

Chapter One

Introduction

1.1 Background to the Study

Attendance is a concept that is widely known and used. In the traditional system, students are stimulated to attend classes using attendance points that at the end of the semester are part of a student's final grade. However, this represents additional effort on the part of the teacher that must be developed to make sure you mark attendance correctly which at the same time wastes a considerable amount of time. Additionally, it can be much more complicated if one must deal with large groups of students. Attendance has become very common and important because of the difficulty in managing student's attendance during lecture periods and sometimes exam halls. Over the years, research has come to prove that there is a link or relationship between school attendance and academic performance and success, while absence from school or lectures is often the greatest single cause of poor performance and failure¹.

Therefore, regular attendance is necessary for success in school. An attendance system therefore helps to ensure that students have the best opportunity for success by making sure he/she is in school every day and most importantly attending lectures. The most common and traditional method that has been adopted over time for taking attendance is the use of timesheets or attendance sheets, but attendance management goes beyond this to provide more security and accuracy, to reduce the rate of fraud. The traditional method involves the use of sheets in taking student's attendance and this attendance sheet could be easily manipulated, destroyed, stolen, or lost. The modern methods that have been adopted include the use of

biometric devices, where the students' biometric information is needed to take attendance and then the record is stored on a database system. Various human and automated tracking approaches and techniques have been developed to ensure that users' and employees' attendance is checked and regularly recorded². Traditional student attendance involves all the roll-calling issues and takes a lot of time for students and teachers to conduct departmental sessions. The procedure is lengthy and takes many instructors' and students' time.³ Also, in many institutions, and academic organizations, attendance is a very important criterion, which is used for various purposes. These purposes include record keeping, assessment of students, and so on. In developing countries, a minimum percentage of class attendance is required in most institutions and this policy has not been adhered to, because of the various challenges the present method of taking attendance presents. This traditional method involves the use of sheets of paper or books in taking student attendance. This method gives much room for impersonation and the attendance sheet could be stolen or lost. Taking of attendance with this method is time-consuming and it is difficult to ascertain the number of students that have made the minimum percentage and thus qualified to sit for the exam. Thus, there is a need for a system that would eliminate all these problems.

1.1.1 Types of Attendance Management System

Attendance Management can be grouped into two categories: The Conventional and the automated methods.

1.1.1.1 Conventional method

This includes the use of a time sheet for the attendance register and a time clock. Time sheets are documents, electronic or otherwise that record what time was spent by the employee on what tasks. This method requires human intervention to register the employee data with the time of arrival or date of presence.

1.1.1.2 Automated method

This is a systematic approach in which attendance sheets are eliminated and user intervention for registering attendance is also eliminated. It can be electronically use of electronic device used to assist in tracking the hours worked by an employee of a company. There are different methods to automate attendance, ranging from QR code technology, which is based on research, and other automated system such as RFID and Facial recognition which are used in this project. The barcode attendance system entails that every employee or student is issued a badge/card in which a barcode is embedded. To mark attendance in or out of the company or institution, the badge/card is swapped on the time clock, and the data will be resisted by the clock and stored on the database⁴.

In the magnetic stripe attendance system, data will be encoded in the magnetic stripe of the employee card. When a card, is being swiped through the employee time clock, the information in the card's magnetic stripe will be stored using the time in the clock. This system reads one card at a time and requires contact with the reader⁵. Radio-frequency identification (RFID) is a technology which is one of the technologies used in this project

makes use of radio waves to transfer data from an electronic tag, called an RFID tag or label, embedded in an object, and sends it to a reader for the aim of identifying and tracking the object. The ID cards of the employees will have it embedded RFID tag which will be read by a reader. This RFID system is interfaced to a database through a computer, each student will have an RFID card, and the reader will record the data of the student when he or she enters or exits the building⁶.

In the biometric Attendance system, there will be an attendance software that will be paired with a time clock for students which will use biometric technology for identification purposes. When these systems are employed use, the employees can use their biometric data such as fingerprints for checking in and checking out. This method has the great benefit that the entire process is easy as well as quick. Other advantages include the elimination of the cost previously incurred in getting the employees' cards⁷. In Biometric recognition, one or more characteristics of the human body will be used. These characteristics can be further divided into groups which are: Visual biometric devices: In this, visual features involve the analysis before an individual has access. These visual features include IRIS recognition, Face recognition, Finger recognition, and Retinal recognition. Behavioral biometric devices: In this group, analysis is done on the individual's walking style and signatures (velocity of sign, width of sign, pressure of sign, and so on) which varies largely amongst individuals. Olfactory biometric devices: an individual's smell or odor is analyzed. Vocal biometric devices: This involves the analyzing of the voice of the individual to grant access.

1.1.2 Benefits of Using a Biometrics System

There are several benefits or advantages of using biometrics for student attendance management systems in universities or educational institutions in general. They are easy to use because they do not require complex technical knowledge. There are also other additional advantages of using it, which include **a High level of Accuracy:** Using biometric systems for student attendance gives a high level of accuracy. Student attendance can be accurately monitored by the Lecturers and the institution in general to avoid impersonation or errors which are common in the method adopted presently by most universities. **Time management:** It is faster compared to other methods presently adopted by institutions. These systems can take a record of student's attendance in mere seconds, which makes it easier for the lecturers. **Convenience:** It provides a more quick and easy way to take attendance by simply scanning since biometric attendance systems are automated and do not require any technical knowledge. It takes students attendance automatically and the report is generated by a computer system. **Efficiency is higher:** Biometric Systems help not only to get rid of errors related to taking attendance data but also speed up data verification which decreases administration time and creates high efficiency. Modern biometric time attendance systems easily connect with your HR software, and this makes report generation easy and without any difficulty, based on the latest data for analysis. You don't have to wait for the data to be updated for verification. **Privacy and security are increased:** In the process of enrolling individuals, the biometric systems convert scanned biometric templates to computer codes and store the information in a database for matching and verification, this makes it virtually impossible to duplicate or replicate the real image for fraudulent purposes. Biometric student attendance system uses

strong encryption methods to protect a database from being compromised, which helps to increase security and protects student's privacy. A biometric attendance system makes the elimination of employee proxy attendance (or buddy punching) possible. Physiological features of the human body like fingerprints are nearly impossible for someone to replicate⁸.

1.1.3 Facial Recognition

Human face recognition can be divided into two strategies: geometrical features and template matching.

1.1.3.1 Facial Recognition Using Geometrical Features

It involves the computation of a set of geometrical features such as nose width and length, mouth position and chin shape, etc. from the picture of the face we want to recognize. This set of features is then matched with the features of known individuals. A suitable metric such as Euclidean distance (finding the closest vector) can be used to find the closest match. The advantage of using geometrical features as a basis for face recognition is that recognition is possible even at very low resolutions and with noisy images (images with many disorderly pixel intensities). Although the face cannot be viewed in detail its overall geometrical configuration can be extracted for face recognition. The technique's main disadvantage is that automated extraction of the facial geometrical features is very hard⁹.

1.1.3.2 Facial Recognition Using Template Match

This is like the template matching technique used in face detection, except here we are not trying to classify an image as a 'face' or 'non-face' but are trying to recognize a face. The basis of the template matching strategy is to extract whole facial regions (matrix of pixels) and compare these with the stored images of known individuals. Once again Euclidean distance can be used to find the closest match.

1.1.4 RFID Cards or Tags

RFID cards also known as RFID (Radio Frequency Identification Cards) can be very useful depending on how it is being applied or used, especially for those organizations, institutions, and individuals who want to put in place greater security. Those companies that work in highly competitive fields might want biometric ID Cards as added security against illegal duplication and theft. Research institutions, government sectors, and even universities and schools are well served by RFID Cards. Even cards for children are starting to be implemented and are an excellent way to identify them quickly and easily, especially if they are young enough to forget important information like their home address and number.

RFID cards are a form of identification that recognizes and analyzes an individual based on their physical and behavioral traits. This includes fingerprints, Retina scanning, iris scanning, voice recognition, facial patterns, body movement, and so on. Biometric ID Cards also involve “smart cards” that include information and several security features, such as a barcode, an embedded chip, and so on. A smart card is a type of identification card that involves the use of

biometric analysis to recognize an individual. They are available in various forms, but the most common and popular are those that have a processor with internal memory.

RFID is the acronym for Radio frequency identification. It is a small electronic device that contains a microchip and an antenna. The microchip is for the storing and processing of information, modulation, and demodulation of a radio frequency signal, and various other functions, while the antenna is for receiving and transmitting the signal. The chip has a memory able to carry a maximum of 2000 bytes. The RFID just like a barcode must be scanned to have access to the information on it. It uses electromagnetic fields to track or identify the tags or cards. The cards or tags contain information that has been stored electronically. It has a unique identifier or reader that is used to access the information. There are two basic types of RFID systems namely the Passive RFID and the Active RFID. An RFID tag or card may either be read-only, that is it has information stored on it by the manufacturer like a serial number that is used as a key or access into a database, or maybe read and write, that is the user can input data or information on it.

1.1.5 Dual Modal Systems

Dual-mode biometric systems take input from two sensors that capture two different modalities of biometric characteristics. For example, a single system combining face and iris information for biometric recognition would be considered a “dual mode” system regardless of whether face and iris images were captured by different imaging devices or the same device. It is not required that the various measures be mathematically combined in any way. For example, a system with fingerprint and voice recognition will be considered “Dual Mode”

using the “OR” rule by allowing users to be verified using either of the modalities. Basically, the “OR” rule will allow to cover a larger population, and Bimodal if the “AND” rule is used, this will allow higher security, because users are being authenticated by both modalities. Despite a lot of technical advantages, using multimodal biometrics could be costly and less user-friendly. Some combinations appear more natural than others: face + iris, fingerprint + hand geometry, fingerprint + palm print + hand geometry.

1.2 Statement of the Problem

In recent times there has been a high level of truancy daily in schools which has become a menace for the lecturers. Students who don't come to class just get one of their friends who are consistent in class to sign the attendance for them. This causes a lack of knowledge and skills for students who have poor attendance in attending classes and it makes it hard for the lecturers to analyze and track students' performances based on attendance factor. A solution to this is the use of an automated system to automate the attendance process either by a single automated system or a bimodal automated system, but the drawback in the earlier one is that when the single point of attendance fails, there is no alternative, queue is formed while each staff waits for another to finish, productive time is wasted on attendance, and the drawbacks of former is that by going through two levels of identification before taking attendance the productive time is also wasted on attendance processes.

1.3 Aim and Objectives

The aim of this project is to build a dual-mode attendance system using facial recognition and an RFID approach. The objectives are as follows:

1. To design a database to capture student's data.
2. To capture information on RFID cards and obtain identifying features on a face and store the information in the designed database for the purpose of identification and verification.
3. To test and evaluate the performance of the system.

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1.3.1 Conceptual Framework

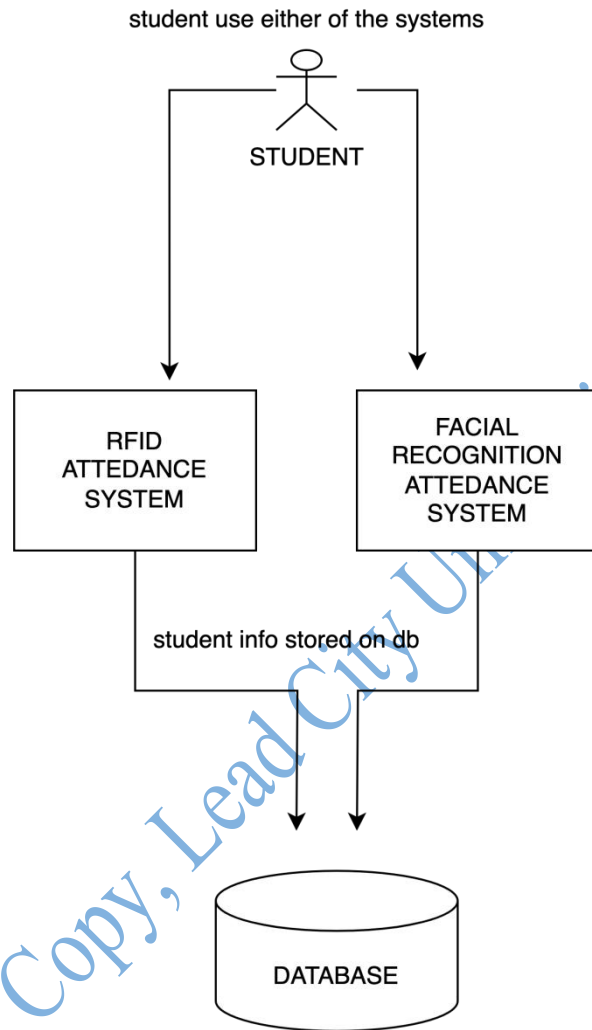


FIG 1.1: Attendance Flow

1.4 Significance of Study

This project eliminates forgery and other drawbacks of the single and bimodal systems and eliminates the single point of failure in the bimodal system. It reduces paperwork. The

proposed dual-mode attendance system also helps to solve the issue of the high response time of the single-mode fingerprint-based attendance system. The proposed system is user-friendly because the storing and retrieval of data is fast, and data is maintained effectively. All the data is fetched into the computer immediately and reports can be generated through computers. Moreover, work becomes easier because there is no need to keep data on paper, all records will be computerized. The graphical user interface is provided in the proposed system, which allows the user to deal with the system very easily. This system will provide a more accurate and efficient record of student attendance which is fully utilized by a computerized system.

1.5 Scope of the Study

The scope of this study is limited to ten students in Lead City University due to financial constraints in terms of acquiring proximity cards for each student and the schedule. Ten students from the Department of Computer with Electronics Lead City University will be used for the system. Areas of technology applied in this research are radio frequency, embedded programming, version control, database, facial recognition, high-level language programming, and cloud computing.

1.6 Limitations of the study

- A major shortcoming or drawback of this system is that electricity is required to power the system. So, if there is no supply of electricity during the period of a course the student would not be able to take attendance.
- The cost of RFID can turn out to be expensive, as students tend to lose such cards.

1.7 Operational Definition of Terms

1. Bimodal

This word is simply a conjunction of two words which are “Bi” which means two and “modal” which is derived from the word mode which means form or type. The word “Bimodal” therefore, simply means two forms or two types.

2. Biometric

This is an automated way of identification that involves parts of a human’s body that are unique to every individual.

3. Attendance

This is a process used to know the individuals present in a particular place at a particular time.

4. Bimodal biometric attendance management system

This is an automated system that uses two modes of biometric capturing for attendance taking and storing. records and generates the report electronically.

5. Dual mode

This word is simply a conjunction of two words which means two and “mode”. It means there are two options available for taking attendance i.e., you can use this or that."Dual mode" generally refers to a system, device, or operation that has two distinct and selectable modes of functioning. These modes can serve different purposes, accommodate different conditions, or offer different features. The term "dual" indicates the presence of two options or states.

6. Version Control

A tool to manage all stages of application development.

7 AWS Control

Simply put, cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet (“the cloud”) to offer faster innovation, flexible resources, and economies of scale.

8. Bimodal system

This word is simply a conjunction of two words which means two and “mode”. It means there are two dependent options available for taking attendance i.e., you must pass through the two systems to take attendance.

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Endnotes

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Chapter Two

Literature Review

2.1 Conceptual Review

As technology continues to evolve, improved systems are being used to fast-track attendance processing. Some of these technologies involve the use of biometrics, RFID, QR codes for taking attendance¹. This automated method involves recognizing people person based on some physiological attributes or behavioral characteristics such as hand geometry, and handwriting. iris, face, fingerprints, retinal, vein, and voice can all be measured, and unique data into hardware such as cards for the purpose of identification when it encounters another hardware component called readers.

An attendance system is used to record the presence of a person or people that are that are physically present at a particular place or event, to know to identify those who are present and those who are not. It is used in identifying each person present at a place who he/she claims to be or not using time of entry and other details. It can use certain features of the body like, the face, iris, finger and so on which can be understood by the recognition system to verify each person's identity and record the time in and time out with necessary details. A dual-mode system is a system that makes use of two independent technologies of identification sensors or biometrics to overcome the limitations of unimodal and bimodal systems. Examples of some of those limitations are iris recognition systems that can be compromised by aging irises and finger scanning systems by worn-out or cut fingerprints and so on and the issue of queuing due to the use of two systems to take attendance which eventually wastes time on attendance

process. Although unimodal systems are limited by how efficient their identifier is, it is very unlikely that when we use them as substitutes for each other the system will undergo or have similar limitations. Dual mode systems do not necessarily have to be two different technologies coming together (that is, requiring fingerprint scans and, using voice recognition, a spoken passcode, and so on), it can also be several combinations of technologies (that is, multiple images of an iris, or scans of the same finger, barcode, RFID and so on).

There are many reasons to promote this development in the attendance system. The most irresistible reason is to bring different modalities together to give options for recognition effectiveness. The other which further boosts the growing trend of dual-mode systems is simply customer request which can require some level of security and save the time wasted on attendance. In addition, dual-mode systems can also deal with a range of issues such as noisy data, limited degrees of freedom, intra-class variations, spoof attacks, non-universality, and unacceptable error rates which may be caused by unimodal biometric systems. Dual-mode systems can also be broadly applied in a wide range of day-to-day activities such as: authenticating and authorizing cashing and credit card transactions, security in the banking sector, and information system portal which may require authentication and authorization via login privileges.

The use of these technologies in national IDs, visas, and biometric passports is boosting the market for these technologies. Also, the rise in security concerns because of the rise of attacks and crimes has required a huge demand for high-level security. Besides, the rising government

schemes such as getting e-passports, national identification programs, and various border control schemes including European Dactyloscopy (EURODAC), Visa Information Systems (VIS), and new generation Schengen Information System (SIS II) have contributed to boosting the growth of multimodal biometric technology market. Therefore, the increasing usage of bimodal biometrics to enhance the security level is expected to create huge opportunities for this market in the upcoming years ².

Therefore, numerous technological advancements are needed to achieve these goals. This also poses a major challenge for market participants who must maintain the reliability and accuracy of identification systems and simultaneously reduce the cost attached to them. A situation can occur where the data obtained from biometric enrollment is used by the administrator for other purposes. For example, most biometric features disclose physiological and/or pathological medical conditions (e.g., some fingerprint patterns are related to chromosomal diseases, iris patterns could reveal genetic sex, hand vein patterns could reveal vascular diseases, most behavioral biometrics could reveal neurological diseases, etc.) ³. Moreover, second-generation biometrics, notably behavioral and electro-physiologic biometrics (e.g., based on electrocardiography, electroencephalography, and electromyography), can also be used for emotion detection.

There are three groups of privacy and security concerns that can occur:

1. Unintended functional scope: This occurs when the authentication goes beyond authentication, such as detecting or finding a tumor.

2. Unintended application scope: This occurs when the authentication process correctly identifies a person when the person did not wish or expect to be identified.
3. Sudden unintended identification: This occurs when a person is identified without seeking identification or authentication, i.e., a person's face is identified in a crowd.

2.1.1. History of Biometrics

The term "Biometrics" was derived from these Greek words: "Bio" which means life and "metric" which means to measure. Automated biometric systems became available over the last few decades, because of the improvement in computer processing. The concepts of many of these new automated techniques are based on ideas that already existed thousands of years ago. One of the oldest and most basic biometric characteristics that is used for recognition is the face. Since the beginning of civilization, the face has been used to identify individuals; some tribes even went as far as giving tribal marks to their children, to identify them. This simple task of identification became more challenging as the population increased and as immigration and emigration rates increased. A biometric identifier is a distinct and quantifiable attribute used in uniquely identifying an individual⁴. There are two types of biometrics namely behavioral and physiological characteristics. Faces, speech, fingerprints, and veins are the most secure and reliable approaches to traditional systems such as knowledge and token-based methods which can be stolen and forgotten⁵.

2.1.1.1 Timeline of Biometric History

1858 - The first systematic capture of hand images for identification purposes is recorded William Herschel, a Civil Service worker in India, was the first person to use biometrics for the purpose of identification by recording the handprint of each worker to avoid impersonation of the day of salary payment. This was the first recorded case of using hand and finger images taken for identification uses¹.

1870 —Bertillon develops anthropometries to identify individuals.

“Bertillonage” or anthropometries was developed by a man named Alphonse Bertillon, this involves identifying a person using their body measurements such as physical descriptions and images. Criminal offenders who were arrested in the past can sometimes provide a different name when apprehended for the sake of disguise. Bertillon came up with the ideology that although people may change their names, there will still be certain features in their body that will remain unchanged. Military authorities all through the world adopted this method, but this method was stopped because it was widely discovered that some people shared the same measurements¹.

1892 — Galton develops a classification system for fingerprints

Francis Galton wrote a comprehensive study of human fingerprints which he presented a revised system that he came about by using prints from all ten fingers. The features and characteristics that Galton used to identify each person is still valid and are still used in modern time. These features are often called to this day Galton’s details¹.

1903 -Bertillon System collapses

Two men, which were later found to be identical twins, were sentenced to the Penitentiary at Leavenworth, Kansa, in the US and were discovered to have almost similar measurements based on the Bertillon system of measurements. Although the origin of this story has been challenged over the years, but nevertheless this story was used to argue that Bertillon measurements were found insufficient to identify two individuals¹.

