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Faculty of Arts, Environment and Technology

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Award name: BSc (Hons) in Computing

Module code: COMP607

Module name: Production Project

Module run:

Coursework title: Integration of Biometrics in a Record Management System

Due Date:

Module leader: (In LBU)

Module Supervisor: (In TBC) Mr. Rohit Raj Pandey

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Integration of Biometrics in a Record Management System

Module: Production Project
Date: [redacted]
BSc. (Hons) in Computing
[Level 6 : 2nd Semester]

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Submitted To: Mr. Rohit Raj Pandey

Submitted By:

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1. ABSTRACT

This project aims at how biometrics can be integrated in any system in a way that makes it more [redacted]

2. INTRODUCTION

Identifying a person based on their physiological or behavioural characteristics through an automated method is called biometrics. Examples of biometric based authentication includes recognition of unique physiological characteristics such as fingerprints, face, voice, iris, hand veins etc. [redacted]

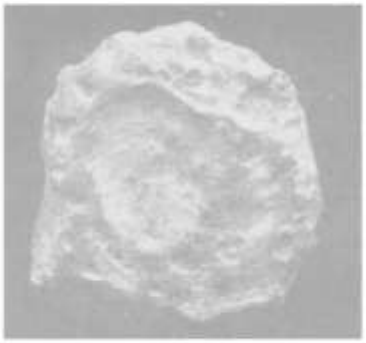
2.1 History and Development of Biometrics

In 1936, Frank Burch proposed the idea of using patterns as a form of personal identification. By the 80s, the idea had appeared in many sci-fi movies but still remained a fiction. In 1987, the idea was patented by Aram Safir and Leonard Flom and they asked help of their colleague John Daugman to create an algorithm for iris identification and differentiation. The development of the algorithm was completed and then patented by Daugman in 1994 and that algorithm is still the basis for all the iris identification system and products developed till today.

The algorithm is now known as Daugman algorithm and is owned by Iridian technologies. The process is permitted for use to other system integrator corporations. Nowadays, developers have made several products that can identify the images over a range of distance. Some banks even use special cameras in the ATM vestibules to capture iris images for personal identification. Iris recognition is no longer a new topic as it has now been implemented in smartphones, laptops and various devices for the purpose of identification. It is also used in many places as a security option such as airports and banks. The Daugman algorithm is still hugely popular and used in almost all the modern devices available.

Neolithic Carvings (Gavrinis Island) [103]

Standing Stone (Goat Island, 2,000 B.C.) [85]



A Chinese clay seal (300 B.C.) [85]

An impression on a Palestinian lamp (400 A.D.) [103]

Figure: Fingerprints found in ancient materials.

2.2 Biometric System

A biometric system works by recognising specific patterns of physiological and behavioural characteristic possessed by a person and verifies based on its authenticity percentage. There are mainly two logical modules [redacted]

similar representation. The final processed representation is then sent to a feature matcher which compares it against the one stored in database. If there is a match of significant percentage, the individual is then identified and verified.

2.3 Requirements of Biometric Identifiers

For a physiological or a behavioural characteristic to be used as a biometric, these requirements should be fulfilled.

[redacted]

But, thinking practically, it may not be feasible for any biometric characteristic to fully fulfil all those requirements. However, there are some issues that must be taken into consideration such as:

a) Performance: This refers to the attainable identification accuracy, swiftness and robustness of the characteristic along with resources required and operational environmental factors that affect it.

[redacted] Acceptability: This refers to the extent to which people feel comfortable to accept a [redacted]

c) [redacted]: This refers to how easy it is to bypass the system by using fraudulent techniques.

A secure and practical biometric system should be able to:

[redacted]

c) [redacted] trickery, bypassing or other fraudulent methods.

2.4 Operational Mode

One of the key concerns in developing a practical biometric identification system is to determine how a user is identified. There are two kinds of identification system in the context of an application, a verification system and an identification system. A verification system is a one to one comparison of the scanned biometrics of a person to his or her own biometric template stored in a database. This is done to check if the identity claimed by someone is true or false. But, an identification system recognizes a person by searching an entire database and coming up with a match (if in the database) to establish the identity of a user. In this case it is one to many comparisons to establish the subject's identity without them having to prove themselves.

A biometric system could either be an online system or an offline one depending upon the application field. In an online verification or identification system, the action should be quick to

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provide an immediate response. But, an offline system usually does not require the identification or verification to be done immediately and a long response delay is often allowed.

2.5 Performance

Biometric characteristics have a huge intraclass variations due to which any identity made by a biometric s

Outcomes 1 and 4 are correct whereas 2 and 3 are not. The confidence level with the identity of an individual may be determined by two error rates known as false acceptance rate and false rejection rate. These rates are categorised by the total distribution of genuine and imposter data information. The false acceptance rate is the probability of an imposter's chance to bypass the system and be passed off as a genuine individual. The false rejection rate is the probability that a genuine user is rejected because they're deemed an imposter. The false rejection rate and the false acceptance rate are inversely proportional to each other. A small false rejection rate means that the false acceptance rate is going to be high and a small false acceptance rate means that the false rejection rate is automatically going to be high. The competence of a biometric system in executing automatic personal identification is measured in terms of false acceptance rate. A false acceptance rate of zero means that the system does not or has not passed any imposters as genuine users.

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2.6 Applications

Biometrics is used widespread nowadays and is an ever evolving technology. It is widely used in forensics department for identification of criminals and prison security. Biometrics is also used in a broad range of civilian applications. The uses of biometrics can be divided into two groups: i) applications such as electronic commerce, banking sectors and access control where biometrics replaces the token based techniques. ii) Applications such as immigration and welfare where neither the token based nor the knowledge based techniques are used.

[redacted]

3. BIOMETRIC TECHNOLOGIES

A biometric characteristic can either be a behavioural or a physiological one. A behavioural characteristic is something that we've learnt to do. A physiological characteristic is something that is innate to us. Generally, physiological characteristics are more accurate in terms of identification than the behavioural characteristics and hence more reliable. This happens because the physiological characteristics have smaller intraclass variation than behavioural biometric characteristic.

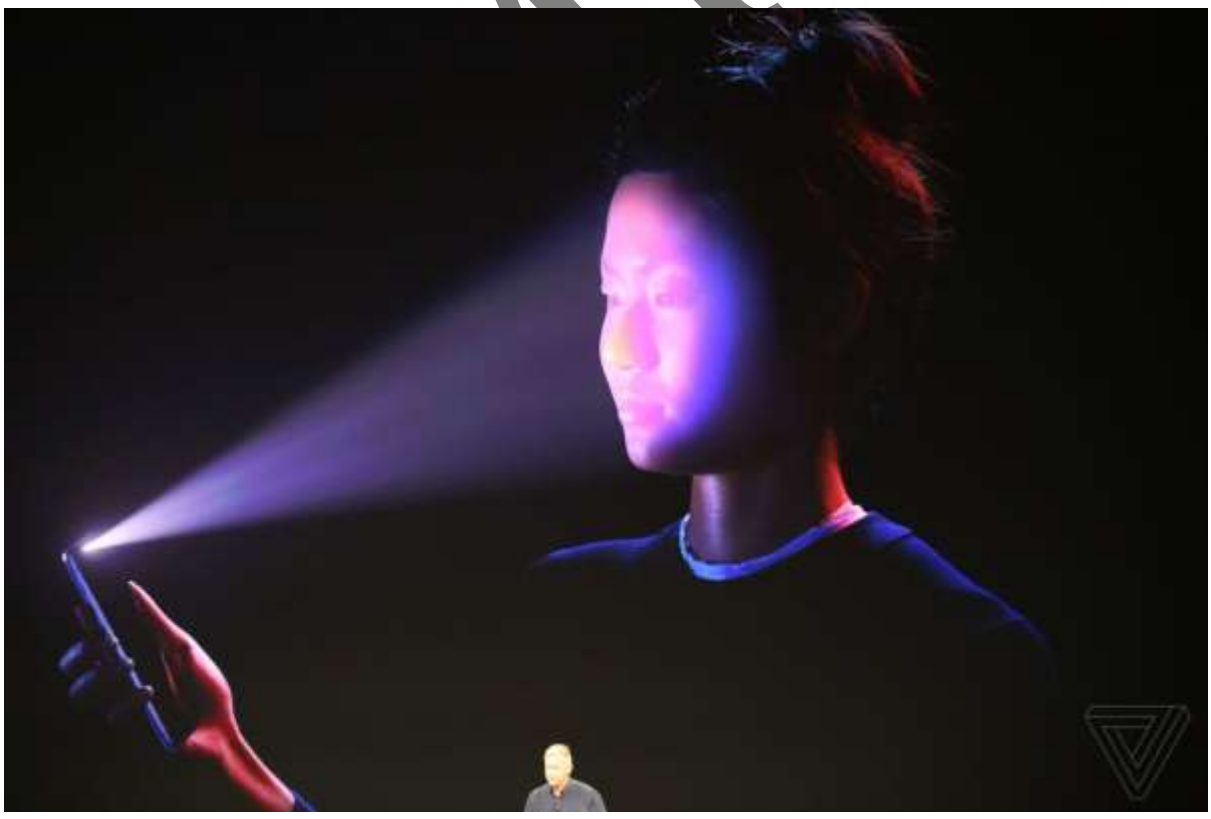
Mainly, there are about nine different biometric technologies that are used worldwide. These [redacted]

