.)

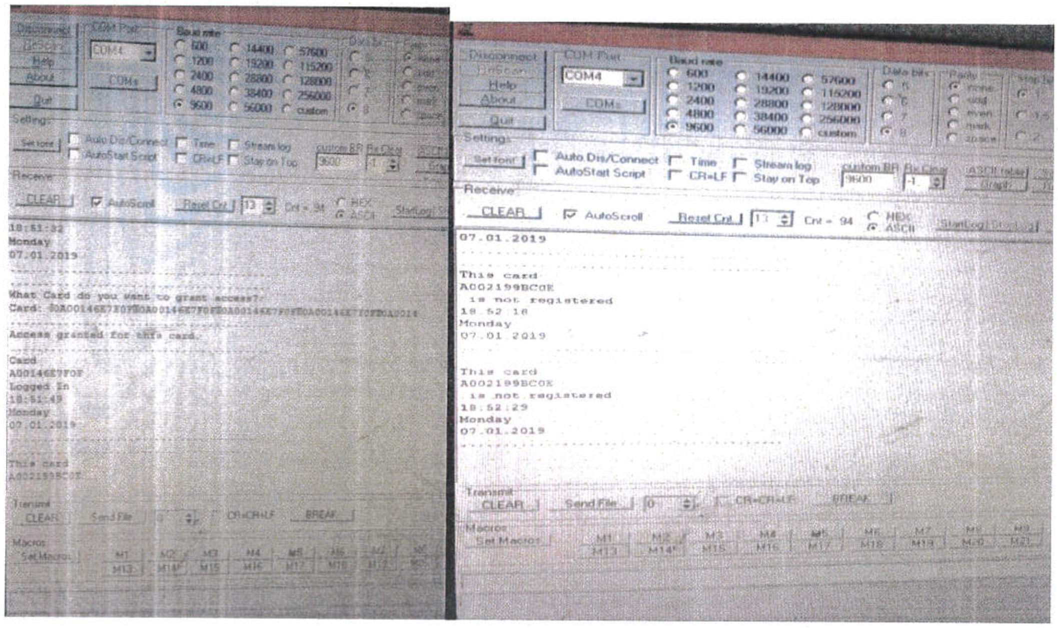


Figure 4.7 Logged data on terminal.exe

4. LCD shows the date and time information

Figure 4.8 LCD Screen information

4.5 TESTING/EVALUATION

Table 4.1 shows the response of the system to tags and cards. In cell one, tag #1 is swiped to grant access to identification cards and the system grants access and registers card. In the next cell, tag #2 is swiped to deny access to cards and the system denies and unregisters card. The same method is used for the remaining cards and all are either registered or unregistered as the case may be.

Table 4.1 Evaluation Results

CARD/TAG UNDER TEST	INFORMATION ON LCD DISPLAY	INFORMATION LOGGED TO PC	REMARKS
TAG #1 CARD #1	To grant access, swipe tag 1 Swipe card now to register	Access granted for this card	Registered
TAG #2 CARD #1	To deny access, swipe tag 2 Swipe card now	Access denied for this card	Not Registered
TAG #1 CARD #2	To grant access, swipe tag 1 Swipe card now to register	Access granted for this card	Registered
TAG #2 CARD #2	To deny access, swipe tag 2 Swipe card now to register	Access denied for this card	Not Registered

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In conclusion, the objective to build an RFID based attendance system was successfully achieved. In terms of performance and efficiency, this project has provided a convenient method of attendance marking compared to the traditional method of attendance system, the data is more organized. This system is also a user friendly system as data manipulation and retrieval can be done via the interface, making it a universal attendance system. Thus, it can be implemented in either an academic institution or in organizations.

5.2 CHALLENGES

During the course of the project, some challenges were encountered:

i. There was a constant energy problem- no utility power.
ii. Bad or damaged modules were sold without refund options as the problem was traced to the manufacturer, for instance, three bad real time clocks were purchased before one good module was gotten.
iii. The SD Card library was conflicting with the Real Time Clock library. This was resolved by modifying the code to print only to PC through the USB Port.
iv. The first RFID Scanner bought could not read through the thickness of the enclosure polymer material. Replacing with a 7cm scanner solved the problem.

5.3 RECOMMENDATIONS

Further improvements can be made on this RFID in order to increase its reliability and effectiveness:

i. An IP camera can be integrated into this system to monitor the actions like buddy-punching wherein a person cheats by scanning for another person.
ii. Also, a fingerprint module can be attached to this system to enhance accuracy and prevent buddy-punching.
iii. Finally, this attendance system can be improved by adding a feature where the attendance system indicates when a student is late for work or classes as the case maybe.

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APPENDIX A

BILL OF ENGINEERING MEASUREMENT AND EVALUATION

S/N	COMPONENT	QUANTITY	PRICE (in naira)
1	RFID scanner RDM630	1	30,000.00
2	Potentiometer	1	200.00
3	ATMEGA328 microcontroller	1	5,000.00
4	Scanning Coil	1	300.00
5	Lithium Ion Battery	1	200.00
6	LED	1	50.00
7	Resistors (1k, 2k, 5.6k,10k, 220k)	5 each	25.00
8	Capacitors (100nf,10uf,47uf,100uf)	10 each	1,500.00
9	1N4001 Diode	1	150.00
10	Connecting wires	2	140.00
11	Bolts and nuts	4	200.00
12	LCD Display	1	200.00
13	Power Switch	1	300.00
14	DS1302 Real time clock	1	400.00
	TOTAL		**38,665.00**

APPENDIX B

SOURCE CODE FOR MICROCONTROLLER PROGRAM

```
void loop(){
while(rfid.available()>0){
  c=rfid.read();
msg += c;
delay(1);
 }
msg=msg.substring(1,13);
if(msg.indexOf(ADD_TAG_CODE)>=0) add();
else if(msg.indexOf(DEL_TAG_CODE)>=0) del();
else if(msg.length()>10) verifica();
msg="";
}
void add(){
Serial.println("......................................");
Serial.println("What Card do you want to grant access?: ");
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Swipe Card now");
lcd.setCursor(0,1);
lcd.print("to register");
delay(3000);
msg="";
```

```
while(msg.length()<13){
while(rfid.available()>0){
    c=rfid.read();
msg += c;
   }
  }
if(ID.indexOf(msg)>=0) {
Serial.println("......................................");
Serial.println("\nAccess already granted for this card.");
msg="";
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Access granted");
lcd.setCursor(0,1);
lcd.print("for this card");
delay(3000);
  }
else{
Serial.print("Card: ");
Serial.println(msg);
   ID += msg;
   ID += ",";
   //Serial.print("ID: ");
  // Serial.println(ID);
msg="";
```

```
Serial.println("......................................");
Serial.println("Access granted for this card.");
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Access granted");
lcd.setCursor(0,1);
lcd.print("for this card");
delay(3000);
 }
}
void del(){
msg="";
Serial.println("......................................");
Serial.println("What Card do you want to deny access?: ");
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Swipe Card now");
lcd.setCursor(0,1);
lcd.print("to deny access");
delay(3000);
while(msg.length()<13){
while(rfid.available()>0){
    c=rfid.read();
msg += c
```