1936 - The concept of using the iris pattern for identification was proposed by An Ophthalmologist named Frank Burch which involves the use of iris patterns as a method of recognizing one individual from another individual¹.

1960—Face recognition becomes semi-automated

Woody Bledsoe and Charles Bisson developed the first semi-automatic face recognition system under the contract of the US Government, this was referred to as many machines. This system required human intervention to locate features like the eyes, ears, nose, and mouth on the photographs, this system relied solely on the ability to extract useable feature points. It would calculate the distances and ratios to a common reference point that was compared to the reference data¹.

1960 —The first model of acoustic speech production is created

A Swedish professor, Gunnar Fant, published a model explaining the physiological characteristics of acoustic speech production. His findings were based on the analysis of X-rays conducted on the people making distinct phonic sounds. His research findings were used to understand better the biological characteristics of speech, a concept crucial to speech recognition¹.

1965 —Automated signature recognition research begins

North America Aviation invented the first signature recognition system in 1965¹.

1969 — FBI pushes to make fingerprint recognition an automated process

In 1969, the Federal Bureau of Investigation (FBI) started the process of developing a system to change the fingerprint identification process to an automated process. The FBI came in contract with the National Institute of Standards and Technology (NIST) to study the process of automating fingerprint identification¹.

1985 — The concept that no two irises are alike is proposed

Dr. Leonard Flom and Dr. Aran Safir, who were ophthalmologists, proposed that no two irises are similar. Later in 1986, Dr. Leonard Flom and Dr. Aran Safir were accorded an award with a patent for their discovery that the iris could also be employed for identification. Dr. Flom employed Dr. John Daugman's services by telling him to develop an algorithm to automate the identification of the human iris¹.

1993 —Face Recognition Technology (FERET) program is initiated

The Face Recognition Technology (FERET) Evaluation was sponsored from 1993 to 1997 by the Defense Advanced Research Products Agency (DARPA) and the Counterdrug Technology Development Program Office to encourage the development of face recognition technology.

1994 —First iris recognition algorithm is patented

Dr. John Daugman was awarded a patent for writing iris recognition algorithms¹.

1994 —INSPASS is implemented

The Immigration and Naturalization Service Passenger Accelerated Service System (INSPASS) was a biometrics implementation that allowed travelers to avoid the immigration

lines at selected airports throughout the US until it was stopped in late 2004. Authorized travelers received a card embedded with their hand geometry information. Rather than being searched by an Immigration Inspector, INSPASS travelers presented their cards with encoded information, and they place their hands on the reading device for scanning. After verification of identity, the individual could proceed to the customs gate, thus avoiding long inspection queues¹.

1995 — Iris prototype becomes available as a commercial product

The first commercial iris product was produced by the collaboration of the Defense Nuclear Agency and Iris scan¹.

1996 — Hand geometry is implemented at the Olympic Games

Hand geometry was used majorly at the 1996 Atlanta Olympic Games. The hand geometry Systems were implemented to protect and control those going in and coming out of the Olympic Village¹.

1996 — NIST begins hosting annual speaker recognition evaluations

The National Institute of Standards and Technology (NIST) Speech Group which was under funding by the National Security Agency started hosting yearly evaluations in 1996. The NIST Speaker Recognition Evaluation Workshop is aimed at the continuous advancement of the speaker recognition community¹.

1998 — FBI launches CODIS (DNA forensic database)

The FBI launched the Combined DNA Index System (CODIS) which is used to digitally keep, search, and obtain substances or materials containing DNA for forensic law enforcement purposes¹.

1999 — FBI's IAFIS major components become operational

The FBI's ten-fingerprint identification system, known as IAFIS, was established, and put into operation. Prior to the creation of this system, fingerprints collected on one database could not be compared or searched against fingerprints stored in another database. IAFIS was developed to tackle the challenges related to communication and information sharing between individual systems, and it also facilitated the introduction of a national network for electronically documenting fingerprints to the FBI. As a result, IAFIS is now extensively used for verifying criminal history and identifying prints obtained from crime scenes¹.

2000 — First Face Recognition Vendor Test (FRVT 20090) is held

In the year 2000, the Face Recognition Vendor Test (FRVT) was sponsored by various US Government agencies. It marked the first open and large-scale evaluation of multiple commercially available biometric systems focused on face recognition technology. Subsequent FRVTs were conducted in 2002 and 2006, and the model was extended to assess the performance of fingerprint recognition in 2003 and iris recognition in 2006. The main objective of FRVT is to evaluate the effectiveness and accuracy of biometric systems by assessing their performance on different databases¹.

2000 — The first research paper describing the use of vascular patterns for recognition is published

This paper outlines the technology that eventually became the first commercially available vascular pattern recognition system in the year 2000. The system utilizes the unique blood vessel patterns present on the back of the hands to achieve recognition and identification¹.

2000 — West Virginia University biometrics degree program is established

In the year 2000, West Virginia University (WVU) and the FBI collaborated, with input from professional associations like the International Association for Identification, to create a pioneering bachelor's degree program in Biometric Systems. While various universities had previously offered courses related to biometrics, this program at WVU marked the first dedicated degree program in this field. WVU actively encouraged students enrolled in the program to pursue a dual degree in Computer Engineering and Biometric Systems since the specific biometric systems degree was not accredited at that time. This initiative aimed to equip students with comprehensive knowledge and expertise in both computer engineering and biometric systems, preparing them for careers in this emerging and important area of technology¹.

2002 — ISO/IEC standards committee on biometrics is established

The International Organization for Standardization (ISO) took the initiative to create the ISO/IEC JTC1 Subcommittee 37 (JTC1 /SC37) with the primary objective of facilitating the standardization of generic biometric technologies. This Subcommittee was dedicated to developing a set of standards that aimed to promote interoperability and seamless data interchange between various biometric applications and systems. By establishing these international standards, ISO/IEC JTC1/SC37 played a crucial role in advancing the adoption and implementation of biometric technologies across different domains and industries.

2002 — Palm Print Staff Paper is submitted to the Identification Services Committee

In April 2002, a Staff Paper focusing on palm print technology and the Integrated Automated Fingerprint Identification System (IAFIS) palm print capabilities was presented to the Identification Services (IS) Subcommittee of the Criminal Justice Information Services

Division (CJIS) Advisory Policy Board (APB). The Joint Working Group strongly advocated for the careful planning, costing, and development of an integrated latent print capability specifically designed for palms within the FBI's CJIS Division. In response to this endorsement, as well as evolving law enforcement needs, the FBI initiated the Next Generation IAFIS (NGI) project. A significant aspect of the NGI initiative involves outlining the requirements and implementing a unified National Palm Print Service. This step was taken to enhance and streamline the identification process, bolstering the capabilities of the existing system and catering to the unique features of palm prints, in addition to fingerprints, to better serve law enforcement agencies and support their investigative efforts¹.

2003 — Formal US Government coordination of biometric activities begins

The National Science & Technology Council, a high-level council within the United States government, created a specialized Subcommittee on Biometrics. The main purpose of this subcommittee is to effectively coordinate and oversee activities related to biometrics research and development (R&D), policy formulation, outreach efforts, and international collaboration. By centralizing these efforts, the Subcommittee on Biometrics aims to enhance the understanding, development, and implementation of biometric technologies while ensuring a cohesive approach to address scientific, technological, and policy challenges related to biometrics at the national and international levels¹.

2003—ICAO adopts blueprint to integrate biometrics into machine-readable travel documents

On May 28, 2003, the International Civil Aviation Organization (ICAO) made a significant decision by adopting a standardized and universally applicable plan for incorporating

biometric identification data into passports and other Machine-Readable Travel Documents (MRTDs). As part of this blueprint, facial recognition technology was chosen as the globally interoperable biometric method to facilitate machine-assisted identity confirmation when using MRTDs. This strategic move aimed to enhance the security and efficiency of international travel by providing a reliable and consistent means of biometric verification at border control points worldwide. By adopting a standardized approach, ICAO ensured that the implementation of biometric technology in travel documents could be seamlessly integrated across different countries, enabling smooth and secure cross-border travel for individuals around the globe¹.

2003 — European Biometrics Forum is established

The European Biometrics Forum is an autonomous organization in Europe, backed by the European Commission, with a grand vision of positioning the European Union as the global frontrunner in Biometrics Excellence. To achieve this vision, the forum takes on the critical mission of overcoming obstacles to biometric technology adoption and minimizing market fragmentation within the European biometrics industry. Acting as a catalyst, the European Biometrics Forum plays a pivotal role in coordinating efforts, providing support, and reinforcing national bodies involved in biometrics development and implementation. By fostering collaboration and knowledge-sharing among stakeholders across Europe, the forum endeavors to promote the growth and widespread utilization of biometric solutions, ensuring that Europe remains at the forefront of biometric advancements and applications on a global scale¹.

2004 - DOD implements ABIS.

The Automated Biometric Identification System (ABIS) is a sophisticated system developed and deployed by the Department of Defense (DoD) with the primary objective of enhancing the United States Government's capacity to monitor, track, and identify potential national security threats. ABIS employs advanced biometric technologies to process and compare vast amounts of biometric data, such as fingerprints, facial features, iris patterns, and more, collected from various sources. By leveraging this comprehensive biometric database, ABIS enables rapid and accurate identification of individuals, which proves invaluable in counterterrorism efforts, border control, law enforcement, and other national security-related applications. The system's capability to identify potential threats helps quickly and efficiently strengthen the nation's security and ensures a more robust response to emerging challenges¹.

2004 - Presidential directive calls for mandatory government-wide personal identification cards for all federal employees and contractors

In 2004, President George W. Bush issued Homeland Security Presidential Directive 12 (HSPD-12), which mandated the implementation of a standardized, government-wide personal identification card for all federal government employees and contractors who required access to Federal facilities and systems. Subsequently, the Federal Information Processing Standard (FIPS) 201 was established, specifically known as "Personal Identity Verification (PIV) for Federal Employees and Contractors." This standard laid out the technical and operational requirements for the PIV system and the associated identification card. To complement FIPS 201, the National Institute of Standards and Technology (NIST) developed a companion document, NIST Special Publication, that detailed how the standard would encompass the acquisition, formatting, and storage of fingerprint images and templates, as well as the

collection and formatting of facial images. Additionally, the publication outlined the specifications for biometric devices used to capture and read fingerprint images. According to NIST Special Publication, the PIV card is required to store two fingerprints as minutia templates, further enhancing the biometric security measures of the card and contributing to a more robust and reliable personal identification system for federal employees and contractors¹.

2004 - Face Recognition Grand Challenge begins

The Face Recognition Grand Challenge (FRGC) is a US Government-sponsored challenge problem posed to develop algorithms to improve specifically identified areas of interest in face recognition. Participating researchers analyze the provided data, try to solve the problem, and then reconvene to discuss various approaches and their results as an undertaking that is driving technology improvement. Participation in this challenge demonstrates an expansive breadth of knowledge and interest in this biometric modality¹.

2005 — US patent for iris recognition concept expires

The patent covering the basic concept of iris recognition expired in 2005, which gave room to marketing opportunities for other companies that have developed their own algorithms for iris recognition¹.

2005 — Iris on the Move is announced at the Biometrics Consortium Conference

The patent that originally covered the fundamental concept of iris recognition reached its expiration in 2005. This event opened new marketing opportunities for other companies interested in developing their own algorithms and technologies for iris recognition. Additionally, the specific patent related to the iris codes implementation of iris recognition was developed by Dr. John Doughman in 2011. Prior to this date, his patented iris codes

algorithm played a significant role in the field of iris recognition. However, after the patent's expiration, other companies and researchers gained the freedom to explore and create their own unique approaches and solutions for iris recognition, leading to increased innovation and competition in the market¹.

2008 — U.S. Government begins coordinating the use of biometric database

The completion and advancement of these biometric recognition methods and the development of the iris quality measurement algorithm are significant achievements in the field of biometrics. These advancements contribute to the improvement of security systems, identification processes, and overall technological capabilities in various applications, such as law enforcement, access control, and identity verification¹.

2010 — U.S. national security apparatus utilizes biometrics for terrorist identification

America began to use biometrics for criminal investigation¹.

2013 — Apple includes fingerprint scanners in smartphones

Touch ID is a fingerprint recognition feature developed and introduced by Apple Inc. It was first made available on the iPhone 5S and later included in subsequent models like the iPhone 6, iPhone 6 Plus, iPad Air 2, and iPad Mini 3. This technology is deeply integrated into iOS devices, providing users with a convenient and secure way to unlock their devices. With Touch ID, users can use their registered fingerprints to unlock their iPhones or iPads quickly. Additionally, Touch ID is utilized for authorizing purchases in various Apple digital media stores, including the iTunes Store, the App Store, and the bookstore. Moreover, it serves as an authentication method for making secure transactions through Apple Pay, whether it's for online purchases or within supported apps¹.

2015 till date — Android phones fingerprint scanners into smartphones

After Apple introduced Touch ID as a fingerprint recognition feature on its iPhone models, other smartphone manufacturers, both Android and iOS, took inspiration from the idea and began incorporating similar fingerprint recognition technologies into their devices. Android smartphone makers started integrating fingerprint sensors into their products as a means of biometric authentication. This allowed users of these devices to unlock their phones, access secure content, and perform various tasks using their registered fingerprints, like Apple's Touch ID functionality. As a result, fingerprint recognition became a standard feature in many smartphones, offering users an additional layer of security and convenience. This widespread adoption of fingerprint sensors across various smartphone brands has since paved the way for further advancements in biometric technologies, such as facial recognition and in-display fingerprint sensors, making authentication on mobile devices more secure and user-friendly¹.

2.2 Methodological Frameworks

Technology has advanced over time and due to this all the different types of designs, and system algorithm has been tested or used for attendance systems. They are properly explained as follows:

2.2.1 Voice Recognition-Based System

Voice recognition, also known as sound recognition in a broader sense, involves the conversion of spoken words, sounds, or phrases into electrical signals, which are then translated into coding patterns with assigned meanings. This process holds great significance

in virtual reality as it offers a natural and intuitive means of controlling simulations while leaving the users hands-free. The emphasis on human voice recognition stems from the fact that we predominantly and instinctively use our voices to convey ideas to those around us. In a virtual environment, employing our primary form of communication, the voice allows for a heightened sense of immersion or a feeling of being truly part of the simulation. Nonetheless, the challenge lies in the fundamental differences between human speech and conventional computer input methods.

Unlike precise and well-defined computer inputs that typically generate specific responses, the human voice introduces complexities. Everyone possesses a unique voice, and identical words can take on diverse meanings based on different inflections or contexts. Overcoming these challenges has led to the exploration of various approaches, with varying degrees of success. Speaker recognition or Voice recognition is a biometric modality that uses an individual's voice for recognition purposes. It is a different technology than speech recognition, which recognizes words as they are articulated from. Speech recognition is not biometric. The speaker recognition process relies on features influenced by both the physical structure of an individual's vocal and the individual's behavioral characteristics. This project will concentrate on speaker recognition. Historically, voice recognition systems have been limited in their adoption due to certain drawbacks and their relatively high cost, making them uncommon except in specific niche applications. However, with the passage of time, the cost of these systems is expected to decrease while their performance steadily improves. One prominent example of their utility is as an alternative to traditional keyboard typing².

Voice recognition finds particular use in situations where users are unable to employ keyboards to input data because their hands are occupied or disabled. The prevalent approaches to voice recognition can generally be categorized into two main groups, as outlined. As technology advances, these systems are likely to become more widespread and accessible, making voice recognition a viable and convenient method for various applications. Historically, voice recognition systems have been limited in their adoption due to certain drawbacks and their relatively high cost, making them uncommon except in specific niche applications.

However, with the passage of time, the cost of these systems is expected to decrease while their performance steadily improves. One prominent example of their utility is as an alternative to traditional keyboard typing. Voice recognition finds particular use in situations where users are unable to employ keyboards to input data because their hands are occupied or disabled. The prevalent approaches to voice recognition can generally be categorized into two main groups, as outlined by. As technology advances, these systems are likely to become more widespread and accessible, making voice recognition a viable and convenient method for various applications³.

Template matching

This is the simplest technique, and it has the highest accuracy when used properly, but it also has the most drawbacks. Just as with every other approach to voice recognition, the very first

step is for the user to say a word or phrase into a microphone. The electrical signal produced or transmitted from the microphone is a digitized voice sample, or template, that has a meaning that is known. This technique is like the traditional command inputs from a keyboard. The program contains the input template with the actual input using a simple conditional statement.

Since people's voices differ, it is not possible for the program to contain a template for each potential user, so the program must be trained first, with the input of a new user's voice before the program can recognize the new user's voice. During the training, the program displays a printed word or phrase severally into a microphone. The program computes a Statistical average of the multiple samples of the same word spoken by the user and stores the averaged sample as a template in a program data structure. This approach to voice recognition provides the program with a "vocabulary" that is limited to the words or phrases used in the training, and its user base is also limited to those users who have trained the program. This type of system is referred to as "speaker dependent." It can have a vocabulary as large as a few hundred words and as small as short phrases, and recognition accuracy is about 98 percent, which is very high⁴.

Feature Analysis

Voice recognition can be performed through feature analysis, leading to speaker-independent voice recognition. Instead of attempting to find an exact or close match between the user's voice and a stored voice template, this method involves processing the user's voice using techniques like "Fourier transforms" or "linear predictive coding (LPC)." The system then

identifies characteristic similarities between the expected inputs and the actual digitized voice input. Since these similarities are available for a wide range of speakers, the system doesn't require training for each new user, making it more versatile.

Speaker-independent speech recognition, however, presents challenges due to the variety of accents and inflections used by speakers of different nationalities. Although it can handle differences like accents, varying speed of delivery, pitch, volume, and inflection, its accuracy is slightly lower than that of speaker-dependent systems, typically ranging between 90 and 95 percent. Another way to differentiate voice recognition systems is based on their ability to handle discrete words, connected words, or continuous speech. Most systems can handle discrete words, where the speaker must pause between words. Connected word systems allow users to say multiple-word phrases while carefully and distinctly pronouncing each word. Handling continuous speech, where words are spoken without pausing or separation, is highly challenging and not as commonly implemented. The system's limitations include susceptibility to malfunction in noisy environments or when students speak loudly, as the noise may trigger false responses. Additionally, the human voice's variability due to factors like colds, hoarseness, stress, emotional states, and puberty vocal changes poses difficulties for implementation. Furthermore, the cost of implementing such systems can be quite high ⁵.

2.2.2 Iris Recognition-Based System

Iris recognition is an automated biometric identification method that utilizes mathematical pattern-recognition techniques on video images of an individual's irises. These complex and

unique patterns are stable and can be captured from a distance. This technology is highly accurate and secure, as iris prints are exceptionally challenging to steal compared to fingerprints, which can be left behind on surfaces. Iris recognition finds widespread application in organizations dealing with large populations, such as the "AADHAR" identification system implemented by the Indian government to maintain records of its citizens. The reason for its popularity is that iris systems utilize prints that remain relatively unchanged throughout a person's lifetime, ensuring stability and reliability.

The process involves video camera technology with subtle near-infrared illumination to capture external images of the intricate iris structures. Digital templates are then encoded from these patterns using mathematical and statistical algorithms, enabling the identification of individuals, or detecting impostors. Matcher engines quickly search databases of enrolled templates at remarkable speeds, measured in millions of templates per second per single-core CPU, with exceptionally low false match rates. Numerous countries worldwide have enrolled several hundred million people in iris recognition systems for various purposes, such as facilitating passport-free automated border crossings and national ID programs. One key advantage of iris recognition, apart from its rapid matching and resistance to false matching, is the iris's stability as an internal and protected, yet externally visible organ of the eye. This combination of attributes makes iris recognition a highly reliable and secure method of biometric identification⁶.

How is iris recognition used?

Iris recognition is considered more secure compared to fingerprint and other biometric technologies. A key advantage of iris recognition, besides its speed of matching and its extreme resistance to false matches, is the stability of the iris as an internal and protected, yet externally visible organ of the eye. Many people have improper fingerprints that are not suitable for fingerprint recognition systems. Iris is the second-best alternative to fingerprint. Children's fingerprints are difficult to scan and can go through changes over time, making it not a suitable biometric identification. Iris is suitable for all ages. The eyes unlike the fingers are a much-protected part of the body and do not go through many changes over the complete lifespan and are good for long-term biometric recognition. Iris recognition works with clear contact lenses, eyeglasses, and non-mirrored sunglasses.

The limitations of the system are: The accuracy of scanners can be affected by changes in lighting. Also, Iris scanners are significantly more expensive than some other forms of biometrics, as well as password and proximity card security systems. The first study on surgical patients involved modern cataract surgery and showed that it can change iris texture in such a way that iris pattern recognition is no longer feasible or the probability of falsely rejected subjects is increased. The scanners are often tough to adjust and can become bothersome for multiple people of different heights to use in succession. Iris recognition is very difficult to perform at a distance larger than a few meters and if the person to be identified is not cooperating by holding the head still and looking into the camera, criminals could exploit this flaw to steal the identities of others.