3.1 Face

This is the most common biometric characteristic used by us humans to identify each other since the beginning of time. Recognition of face is one of the most studied and researched field in this decade with [redacted] live

SAMPLE

face in a noisy background can be found. A static face recognition means that the acquisition of the images of the face is done in a controlled environment. This result in a far less intraclass variation which helps the application to make the necessary identification. A dynamic face recognition means that there is no fixed or a controlled environment and the portrait is not static. This makes it harder for the application to process the input because the intraclass



3.2 Face Thermogram

When heat passes through the facial tissue and emitted from the skin, the vascular system in the human [redacted] body temperature etc.

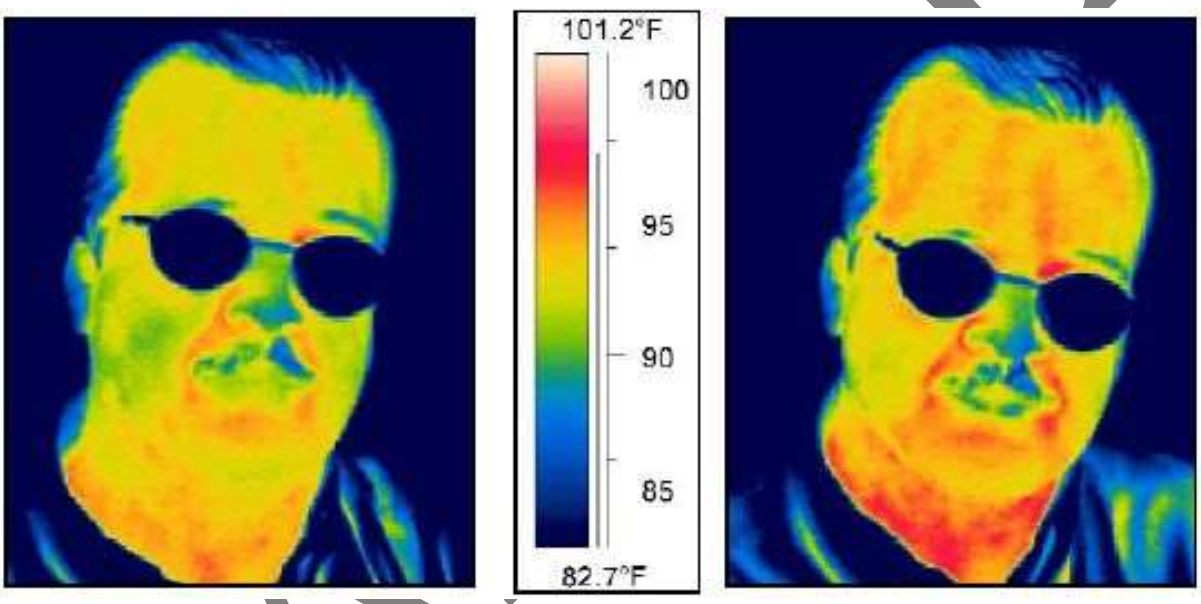


Figure: A face thermogram of a person.

3.3 Fingerprints

Possibly t[redacted]

technology. We will discuss more of this in the latter parts of this report. We will focus on how a fingerprint is extracted, classified and identified for the purposes of fingerprint recognition.

Figure 2.5: The nine patterns illustrated in Purkinje's thesis [103].

3.4 Hand Geometry

Geometries of the hand, like the shape, the length and the widths of the fingers etc. can be used as a biometric characteristic. Installed at over 4,000 places around the world, the technique of hand [redacted]

Figure: A hand geometry system.

3.5 Hand Vein

Hand veins are another very strong candidate of viable biometric characteristics for personal identification. [redacted]

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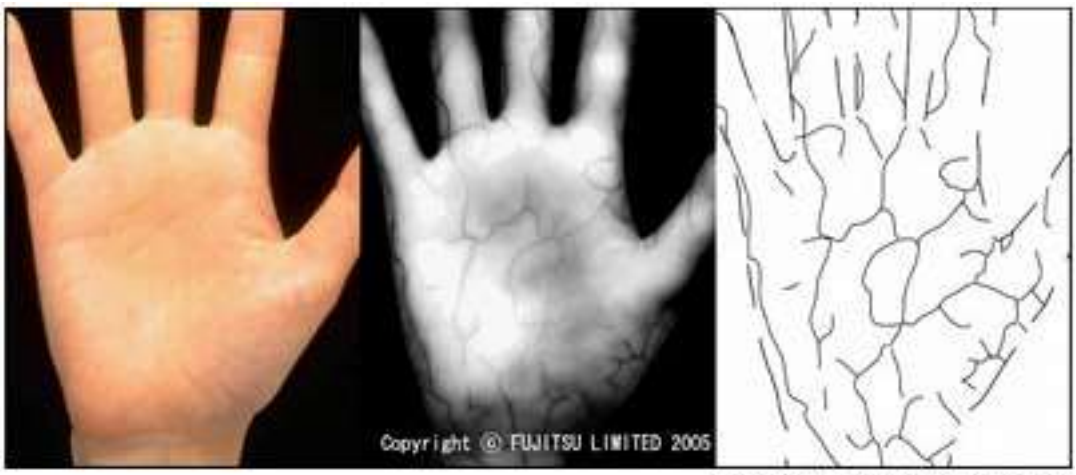

Source: Fujitsu Limited

3.6 Iris

Iris is a part of the eye outside the pupil but inside the sclera. The white part is sclera, the black circle in the middle is the pupil and the circle outside the pupil is the iris. The texture formation of the iris depends on the embryonic mesoderm. It is one of the physiological characteristic that never changes from one's birth to death. Isolated from external environment means that the iris is unaffected by anything. Plus, it cannot be modified by any surgical operations, which means it is one of the most secure form of physiological biometric characteristic with minimal chance of successful fraudulent attempts. [redacted]