Retinal scanning is a different, ocular-based biometric technology that uses unique patterns on a person's retina blood vessels and is often confused with iris recognition. The human retina is a thin tissue composed of neural cells that are in the posterior portion of the eye. Because of the complex structure of the capillaries that supply the retina with blood, each person's retina is unique. The network of blood vessels in the retina is not entirely genetically determined and thus even identical twins do not share a similar pattern. A retinal scan is performed by casting an unperceived beam of low-energy infrared light into a person's eye as they look through the scanner's eyepiece. This beam of light traces a standardized path on the retina. Because retinal blood vessels absorb light more readily than the surrounding tissue, the amount of reflection varies during the scan. The pattern of variations is digitized and stored in a database.

Some of the limitations of this system are: Although retinal patterns may be altered in cases of diabetes, glaucoma, and retinal degenerative disorders, the retina typically remains unchanged from birth until death. Due to its unique and unchanging nature, the retina appears to be the most precise and reliable biometric, aside from DNA. Also, the National Center for State Courts estimates that retinal scanning has an error rate of one in ten million. For retinal scanning, the eye must be brought very close to an eyepiece just like looking into a microscope. Retinal scanning is invasive⁷.

2.2.3 RFID-Based System

Radio Frequency Identification (RFID) operates in conjunction with a microchip, a powered antenna, and a scanning device. While its initial commercial applications date back to the

1970s, it has become more widely accessible in recent times due to technological advancements in information storage and retrieval. With improvements in the reading and data storage technology, RFID has become more cost-effective to acquire and implement. RFID functions by utilizing a small electronic component, typically a microchip, to store information. These microchips are typically compact in size, sometimes as small as a grain of rice, yet they have the capacity to store significant amounts of data. While not all of them generate electricity themselves, certain RFID microchips may contain a built-in power source or batteries. Additionally, the scanning devices used to read these microchips can provide the necessary power for reading purposes. RFID technology finds numerous applications, but it is most employed for tracking products, animals, and currency⁸.

According to the article, the RFID reader automatically detects and records the student's attendance when the RFID card comes within proximity, utilizing a non-contact reader and passive cards. The entire process is automated with high transparency. As soon as the card is read by the reader, the attendance data is updated automatically. Compared to traditional methods, this system is considered more accurate as computer recording eliminates manual errors. Additionally, the RFID technology minimizes impersonation risks, as each student has a unique RFID card.

Despite its advantages, the system has some drawbacks. Impersonation can still occur to some extent because the RFID technology does not require the user to be physically present. Students may lend their RFID cards to their friends, allowing them to mark attendance on their

behalf. Moreover, students must always carry their cards to avoid being marked as absent. If an RFID card is lost or damaged, students may face complexities in reporting the issue, as the system lacks a manual key for overrides. Overall, the RFID-based attendance management system offers significant benefits in terms of automation, accuracy, and reduced human intervention. However, it also poses some challenges related to potential impersonation and the dependency on the RFID cards' physical presence.

2.2.4 Fingerprint-Based System

Fingerprint technology relies on the unique patterns of a person's fingerprints for identification purposes through fingerprint scanning. This technology finds application not only in security systems but also in the realms of forensic science and the investigation of crime scenes. Additionally, it can be integrated into household gadgets, such as specific laptop computers. Every individual possesses a distinct set of fingerprints, often referred to as a biometric fingerprint. Biometrics is the field of study concerned with understanding the variations among humans based on biological characteristics, like the formation of each person's fingerprints. Interestingly, even identical twins do not share identical sets of fingerprints. In essence, a person's fingerprints can be likened to an individualized identification card⁹.

2.2.5 Near-field communication (NFC)

Near-field communication (NFC) is a short-range wireless technology that enables communication between devices when they are brought close together or touched. It utilizes magnetic field induction to facilitate interactions within a few centimeters of distance. NFC

has a wide range of applications, including authenticating credit cards, providing physical access, transferring small files, and initiating more advanced wireless connections built upon and extending the capabilities of existing radio frequency ID tags (RFID) standards. While NFC shares some similarities with RFID, it adds more dynamic features, especially when combined with modern smartphones. Nowadays, all modern phones come equipped with NFC chips, allowing them to support applications like Apple Pay and Google Pay, leveraging the billions of existing RFID tags and terminals.

One of the primary advantages of NFC is its ability to consolidate multiple cards into a single smartphone for various purposes such as payments, accessing municipal transit, building entry, and even opening car doors. NFC can also enable interactive applications, like automatically pairing Bluetooth headphones and Wi-Fi connections. Moreover, it allows devices to pull up data or launch apps from posters or advertisements. Originally designed for file transfer between phones using Android Beam, NFC has evolved to support faster network configurations through services like Google Nearby Share. While NFC's short-range communication provides physical security benefits, users must be within a close distance (around 3.5 inches or 10 cm) of an NFC terminal for payment processing or door access. A significant advantage of NFC is that it operates without the need for a power source for basic listening and responding to requests. This makes it suitable for implementation in battery-less items like credit cards, further expanding its range of applications.

2.3. Review of Related Works

2.3.1 Student Attendance Management.

The traditional attendance system has several disadvantages, which necessitates the need for a replacement with an attendance system software. One major drawback of the traditional system is the time-consuming and costly paperwork involved in recording and managing attendance data. This manual process leads to inefficiencies and potential errors in maintaining accurate attendance records. In contrast, the proposed attendance system software aims to address these shortcomings. It offers a more streamlined and efficient approach to managing attendance. The main objective is to reduce processing time and paperwork costs associated with the traditional system. By transitioning to the proposed system, users can expect a significant improvement in attendance management.

The proposed system stands out for its simplicity and ease of use. It offers a user-friendly application with features that enable users to manage student attendance effectively and efficiently. Unlike other attendance systems that require specialized hardware like fingerprint scanners or mobile phones, the proposed system only needs basic equipment, such as a set of desktop computers, to function properly. The key characteristic of the proposed system is its computerized approach, which automates attendance record-keeping and reduces the workload for users. It introduces two modules: the admin module for managing classes and the report module for generating attendance reports. By using this system, users can avoid the manual hassle of recording attendance on paper.

Overall, the proposed attendance system offers numerous advantages over the traditional method. It is cost-effective, as it reduces the need for paper-based data processing. Additionally, it saves significant time for lecturers who no longer must spend hours recording student attendance throughout the semester. Embracing this computerized system allows educational institutions to achieve more efficient attendance management. The system does not require any special hardware to make it work, so it will be very easy to use due to its simplicity. At the same time, it will reduce the training cost required to train the user on how to operate the student attendance system. Besides that, it only requires a local database to store all the information of the student's attendance which means the lecturers do not need to worry about the network coverage issues. Other than that, the attendance system was designed with an extremely simple graphical user interface which allows users to easily deal with the system. The system will still require the lecturers to key in student attendance records in every class. Although the system had developed to work in computerization, it still requires computer operators to manage the storing and retrieving of information frequently. So, the proposed system had only converted the traditional attendance system to computerization, but everything still must be done manually such as key-in student attendance and so on. The proposed attendance system focuses on reducing paperwork costs but does not significantly address the issue of saving time in recording student attendance. The traditional system might still require considerable effort from lecturers to manually input attendance data for each class. Therefore, the time-saving aspect of the proposed system might be limited in this context.

Another concern raised in the paper is the possibility of lecturers manipulating attendance records to help students who frequently miss classes and prevent them from being barred from the final exam. Since the proposed system relies on lecturers to input attendance data, there may be a risk of bias or favoritism affecting the accuracy of attendance records. Furthermore, the paper indicates that the proposed system offers only very basic functions for lecturers to use. This limitation could hinder the system's overall effectiveness in providing comprehensive attendance management features and addressing the complexities that might arise in a real-world educational setting. In summary, while the proposed attendance system aims to reduce paperwork costs, it may not significantly alleviate the time burden on lecturers for attendance recording. Additionally, the potential for attendance data manipulation and the lack of advanced functionalities may raise concerns about the system's overall efficiency and accuracy in managing student attendance.

2.3.2 RFID-Based Attendance Management System

2.3.2.1 Overview

Attendance management is essential in various places such as schools, colleges, universities, and workplaces. The focus of this article is to replace the traditional attendance system with Radio Frequency Identification (RFID) technology to overcome existing issues. The RFID system is developed and proven suitable for tracking both student and employee attendance. The article introduces two modules: the reader module and the RFID module. Each student or employee is required to possess a valid RFID card or tag to interact with the RFID reader installed in their respective workplace or school.

With RFID technology, the attendance process becomes highly automated and transparent. The RFID reader automatically detects and records the attendance when the RFID card comes within proximity, utilizing a non-contact reader and passive cards. This automation reduces the need for extensive human involvement in the attendance record process, as students or employees merely need to carry their RFID cards to log their attendance. Compared to the traditional attendance system, the RFID-based system significantly improves efficiency. It eliminates the time-consuming practice of passing around attendance sheets in classes and eradicates the need for manual attendance marking by workers. The transition to RFID-based attendance management streamlines the entire process and reduces administrative burdens.

In conclusion, the RFID-based attendance system presents a fully automated and efficient approach to attendance management. With its high level of automation and transparency, it offers advantages over the traditional system, making it a promising solution for various educational institutions and workplaces. The RFID-based attendance system offers various benefits, including real-time check-in and check-out times for users. The system allows users to view attendance lists immediately through the computer interface or remotely from another computer. The automated database updates ensure accurate attendance records, eliminating the errors that might occur in the manual record-keeping of the traditional method. Additionally, the uniqueness of each student's RFID card prevents unauthorized attendance signing for absent buddies, enhancing the system's reliability¹¹.

2.3.2.2 Limitation

However, the system also has some drawbacks. Users, both students and employees, must always carry their RFID cards to check in or check out for attendance. Losing the RFID card poses challenges as they need to incur costs to obtain a new one, and the process of generating a new card might lead to delays in attendance recording. In cases of lost cards, students may need to report to the office with the lecturer's approval as evidence to regain their attendance status. The lack of a manual key-in function for the lecturer might add complexity to this process. Furthermore, while the RFID system helps prevent students from faking their attendance individually, it cannot eliminate the possibility of buddy signing. Students might still attempt to take their friend's RFID cards to scan on their behalf, creating a potential loophole in the system. In conclusion, the RFID-based attendance system offers numerous advantages, such as real-time updates and accurate record-keeping. However, it has limitations, including the requirement for constant card possession, challenges with lost cards, and the possibility of buddy signing. Despite these drawbacks, the system remains a significant improvement over the traditional manual attendance method.

2.3.3 Bar Code Scanner Based Student Attendance System (SAS)

2.3.3.1 Overview

Student attendance and active participation are crucial factors in achieving good academic outcomes for both students and schools. The main objective of this system is to replace the non-automated attendance record system with barcode scanner technology for more efficient and effective management of student attendance records. The system aims to address the cost

concerns associated with RFID-based and biometric-based technologies, as barcode technology proves to be more affordable. It introduces a barcode scanner attendance system to streamline administrative processes, especially in generating daily, weekly, and yearly student attendance reports. The barcode scanner technology is indeed a cost-effective option compared to RFID and biometrics technology, primarily due to the lower hardware equipment costs. The system's automation helps minimize human errors, making it more accurate in recording student attendance¹².

2.3.3.2 Limitation

However, a potential drawback of the barcode scanner system is that students might forget to bring their ID cards to class. This would require lecturers to approach the admin staff to change the student's attendance status, as they lack the authority to manually input attendance data into the system. Another limitation is that the system does not allow lecturers to generate warning letters directly. Instead, the warning letter is given to the student, who might then pass it to their parents. This indirect communication might lead to students discarding the warning letter or not informing their parents, which could hinder the intended purpose of encouraging regular class attendance. In conclusion, the barcode scanner technology offers cost advantages and increased accuracy in attendance recording. However, it may face challenges when students forget their ID cards or in the indirect communication of warning letters. Addressing these limitations could further enhance the effectiveness of the system in managing student attendance.

2.3.4 Facial Recognition System for Monitoring and Recognizing Students During Class Session

2.3.4.1 Overview

The use of face recognition technology in the attendance system is considered more efficient than other methods, including other biometric systems. The main objective of implementing this technology is to replace the manual attendance record system, thereby eliminating the need for paper-based processes and reducing the time taken for students to write their names. Among various biometric attendance systems, face detection is deemed the most accurate and fastest method since a person's face can represent their unique identity. In the described system, the classroom's camera captures a picture of the entire class, and the uploaded image is subjected to face filtering to identify individual students. The attendance of each student is automatically checked by the system through successful face matching. The system also offers a helpful feature where the lecturer can manually intervene by dragging and dropping a student's picture into the system if it fails to recognize the student's face. This allows for enhanced accuracy and reliability in attendance tracking.

Compared to the traditional manual attendance system in schools, face recognition technology offers significant advantages. Lecturers can simply activate the classroom's camera to capture the picture of the whole class, eliminating the need for manual attendance taking by students. This streamlined process enhances efficiency and saves time. In conclusion, the use of face recognition technology in the attendance system offers superior accuracy, speed, and efficiency when compared to other biometric methods and manual attendance processes. It

presents a promising solution for schools aiming to eliminate paper-based attendance records and optimize the attendance tracking process.

The system provides a high security feature since face recognition will only start to record attendance by performing face filtering after the lecturer has login using their ID and password and then captures the picture of the whole class. Every student's attendance will not be recorded before the lecturer uploads the picture and it makes the system security more convenient. Sometimes the student's face may not be recognized by the face detection system, but the system provides good features that allow the lecturer to upload the student's photo which will then be used to match the photo of the student stored in the database. By having these features. A student who was not recognized by the face detection would also be able to take attendance. The use of face recognition technology in the attendance system indeed offers a highly effective way to reduce or eliminate fake attendance, as everyone's face serves as a unique identity marker. Lecturers do not need to manually verify attendance, as the face recognition system can automatically solve this problem¹³.

2.3.4.2 Limitation

However, the system's reliance on manual photo uploads by lecturers raises concerns about mobility and automation. Manual control may not be the most efficient solution, and the system could benefit from further improvements in this aspect. Another limitation is that the report feature only allows the immediate generation of attendance reports. If the report is lost, there is no way to print it again without manually retrieving the data from the database server.

This lack of web services for report printing could be a drawback in terms of user convenience.

The cost of hardware for face recognition can be expensive, making it impractical to implement in every classroom. Additional CCTV hardware and computers are required to handle face recognition, adding to the system's overall cost. Moreover, the face recognition system may encounter challenges in capturing all faces in a classroom, and in cases of twins, there is a risk of incorrect identity matching. In conclusion, while face recognition technology offers effective ways to address fake attendance issues, there are some limitations that need to be considered. Improvements in automation, report generation, and hardware costs could enhance the system's overall efficiency and usability. It is crucial for educational institutions to weigh the benefits and drawbacks carefully before implementing face recognition technology in their attendance management systems.

2.3.5 Wireless Attendance Management System Based on Iris Recognition

2.3.5.1 Overview

Iris recognition is a highly reliable biometric method used for identifying individuals. Though once considered science fiction, advancements in technology have made iris recognition feasible for various applications, including attendance management systems. The main objective is to apply biometrics, specifically iris recognition, to wireless attendance management systems to enhance user attendance tracking in a more convenient and effective manner.

In the iris recognition system, the lecturer or admin staff acquires iris images of all students or staff and stores them securely in the database after undergoing various processing steps by the system. Unlike traditional methods such as magnetic cards or barcode scanners, iris recognition significantly reduces the chances of faked attendance since the iris is unique and cannot be easily separated from the individual. Additionally, the iris is well-protected behind the cornea and eyelid, making it less prone to damage compared to other biometric features like the face or voice.

Implementing iris recognition in the attendance system leads to improved staff and student attendance. For companies, it boosts staff morale, increases work efficiency, and enhances the company's image. For students, it encourages better attendance and obedience in attending classes. The use of wireless techniques in the system further reduces the risk of malfunctions associated with wired-based machines.

2.3.5.2 Limitation

However, the initial cost of implementing this attendance system can be a burden as the hardware devices required for iris recognition are relatively expensive compared to other biometric devices. The use of wireless techniques demands high transmission speeds for efficient identity verification. Without sufficient transmission speed, there may be delays in verifying student or staff identities as data continuously transmits between the data server and attendance verification devices.

In conclusion, iris recognition offers a reliable and secure solution for attendance management systems. While it may come with a higher initial cost and require high-speed wireless networks, the long-term benefits of attendance tracking, and increased efficiency make it a valuable investment for companies and educational institutions.

2.3.6 Wireless Fingerprint-Based College Attendance System Using Zigbee Technology

2.3.6.1 Overview

The fingerprint recognition attendance system is indeed more efficient than the manual attendance system, providing increased automation in managing student attendance. Compared to other biometric methods like facial recognition, the hardware cost for implementing fingerprint recognition is relatively lower, making it a practical choice for many institutions. The main objectives of the system focus on saving time in recording student attendance and expediting report generation. Students register their fingerprints into the database for future matching when attending classes. Fingerprint recognition is widely used and easily accessible in the community, simplifying hardware acquisition.

Fingerprint recognition is well-known for its accuracy and uniqueness, making it a successful biometric method for identity verification. The automated nature of the system allows for high-speed report generation, reducing errors in comparison to manual methods. Impersonation is eliminated since students must be physically present attendance system offers efficient and accurate attendance management. While it provides numerous benefits,

such as

Do Not Copy, Lead City University, Nigeria

automation and reduced impersonation, it should also be designed with flexibility in handling different attendance policies and considerations for potential network-related challenges.

2.3.6.2 Limitation

Moreover, issues with network connectivity could cause delays in students' attendance taking due to low response times. A robust network infrastructure is crucial to ensuring smooth operation and timely attendance recording. In conclusion, the fingerprint recognition would be required to overcome the challenges identified in the analysis and create a more reliable and accurate voice recognition attendance system.

2.3.7. Development of Voice Recognition for Student Attendance

2.3.7.1 Overview

The research on using a voice recognition system for student attendance was conducted, but the system was not implemented due to certain limitations. The programming system required improvement and testing with feature selection methods to achieve a more accurate outcome. The research mainly focused on the theoretical aspect and analysis of the system rather than practical implementation. As a result, no device was built or put into operation. The analysis revealed that the system faced challenges in recording and distinguishing voice amidst background noise, making it difficult for the system to accurately match the correct voice to the respective student.

2.3.7.2 Limitation

Despite the potential benefits of a voice recognition attendance system, the research highlighted the need for further development and refinement before it could be effectively utilized in a real-world setting. Addressing the noise interference and improving the overall accuracy were identified as crucial areas for enhancement. In conclusion, while the research provided valuable insights into the use of voice recognition for student attendance, the system was not fully implemented due to the need for improvement and testing. Additional work to register their attendance. However, a limitation of the system is the absence of a manual attendance feature. Students arriving late might be registered as absent since there is no provision for manual input. In some schools, late arrivals might be considered within a specific time frame, but the lack of flexibility in the system could lead to inaccuracies in the student attendance report¹⁴.

2.3.8 Biometric-Based Attendance System's Epee Campus as a case study

2.3.8.1 Overview

The use of a fingerprint-based attendance system has proven to be much faster and easier compared to the traditional manual method of taking attendance. A dedicated database was designed to store and maintain attendance records over time for each course. The system operates in two stages: the enrollment stage, where students' fingerprints are stored in the system, and the authentication stage, where attendance is taken using fingerprint identification. The execution time for the automatic attendance management system using fingerprint

identification is significantly lower than the manual method. For 80 students, the average execution time for the automatic system is approximately 3.79 seconds, while the manual method takes around 17.83 seconds. Moreover, the system efficiently generates attendance reports in just 30 seconds. This system has been successfully used in both lecture and examination halls, leading to its adoption in other schools due to its efficiency.

2.3.8.2 Limitation

However, the enrollment process, which involves storing the fingerprints of all students, can be time-consuming and labor-intensive, especially for schools with many students. Additionally, for effective implementation, each lecture room and examination hall must be equipped with a fingerprint recognition device, which can be costly depending on the number of rooms and halls in the school. In conclusion, the fingerprint-based attendance system offers notable advantages over the traditional manual method, such as speed and accuracy. However, careful consideration should be given to the enrollment process and the cost of implementing the system in multiple locations throughout the school. Overall, the system provides a viable and efficient solution for attendance management in educational institutions.

2.3.9 Speech Recognition of Offline Attendance Systems

2.3.9.1 Overview

The paper discussed various strategies and algorithms used in speech recognition to develop more advanced extracted features at each level of the system. The extraction of signals and their classification plays a critical role in speech recognition, and these two phases enable the

extraction of peak values. The efficiency of two techniques, namely GFCC and MFCC, in both noisy and noise-free environments was also examined in the paper. Additionally, the paper concluded that CMN (cepstral mean normalization) and GMM (Gaussian mixture model) models used in the final stages of the system proved to be more accurate, even in noisy environments, compared to other techniques. The research aimed to address the issue of system malfunctioning due to noise, which could result in the system's inability to take attendance. By exploring and comparing various techniques and algorithms, the paper attempted to find solutions to improve speech recognition performance, particularly in noisy conditions. Overall, the paper provided valuable insights into the challenges and advancements in speech recognition for attendance management systems, and it proposed potential solutions to enhance system efficiency and accuracy in different environments.

2.3.9.2 Limitation

It is expensive to set up. Given the complexity of many expensive experiments, there is an elevated risk of failure. If an experiment does not yield the expected results or breakthroughs, it can be seen as a substantial waste of resources.

2.3.10 Fingerprint-Based Attendance Management System

2.3.10.1 Overview

The research aimed to address the prevalent issue of high levels of impersonation in various sectors, including the ghost worker syndrome in government organizations and concerns over absenteeism in the workforce. Additionally, the difficulty in managing student attendance

during lecture periods was a concern that needed to be addressed. To combat these challenges, the researchers proposed the development of a fingerprint-based Attendance Management System. This system aimed to offer a faster, more secure, and convenient method of user verification compared to traditional methods like passwords and tokens, ensuring reliable personal identification. The proposed system consists of two main processes: enrollment and authentication. During enrollment, the biometric data of the user, specifically their fingerprints, is captured and stored as a template in a database along with their unique ID. This template is used to determine the user's identity during the authentication process. The enrollment process is conducted by an administrator of the attendance management system. During authentication, the user's biometric data is again captured, and the extracted features are compared with the templates stored in the database. A successful match confirms the user's identity, and attendance is marked against their ID in the system. To implement the system, a fingerprint reader was used to acquire fingerprint images. A program with fingerprint recognition and identification capabilities was developed, along with a database to store users' information. The database contained the fingerprint templates, other relevant user information, and attendance records. In conclusion, the proposed fingerprint-based Attendance Management System aimed to improve the accuracy and efficiency of attendance tracking, reducing impersonation, and enhancing user verification for both staff and students. The utilization of fingerprint biometrics provided a reliable and robust means of personal identification, contributing to a more reliable attendance management process¹⁸.

2.3.10.2 Limitation

In situations where a person has a cut or wound, or when fingerprints are obscured by dirt or grease, there is a notable limitation in the ability to reliably identify the individual using fingerprint technology. Fingerprint sensors are highly sensitive, which is advantageous when dealing with clean fingerprints, but this sensitivity becomes a drawback in industries like mining, construction, and manufacturing, where hands often become soiled or damaged.

2.3.11 Biometrics Attendance System

2.3.11.1 Overview

The research presented a multimodal system designed for controlling access and measuring student attendance in Learning Management System (LMS) environments. The primary objective of the student attendance measurement system was to provide biometric logs that offer reliable feedback on students' behavior while using the LMS. The control access was based on a combination of different biometric modalities, including face, voice, or fingerprint. The student attendance measurement system relied on face tracking and verification techniques. To ensure continuous and reliable authentication, joint authentication was integrated into the system. This collaborative authentication method was employed when the tracking system couldn't authenticate the student's identity, thus reinforcing the reliability of biometric logs. A key finding of the research was that human factors could significantly affect the performance of a non-collaborative authentication scheme. Some users exhibited special behaviors that degraded the system's performance.

However, by incorporating the collaborative authentication approach, the influence of such human factors on the system's performance was reduced. This resulted in noticeable improvements in terms of Student Presence Detected Time, and these improvements were achieved seamlessly since only a small subset of users were required to provide collaborative authentication. Overall, the multimodal system demonstrated its capability to enhance student attendance measurement and access control in LMS environments, and the incorporation of collaborative authentication proved to be an effective strategy in addressing challenges posed by certain user behaviors.

2.3.11.2 Limitation

The primary drawback of biometrics is the immutability of biometric data. Unlike passwords, which can be changed or reset if stolen, biometric characteristics cannot be altered. For instance, in the event of a password theft, a new password can be generated. Conversely, if a biometric feature is stolen or compromised from a database, there is no possibility of issuing a new biometric characteristic. Consequently, if a biometric database is breached, the compromised biometric used for authentication becomes unusable and cannot be reissued for security purposes.

2.4 Summary of Gaps in Literature

I have rightly pointed out an important characteristic shared by many of the discussed attendance systems, which is their reliance on a single mode of operation. When a system is dependent on a single mode of operation, it becomes vulnerable to operational threats. If that

single source fails, the entire attendance operation can be jeopardized, leading to disruptions in recording attendance data. Additionally, when dealing with large numbers of students, systems with a single mode of operation may lead to the buildup of queues, causing delays and consuming considerable productive time. This can be especially problematic in educational settings, where time is crucial for delivering lectures and conducting other academic activities. Furthermore, the cost of acquisition or implementation can be a significant factor in deciding which attendance system to adopt.

Some systems, such as speech recognition systems, may require costly hardware or software, making them less feasible for institutions with budget constraints. To address these issues, some institutions may opt for multi-modal attendance systems that combine multiple modes of operation, such as using a combination of RFID, fingerprint recognition, and facial recognition. Multi-modal systems provide redundancy and resilience against the failure of individual modes, ensuring more reliable attendance recording. Moreover, they can help alleviate queues and save productive time as students can choose from different modes for attendance recording. Considering cost implications, institutions need to weigh the benefits of the attendance system against its cost-effectiveness. While some advanced systems may be expensive, they can offer long-term efficiency gains and improved accuracy in attendance management. Ultimately, selecting the most suitable attendance system requires a careful assessment of the institution's specific needs, budget, and the potential benefits it offers in terms of efficiency, accuracy, and overall convenience.

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Chapter Three: Methodology

Methodology

3.1 Research Approach

Qualitative analysis revolves around examining data that cannot be easily quantified. This form of analysis focuses on gaining insights and understanding the properties and attributes of objects, typically participants in a study. Qualitative analysis delves into the "why" behind a particular phenomenon, providing a deeper comprehension of its underlying reasons. It can complement quantitative analysis or serve as a preliminary step before quantitative analysis is conducted. In contrast to quantitative analysis, which adheres to specific classification rules and numerical data, qualitative data analysis is more expansive and multifaceted. It is characterized by subjectivity, descriptiveness, a lack of statistical elements, and an exploratory approach to uncovering insights.

Quantitative analysis is often associated with numerical methods of data collection, categorization, and subsequent computation using statistical techniques. It involves the random selection of data from large samples, followed by a rigorous analysis. One of the key advantages of quantitative analysis is its ability to generate findings that can be applied to a broader population, leveraging research patterns developed from the sample. This is a limitation of qualitative data analysis, which typically has a more limited generalizability of findings. Quantitative analysis is characterized by its objective approach, aiming to understand the occurrence of events and describe them through statistical means. However, a more comprehensive understanding can often be achieved by employing both qualitative and

quantitative methods simultaneously. Quantitative analysis tends to overlook random and infrequent events in research results, while qualitative analysis is more attentive to them.

This research makes use of quantitative analysis and focuses on the design and construction of a proposed dual-mode attendance system device, which integrates facial recognition and RFID Card technologies. It is quantitative research of a quasi-experimental nature, indicating that it involves collecting and analyzing numerical data for evaluation and comparison. The system architecture or structure describes the overall design and layout of the Dual mode attendance system. It may include information on how the facial recognition and RFID Card components are integrated, how data is processed and stored, and how the system interacts with users and databases.

The hardware requirements outline the specific physical components needed to build the attendance system. This may include details about the cameras and sensors required for facial recognition, the RFID Card readers, microcontrollers or processors, memory storage, and any other relevant hardware. On the other hand, the software requirements specify the necessary programs and algorithms that are used to enable facial recognition and RFID Card processing. This involves using computer vision algorithms for facial recognition, developing software interfaces for RFID Card authentication, and integrating the software with the hardware components.

The waterfall software development approach is used which follows a linear and sequential process. It typically consists of several phases, including requirements gathering, system

design, implementation, testing, and maintenance. In this context, it is used as the development methodology for the Dual mode attendance system, guiding the researchers through each step to ensure a well-structured and systematic development process. Overall, this chapter serves as a foundation for understanding the technical aspects and implementation details of the Dual mode attendance system. It provides insights into how the system is designed, built, and tested to achieve the desired functionality of combining facial recognition and RFID Card technologies for attendance management¹.

Waterfall Model

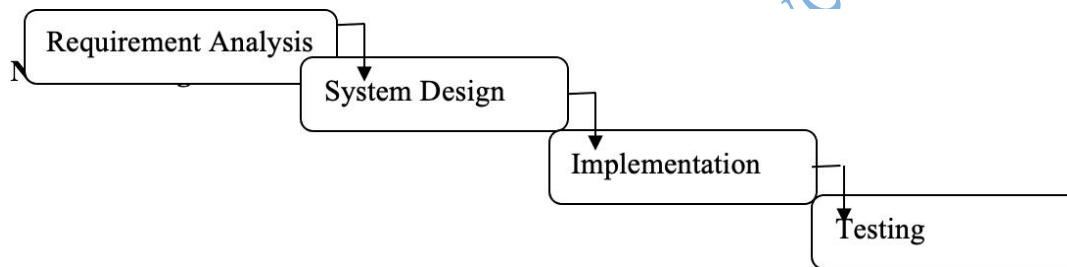


Figure 3.1: Waterfall Model

The waterfall model is a type of method used in software development processes. It is also referred to as the Linear Sequential Life Cycle Model. As the name implies, the process follows an order which is just like a waterfall. In a waterfall model, each phase must be completed fully before the next phase can begin.

The phases in the waterfall model are explained below:

- **Requirements Analysis:** This is the first phase of development where all the hardware and software requirements are gathered, documented, and analyzed.

- **Design:** In this phase, all the system design is analyzed and specified like hardware, system configuration, and architecture of the system.
- **Implementation:** In this phase, all the development works are performed, and the development components are handed over for testing.
- **Testing:** In this phase, each unit or component is tested to make sure they all work as expected. All the testing activities are performed in this phase.

3.2 System Design

When designing electronic circuits (or diagrams), a good knowledge of the components to be used is necessary. Concerning this project, to reach the stated goal and objectives which is to build a dual-mode attendance system based on Radio Frequency Identification (RFID) and Facial recognition, we must first study some key components.

3.2.1 List of Components For RFID

This project is constituted by the following named components.

- RFID Tags.
- Buzzer
- RFID reader.
- LED
- ATMEGA328 Microcontroller
- Jumper wire

Buzzer

Correct, a buzzer or beeper is an audio signaling device that produces a buzzing or beeping sound to alert or notify users of certain events or conditions. It can be implemented using

various technologies, such as electronic circuits, electromechanical components, or piezoelectric materials².

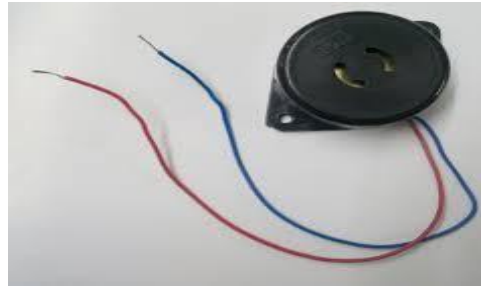


Figure 3.2: Buzzer

Jump Wire

A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are connected by inserting their end connectors into the slots offered in a breadboard or Arduino board, a circuit board header connector, or a piece of test equipment.



Figure 3.3: Jump Wire

RFID Tag

Correct, in the context of RFID technology, a tag is a small electronic device that holds data and communicates with an RFID reader when it is activated or interrogated by the reader. The tag can be either an Integrated Circuit (IC) based tag or a chipless tag. Integrated Circuit (IC) based tags, also known as transponders, contain a microprocessor chip that stores and processes data. These tags can perform more complex functions and can store additional information compared to chip-less tags. IC-based tags are commonly used in various RFID applications, such as asset tracking, inventory management, access control, and contactless payment systems.

On the other hand, chip-less tags do not have a microprocessor onboard and rely on unique patterns or arrangements of materials to represent data. They are simpler in design and cost-effective, making them suitable for applications where basic identification and tracking functions are sufficient. Both IC-based and chip-less tags have their advantages and

limitations, and the choice of tag type depends on the specific requirements of the RFID application. IC-based tags provide more flexibility and capabilities but may come at a higher cost, while chip-less tags offer cost-effectiveness and simplicity but have fewer functionalities³.



Figure 3.4 RFID Tag

RFID-RC522 READER

In this RFID-based attendance system, The RFID reader is a tool used in the processing of RFID card or RFID tag information or data. It is used for individual objects and transfers the data via radio waves from the RFID tag to the RFID card reader. The RFID reader does not scan all the RFID tags; it only scans the tags which is 3 to 300 feet. The RFID technology allows several items to be scanned quickly and fast for identification of the specific objects⁴.



Figure 3.5 RFID-RC522 Reader Module

Light Emitting Diode

You have provided an accurate description of light-emitting diodes (LEDs). LEDs are semiconductor devices that emit light when a current passes through them. They have the property of emitting light in a specific wavelength, which determines the color of the emitted light. This monochromatic nature of LEDs allows them to be used for various applications, including signaling on home appliances, mobile phone flashes, home lighting, entertainment lighting, flashlights, and more.

LEDs can be classified based on their power rating, with low-power LEDs typically being used for signaling purposes, and high-power LEDs being used in more demanding applications like lighting. Additionally, LEDs can be classified based on the distribution of energy in the wavelength range covering the visible spectrum. Chromatic LEDs emit light in a narrow wavelength range, while white LEDs distribute energy over the entire visible range, and infrared LEDs emit light beyond the visible spectrum. Due to their energy efficiency, reliability, and long lifespan, LEDs have become increasingly popular and widely used in

various lighting and signaling applications, replacing traditional incandescent and fluorescent lights in many cases⁵.

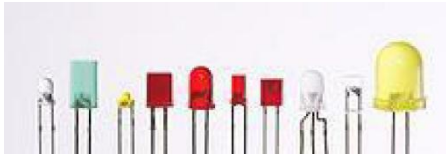


Figure 3.6: Light Emitting Diodes

MICROCONTROLLER

A microcontroller is a single-chip microcomputer that consists of at least a microprocessor, program memory, data memory, and input/output devices. A microcontroller is characterized by its integration, and a lower electric consumption (that is some milliwatt when ON and some nanowatt when OFF)⁵.

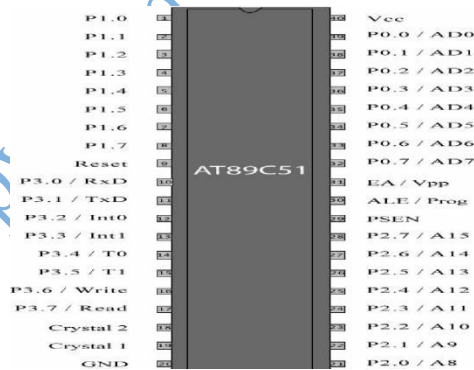


Figure 3.7: ATmega328P Arduino Microcontroller

3.2.2 Hardware Design

3.2.2.1 Arduino Uno Card

The Arduino Uno is a popular microcontroller board widely used in the maker and DIY electronics communities. It is based on the ATmega328 microcontroller, which is a part of the AVR family of microcontrollers. The board comes with a set of digital input/output (I/O) pins, analog input pins, and other necessary components to support the microcontroller's operation. The Uno board provides 14 digital I/O pins, out of which 6 can be used as PWM (Pulse Width Modulation) outputs. PWM pins are useful for controlling motors, LEDs, and other devices that require variable power levels. Additionally, there are 6 analog input pins, which can be used to read analog values from sensors and other analog devices.

The board is designed to be easy to use and program. It can be connected to a computer using a USB cable, allowing users to upload their programs (sketches) to the microcontroller using the Arduino Integrated Development Environment (IDE). The IDE provides a user-friendly interface for writing, compiling, and uploading code to the board. The Arduino Uno is a versatile board, suitable for a wide range of projects, from simple LED blinking experiments to complex robotics and automation projects. It is named "Uno" to signify that it is the first version of Arduino based on the ATmega328 and to mark the release of Arduino 1.0 software, which was a significant milestone in the Arduino platform's development. Overall, the Arduino Uno is a powerful and accessible microcontroller board that has played a crucial role in enabling countless creative projects and innovations in the field of electronics and programming.

- Microcontroller ATmega328
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V.
- Input Voltage (limits) 6-20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB of which 0.5 KB used by bootloader SRAM 2 KB
- EEPROM 1 KB
- Clock Speed 16 MHz

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be attached by plugging a 2.1mm center-positive connector into the board's power jack. Leads from a battery can be inserted in the GND and VIN pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. **VIN** The input voltage to the Arduino board when it's using an external

power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator or be supplied by USB or another regulated 5V supply. The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library). Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode (), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 K Ω . In addition, some pins have specialized functions.

Serial 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.**External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details. The Uno has 6 analog inputs, each of which provides 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function? Additionally, some pins have specialized functionality. **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the

board. Arduino Uno has several facilities for communicating with a PC, another Arduino, or different microcontrollers. The ATmega328 gives UART TTL (5V) sequential correspondence, which is accessible on computerized pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this sequential correspondence over USB and shows up as a virtual com port to programming on the PC. The '8U2 firmware utilizes the standard USB COM drivers, and no outside driver is required. Be that as it may, on Windows, a *.inf record is required.

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). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega328 datasheet. The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno w/ ATmega328" from the Tools > Board menu (per the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 on the Arduino Uno comes pre bonded with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header. (Wikipedia, ATmega328, 2015). The ATmega8U2 firmware source code is available. The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer.

One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nano-farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e., anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110ohm resistor from 5V to the reset line; see this forum thread for details. The Arduino Uno has a resettable polyfused that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed. The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension.

Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160mil (0.16"), not an even multiple of the 100mil spacing of the other pins. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone, or they can communicate with software running on a computer (e.g., Flash, Processing, MaxMSP).

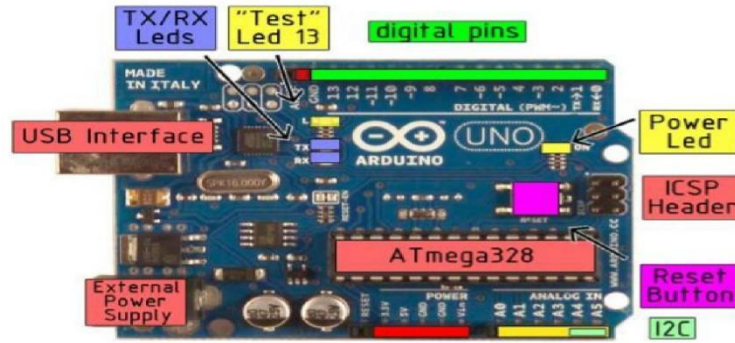


Figure 3.8: Pin diagram of Arduino Uno card.

3.2.2.2 RFID-RC522 READER MODULE

This board is based on the RFID-RC522 Module. Using the board with microcontrollers to read a card's data is very simple and requires just a serial connection. The board has a 3V voltage regulator so it can be powered by a 9~15V DC adapter. This module can also be powered through header wires (+3V & GND) from other interfacing boards. The board has a power indication LED (Labeled red in color) and to indicate the detection of Card/Tag, it has a LED (Labeled green in color) and Buzzer. SEL selection jumper is used to switch between two output formats:

- Serial O/P from TTL/CMOS Pin (Microcontroller Compatible) and RS232 O/P from DB9 Female Connector. (Note that Data is available at both TTL/CMOS and DB9 simultaneously.)
- Weigand26 O/P from ONLY DATA2 (It is DATA0 pin of EM-18) & DATA1 (It is DATA1 pin of EM-18) Pins. (Note that this is a different mode that uses different protocols, so if selected data can't be read using SERIAL Protocols, Like on UART or HyperTerminal.)

3.2.2.3 Serial Port Converter

A serial port is a serial communication interface through which information passes one bit at a time in or out sequentially, as opposed to a parallel port that simultaneously transmits several bits. Throughout most of the history of personal computers, data was transferred through serial ports to devices such as modems, terminals, and various peripherals.



Figure 3.10: Serial Port

3.2.3 Software Design

3.2.2.1 OpenCV Library

OpenCV is a Python library that allows you to perform image processing and computer vision tasks. It provides a wide range of features, including object detection, face recognition, and tracking, it was used to develop the facial recognition part of the system.

3.2.2.2 Django

Django is a high-level Python web framework that encourages rapid development and clean, pragmatic design. Built by experienced developers, it takes care of much of the hassle of web

development, so you can focus on writing your app without needing to reinvent the wheel. It's free and open source. It was used to develop the web part of the system.

3.2.2.3 Git

Git is a free and open-source distributed version control system designed to handle everything from small to very large projects with speed and efficiency. It was used to maintain each version of the application.

3.3 Requirements Specification

3.3.1 Working Principle

The word RFID (radio frequency identification) is an electronic device of one kind, which includes a small antenna and sensor. Using radiofrequency electromagnetic fields, this device is used to transmit information such as persons, animals, books or any stuff between the reader and RFID tag. It can carry 2k bytes of data. There are different kinds of RFID systems in the market, which consist of an antenna, a transponder, and a transceiver. Some types of tags can be located close to the RFID reader and some tags can be located far from the reader. The operating frequency ranges of these devices mainly include low, mid, and high ranges. The low-frequency range is from 30kHz to 500kHz, the mid-frequency range is from 900kHz to 1500kHz, and high-frequency range is 2.4kHz to 2.5kHz.