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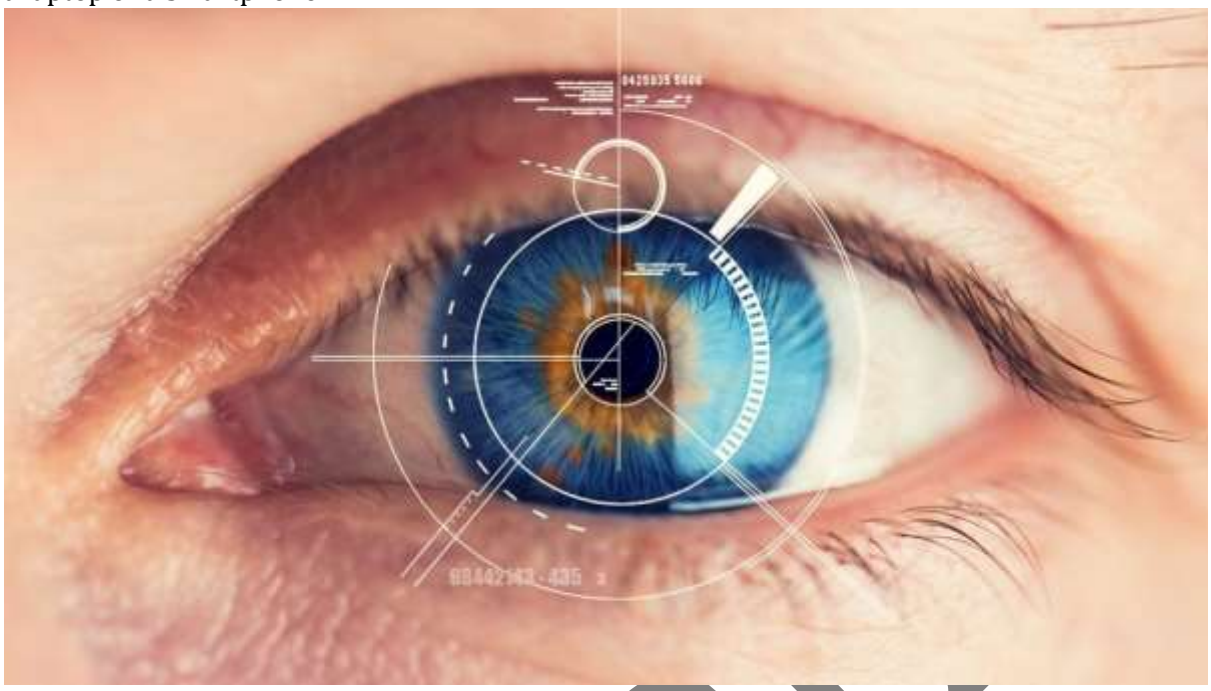
a laptop or a smartphone.



3.7 Retinal Pattern

The veins in the retina form a repeatable patterns called retinal patterns which are unique to each individual. [redacted]

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Figure: Retinal Scanner scanning the retina of a person.

3.8 Signature

Signatures have been used by humans since a very long time for verification purposes. Everyone has a unique style of writing and signature is kind of "fingerprint" which is not physiological but

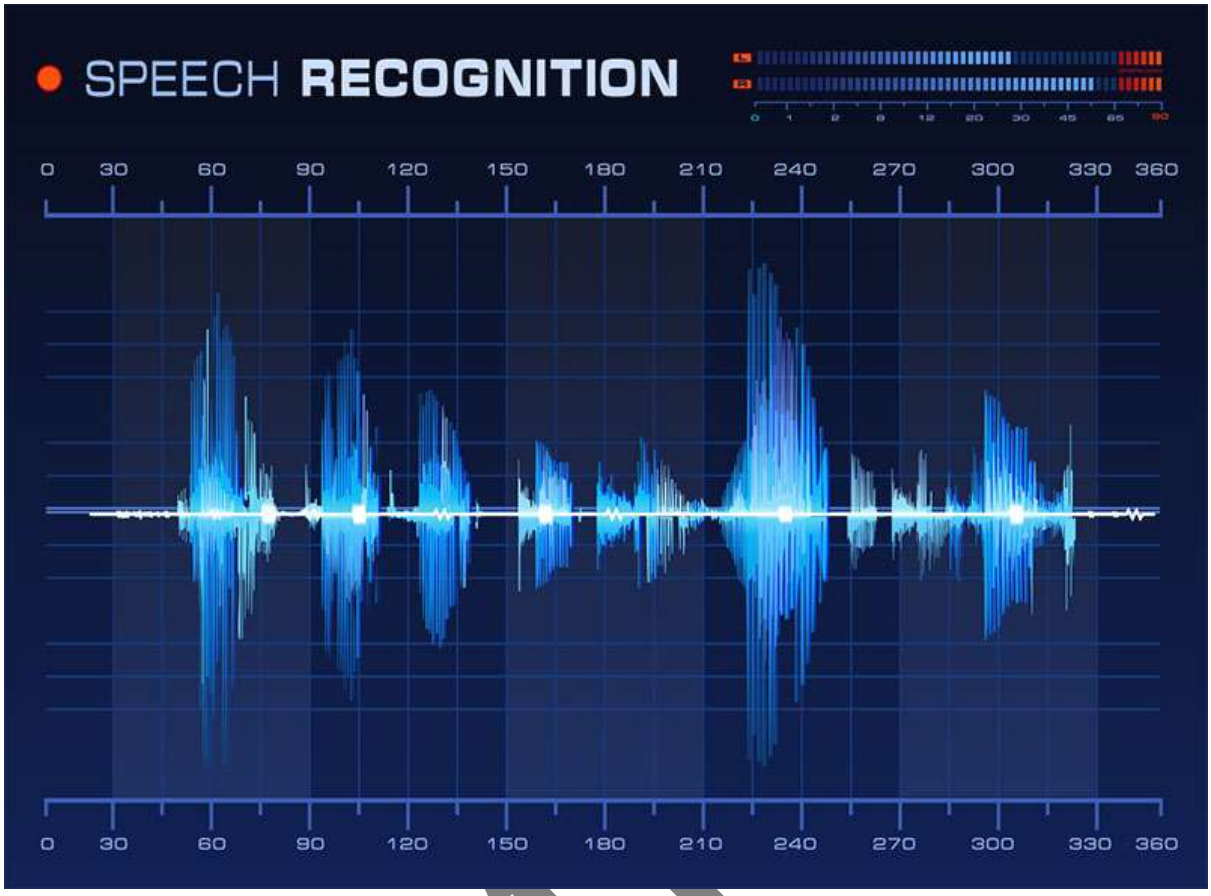
[redacted]

SAMPLE

Figure: These are the signatures of different well-known people.

3.9 Voice Print

Voice prints refer to the audio output from each user determined by their vocal tract, nasal cavities and their mouth aided by other vocal processing mechanisms in the body. Humans can differentiate each other from the sound of one's voice since they are unique to one another. With the advancement of technology, the audios now can be processed to identify and verify an individual. There are two [redacted]



3.10 Other Biometric Techniques

Besides the biometric techniques that are mentioned above, a number of other techniques are being [redacted] potential to become a successful biometric characteristic surpassing others in the near future.

3.11 Comparison of Biometric Technologies

Each biometric characteristic mentioned above have their own pros and cons. No single technique can outperform all the others in all operational environments since the application of a certain biometric technique depends heavily on the application domain. An example of this is, we know that fingerprint and iris scan techniques are more secure than a voice print, but in the telecommunication industry if you are required to verify someone from the phone, the fingerprint and iris scan techniques are useless and voice print is much more applicable since it can be integrated seamless into the current system.

Also, most of the aforementioned biometric characteristics are not recognised by the law in the court except the fingerprints as a piece of identity. Signatures used to be a valid behavioural

technique but it was deemed unsecure due to large amounts of forgery attempts. Here is a table comparing the most common biometric technologies against seven different factors.

Biometrics	**Universality**	**Uniqueness**	**Permanence**	**Collectability**
Face	*High*	*Low*	*Medium*	*High*
Fingerprint	*Medium*	*High*	*High*	*Medium*
Hand Geometry	*Medium*	*Medium*	*Medium*	*High*
Hand Vein	*Medium*	*Medium*	*Medium*	*Medium*
Iris	*High*	*High*	*High*	*Medium*
Retinal Pattern	*High*	*High*	*Medium*	*Low*
Signature	*Low*	*Low*	*Low*	*High*
Voice Print	*Medium*	*Low*	*Low*	*Medium*
Face Thermogram	*High*	*High*	*Low*	*High*

Biometrics	**Performance**	**Acceptability**	**Circumvention**
Face	*Low*	*High*	*Low*
Fingerprint	*High*	*Medium*	*High*
Hand Geometry	*Medium*	*Medium*	*Medium*
Hand Vein	*Medium*	*Medium*	*High*
Iris	*High*	*Low*	*High*
Retinal Pattern	*High*	*Low*	*High*
Signature	*Low*	*High*	*Low*
Voice Print	*Low*	*High*	*Low*
Face Thermogram	*Medium*	*High*	*High*

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4. REVIEW OF LITERATURE

4.1 Problem Definition and Overview

[redacted] for me to embrace this project.

4.2 [redacted]

[redacted]

4.2.1 Increasing productivity

[redacted]

4.2.2 Establishing Responsibility: The biometric system is fool proof so the data is always true. The data recorded reflects real life so that people can be held accountable without a doubt if people are seen to be irregular. The data does not lie so it can be used as a reliable evidence against students or employees.

[redacted]

4.3 Cultural, Social and Legal Considerations

4.3.1 Concerns

[redacted]

4.3.2 Analysis

[redacted] time consuming and inconvenient for people just wishing to enter the building.

4.3.3 Privacy Breach

Another thing that people seem to worry about is that there are some biometrics systems that recognize and track people without their knowledge. Such identification systems have not been

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widely deployed yet but the potential use can raise concerns. Although the biometric industry has dismissed such concerns, they could be in use without the knowledge of the general public. If such things are done and the information is shared, identification can be made and the privacy is easily violated. Example of this could be the recognition and identification of a person through the security camera of a shopping mall means that the location of the said individual is disclosed without his/her consent which is a huge violation of privacy.

4.3.4 Summary

[redacted]

5. REVIEW OF TECHNOLOGIES

[redacted]

5.1 Hardware

[redacted]

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[redacted]

The other hardware used for this project are:

[redacted]

Since computers are already available in all of the classrooms, implementing this system in our college should not be very hard. Below is a table that shows the expense for the implementation cost for the shown device across all the classrooms.

[redacted]			
[redacted]			
[redacted]			
[redacted]			

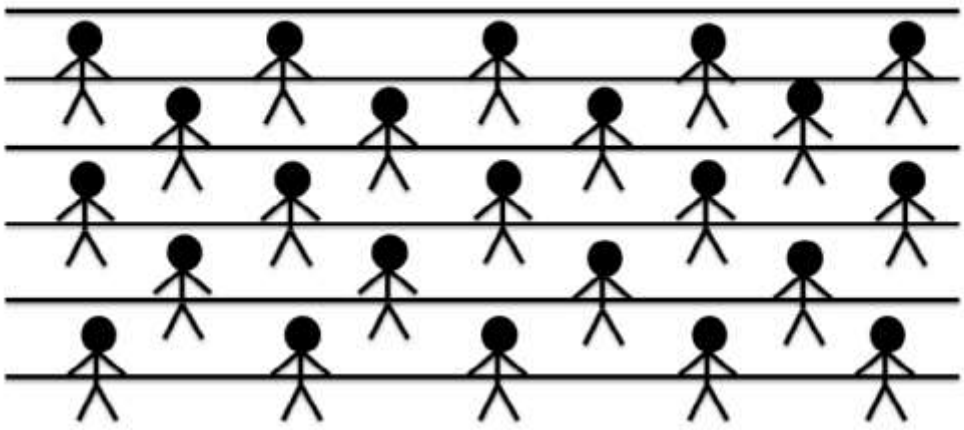
Table 1.1: Estimated Budget

The way the system works is that the fingerprint scanners will be used to input the fingerprints of students. The device is connected to the computer where the database is stored. Every time someone scans a fingerprint into the device, the device will process it and extract features to see if it matches with the ones it has in the database. If the input matches with the one in the database, the attendance will be marked present and the database will be updated accordingly.

5.2 The Attendance Management Approach

Here is how the attendance management system is implemented seamlessly and without any [redacted]

[redacted]



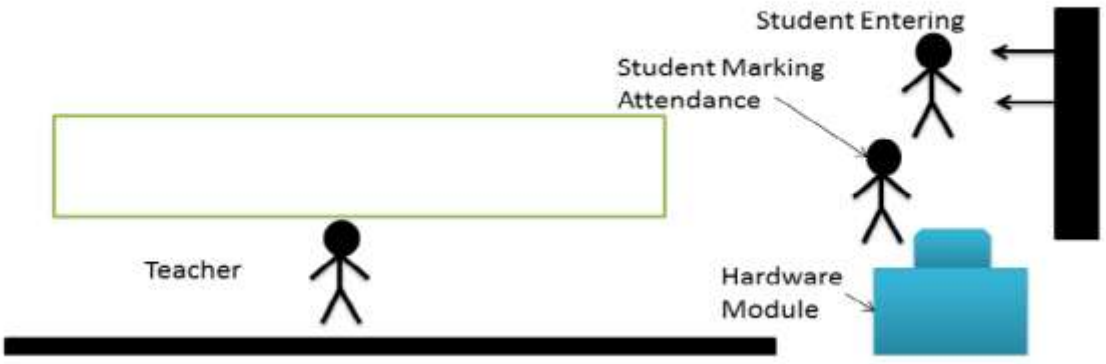


Figure: A typical classroom scenario.

5.3 On-Spot Attendance Report Generation

[redacted]

$$\text{Attendance} = \frac{Classes\ Attended}{Classes\ Held} * 100$$

5.4 Network and Database Management

One of the ideas for this attendance management system is to have a centralized database. All the different devices in different classes will be connected via intranet to the internet. That way the whole system can be in sync and updated with every new action. While it is not possible for me at this time to create an intranet of the system just for this project, it would be possible if the college was to implement it. With the intranet connected to the network the data and the attendance records could be accessed from anywhere plus the monthly, weekly attendance reports could be emailed to the respective students and their parents automatically. This removes the hassle for any manual labour and does the required job perfectly without anyone have to worry about messing something up.

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5.4 Wireless Network and Portability

For this project, I'm using LAN for communication among hardware, but we can instead use wireless LAN with portable devices. The portable device can have an embedded fingerprint scanner, a processor, our software, memory and a display screen. A device like this can change the overall configuration of the system making it much more efficient because of its portability. The size of such devices could vary depending upon how it is manufactured and the most compact ones are the size of a small mobile phone.

5.5 [redacted]

[redacted] system is far better to be implemented than the other systems.

5.6 Integrated Development Environments

The development process of this project was aided by different software and development [redacted]

```
create procedure pro_add_attendance(
  @attendance_date date=null,
  @student_id int=null,
  @class varchar(25)=null,
  @student_name varchar(25)=null
)
as
begin
insert into [dbo].[tbl_attendance]
       ([attendance_date]
       ,[student_id]
       ,[class]
       ,[student_name]
       )
 values
       ( @attendance_date, @student_id, @class,@student_name)
       end
```

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6. METHODOLOGY AND DESIGN

This section of the report explains how this project was managed, the variety of software development management tools used, the involved technologies, what made me choose the technologies used, and the different stages of software development used. Software development life cycle has various stages of development when an application or a software needs to be developed. There are many different kinds of software development life cycle which all have various strengths and weaknesses. There is no good or bad software development life cycle, just fitting or not for a specific project. One kind of software development life cycle can be beneficial for a certain type of project while another kind of software development life cycle can be beneficial for some other types of projects. Adopting a certain type of software development life cycle can completely change the whole development process of the product. All of the software development processes require extensive management of budget and time. So, choosing the correct software development life cycle for any product is really important.