RFID belongs to a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and

enter those data directly into computer systems with little or no human intervention.

To do this RFID systems use radio waves. RFID systems are composed of three components at a simple level: an RFID tag or smart mark, an RFID reader, and an antenna. RFID tags include an integrated circuit and antenna for transmitting data to the RFID reader (also known as an interrogator). Then, the reader converts the radio waves to a more usable data form. Information collected from the tags is then transmitted to a host computer system via a communication interface, where the data can be stored in a database and analyzed later. RFID (radio frequency identification) is designed to serve as the Purpose of a barcode scanner or a magnetic strip on the back of the ATM card. It creates a unique identifier for that object and just like a barcode or magnetic strip; it needs to be checked to get the RFID information to recover the information.

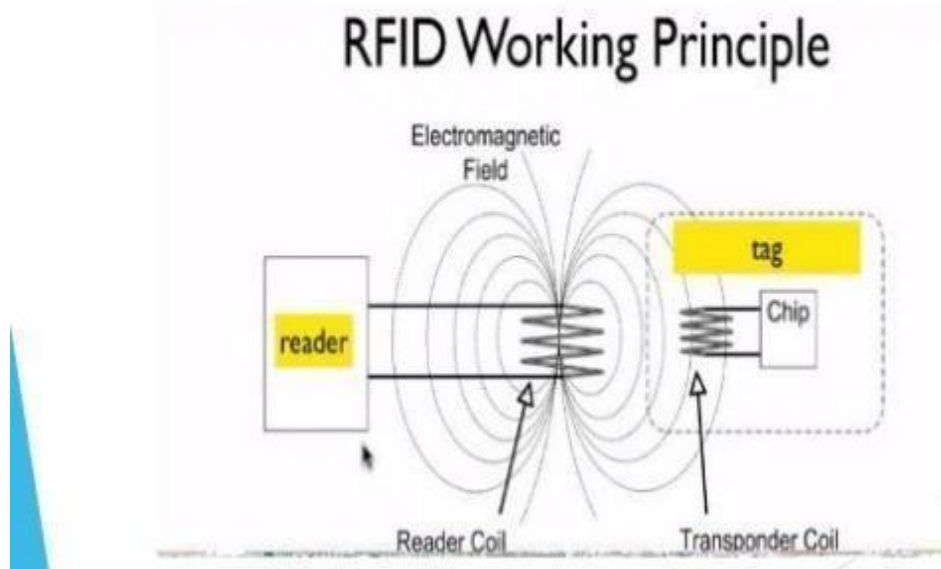


Figure 3.11: RFID Working Principles

3.3.2 Design

The software development units consist of C programming language, Arduino IDE, and Visual Studio IDE (C#).

C Programming Language

C is a general-purpose computer programming language developed in 1972 by Dennis Ritchie at the Bell Telephone Laboratories for use with the Unix operating system. Although C was designed for implementing system software, it is also widely used for developing portable application software. C is one of the most common programming languages ever and there are very few computer architectures that don't have a C compiler for. C influenced many other popular programming languages, particularly C++, which began as an extension to C. Design: In this project, C is used to permit the administrator (or lecturer) to validate the attendance of each student after they have swiped their card (or RFID Tag) at the beginning of each lecture class. This permits the administrator (or lecturer) the possibility of canceling the attendance of a student who decides to leave the class before the end of a lecture. In fact, it is in this section that the RFID Tag (or transponder) of each registered student is marked present automatically when he (or she) attends a lecture class, and it is also here that the attendance list of each class is generated before it is sent to the server.

Visual Studio IDE.

The system GUI is created using Microsoft Visual Studio as the IDE, using C#. The attendance interface is split into two parts which are the main interface (attendance) and the admin component. The purpose of the login part is to make the system more secure as admin must login before having access of the admin interface. C# (pronounced sharp, like the musical note C#, but written with the number sign) is a general-purpose, multi-paradigm programming language encompassing strong typing, lexically scoped, imperative, declarative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines. It was developed around 2000 by Microsoft as part of its .NET initiative and later approved as an international standard by (ECMA-334) and ISO (ISO/IEC 23270:2018). Mono is the name of the free and open-source project to develop a compiler and runtime for the language. C# is one of the programming languages designed for the Common Language Infrastructure (CLI). C# was designed by Anders Hejlsberg, and its development team is currently led by Mads Torgersen. The most recent version is 8.0, which was released in 2019 alongside Visual Studio 2019 version 16.3.

Python

The Python programming language has long been seen as one of the best ones to use. It has a big library to use, is easy to read, and has all the great features one needs for development

3.4 Research Methods

A top-down model was adopted in designing the RFID Based Student Attendance System. The result of the analysis was broken down into different components where the design started

from the main component down to the elementary components. The System was categorized into two (2) major subsystems which are the admin subsystem and the attendance subsystem. Each of the listed subsystems above has a different user privilege to use the systematic subsystem, here the user has the following privileges: add/delete/update records and system-wide information. In the listed subsystems, the administrator can delete, add, and update the subsystem information. This subsystem can view a student's record or marked attendance. Student subsystem, here the student marks attendance for each class attended, by swiping their ID cards across the sensor, the sensor accepts the registered student and marks the student present for the class.

3.4.1 Figures

Figure 3.10 describes the top-down design approach used; Figure 3.11 shows the application flow for the new system in flowchart drawings. The start page is used as the landing form of the system and each user based on their role will select the module, they have the privilege to access. Figure 3.12 shows the application flow chat for the student attendance subsystem.

Figure 3.13 shows the circuit diagram of the attendance system.

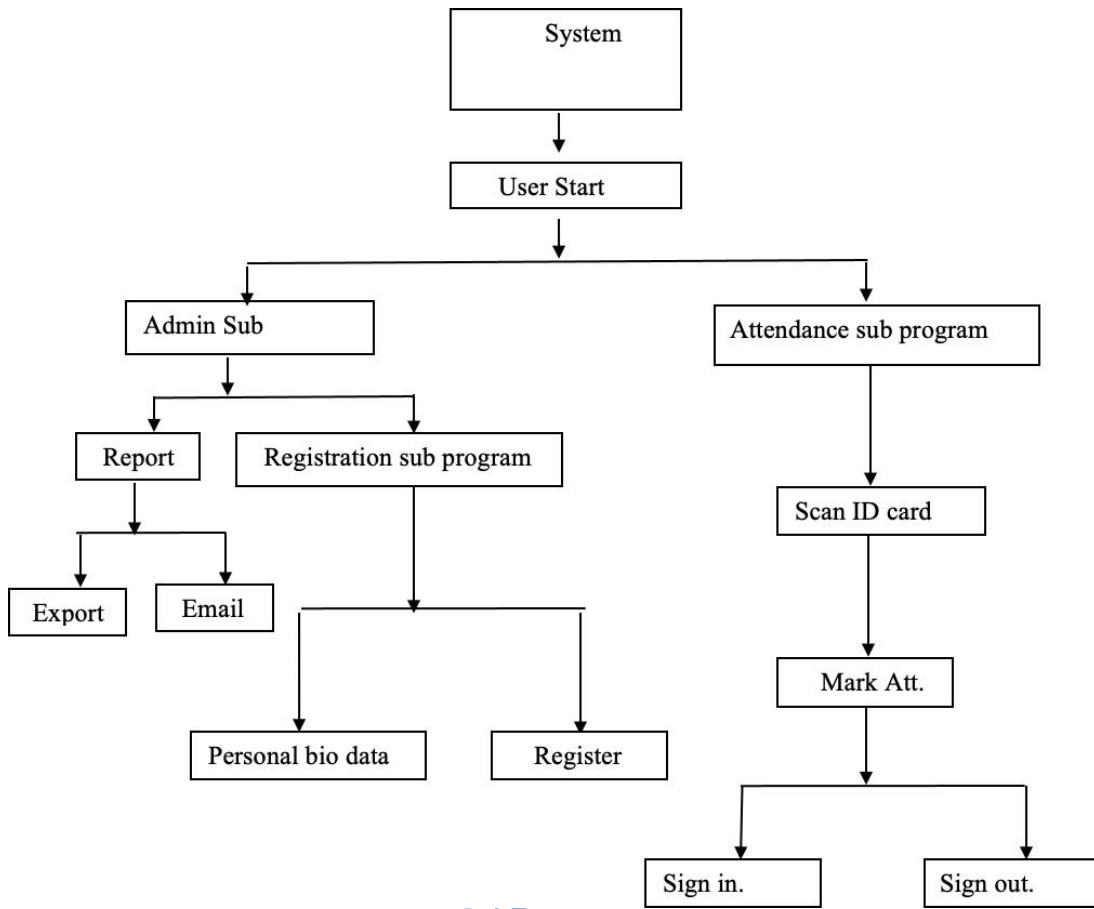
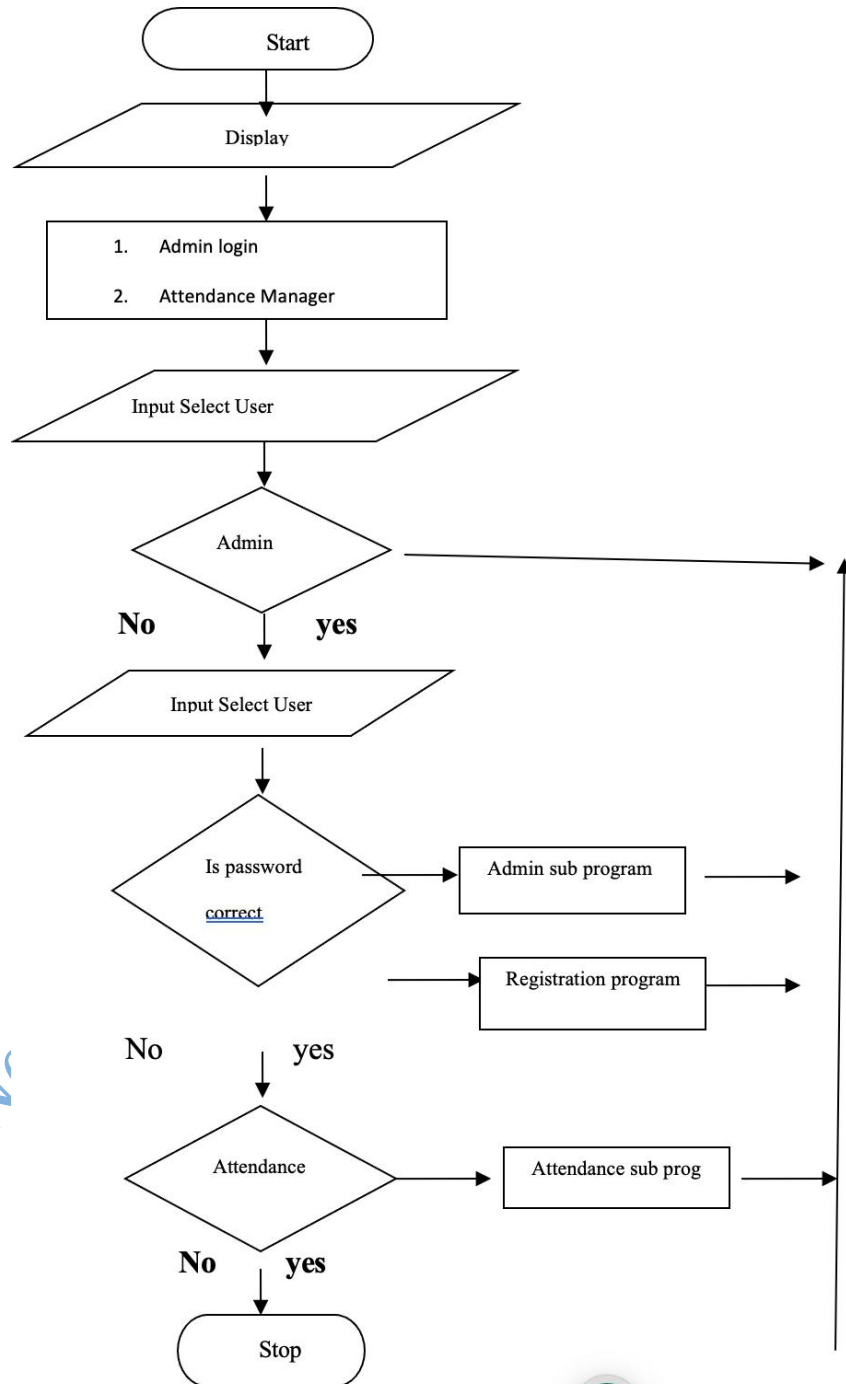


Figure 3.12: Top Down

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Figure 3.13: Flowchart of RFID Attendance System

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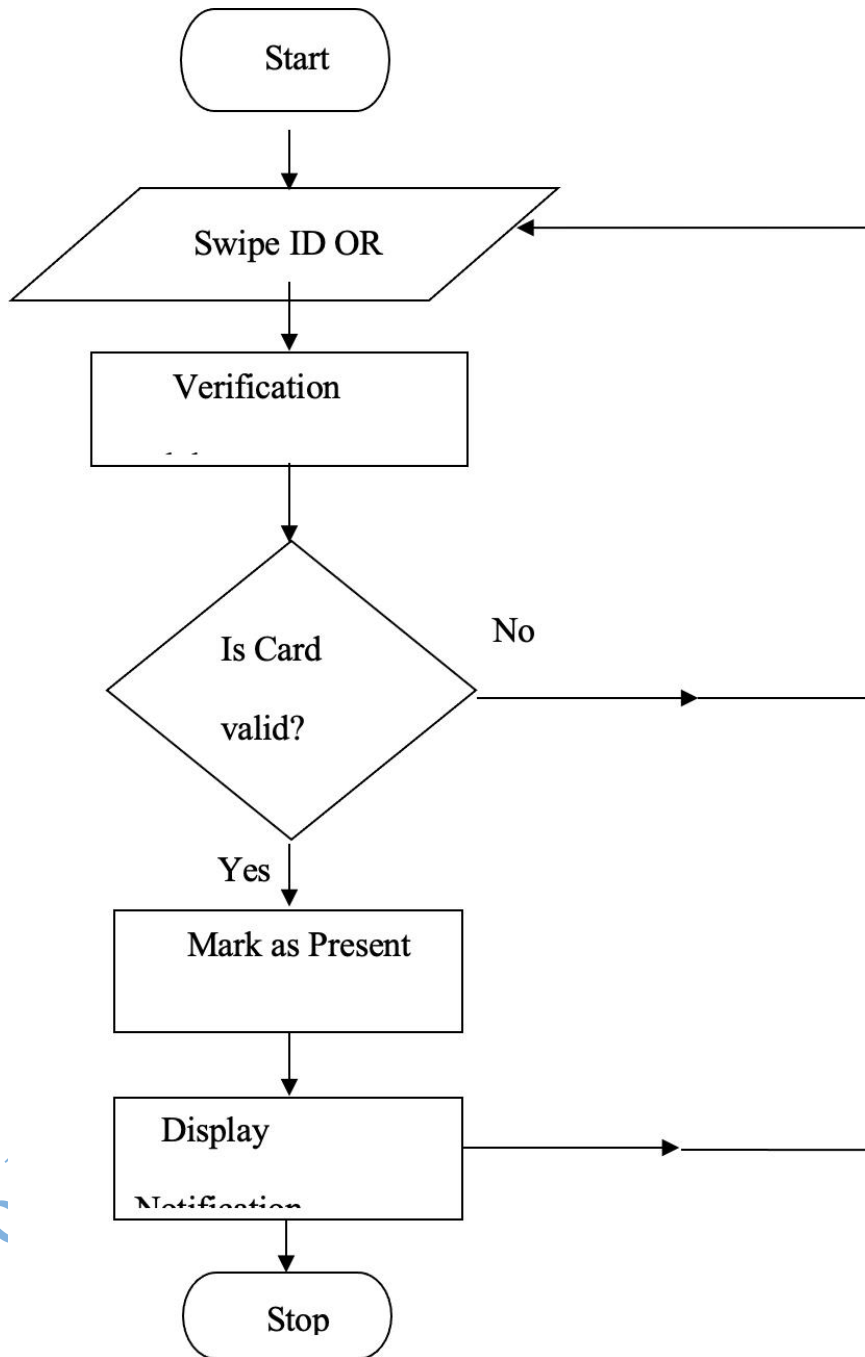


Figure 3.14: Flow Chart for Attendance Sub-Program

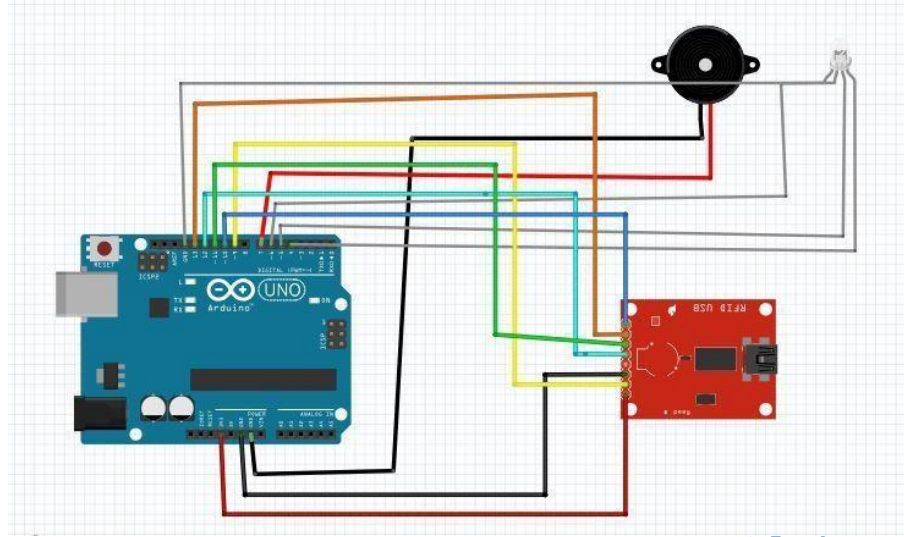


Figure 3.15: Circuit Diagram for an RFID-based Attendance System

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Chapter Four

Implementation and Evaluation

4.1 Implementation

This refers to how the main system is being implemented, explaining in steps how the system works and functions. There are several interfaces that make up the entire system which is broadly divided into two main sections which are the admin interface and the attendance interface which is also the student interface. System design is the development or creation of a computer-based technical solution for the business needs defined in the system review. It gives the plan or model of a system consisting of all specifications giving the system its shape and function (i.e., the formal implementation of the study of the system).

4.1.1 Choice of Programming Language

The system was designed using common and popular window development technology which includes Microsoft Visual C# and MSSQL Server 2012.

- **C#:** (pronounced see, sharp, like the musical note C#) is a general-purpose, multi-paradigm programming language encompassing strong typing, lexically scoped, imperative, declarative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines.
- **.NET Framework:** C# the programs run on the. Net Framework which is an integral component of Windows and includes the Common Language Runtime (CLR) virtual execution framework and a single collection of class libraries. The source code written

in VISUAL C #is compiled into an Intermediate Language (IL) specification that conforms to the Common Language Infrastructure (CLI).

- **Microsoft SQL Server:** MSSQL server is used to implement the back end of the new system. The server uses a relational database management system that offers a variety of administrative tools to ease the burdens of database development, maintenance, and administration. It also allows the use of stored procedure which is used to implement some of the business logic directly from the database.
- **T-SQL:** Transaction Structured Query Language is used to write stored procedures embedded in the Microsoft SQL server.
- **Python:** Python is a general-purpose, versatile, and popular programming language. Python is also a great first language because it is concise and easy to read. A good language to have in any programmer's stack, Python can be used for everything from web development to software development and data science applications.
- **OpenCV:** OpenCV is an image processing library created by Intel later supported by Willow Garage and now maintained by Itseez. opencv is available on Mac, Windows, and Linux. Works in C, C++, and Python. it is Open Source and free.

4.1.2 Main Menu

Figure 4.1 shows the menus available in the application which include the admin, the lecture, and export. The admin menu leads to the welcome pain for the admin to log in with the log in credentials, the lecture page takes the application to where the students can swipe the RFID

embedded ID card to load their details to mark the attendance for the class while the export leads to the part to export the selected file to an email address specified by the admin.