6.1 Software Development Life Cycle

[redacted]

Agile methodology is great as it consists of short intervals between different phases so that the changes can be quickly implemented which helps in finding errors in the early phases. There are different forms of agile methodology that are more famous than the other ones and this includes the feature driven development (FDD) and scrum.

For this project, the feature driven development of agile methodology has been adopted because of the well-defined milestones of FDD plus, the progress can be tracked very easily and it has been one of the most efficient methods in recent times. It is very easy to keep track of the progress of every task and is incredibly helpful in overall planning. Therefore, due to all these advantages, I have chosen the feature driven development to be the one implemented in this project.

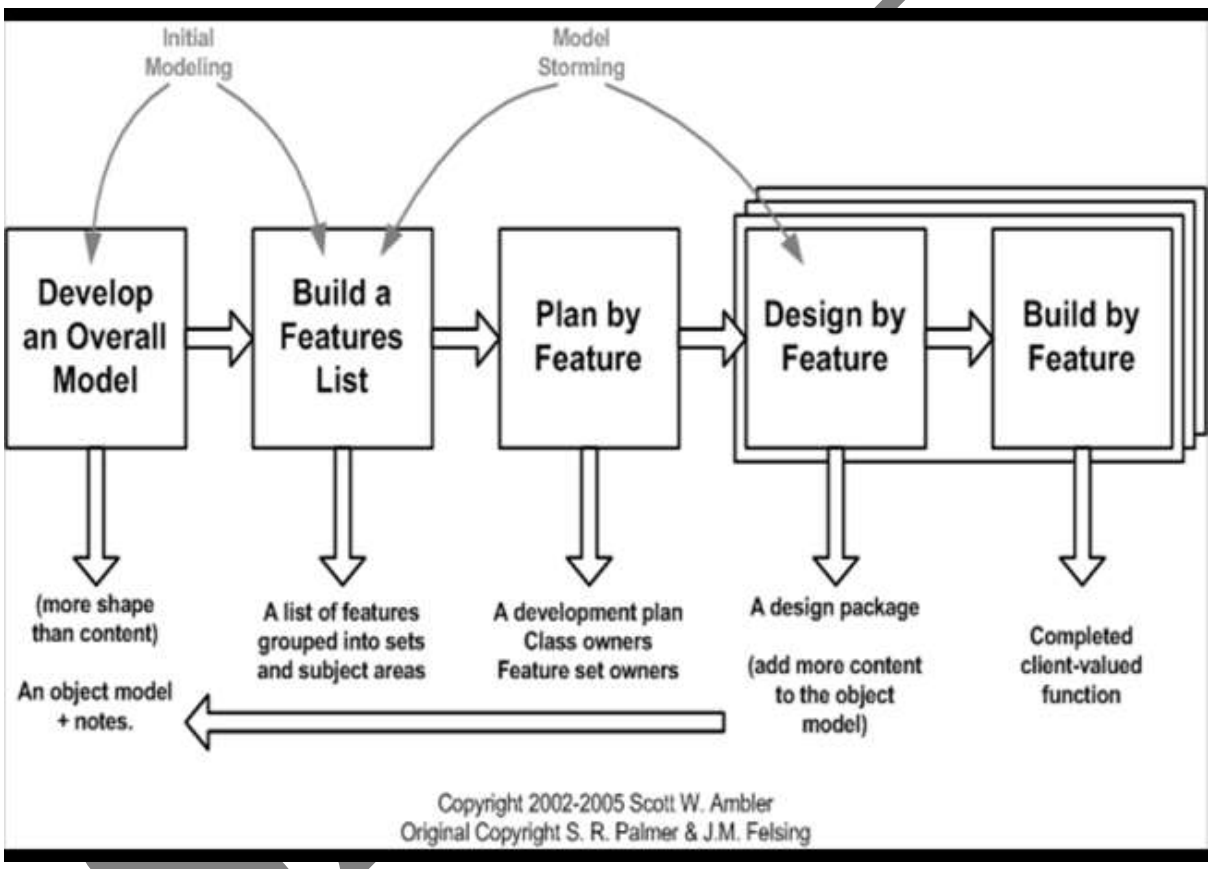
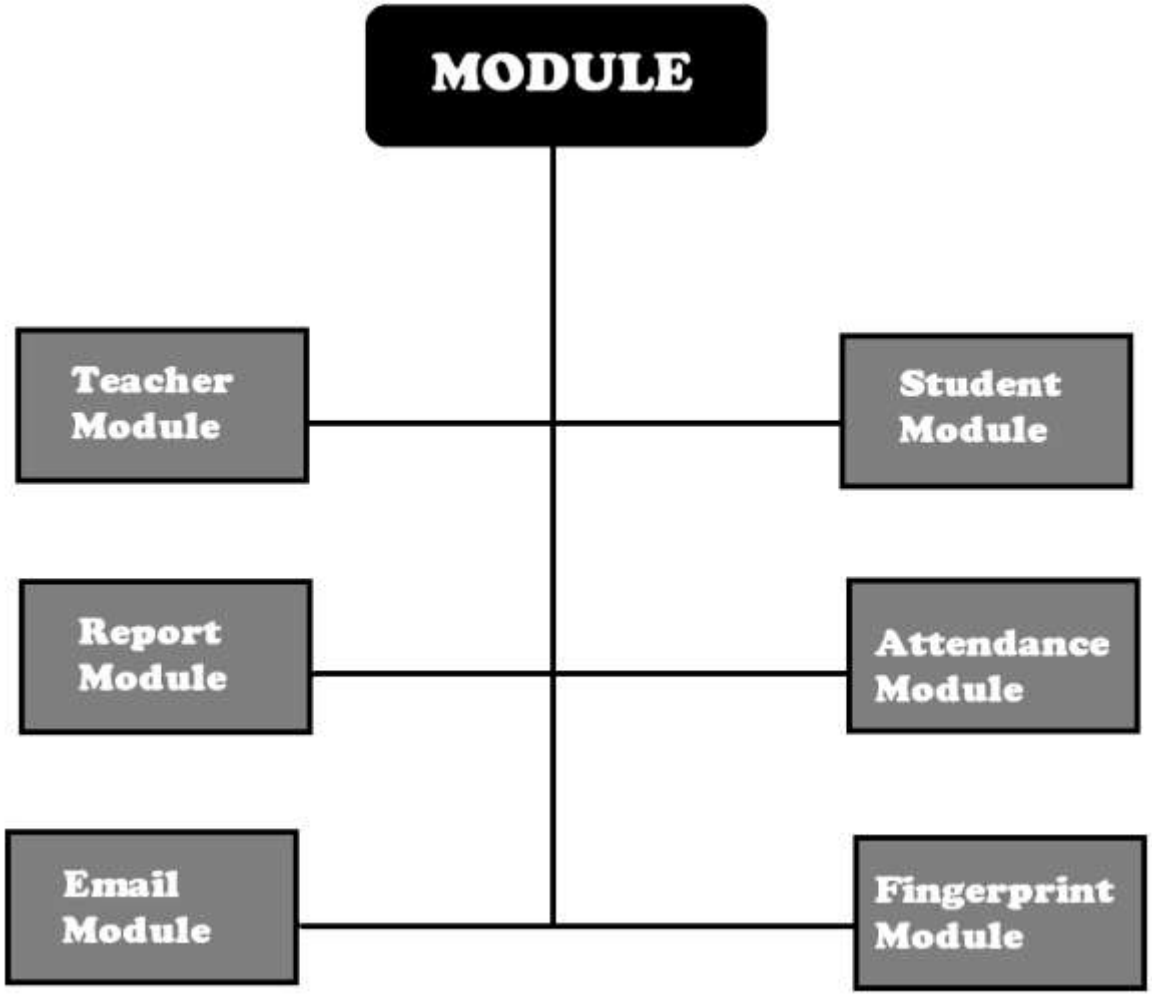


Figure: A diagram of how the feature driven development works.