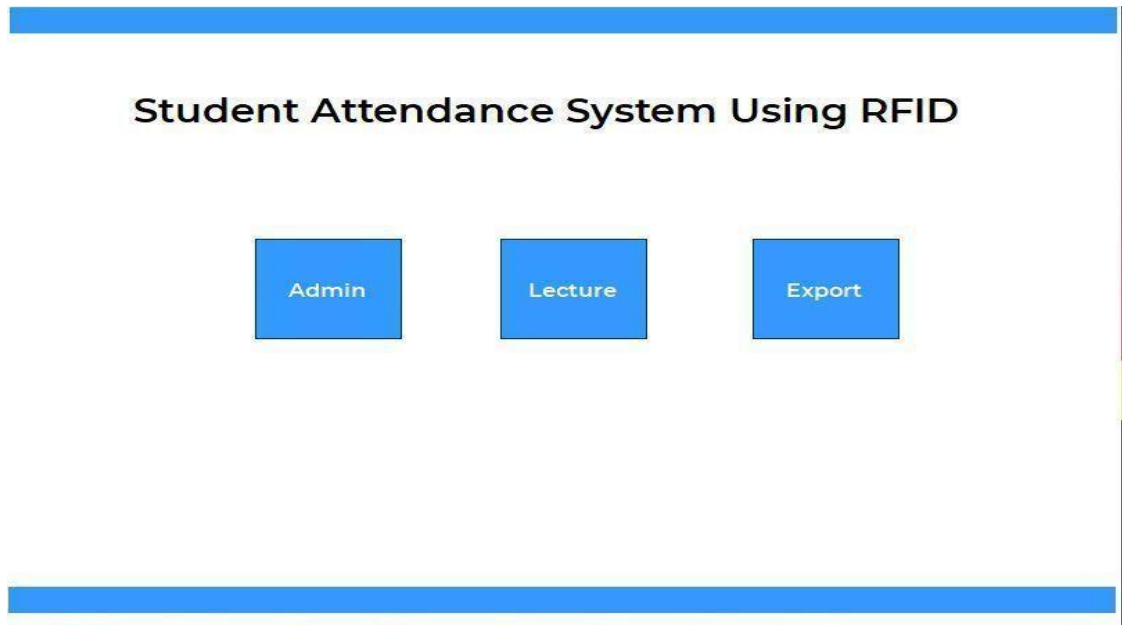


Figure 4.1: Main Menu

4.1.3 Admin Login Page

Figure 4.2.2 depicts the login form of the administrator. The administrator types in his/her username and password in order to navigate to the admin page where he/she to perform enrollment, updates, and settings.



The image shows a web page for an administrator login. At the top, there is a blue header bar. Below it, the text "Welcome Admin" is displayed in a blue font, followed by "Please Log in to The Dashboad" in a smaller blue font. There are two input fields: "User Name" and "Password", each with a corresponding text label to its left. Below the input fields are two blue buttons: "Log In" and "Cancel". In the bottom right corner, there is a blue button labeled "Exit". The entire page is framed by a blue border.

Figure 4.2 Admin Page

4.1.4 Admin Dashboard

In Figure 4.4, the various options available to the admin include adding a new student, report export, about the application, etc.

Admin Panel



Exit

Figure 4.3: Admin Panel

4.1.5 Enrollment

In figure 4.4, the students are being enrolled by the administrator or lecturer. The student's bio data is being registered and the RFID of each student ID card is being captured for authentication of the attendance. Once this is done the student can access the application for attendance marking as this will validate their various identity card issued to them.

The screenshot shows a web interface for student enrolment. The main heading is 'Enrolment'. On the left side, there is a vertical list of form fields: 'First Name:', 'Last Name:', 'Admission Year:', 'Faculty:', 'Department:', 'Sex:', 'Phone:', and 'Email:'. Each field has a corresponding input box or dropdown menu. To the right of these fields is a larger section for a student's profile. It includes a placeholder image of a person's head and shoulders. Below the image are two buttons: 'Upload Image' and 'Get Rfid'. Underneath these buttons are two more input fields: 'Matric No:' and 'RFid Tag'. On the right side of the form, there are two prominent blue buttons: 'Enrol' and 'Reset'. At the bottom right corner of the form area, there is a 'Back' button.

Figure 4.4: Capture Student

4.1.6 Report Extraction

The lecturer can extract the needed data in different ways which include selecting the data range, the number of time students attended a particular class, exporting the data to Microsoft excel, exporting the data to send via email to a source that needed it. Figure 4.6 below show the form that handles the extraction of the attendance from the database.

Attendance Profile

Course Code:

Course Date:

SN	Matric No	Rfid Tag	Department	Course Code	Date

Course Code:

From:

To:

SN	Matric No	Attendance	Department	Course

Figure 4.5: Report Extractions

4.1.7 Attendance

Students can mark attendance by swiping their id card across the hard connected with the application and reading their data from the database by so doing they can fill in the course code they are taking at that time; the application signs them in at the exact time and after the class they must repeat the same procedure to make sure the finish the class and close the class.

Figure 4.7 below shows the form that performs the function mentioned above.

Matric No:

First Name:

Last Name:

RFID Tag:

Year:

Department:

Faculty:

Sex:

Phone:



Time In:

Time Out:

Input Course:

Read Data

Sign In

Sign Out

Exit

Figure 4.6: Marking Attendance

4.1.8 Database Design

MYSQL database was used for this system because of its simplicity, readily available and easy to use as well as the language program used is attached with it already. Multithreading is the key feature to support MySQL performance design goals. MySQL performs the following functions:

- Accesses and manipulates databases.
- Executes stored queries against the database.
- Retrieves saved data from the database.
- Inserts and updates records into a database.
- Deletes records from a database.
- Creates new databases and creates new tables in a database etc.

The database for this project consists of the following tables which are described below:

1. Attendance Table
2. Deptlist Table
3. Facultylist Table
4. StudentData Table.

Attendance table

This table is used to store all the attendance for all the students. Its structure is defined below:

Column Name	Data Type	Allow Nulls
id	int	<input type="checkbox"/>
MatricNo	numeric(18, 0)	<input checked="" type="checkbox"/>
Rfid	varchar(MAX)	<input checked="" type="checkbox"/>
Dept	varchar(MAX)	<input checked="" type="checkbox"/>
Faculty	varchar(MAX)	<input checked="" type="checkbox"/>
TimeIn	date	<input checked="" type="checkbox"/>
TimeOut	date	<input checked="" type="checkbox"/>
CourseTaken	varchar(MAX)	<input checked="" type="checkbox"/>
StatusCheck	bit	<input checked="" type="checkbox"/>
		<input type="checkbox"/>

Figure 4.7: Attendance Table

Deptlist table

The table below is used to store departments in the Institution. Its structure is defined below:


	Column Name	Data Type	Allow Nulls
	ID	int	<input type="checkbox"/>
	Dept	varchar(MAX)	<input type="checkbox"/>
	FacultyIdentifier	varchar(MAX)	<input type="checkbox"/>

Figure 4.8 Deptlist Table

Faculty list table

The table below is used to store the faculty list of the institution. Its structure is defined below:


	Column Name	Data Type	Allow Nulls
	Id	int	<input type="checkbox"/>
	Faculty	varchar(MAX)	<input type="checkbox"/>
	Identifier	varchar(50)	<input type="checkbox"/>

Figure 4.9: Faculty List Table

StudentData table

The table below is used to store the biodata, RFID tag and other relevant details need from the student. Its structure is defined below:

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Column Name	Data Type	Allow Nulls
Id	int	<input type="checkbox"/>
Fname	varchar(MAX)	<input type="checkbox"/>
Lname	varchar(MAX)	<input type="checkbox"/>
Yearofent	date	<input type="checkbox"/>
Faculty	varchar(MAX)	<input type="checkbox"/>
Dept	varchar(MAX)	<input type="checkbox"/>
Sex	varchar(50)	<input type="checkbox"/>
Rfid	varchar(MAX)	<input type="checkbox"/>
PhoneNo	numeric(18, 0)	<input type="checkbox"/>
EmailAdd	varchar(MAX)	<input type="checkbox"/>
MatricNo	numeric(18, 0)	<input type="checkbox"/>
Photofile	varbinary(MAX)	<input checked="" type="checkbox"/>
StatusCheck	bit	<input type="checkbox"/>

Figure 4.10: Student Data Table

4.2 Testing and Results

This is a formal process of soliciting feedback on or from a system that is being developed. It is used to determine the effectiveness, correctness, efficiency, reliability, and robustness of the proposed system. Unit testing was carried out on individual components of different layers in the application to verify and ensure all different components such as classes are at the required minimal functional level. Also, an integration test was carried out, where all the independent components or modules are then integrated together to further verify the functionality of the interfaces of each component to spot defects in various interfaces and the behavior or responsiveness of each component when interacting together.

4.2.1 Test Plan

It involves a stage-by-stage assessment of all the subsystems which is carried out to determine the performance and efficiency of the authentication system and to equate the outcome with the expected overall result. It verifies the proper integration of machine components.

4.2.2 Test Data

The data needed for the testing comprises all student information such as student ID, matric no, name, department and sex, email, phone number, department, and picture. The course details also such as course code, course title, course description, add course, and course unit which are to be filled by the administrator after the students and the lecturers have been rolled and authenticated.

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Name	Year	RFID	Department	Level
<u>Adewusi Taiwo</u>	2022-08-05	20 201 26 141	CSE	200
<u>Dunsin Oyewo</u>	2022-08-05	06 173 33 72	CSE	300
<u>Poopola Praise</u>	2022-08-05	06 565 45 02	CSE	300
Kolawole David	2022-08-05	06 174 05 12	CSE	300
<u>Fola Bello</u>	2022-08-05	06 174 15 02	CSE	300
Olayinka Kunle	2022-08-05	06 174 25 23	CSE	300
<u>Karim Lookman</u>	2022-08-05	06 174 45 90	CSE	300
Akin Joshua	2022-08-05	06 174 45 12	CSE	300
<u>Akanni Rachel</u>	2022-08-05	06 174 45 45	CSE	300

Figure 4.11 Data sed.

4.2.3 Test Results

The result of this system testing is based on the information of these individuals listed above and due to alternative modes of attendance, no queue was formed, the attendance process was smooth and attendance time was reduced.


Matric No :	<input type="text" value="133574"/>		<input type="button" value="Read Data"/>
First Name:	<input type="text" value="Taiwo"/>		
Last Name:	<input type="text" value="Adewusi"/>	<input type="button" value="Sign In"/>	
RFID Tag:	<input type="text" value="20 201 26 141"/>		
Year:	<input type="text" value="01-Jan-15 12:00:00 AM"/>	<input type="button" value="Sign Out"/>	
Department:	<input type="text" value="Computer Science and Engin"/>		
Faculty:	<input type="text" value="FET"/>	<input type="button" value="Exit"/>	
Sex:	<input type="text" value="Male"/>		
Phone:	<input type="text" value="8164818909"/>		
Time In:	<input type="text" value="2019- 10-30"/>		
Time Out:	<input type="text" value="2019- 10-30"/>		
Input Course:	<input type="text"/>		

Figure 4.12: Sample One

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Chapter Five

Conclusion

5.1 Summary of Results

At the end of this study report, we need to specify the steps that will enable us to carry out an RFID-based and Facial Recognition attendance system; the different stages are defined in this report in Chapter I, we have the general introduction to the context of the study to carry out the problem statement, then we look at the research question so that we can carry out the research hypothesis. In Chapter II we reviewed the related literature where we talked about the different types of attendance systems (such as the barcode, biometric fingerprint, magnetic stripe, and the RFID attendance systems.), and the history of RFID.

The RFID Reader and the RFID Tag We had the research methodology in Chapter III, which was the opportunity for us to demonstrate our line of reflection to carry out this project through system review, system hardware creation, and finally system software development. In Chapter IV we had the design, implementation, testing, and result that presents the various parts (such as the UNO Card circuit for hardware program storage, the creation of the interface using C #with Visual Studio IDE, and the storage of device attendance in the database using MySQL) of the materialized piece that we have already realize and the method we used.

5.2 Contribution to Knowledge

In conclusion, the objective to build an attendance system based on RFID 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 (that is paper attendance). By using databases, 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.

5.3 Suggestion for Further Studies

Every good engineering design innovation has limitations, and the limitations of this design would be improved upon in the future by considering however some improvements that can be made on this project to increase its reliability and effectiveness. Some of these improvements are listed below.

1. An IP camera can be integrated into this system to monitor actions like buddy-punching wherein a person cheats by scanning for another person.
2. Also, a GSM can be incorporated into the system for sending messages to student's parents or guardians to confirm their presence or absence after a lecture class.
3. Finally, Ultra-High Frequency (UHF) active RFID tags (that is 3m to 9ft) can be used rather than High Frequency (HF) active RFID tags (that is 1m to 3ft) for better performance and flexibility of users.

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Appendices

A. C Program for

Arduino #include

<SPI.h> #include

<MFRC522.h>

#include <SoftwareSerial.h>

SoftwareSerial mySerial(6, 3);

char msg;

char call;

String c;

#define RST_PIN 5

#define SS_PIN 10

MFRC522 mfrc522(SS_PIN, RST_PIN);

const int buzzer = 7; //buzzer to arduino pin 7

int led =6;

void setup()

{

Serial.begin(9600);

mySerial.begin(9600);

SPI.begin();

mfrc522.PCD_Init();

pinMode(buzzer, OUTPUT); // Set buzzer - pin 7 as an output

```
pinMode(led, OUTPUT); }
```

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```
void loop()
{ RfidScan();
if(Serial.available()>0)
{
  c=Serial.readString();
  sendMessage(c);
}
}

void dump_byte_array(byte *buffer, byte bufferSize)
{ for (byte i = 0; i < bufferSize; i++)
{ Serial.print(buffer[i] < 0x10 ? " 0" : " ");
Serial.print(buffer[i], DEC);
}
Serial.println();
delay(1000);
}

void RfidScan()
{
if ( ! mfrc522.PICC_IsNewCardPresent())
return;

if ( ! mfrc522.PICC_ReadCardSerial())
return;
```

```
digitalWrite(led, HIGH);

delay(1000);

digitalWrite(led, LOW);

digitalWrite(buzzer, HIGH);

delay(1000);

digitalWrite(buzzer, LOW);

dump_byte_array(mfrc522.uid.uidByte, mfrc522.uid.size);

}

void sendMessage(String a)

{

    //String a;

    // a=Serial.readString();

    // Serial.println(a);

    String d = "AT+CMGS=\"" + a + "\"" + "\r";

    mySerial.println("AT+CMGF=1"); //Sets the GSM Module in Text

    Mode delay(1000); // Delay of 1000 milli seconds or 1 second

    mySerial.print(d); delay(1000);

    mySerial.println("your child is present today");// The SMS text you want to send

    delay(100);

    mySerial.println((char)26);// ASCII code of CTRL+Z

    delay(1000);

}
```

Appendix: Load Form

```
using System;
```

```
Using System.IO.Ports;
```

```
using System.Windows.Forms;
```

```
namespace FinalYear
```

```
{
```

```
    public partial class Form1 : Form
```

```
    {
```

```
        public Form1()
```

```
        {
```

```
            InitializeComponent();
```

```
        }
```

```
        private void button1_Click(object sender, EventArgs e)
```

```
        {
```

```
            Wlcome nn = new Wlcome(); nn.Show();    this.Hide();
```

```
        }
```

```
        private void button2_Click(object sender, EventArgs e)
```

```
{
    try
    {
        string[] ports = SerialPort.GetPortNames();
        foreach (string port in ports)
        {
            label2.Text = port;
        }
        if (label2.Text != "l")
        {
            Lecture nn = new Lecture();    nn.Show();    this.Hide();
        }
        else
        {
            MessageBox.Show("Please plug in the hardware Component");
            return;
        }
    }
    catch (Exception ex)
    {
        MessageBox.Show(ex.ToString());
    }
}
```

```
private void button4_Click(object sender, EventArgs e)
{
    if (MessageBox.Show("Are you sure to exit", "Warning", MessageBoxButtons.YesNo,
MessageBoxIcon.Warning) == DialogResult.Yes)
    {
        Application.Exit();
    } }
private void timer1_Tick(object sender, EventArgs e)
{
    progressBar1.Visible = true;
    this.progressBar1.Value = this.progressBar1.Value + 2;
    if (this.progressBar1.Value == 10)
    {
        label1.Text = "Reading modules..";
    }
    else if (this.progressBar1.Value == 20)
    {
        label1.Text = "Turning on modules.";
    }
    else if (this.progressBar1.Value == 40)
    {
```

```
        label1.Text = "Starting modules..";
    }
    else if (this.progressBar1.Value == 60)
    {
        label1.Text = "Loading modules..";
    }
    else if (this.progressBar1.Value == 95)
    {
        label1.Text = "Done Loading modules..";
    }
    else if (this.progressBar1.Value == 100)
    {
        timer1.Enabled = false; progressBar1.Visible = label1.Visible = false;
        button1.Visible = button2.Visible = button3.Visible = true;
    }
}

private void button3_Click(object sender, EventArgs e)
{
    SendReport nn = new SendReport(); nn.Show(); this.Hide();
}
}
```

Appendix: Lecturer Form

using System;

using System.Data.SqlClient;

using System.Drawing;

using System.IO;

using System.IO.Ports;

using System.Linq;

using System.Text;

using System.Threading.Tasks;

using System.Windows.Forms;

namespace FinalYear

{

 public partial class Lecture : Form

```
{
    String a; string[] abc = new String[100];

    SqlCommand cm; SqlConnection cn; SqlDataReader dr;

    bool chk = false;

    public Lecture()
    {
        InitializeComponent();

        try
        {
            string[] ports = SerialPort.GetPortNames();

            foreach (string port in ports)
            {
                label2.Text = port;
            }

            serialPort1.PortName = label2.Text;

            serialPort1.Open();
        }
        catch
        {
            MessageBox.Show("Please plug in the hardware Component");    return;
        }
    }
}
```

```
private void button4_Click(object sender, EventArgs e)
{
    Upload nn = new Upload(); nn.Show(); this.Close();
}

private void phoneTextBox_KeyPress(object sender, KeyPressEventArgs e)
{
    e.Handled = !char.IsDigit(e.KeyChar) && !char.IsControl(e.KeyChar);
}

connect v = new connect();

public void Check()
{
    cn.Close(); cn.Open();

    string sql = @"Select * from LecturerData where rfid like '" + mm + "'"; // sql string to
check the supplied rfid card from database

    cm = new SqlCommand(sql, cn); // sql command

    dr = cm.ExecuteReader(); // command to read the data gotten from the database

    dr.Read(); // reading the data from the database

    try
    {
        if (dr.HasRows) // line to check if the supplied details checks out from the database
```

```

    {
        nameTextBox.Text = (dr[1].ToString()); f_NameTextBox.Text =
(dr[2].ToString());

        batchTextBox.Text = (dr[3].ToString()); sectionTextBox.Text =
(dr[6].ToString());

        departmentTextBox.Text = (dr[4].ToString()); idTextBox.Text =
(dr[5].ToString());

        roll_No_TextBox.Text = (dr[7].ToString());phoneTextBox.Text =
(dr[9].ToString()); rfid_CardTextBox1.Text = (dr[3].ToString()); dr.Close();
    }
    else
    {
        MessageBox.Show("Access Denied! ", "Error!", MessageBoxButtons.OK,
MessageBoxIcon.Stop);// if the supplied details do not check out it shows this error message

        cn.Close();    } }
    catch
    {
    }
}

DataSet ds;

private void refreshImageList()
{

```

```
try
{
    connect nn = new connect(); using (SqlConnection conn = new
SqlConnection(nn.connection))
    {
        conn.Open();

        using (SqlDataAdapter adapter = new SqlDataAdapter("SELECT id,photofile
FROM LecturerData where StaffId = " + roll_No_TextBox.Text + "", conn))
        {
            ds = new DataSet("myDataSet"); adapter.Fill(ds); DataTable dt = ds.Tables[0];

            comboBox1.Items.Clear();

            foreach (DataRow dr in dt.Rows)
            {
                comboBox1.Items.Add(dr["id"].ToString());
            }

            comboBox1.SelectedIndex = 0;    dataGridView1.DataSource = dt;
        }
    }
}

catch (Exception ex)
{
    MessageBox.Show(ex.Message);
}
```

```
} }  
  
public void Aca()  
{  
    try {  
        DataTable dataTable = ds.Tables[0];  
        if (photoPictureBox.Image != null)  
        {  
            photoPictureBox.Image.Dispose();  
        }  
        photoPictureBox.Image = null;    photoPictureBox.Refresh();  
        //Initialize a file stream to write image data  
        try {  
            FileStream fs = new FileStream("image1.jpg", FileMode.Create);  
            foreach (DataRow row in dataTable.Rows)  
            {  
                if (row[0].ToString() == comboBox1.SelectedItem.ToString())  
                {  
                    //Store binary data read from the database in a byte array  
                    byte[] blob = (byte[])row[1];  
                    //Write data in image file using file stream fs.Write(blob,  
                    0, blob.Length); fs.Dispose(); fs.Close();  
                    photoPictureBox.Image = Image.FromFile("image1.jpg");  
                }  
            }  
        }  
    }  
}
```

```

        photoPictureBox.SizeMode = PictureBoxSizeMode.StretchImage;

        photoPictureBox.Refresh(); fs.Dispose(); fs.Close();

    }    }    }

    catch (Exception l)

    {    }    }

    catch

    {    }}

    public void CheckCourse()

    {

        cn.Close(); cn.Open();

        string sql = @"Select * from ClassData where Staffid like '" + roll_No_TextBox.Text

+ "' and StatusCheck = 1"; // sql string to check the supplied rfid card from database

        cm = new SqlCommand(sql, cn); // sql command

        dr = cm.ExecuteReader(); dr.Read();

        if (dr.HasRows)