6.2 Modules Designed for Project Scope



[redacted]

6.2.2 Student Module

Similar to the teacher module, the admins can perform the CRUD operations in the student module too. But unlike the teacher module, the students cannot register themselves as students and this has to be done by the admin. This is implemented so as to regulate the system from being accurate and stopping fraudulent attempts. Students have no way to interfere with the database except when they scan their fingerprint, in which case they are just marked present if

the fingerprint matches. There are lots of features that can be played with in this module such as the student photo can be changed along with almost every field of data can be edited, except the student id which is the primary key. This however, does not allow anyone to temper with the attendance data. The most an admin can do is mark a student present in some rare case the fingerprint scanner does not work. One neat feature is that, not only the teachers and the admins but the students themselves can view the attendance record but it will be of only themselves.

[redacted]

In this module, all the fingerprint images are stored in the database which will later be used for personal identification and verification purposes. At the beginning, all the students are required to scan their fingerprints to be stored in the database. The fingerprints are stored in the fingerprint device as images. When someone needs to be verified later, they need scan their fingerprint at the scanner and then the scanner will check if the scanned fingerprint matches with the ones they have in their database. If the matching is successful then there is a prompt showing "XYZ is presented" on the screen and a voice prompt from the device saying "Thank you". If the matching is unsuccessful then there is a prompt showing "Fingerprint does not match" on the screen and a voice prompt from the device saying "Please try again".

6.2.4 Attendance Module

This module is for taking the attendance by taking into account the number of correct fingerprints scanned. The matching of a correct fingerprint marks as present for that student. The ones who didn't scan the fingerprint are deemed absent. There is one other rule that I have implemented where that a student who arrives after more than 20 minutes will be deemed as absent automatically. I discussed this rule with various teachers and came to the conclusion that it is only fair that this rule is implemented. In case the student has a valid excuse and the subject teacher wants to consider it, the teacher can manually mark him as present as the teacher has full rights to do so for the students of his class.

6.2.5 Report Module

As the name suggests, the report module is responsible for generating reports of the students' attendance. There are different kind of reports that can be generated like daily, weekly and monthly reports. The report can also be generated for a particular semester for a particular class. To make the reports interactive, the attendance reports can be viewed not only in the data grid view but also in the bar graph as well. The system automatically detects the date and uses that as a basis when making the reports. The reports can be viewed by all three types of users, the admin, the teacher as well as the students.

6.2.6 Email Module

This module is used to send emails attached with the attendance report of students to themselves and their parents. Also, if a student is absent for a long period of time without any notice, the system automatically sends an email alerting the parents about the absence. Parents are also sent the weekly and the monthly attendance reports of their child. This module is especially helpful for parents who want to keep track of their children and their study habits.

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[redacted]

Entity relationship diagram is a simple graphical illustration of the total entities in a system's database showing the nature of their relationship with each other. Before the development of the software of this project, an entity relationship diagram was created. The reason for this was that an entity relationship diagram gives a very comprehensive idea about the entities present and the exact relationship of these entities with each other. It would have been very difficult to map this without drawing the entity relationship diagram along with the fear of missing out on important relationship between two entities. The entity relationship diagram helps to visualize the system as a whole, and it is easy to categorize activities which helps in the development of the product.

The entity relationship diagram submitted at the project initiation were reviewed more thoroughly and couple of issues were found which are amended in the final entity relationship diagram shown below.

6.4 Use Case Diagram

Use case diagrams are the graphical illustrations of the connection between a system and a user. These diagrams are used to analyse a system and to identify the system requirements. Here, 'system' may refer to anything that is being developed or operated. The use case diagrams are employed in unified modelling language which is a standard representation for the demonstration of real world systems. There are four components of a use case diagram. They are:

[redacted]

Symbols used in Use Case Diagram

Below are the use case diagrams used in this project.

1. Use case for admin

SAMPLE

2. Use case for Teacher

3. Use case for student

6.5 Activity Diagram

Another important graphical representation is an activity diagram which helps to show [redacted]

These types of diagrams can be used in many cases such as to: [redacted]

Two of the activity models designed are shown below.

Figure: Activity diagram to register fingerprint.

Figure: Attendance diagram to view personal attendance report.

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6.6 Network Model Diagram

Network model diagram refers to the setup of the appliances and applications to make a functioning system. It shows the most effective way a system can perform. The network model diagram is very helpful as it helps to visualise the system and makes it easier to improve or add functionalities accordingly. A diagram depicting the implementation of our fingerprint system is shown below.