        {

            textBox1.Text = (dr[7].ToString()); button3.Enabled = true; button2.Enabled =

false;

            dr.Close();

        }

        else

        {

```

```
        button3.Enabled = false;    button2.Enabled = false;    textBox1.Text = "";
    }
}

string mm;    string rfidtag;

private void button1_Click(object sender, EventArgs e)
{
    mm = rfidtag;    if (mm != null)
    {
        Check();    refreshImageList();    Aca();    CheckCourse();
    }
    else
    {
        MessageBox.Show("Error, Reading data from Tag. Swipe again");
    }
}

public void InsertTrail()
{
    dr.Close();
    SqlConnection cnnn = new SqlConnection(v.connection);

    try
    {
```

```

        string sql = @"INSERT INTO ClassData
(StaffId, Faculty, Dept, Rfid, TimeOut, TimeIn, CourseTaken, StatusCheck) values ('" +
roll_No_TextBox.Text + "','" + sectionTextBox.Text + "','" + departmentTextBox.Text + "','"
+ idTextBox.Text + "','" + DateTime.Now.Date + "','" + dateTimePicker2.Text + "','" +
textBox1.Text + "','" + true + "')"; // sql string containing supplied user details

        cm = new SqlCommand(sql, cn); // sql comand to run at the database

        cm.ExecuteNonQuery(); // execute the above command and returns the number of
rows affected in the database

        serialPort1.Close();

        MessageBox.Show("Class Started", "Signed In");

        Student mm = new Student(); mm.Show(); this.Hide();
    }

    catch (SqlException l)
    {
        MessageBox.Show(l.Message); // show the runtime error
    } }

private void button2_Click(object sender, EventArgs e)
{
    if (roll_No_TextBox.Text == "")
    {
        MessageBox.Show("Please swipe card to start class"); // show the runtime error
    }
}

```

```

}

else {

    InsertTrail();

    nameTextBox.Text = f_NameTextBox.Text = batchTextBox.Text =
sectionTextBox.Text = departmentTextBox.Text = idTextBox.Text =
roll_No_TextBox.Text = phoneTextBox.Text =
rfid_CardTextBox1.Text = textBox1.Text = "";

    photoPictureBox.Refresh();

    photoPictureBox.Image = Properties.Resources.photo;

} }

public void InsertTrail1()

{

    try

    {

        string sql = @"Update ClassData set TimeOut = " + dateTimePicker2.Value + ",
StatusCheck = 0 where Staffid like " + roll_No_TextBox.Text + " and StatusCheck = 1";

        cm = new SqlCommand(sql, cn);

        cm.ExecuteNonQuery();// execute the above command and returns the number of
rows affected in the database

        MessageBox.Show("Class Ended");

    }

    catch (SqlException l)

```

```
{
    MessageBox.Show(l.Message);// show the runtime error
}

private void button3_Click(object sender, EventArgs e)
{
    InsertTrail1(); nameTextBox.Text = f_NameTextBox.Text = batchTextBox.Text
    = sectionTextBox.Text = departmentTextBox.Text = idTextBox.Text =
    roll_No_TextBox.Text = phoneTextBox.Text = rfid_CardTextBox1.Text =
textBox1.Text = ""; photoPictureBox.Image = Properties.Resources.photo;

private void serialPort1_DataReceived_1(object sender, SerialDataReceivedEventArgs e)
{
    a = serialPort1.ReadLine(); rfidtag = a;
}

private void Lecture_Load(object sender, EventArgs e)
{
    cn = new SqlConnection(v.connection);
}

private void textBox1_TextChanged(object sender, EventArgs e)
{
    button2.Enabled = true;
}
```

```
}}
```

Appendix: Student Form

```
using System;
```

```
using System.Collections.Generic;
```

```
using System.ComponentModel;
```

```
using System.Data;
```

```
using System.Data.SqlClient;
```

```
using System.Drawing;
```

```
using System.IO;
```

```
using System.IO.Ports;
```

```
using System.Linq;
```

```
using System.Text;
```

```
using System.Threading.Tasks;
```

```
using System.Windows.Forms;
```

```
namespace FinalYear
```

```
{
```

```
    public partial class Student : Form
```

```
    {
```

```
        int i = 5;
```

```
        String a;
```

```
        string[] abc = new String[100];
```

```
        SqlCommand cm;
```

```
SqlConnection cn;

SqlDataReader dr;

bool chk = false;

public Student()

{

    InitializeComponent();

    try

    {

        string[] ports = SerialPort.GetPortNames();

        foreach (string port in ports)

        {

            label2.Text = port;

        }

        serialPort1.PortName = label2.Text;

        serialPort1.Open();

    }

    catch

    {

        MessageBox.Show("Please plug in the hardware Component");

        return;

    }

}
```

```
rfid_CardTextBox.Enabled = false;    }
```

```
private void Student_Load(object sender, EventArgs e)
```

```
{
```

```
    cn = new SqlConnection(v.connection);
```

```
    CheckCourseTrue();
```

```
}    connect v = new connect();
```

```
public void Check()
```

```
{
```

```
    cn.Close(); cn.Open();
```

```
    string sql = @"Select * from StudentData where rfid like '" + mm + "'"; // sql string to
```

check the supplied rfid card from database

```
    cm = new SqlCommand(sql, cn); // sql command
```

```
    dr = cm.ExecuteReader(); // command to read the data gotten from the database
```

```
    dr.Read(); // reading the data from the database
```

```
    if (dr.HasRows) // line to check if the supplied details checks out from the database
```

```
{
```

```
    nameTextBox.Text = (dr[1].ToString());
```

```
    f_NameTextBox.Text = (dr[2].ToString());
```

```
    batchTextBox.Text = (dr[3].ToString());
```

```

        sectionTextBox.Text = (dr[4].ToString());

        departmentTextBox.Text = (dr[5].ToString());

        idTextBox.Text = (dr[7].ToString());

        roll_No_TextBox.Text = (dr[10].ToString());

        phoneTextBox.Text = (dr[8].ToString());

        rfid_CardTextBox1.Text = (dr[6].ToString());

        dr.Close();

    }

    else

    {

        MessageBox.Show("Access Denied! ", "Error!", MessageBoxButtons.OK,
        MessageBoxIcon.Stop); // if the supplied details do not check out it shows this error message

        cn.Close();

    }

}

public void CheckAttendance()

{

    cn.Close();      cn.Open();

    string sql = @"Select * from Attendance where rfid like '" + idTextBox.Text + "' and
CourseTaken = null "; // sql string to check the supplied rfid card from database

    cm = new SqlCommand(sql, cn); // sql command

    dr = cm.ExecuteReader(); // command to read the data gotten from the database

```

```
dr.Read();// readind the data from the database

if (dr.HasRows)// line to check if the supplied details checks out from the database
{

}

else
{
    button2.Enabled = true;
    MessageBox.Show("Access Denied! ", "Error!", MessageBoxButtons.OK,
    MessageBoxIcon.Stop);// if the supplied details do not check out it shows this error message
    cn.Close();
}
}

DataSet ds;

private void refreshImageList()
{
    try
    {
        connect nn = new connect();
        using (SqlConnection conn = new SqlConnection(nn.connection))
        {
```

```
conn.Open();

using (SqlDataAdapter adapter = new SqlDataAdapter("SELECT id,photofile FROM
StudentData where MatricNo = " + roll_No_TextBox.Text + "'", conn))
{

    ds = new DataSet("myDataSet");
    adapter.Fill(ds);
    DataTable dt = ds.Tables[0];
    comboBox1.Items.Clear();
    foreach (DataRow dr in dt.Rows)
    {
        comboBox1.Items.Add(dr["id"].ToString());
    }
    comboBox1.SelectedIndex = 0;
    dataGridView1.DataSource = dt;
}
}
}
catch (Exception ex)
{
    MessageBox.Show(ex.Message);
}
}

public void Aca()
```

```
{
    DataTable dataTable = ds.Tables[0];
    if (photoPictureBox.Image != null)
    {
        photoPictureBox.Image.Dispose();
    }

    try
    {
        FileStream fs = new FileStream("image.jpg", FileMode.Create);
        foreach (DataRow row in dataTable.Rows)
        {
            if (row[0].ToString() == comboBox1.SelectedItem.ToString())
            {
                byte[] blob = (byte[])row[1];
                fs.Write(blob, 0, blob.Length);
                fs.Dispose(); fs.Close(); fs = null;
                photoPictureBox.Image = Image.FromFile("image.jpg");
                photoPictureBox.SizeMode = PictureBoxSizeMode.StretchImage;
                photoPictureBox.Refresh();
            }
        }
    }
    catch (Exception l)
```

```

    {
    }
}

public void InsertTrail()
{
    dr.Close();

    SqlConnection cnnn = new SqlConnection(v.connection);

    try
    {
        string sql = @"INSERT INTO Attendance
(MatricNo, Faculty, Dept, Rfid, TimeOut, TimeIn, CourseTaken, StatusCheck) values (' +
roll_No_TextBox.Text + "','" + sectionTextBox.Text + "','" + departmentTextBox.Text + "','"
+ idTextBox.Text + "','" + DateTime.Now.Date + "','" + dateTimePicker2.Text + "','" +
textBox1.Text + "','" + true + "')"; // sql string containing supplied user details

        cm = new SqlCommand(sql, cn); // sql comand to run at the database

        cm.ExecuteNonQuery(); // execute the above command and returns the number of
rows affected in the database

        MessageBox.Show("Attendance Marked", "Signed In");
    }
    catch (SqlException l)
    {
        MessageBox.Show(l.Message); // show the runtime error
    }
}
}

```

```
public void InsertTrail1()
{
    try
    {
        string sql = @"Update Attendance set TimeOut =
"+ dateTimePicker2.Value + ", StatusCheck = 0 where MatricNo like " +
roll_No_TextBox.Text+ " and StatusCheck = 1";

        cm = new SqlCommand(sql, cn);

        cm.ExecuteNonQuery();// execute the above command and returns the number of
rows affected in the database

        MessageBox.Show( "Signed Out");

        photoPictureBox.Image = Properties.Resources.photo;
    }

    catch (SqlException l)
    {
        MessageBox.Show(l.Message);// show the runtime error
    } }

private void button2_Click(object sender, EventArgs e)
{
    if (roll_No_TextBox.Text == "")
    {
        MessageBox.Show("Swipe Card to mark attendance");
    }
}
```

```

else
{
    photoPictureBox.Image = Properties.Resources.photo;    InsertTrail();
    nameTextBox.Text = f_NameTextBox.Text = batchTextBox.Text =
    sectionTextBox.Text = departmentTextBox.Text = idTextBox.Text =
    roll_No_TextBox.Text = phoneTextBox.Text = rfid_CardTextBox1.Text =
textBox1.Text = ""; photoPictureBox.Image = Properties.Resources.photo;
    button2.Enabled = false    CheckCourseTrue(); this.Refresh(); }
}

private void button3_Click(object sender, EventArgs e)
{
    InsertTrail1();
    nameTextBox.Text = f_NameTextBox.Text = batchTextBox.Text =
sectionTextBox.Text = departmentTextBox.Text = idTextBox.Text =
    roll_No_TextBox.Text = phoneTextBox.Text = rfid_CardTextBox1.Text =
textBox1.Text = "";    photoPictureBox.Image = Properties.Resources.photo;
    button3.Enabled = false;
}

string rfidtag;

private void serialPort1_DataReceived(object sender,
System.IO.Ports.SerialDataReceivedEventArgs e)
{

```

```

a = serialPort1.ReadLine(); rfidtag = a;    }

public void CheckCourse()
{
    cn.Close();    cn.Open();

    string sql = @"Select * from Attendance where MatricNo like "" +
roll_No_TextBox.Text + "" and StatusCheck = 1"; // sql string to check the supplied rfid card
from database

    cm = new SqlCommand(sql, cn); // sql command
    dr = cm.ExecuteReader();    dr.Read(); if (dr.HasRows)
    {
        textBox1.Text = (dr[7].ToString()); button3.Enabled = true; button2.Enabled = false;
        dr.Close();
    }
    else
    {
        button3.Enabled = false; button2.Enabled = true;
    }
}
string mm;

private void button5_Click(object sender, EventArgs e)
{
    photoPictureBox.Image.Dispose();
}

```

```
mm = rfidtag;

if (mm != null)

{

    Check(); refreshImageList(); Aca(); CheckCourse();

}

else

{

    MessageBox.Show("Error, Reading data from Tag. Swipe again");

}}

public void CheckCourseTrue()

{

    cn.Close(); cn.Open();

    string sql = @"Select * from ClassData where StatusCheck = 1"; // sql string to check

the supplied rfid card from database Staffid like "" + roll_No_TextBox.Text + "" and

    cm = new SqlCommand(sql, cn); // sql command

    dr = cm.ExecuteReader();

    dr.Read();

    if (dr.HasRows)

    {

        textBox1.Text = (dr[7].ToString());

        dr.Close();

    }

}
```

```
else
{
    textBox1.Text = "";
} }

private void button4_Click(object sender, EventArgs e)
{
    serialPort1.Close(); Lecture mm = new Lecture(); mm.Show(); this.Close();
} }
```

Appendix: Upload Data Form

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Data.SqlClient;
using System.Drawing;
using System.IO;
using System.IO.Ports;
```

```
using System.Linq;

using System.Text;

using System.Threading.Tasks;

using System.Windows.Forms;

namespace FinalYear
{
    public partial class Upload_Data : Form
    {
        SqlCommand cm;

        SqlConnection cn;

        public Upload_Data()
        {
            InitializeComponent();

            rfid_CardTextBox.Enabled = false;

            string[] ports = SerialPort.GetPortNames();

            foreach (string port in ports)
            {
                label3.Text = port;
            }

            serialPort1.PortName = label3.Text; serialPort1.Open();
        }
    }
}
```

```
}
```

```
private void Upload_Data_Load(object sender, EventArgs e)
```

```
{
```

```
    SelectFDData();    cn = new SqlConnection(v.connection);
```

```
}
```

```
connect v = new connect();
```

```
string imageName;
```

```
string deptlist;
```

```
private void SelectFDData()
```

```
{
```

```
    comboBox1.Items.Clear();
```

```
    SqlConnection con = new SqlConnection(v.connection);
```

```
    SqlCommand cmd = new SqlCommand(" Select Faculty from Facultylist", con);
```

```
    SqlDataReader dr = null;
```

```
try
```

```
{
```

```
    if (con.State == ConnectionState.Closed)
```

```
        con.Open();    dr = cmd.ExecuteReader(); int satay = 0
```

```
    while (dr.Read())
```

```
    {
```

```
        comboBox1.Items.Add(dr["Faculty"].ToString());
```

```
        satay++;
    }

}

catch (SQLException ex)
{
    string un = ex.Message;
}

finally
{
    dr.Close();    con.Dispose(); con.Close();
}

connect mm = new connect();

private void SelectDData()
{
    departmentComboBox.Items.Clear();

    SqlConnection con = new SqlConnection(mm.connection);

    SqlCommand cmd = new SqlCommand(" Select Dept from Deptlist where
FacultyIdentifier='"+deptlist+"'", con); SqlDataReader dr = null;

    try
    {
        if (con.State == ConnectionState.Closed)
```

```
        con.Open();

        dr = cmd.ExecuteReader();

        int satay = 0;

        while (dr.Read())

        {

            departmentComboBox.Items.Add(dr["Dept"].ToString());

            satay++;

        }

    }

    catch (SqlException ex)

    {

        string un = ex.Message;

    }

    finally

    {

        dr.Close();    con.Dispose(); con.Close();

    }

}

public void SetPortNameValues(object obj)

{

    string[] ports = SerialPort.GetPortNames(); // load all name of com ports to string

    ((ComboBox)obj).Items.Clear(); //delete previous names in combobox items

    foreach (string port in ports) //add this names to comboboxPort items    {
```

```
((ComboBox)obj).Items.Add(port); //if there are some com ports ,select first
}
if (((ComboBox)obj).Items.Count > 0)
{
    ((ComboBox)obj).SelectedIndex = 0;
}
else
{
    ((ComboBox)obj).Text = " "; //if there are no com ports ,write Empty
} }

private void insertData()
{
    if (imageName == "")
    {
        return;
    }
    try
    {
        //Initialize a file stream to read the image file
        FileStream fs = new FileStream(@imageName, FileMode.Open, FileAccess.Read);
        //Initialize a byte array with size of stream
        byte[] imgByteArr = new byte[fs.Length];
```

```

//Read data from the file stream and put into the byte array
fs.Read(imgByteArr, 0, Convert.ToInt32(fs.Length));

fs.Close();

// Save binary data in database

using (SqlConnection conn = new SqlConnection(mm.connection))
{
    conn.Open();    string sql = "update studentdata set Photofile = @img where
StatusCheck = 1";    using (SqlCommand cmd = new SqlCommand(sql, conn))
    {
        cmd.Parameters.Add(new SqlParameter("img", imgByteArr));
        int result = cmd.ExecuteNonQuery();
        if (result == 1)
            { MessageBox.Show("Image Added");    } } }
catch (Exception ex)
{
    MessageBox.Show(ex.Message);
} }
public void InsertTrail()
{
    if (photoPictureBox.Image == Properties.Resources.photo && nameTextBox.Text ==
"" && f_NameTextBox.Text == "" && rfid_CardTextBox.Text == "" && emailTextBox.Text
== "" && phoneTextBox.Text == "" && roll_No_TextBox.Text == "" &&

```

```

batchComboBox.SelectedItem.ToString() == "----Select Faculty  " &&
comboBox1.SelectedItem.ToString() == "---Select Sex  " &&
departmentComboBox.SelectedItem.ToString() == "----Select Department  " &&
batchComboBox.SelectedItem.ToString() == "Select Nationality or input year")
{
    MessageBox.Show("Please fill all required details");
}
else
{
    try
    {
        string sql = @"INSERT INTO StudentData
(Fname,Lname,Yearofent,Faculty,Dept,Sex,Rfid,PhoneNo,EmailAdd,MatricNo,StatusCheck)
values ('" + nameTextBox.Text + "','" + f_NameTextBox.Text + "','" +
batchComboBox.Text.ToString() + "','" + sectionComboBox.SelectedItem.ToString() + "','" +
departmentComboBox.SelectedItem.ToString() + "','" + comboBox1.SelectedItem.ToString()
+ "','" + rfid_CardTextBox.Text + "','" + phoneTextBox.Text + "','" + emailTextBox.Text + "','"
+ roll_No_TextBox.Text + ",1)";// sql string containing supplied user details
        cm = new SqlCommand(sql, cn);// sql comand to run at the database
        cn.Open(); cm.ExecuteNonQuery(); cn.Close(); cn.Open();
        insertData(); cn.Close();    cn.Open();
    }
}

```

```

        SqlCommand cmd = new SqlCommand("update studentdata set statuscheck = 0
where statuscheck = 1", cn); cmd.ExecuteNonQuery(); cn.Close();

        MessageBox.Show("Successful", "Done"); }

catch (SqlException l)

{

    MessageBox.Show(l.Message);// show the runtime error

} } }

```

```

private void button1_Click(object sender, EventArgs e)

{

    try

    {

        OpenFileDialog fldlg = new OpenFileDialog();

        fldlg.InitialDirectory = Environment.SpecialFolder.MyPictures.ToString();

        fldlg.Filter = "Image File (*.jpg;*.bmp;*.gif)|*.jpg;*.bmp;*.gif";

        if (fldlg.ShowDialog() == DialogResult.OK)

        {

            imageName = fldlg.FileName;    Bitmap bmp = new Bitmap(imageName);

            photoPictureBox.SizeMode = PictureBoxSizeMode.StretchImage;

            photoPictureBox.Image = (Image)bmp;

        }

        fldlg = null;

```

```
}  
catch (Exception ex)  
{  
    MessageBox.Show(ex.Message.ToString());  
}  
  
private void button4_Click(object sender, EventArgs e)  
{  
    InsertTrail();    button3_Click(sender, e);  
}  
  
private void button3_Click(object sender, EventArgs e)  
{  
    nameTextBox.Text = f_NameTextBox.Text = rfid_CardTextBox.Text  
    = phoneTextBox.Text = emailTextBox.Text = roll_No_TextBox.Text = "";  
    batchComboBox.SelectedIndex = sectionComboBox.SelectedIndex =  
    departmentComboBox.SelectedIndex = comboBox1.SelectedIndex = 0;  
    photoPictureBox.Image = Properties.Resources.photo;  
}  
  
private void button2_Click(object sender, EventArgs e)  
{  
    serialPort1.Close();    this.Hide()    Main_Menu u = new Main_Menu();    u.Show();  
}  
  
public void hide()
```

```

{
    string sql = @"INSERT INTO StudentData
VALUES(@Fname,@Lname,@Yearofent,@Faculty,@Dept,@Rfid,@PhoneNo,@EmailAdd,
@MatricNo,@StatusCheck,@Sex,@Photofile");// sql string containing supplied user details
    cn = new SqlCommand(sql, cn);// sql comand to run at the database
    cn.Open();
        cm.Parameters.AddWithValue("@Fname", nameTextBox.Text);// command
parameter to add date from a label
        cm.Parameters.AddWithValue("@Lname", f_NameTextBox.Text);// command to
store user details
        cm.Parameters.AddWithValue("@Yearofent",
batchComboBox.SelectedItem.ToString());//command to store the authority as a cashier
        cm.Parameters.AddWithValue("@Faculty",
sectionComboBox.SelectedItem.ToString());// command parameter to add date from a label
        cm.Parameters.AddWithValue("@Dept",
departmentComboBox.SelectedItem.ToString());// command to store user details
        cm.Parameters.AddWithValue("@Sex", comboBox1.SelectedItem.ToString());
        cm.Parameters.AddWithValue("@Rfid", rfid_CardTextBox.Text);//command
to
store the authority as a cashier
        cm.Parameters.AddWithValue("@PhoneNo", phoneTextBox.Text);// command
parameter to add date from a label