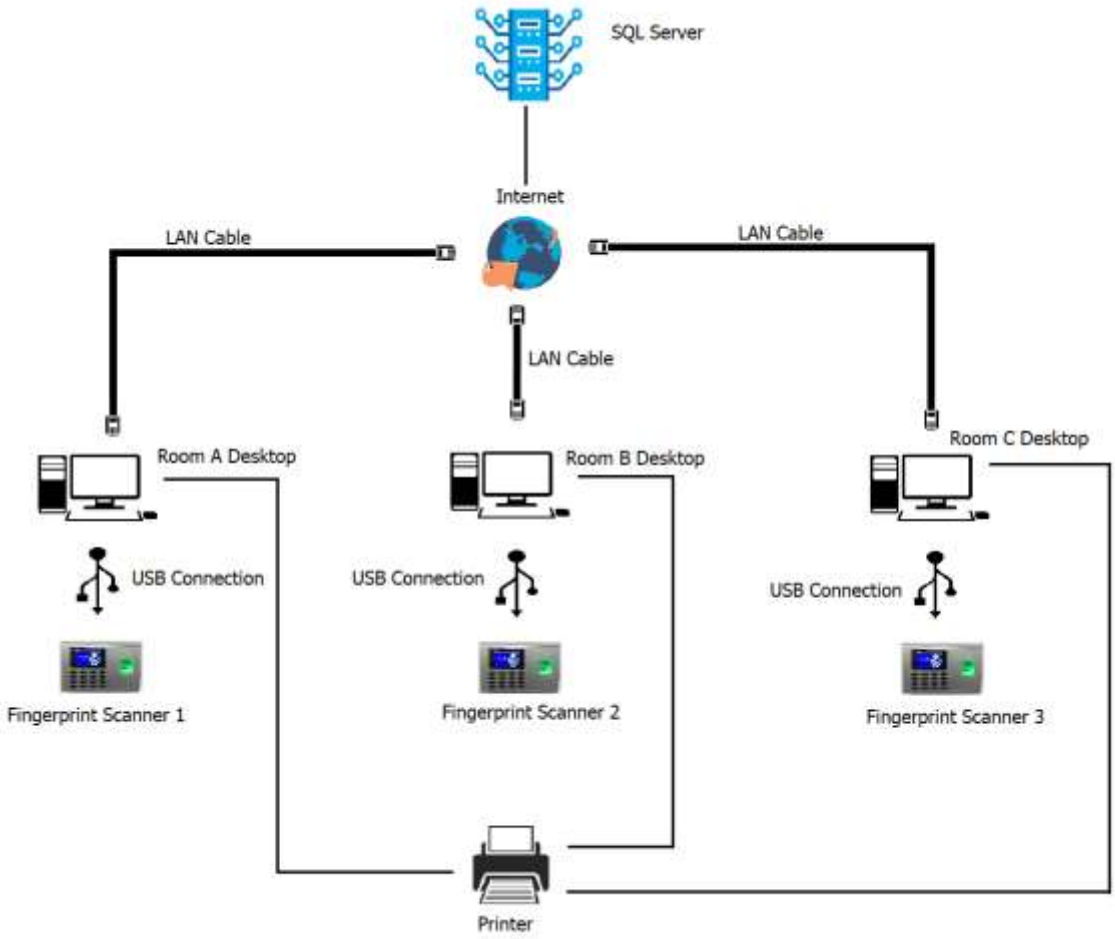
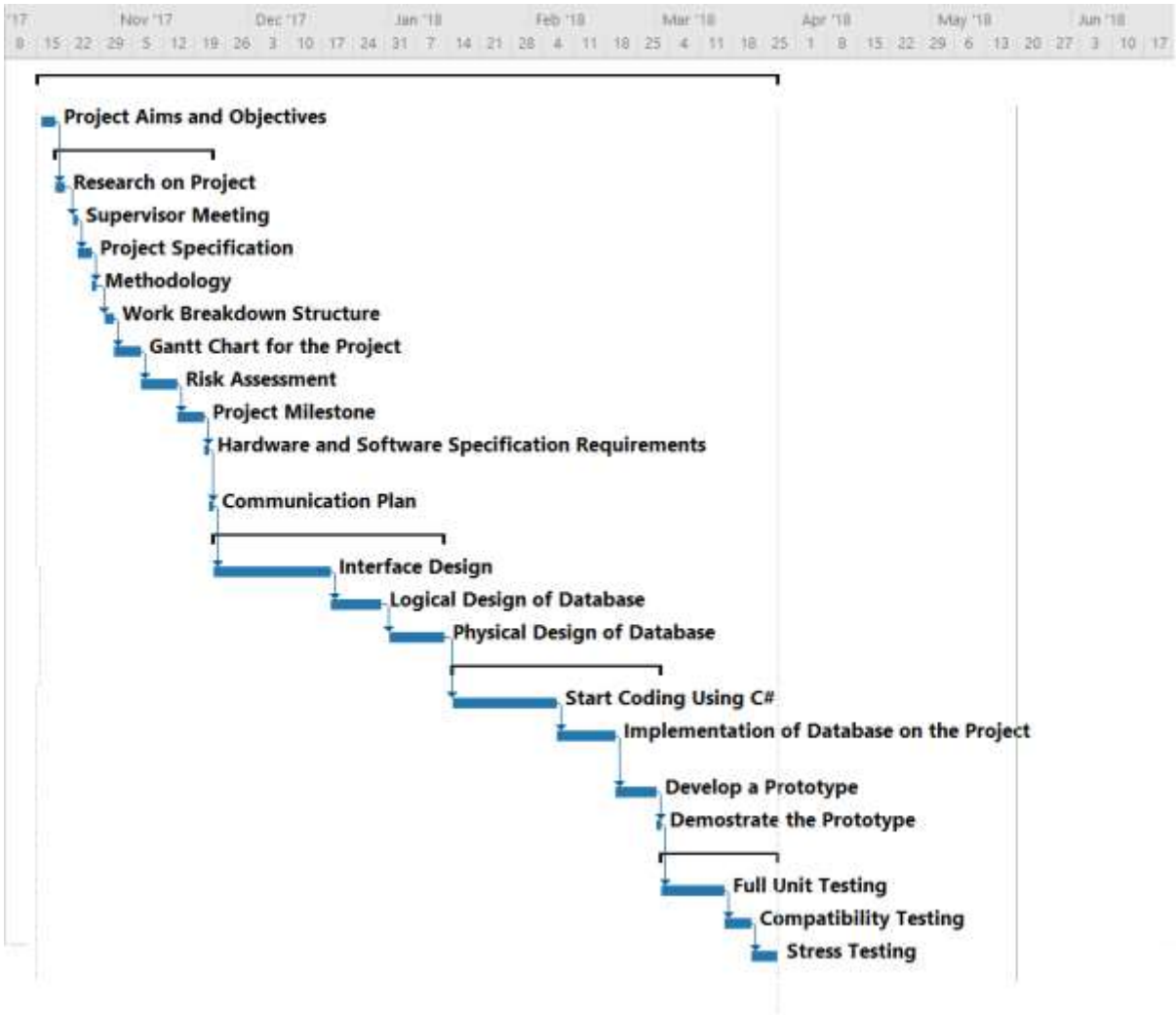


Figure: A network model diagram which can be implemented in The British College.

6.7 Work Breakdown Structure

Gantt Chart



The work breakdown structure and the Gantt chart were made in MS Project. These structures help to divide the tasks into little pieces so as to focus on them one at a time. The tasks dependencies implemented are finish to start where the second task starts only after the first task is completed. This was done to ensure that previous tasks are fully completed minimizing the occurrence of any errors in the latter parts of the development. Beside main tasks, you can see other subtasks, each of which are assigned a duration of time to be worked on. The Gantt chart then visualises in a more graphical form showing the start and finish date for each of the tasks along with coloured bar representing each of the task with its name beside it.

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[redacted]

different scenarios to see if it is fit to be fully deployed. The system also must go through different kinds of testing which is done in this project and is covered later.

7.2 Architecture

For this process, a three-tier architecture has be implemented. Also, the process logic of the functions, access of data, store of data in the computer, and user interface are established as independent modules. The three-tier architecture is one of the most popular software design patterns and is vastly used by other software developers. The three tiers of this projects are as follows:

7.2.1

[redacted]

7.2.2

[redacted]

7.2.3

[redacted]

7.3 System Testing

System testing is done to ensure that the program is running smoothly and is free of any bugs. There are lots of testing done on a system before it is released. Any errors, or bugs detected during the tested are then fixed and then later updated into the program. Even though rigorous testing is done before the release of a particular software, the program is labelled in 'beta' stage while rolling out. Beta means that the software or the application is still under testing and prompts user to report any bug found so that it can be fixed. There are different types of testing that can be done such as unit testing, integration testing, system testing, and compatibility testing. System testing is done not only by the developer but by the users who use the program at its beta stage. Unit testing is done by the developer to test every pattern and modules of the system. This testing can be much harder and time consuming because the tester needs to ensure that each and every part of the system works correctly and is bug free before the deployment of the system. Every steps done in unit testing are stored in test cases for later review. The test cases for our project are shown below in a table with screenshots shown in appendices.

Other than unit testing, the other testing that plays a huge role while evaluating a product is integration testing. This testing makes sure that there are no flaws while integrating different modules to create one functioning piece. While the unit testing finds errors that users might be have to deal with, the integration testing tests the logicality of the program to see if everything makes sense and works properly.