```

```

        cm.Parameters.AddWithValue("@EmailAdd", emailTextBox.Text); // command
to store user details

        cm.Parameters.AddWithValue("@MatricNo",
roll_No_TextBox.Text); // command to store the authority as a cashier

        cm.Parameters.AddWithValue("@StatusCheck", true); // command to store the
authority as a cashier

        cm.Parameters.AddWithValue("@Photofile", true); // command to store the
authority as a cashier

        cm.ExecuteNonQuery(); // execute the above command and returns the number of
rows affected in the database

        insertData(); cn.Close();    cn.Open();
}

private void comboBox1_SelectedIndexChanged(object sender, EventArgs e)
{
    deptlist = comboBox1.SelectedItem.ToString();    SelectDDData();
}

private void phoneTextBox_KeyPress(object sender, KeyPressEventArgs e)
{
    e.Handled = !char.IsDigit(e.KeyChar) && !char.IsControl(e.KeyChar);
}
}
}

```

Appendix: Report Form

```
using System;
```

```
using System.Data.SqlClient;
```

```
using System.Drawing;
```

```
using System.Linq;
```

```
using System.Windows.Forms;
```

```
using Excel = Microsoft.Office.Interop.Excel;
```

```
namespace FinalYear
```

```
{
```

```
    public partial class Report : Form
```

```
    {
```

```
        public Report()
```

```
        {
```

```
            InitializeComponent();
```

```
        }
```

```
        connect vv = new connect();
```

```
        private void button2_Click(object sender, EventArgs e) {
```

```
            SqlConnection con = new SqlConnection(vv.connection); con.Open();
```

```

SqlCommand cmd1 = new SqlCommand("select * from attendance where
CourseTaken ='" + textBox1.Text + "' and TimeIn = '" + dateTimePicker1.Text + "' ", con);

SqlDataReader dr1 = cmd1.ExecuteReader();

int v = 0;    int m = 0;

while (dr1.Read())

{

    listView1.Items.Add((v + 1).ToString());

    listView1.Items[v].SubItems.Add(dr1["MatricNo"].ToString());

    listView1.Items[v].SubItems.Add(dr1["Rfid"].ToString());

    listView1.Items[v].SubItems.Add(dr1["Dept"].ToString());

    listView1.Items[v].SubItems.Add(dr1["CourseTaken"].ToString());

    listView1.Items[v].SubItems.Add(dr1["TimeIn"].ToString());

    v++;      m++;    }    con.Close();

if (listView1.Items.Count > 0)

{

    button1.Enabled = true;

}    }

public void loadColumn()

{

    SqlConnection con = new SqlConnection(vv.connection);    con.Open();

```

```
SqlCommand cmd1 = new SqlCommand("select distinct MatricNo, count(*) as  
[Number of attendance] from attendance where CourseTaken ='" + textBox3.Text + "'  
group by MatricNo ", con);
```

```
        SqlDataReader dr1 = cmd1.ExecuteReader();        int v = 0;  
  
int m = 0;
```

```
    while (dr1.Read())
```

```
    {
```

```
        listView2.Items.Add(v + 1.ToString());
```

```
        listView2.Items[v].SubItems.Add(dr1["MatricNo"].ToString());
```

```
        listView2.Items[v].SubItems.Add(dr1["Number of attendance"].ToString());
```

```
v++;        m++;    }
```

```
    con.Close();
```

```
    if (listView1.Items.Count > 0)
```

```
    {
```

```
        button1.Enabled = true;
```

```
    } }
```

```
private void button1_Click(object sender, EventArgs e)
```

```
{
```

```
    if (listView1.Items.Count > 0)
```

```
    {
```

```
        Excel.Application app = new Excel.Application();
```

```
        app.Visible = true;    Excel.Workbook wb = app.Workbooks.Add(1);
```

Excel.Worksheet ws = (Excel.Worksheet)wb.Worksheets[1]; int i = 1;

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```
int i2 = 2; int x = 1;int x2 = 1;

int colNum = listView2.Columns.Count;

// Set first ROW as Column Headers Text

foreach (ColumnHeader ch in listView2.Columns)

{

    ws.Cells[x2, x] = ch.Text; x++;

}

foreach (ListViewItem lvi in listView2.Items)

{

    i = 1; foreach (ListViewItem.ListViewSubItem lvs in lvi.SubItems)

    {

        ws.Cells[i2, i] = lvs.Text; i++;

    } i2++; }

ws.Cells.Select(); ws.Cells.EntireColumn.AutoFit();

}

else

{

    MessageBox.Show("No Record to Export!!");

} }

private void textBox1_TextChanged(object sender, EventArgs e)

{
```

```
if (textBox1.Text.Count() < 1)
{
    button7.Enabled = false;
}
else
{
    button7.Enabled = true;
} }

private void button4_Click(object sender, EventArgs e)
{
    Main_Menu mm = new Main_Menu(); mm.Show();this.Close(); }
private void button5_Click(object sender, EventArgs e)
{
    loadColumn();
}
private void Report_Load(object sender, EventArgs e)
{
    button7.Enabled = false;
}
private void button6_Click(object sender, EventArgs e)
{if (textBox3.Text == "")
{
    MessageBox.Show("Please fill course code."); } }
```

```

else
{
    listView2.Items.Clear(); SqlConnection con = new SqlConnection(vv.connection);
    con.Open();

    SqlCommand cmd1 = new SqlCommand("select distinct MatricNo, dept,
CourseTaken, count(*) as [Number of attendance] from attendance where CourseTaken ="
+ textBox3.Text + " group by MatricNo,dept,CourseTaken ", con);

    SqlDataReader dr1 = cmd1.ExecuteReader(); int v = 0; int m = 0;

    if(dr1.HasRows)
    {
        while (dr1.Read())
        {
            listView2.Items.Add((v + 1).ToString());

            listView2.Items[v].SubItems.Add(dr1["MatricNo"].ToString());

            listView2.Items[v].SubItems.Add(dr1["Number of attendance"].ToString());

            listView2.Items[v].SubItems.Add(dr1["Dept"].ToString());

            listView2.Items[v].SubItems.Add(dr1["CourseTaken"].ToString());

            v++;    m++;    }
        }

    else

    {

        MessageBox.Show("No Record available");
    }
}

```

```

    }

    con.Close();

    if (listView1.Items.Count > 0)
    {
        button1.Enabled = true;
    } }

private void button7_Click_1(object sender, EventArgs e)
{
    listView1.Items.Clear();

    SqlConnection con = new SqlConnection(vv.connection);

    SqlCommand cmd1 = new SqlCommand("select * from attendance where
CourseTaken ='" + textBox1.Text + "' and TimeOut = '" + dateTimePicker1.Text + "' ", con);

    SqlDataReader dr1 = cmd1.ExecuteReader();

    int v = 0; int m = 0;

    if (dr1.HasRows)
    {
        while (dr1.Read())
        {
            listView1.Items.Add((v + 1).ToString());

            listView1.Items[v].SubItems.Add(dr1["MatricNo"].ToString());

            ; listView1.Items[v].SubItems.Add(dr1["Rfid"].ToString());

            listView1.Items[v].SubItems.Add(dr1["Dept"].ToString());
        }
    }
}

```

```

        listView1.Items[v].SubItems.Add(dr1["CourseTaken"].ToString())
; listView1.Items[v].SubItems.Add(dr1["TimeOut"].ToString());
v++;          m++;          }      }

else
{
    MessageBox.Show("No Record available");
}

con.Close();

if (listView1.Items.Count > 0)
{
    button1.Enabled = true;    } } }}

```

B. Python Code

```

import os
import subprocess
import mimetypes
import tempfile
import time
import logging
import openai
import msal,requests
from flask import Flask, request, jsonify
from azure.identity import DefaultAzureCredential
from azure.search.documents import SearchClient

```

```

from approaches.chatreadretrievereadwithdocsecurity import
Chatreadretrievereadwithdocsecurity
from approaches.retrievethenread import RetrieveThenReadApproach
from approaches.readretrieveread import ReadRetrieveReadApproach
from approaches.readdecomposeask import ReadDecomposeAsk
from approaches.chatreadretrieveread import ChatReadRetrieveReadApproach
from azure.storage.blob import BlobServiceClient

# Replace these with your own values, either in environment variables or directly here
AZURE_STORAGE_ACCOUNT = os.environ.get("AZURE_STORAGE_ACCOUNT") or
"mystorageaccount"
AZURE_STORAGE_CONTAINER = os.environ.get("AZURE_STORAGE_CONTAINER")
or "content"
AZURE_SEARCH_SERVICE = os.environ.get("AZURE_SEARCH_SERVICE") or "gptkb"
AZURE_SEARCH_INDEX = os.environ.get("AZURE_SEARCH_INDEX") or "gptkbindex"
AZURE_OPENAI_SERVICE = os.environ.get("AZURE_OPENAI_SERVICE") or
"myopenai"
AZURE_OPENAI_GPT_DEPLOYMENT =
os.environ.get("AZURE_OPENAI_GPT_DEPLOYMENT") or "davinci"
AZURE_OPENAI_CHATGPT_DEPLOYMENT =
os.environ.get("AZURE_OPENAI_CHATGPT_DEPLOYMENT") or "chat"
AZURE_FORMRECOGNIZER_SERVICE =
os.environ.get("AZURE_FORMRECOGNIZER_SERVICE") or "cog-fr-znrq6hs2daq2s"
AZURE_TENANT_ID = os.environ.get("AZURE_TENANT_ID") or
"faa81f90-b74f-4422-9b35-40dbd3151dd5"
Group_Ids = []

KB_FIELDS_CONTENT = os.environ.get("KB_FIELDS_CONTENT") or "content"
KB_FIELDS_CATEGORY = os.environ.get("KB_FIELDS_CATEGORY") or "category"
KB_FIELDS_SOURCEPAGE = os.environ.get("KB_FIELDS_SOURCEPAGE") or
"sourcepage"

# Use the current user identity to authenticate with Azure OpenAI, Cognitive Search and Blob
Storage (no secrets needed,
# just use 'az login' locally, and managed identity when deployed on Azure). If you need to use
keys, use separate AzureKeyCredential instances with the
# keys for each service
# If you encounter a blocking error during a DefaultAzureCredential resolution, you can
exclude the problematic credential by using a parameter (ex.
exclude_shared_token_cache_credential=True)
azure_credential = DefaultAzureCredential()

# Used by the OpenAI SDK
openai.api_type = "azure"

```

```

openai.api_base =
f"https://{AZURE_OPENAI_SERVICE}.openai.azure.com"
openai.api_version = "2022-12-01"

# Comment these two lines out if using keys, set your API key in the OPENAI_API_KEY
environment variable instead
openai.api_type = "azure_ad"
openai_token = azure_credential.get_token("https://cognitiveservices.azure.com/.default")
openai.api_key = openai_token.token

# Set up clients for Cognitive Search and Storage
search_client = SearchClient(
    endpoint=f"https://{AZURE_SEARCH_SERVICE}.search.windows.net",
    index_name=AZURE_SEARCH_INDEX,
    credential=azure_credential)
blob_client = BlobServiceClient(
    account_url=f"https://{AZURE_STORAGE_ACCOUNT}.blob.core.windows.net",
    credential=azure_credential)
blob_container = blob_client.get_container_client(AZURE_STORAGE_CONTAINER)

# Various approaches to integrate GPT and external knowledge, most applications will use a
single one of these patterns
# or some derivative, here we include several for exploration purposes
ask_approaches = {
    "rtr": RetrieveThenReadApproach(search_client,
AZURE_OPENAI_GPT_DEPLOYMENT, KB_FIELDS_SOURCEPAGE,
KB_FIELDS_CONTENT),
    "rrr": ReadRetrieveReadApproach(search_client,
AZURE_OPENAI_GPT_DEPLOYMENT, KB_FIELDS_SOURCEPAGE,
KB_FIELDS_CONTENT),
    "rda": ReadDecomposeAsk(search_client, AZURE_OPENAI_GPT_DEPLOYMENT,
KB_FIELDS_SOURCEPAGE, KB_FIELDS_CONTENT)
}

chat_approaches = {
    "rrr": ChatReadRetrieveReadApproach(search_client,
AZURE_OPENAI_CHATGPT_DEPLOYMENT, AZURE_OPENAI_GPT_DEPLOYMENT,
KB_FIELDS_SOURCEPAGE, KB_FIELDS_CONTENT),
    "rrrds": Chatreadretrieve_readwithdocsecurity(search_client,
AZURE_OPENAI_CHATGPT_DEPLOYMENT, AZURE_OPENAI_GPT_DEPLOYMENT,
KB_FIELDS_SOURCEPAGE, KB_FIELDS_CONTENT)
}

app = Flask(_name_)

```

```

@app.route("/", defaults={"path": "index.html"})
@app.route("/<path:path>")
def static_file(path):
    return app.send_static_file(path)

# Serve content files from blob storage from within the app to keep the example
self-contained.
# *** NOTE *** this assumes that the content files are public, or at least that all users of the
app
# can access all the files. This is also slow and memory hungry.
@app.route("/content/<path>")
def content_file(path):
    blob = blob_container.get_blob_client(path).download_blob()
    mime_type = blob.properties["content_settings"]["content_type"]
    if mime_type == "application/octet-stream":
        mime_type = mimetypes.guess_type(path)[0] or "application/octet-stream"
    return blob.readall(), 200, {"Content-Type": mime_type, "Content-Disposition": f'inline;
filename={path}'}

@app.route("/ask", methods=["POST"])
def ask():
    ensure_openai_token()
    approach = request.json["approach"]
    try:
        impl = ask_approaches.get(approach)
        if not impl:
            return jsonify({"error": "unknown approach"}), 400
        r = impl.run(request.json["question"], request.json.get("overrides") or {})
        return jsonify(r)
    except Exception as e:
        logging.exception("Exception in /ask")
        return jsonify({"error": str(e)}), 500

@app.route("/chat", methods=["POST"])
def chat():
    ensure_openai_token()
    approach = request.json["approach"]
    username = request.json["username"]
    try:
        Group_Ids = GetGroupIdsOfUserFromAAD(username)
        print(Group_Ids)
        impl = chat_approaches.get(approach)

```

```

    if not impl:
        return jsonify({"error": "unknown approach"}), 400
    r = impl.run(request.json["history"], request.json.get("overrides") or {}, Group_Ids)
    return jsonify(r)
except Exception as e:
    logging.exception("Exception in /chat")
    return jsonify({"error": str(e)}), 500

@app.route("/documentprep", methods=["Post"])
def documentprep():
    blob_name = request.json["blob_name"]
    group_ids = request.get_json()
    try:
        if not blob_name:
            return jsonify({"error": "please provide blob_name"}), 400
        else:
            print(group_ids.get('group_ids', []))
            download_report(blob_name,group_ids.get('group_ids', []))
            return jsonify("file successfully downloaded from blob")
    except Exception as e:
        return jsonify({"error": str(e)}), 500

def download_report(blob_name,groupids):

    print(groupids)
    # Connection string for the Azure Storage account
    connection_string =
    "DefaultEndpointsProtocol=https;AccountName=stznrq6hs2daq2s;AccountKey=t1F1BJ18i7H
    7Ksl44TB5ySiXNQ/zwvaQhFFdaZrZaE+MNfgJDFteINkeFIA+paTAWs6GRIF+9G2b+ASst
    I TKdA==;EndpointSuffix=core.windows.net"

    # Name of the container and the blob
    container_name = "files"
    #blob_name = "Leave Policy.pdf"

    # Create a BlobServiceClient object using the connection string
    blob_service_client = BlobServiceClient.from_connection_string(connection_string)

    # Get a reference to the container
    container_client = blob_service_client.get_container_client(container_name)

    # Get a reference to the blob
    blob_client = container_client.get_blob_client(blob_name)

```

```

# Download the blob to a temporary file
with tempfile.NamedTemporaryFile(prefix=blob_name+'-', delete=False) as tmp_file:
    blob_data = blob_client.download_blob()
    blob_data.readinto(tmp_file)

# Rename the temporary file to remove the suffix
new_file_name = tmp_file.name.split("-")[0]
os.rename(tmp_file.name, new_file_name)

#convert list into string
groupid = ''.join(groupids)
print(groupid)

# Call the Python script with the downloaded file as an argument
return_code = subprocess.call(['python', 'prepdocs.py', new_file_name, '--storageaccount',
AZURE_STORAGE_ACCOUNT, '--container', AZURE_STORAGE_CONTAINER,
'--searchservice', AZURE_SEARCH_SERVICE, '--index', AZURE_SEARCH_INDEX,
'--searchkey',
'BKto4pBDAN4im02VUrkKGOjTcD7t7nX2AR9aThNlvoAzSeCCum2N', '--
formrecognizerkey', '28582b80ed894b55ab3b271ca151bb3e', '--storagekey',
't1F1BJ18i7H7Ksl44TB5ySiXNQ/zwvvaQhFFdaZrZaE+MNfgJDFteINkeFIA+paTAWs6GRI
F
+9G2b+ASStlTKdA==', '--formrecognizerservice',
AZURE_FORMRECOGNIZER_SERVICE, '--tenantid', AZURE_TENANT_ID, '-v',
'--list',groupid])

if return_code == 0:
    print("Script ran successfully!")
else:
    print("Script encountered an error.")

# # Delete the temporary file
# os.unlink(tmp_file.name)
os.unlink(new_file_name)

return 'File processing started.'

def GetGroupIdsOfUserFromAAD(user_name) :

# Define the client ID, client secret, and tenant ID
tenant_id = "faa81f90-b74f-4422-9b35-40dbd3151dd5"
client_id = "2d256fa7-85f7-43c3-b64a-f90d3acadbca"
client_secret = "FSg8Q~tqbbDxYw1Vdj2oo1zUFFs~NMojXWSFuaQ4"

```

Define the required permissions

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```

scopes = ['https://graph.microsoft.com/.default']

# Create a new MSAL application object
app = msal.ConfidentialClientApplication(
    client_id=client_id,
    client_credential=client_secret,
    authority=f'https://login.microsoftonline.com/{tenant_id}',
)

# Acquire an access token for the Microsoft Graph API
result = app.acquire_token_for_client(scopes=scopes)

# Check if the access token was successfully acquired
if "access_token" in result:
    access_token = result["access_token"]
else:
    print(result.get("error"))

access_token = result["access_token"]

#Token generation and access user ID code.

# Set the MSAL app configuration
# Define the client ID, client secret, and tenant ID
client_id = "2d256fa7-85f7-43c3-b64a-f90d3acadbca"
authority = "https://login.microsoftonline.com/faa81f90-b74f-4422-9b35-40dbd3151dd5"
scopes = ["User.Read"]

# Create the MSAL app instance
app = msal.PublicClientApplication(
    client_id=client_id,
    authority=authority
)

# Get the access token silently
result = app.acquire_token_silent(scopes=scopes, account=None)

# Get the access token from the result
access_token = result["access_token"]
print(access_token)
# Use the access token to make API requests
# For example, to get the user's display name:
headers = {"Authorization": f'Bearer {access_token}'}
response = requests.get("https://graph.microsoft.com/v1.0/me", headers=headers)

```

```
display_name = response.json()["displayName"]
print(display_name)

# Make API request to get user ID
user_url = "https://graph.microsoft.com/v1.0/users?$filter=displayName eq '" + user_name
+ "'"
user_response = requests.get(user_url, headers={"Authorization": "Bearer " +
access_token})
user_id = user_response.json()["value"][0]["id"]
print("User Id:", user_id)

# Make API request to get groups for user
groups_url = "https://graph.microsoft.com/v1.0/users/" + user_id + "/memberOf"
groups_response = requests.get(groups_url, headers={"Authorization": "Bearer " +
access_token})
groups = groups_response.json()["value"]

groupids = list(map(lambda x: x.get('id'), groups))
return groupids

def ensure_openai_token():
    global openai_token
    if openai_token.expires_on < int(time.time()) - 60:
        openai_token =
azure_credential.get_token("https://cognitiveservices.azure.com/.default")
        openai.api_key = openai_token.token

if __name__ == "__main__":
    app.run()
```

Biodata

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University Compliance Certificate

This is to certify that this thesis by Yinka John Adegoke with matriculation number LCU/PG/00379 in the Department of Computer Science, Faculty of Natural and Applied Sciences, Lead City University, Ibadan, Oyo State, is in full compliance with the approved University's style /

Signature

Date

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