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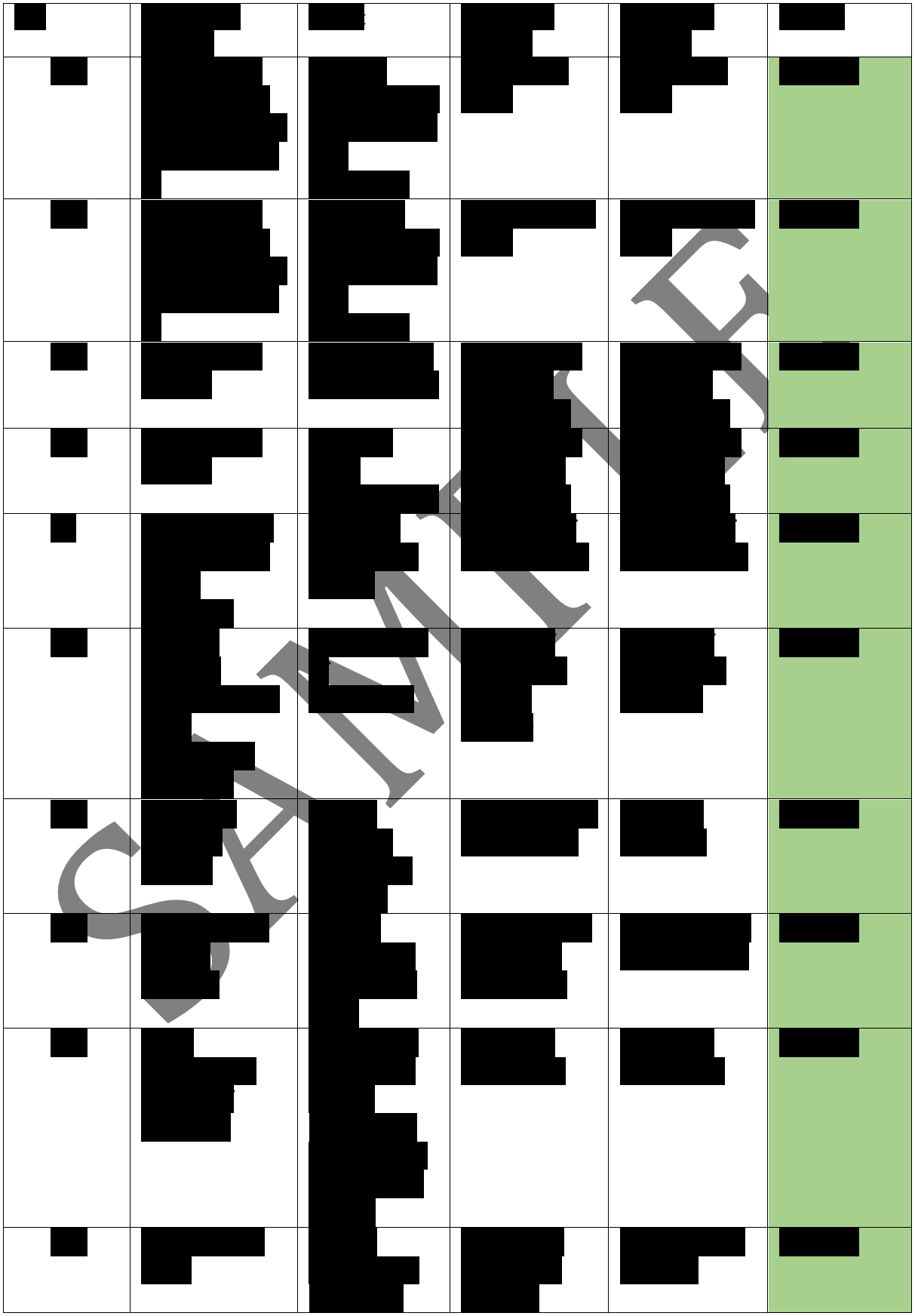
Here is the table with complete list of testing performed on this system.

All the evidences are shown with screenshots in the appendices below.



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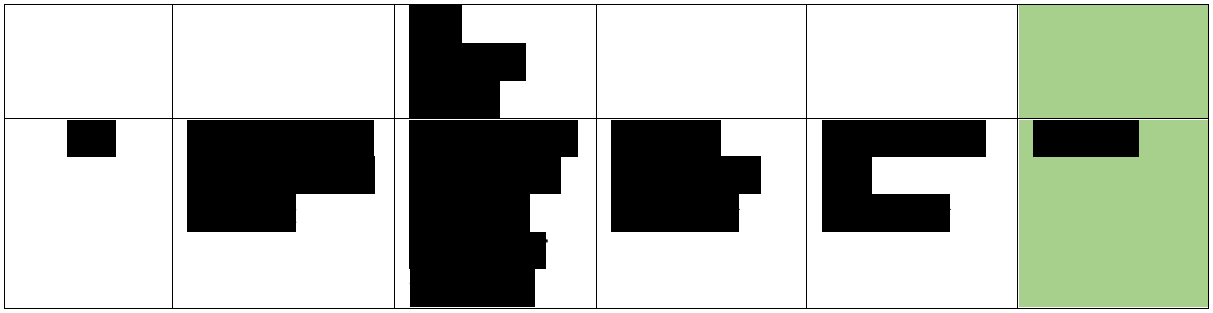

7.3 Communication Plan

To establish proper assembly between all the stakeholders, a proper communication plan is needed. The table shows the relation between all the stakeholders and the means of communication used.

Name	Position	Email
[redacted]	[redacted]	[redacted]
Mr. Rohit Pandey	Supervisor	rpandey@thebritishcollege.edu.np
[redacted]	[redacted]	[redacted]

Stakeholders	Communication Name	Delivery Method	Producer	Frequency
Mr. Arun Joshi	Project Completion	Email	Mr. Arun Joshi	Twice every semester
Mr. Rohit Pandey	Project Status and Issues	Email + Meeting	Mr. Rohit Pandey	Once every two weeks
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

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8. PRODUCT DESIGN AND FUNCTIONALITY PREVIEW

Figure: This is the opening page for login and signup purposes.

Figure: If incorrect password is entered, an alert box is shown.

Figure: This is the admin dashboard. This is the first page that an admin is redirected to after a successful login.

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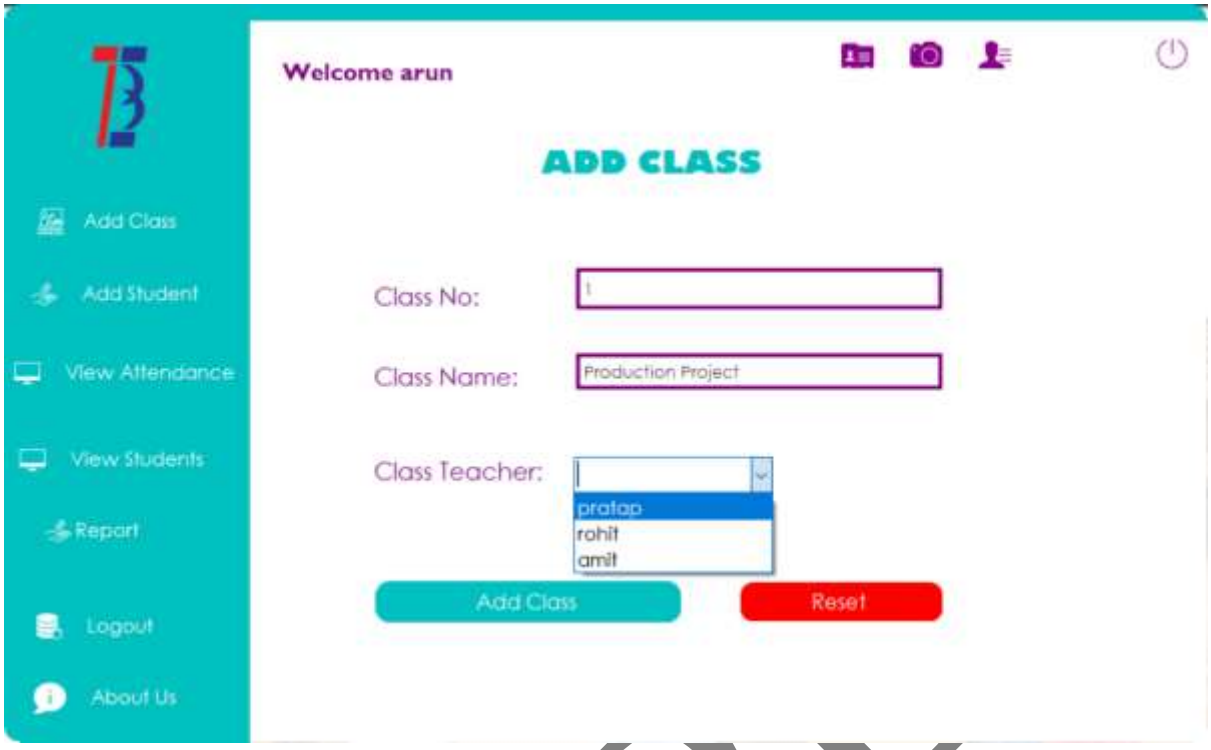

Figure: An admin can add class. The class teacher dropdown is dynamic so the data is extracted from the database.

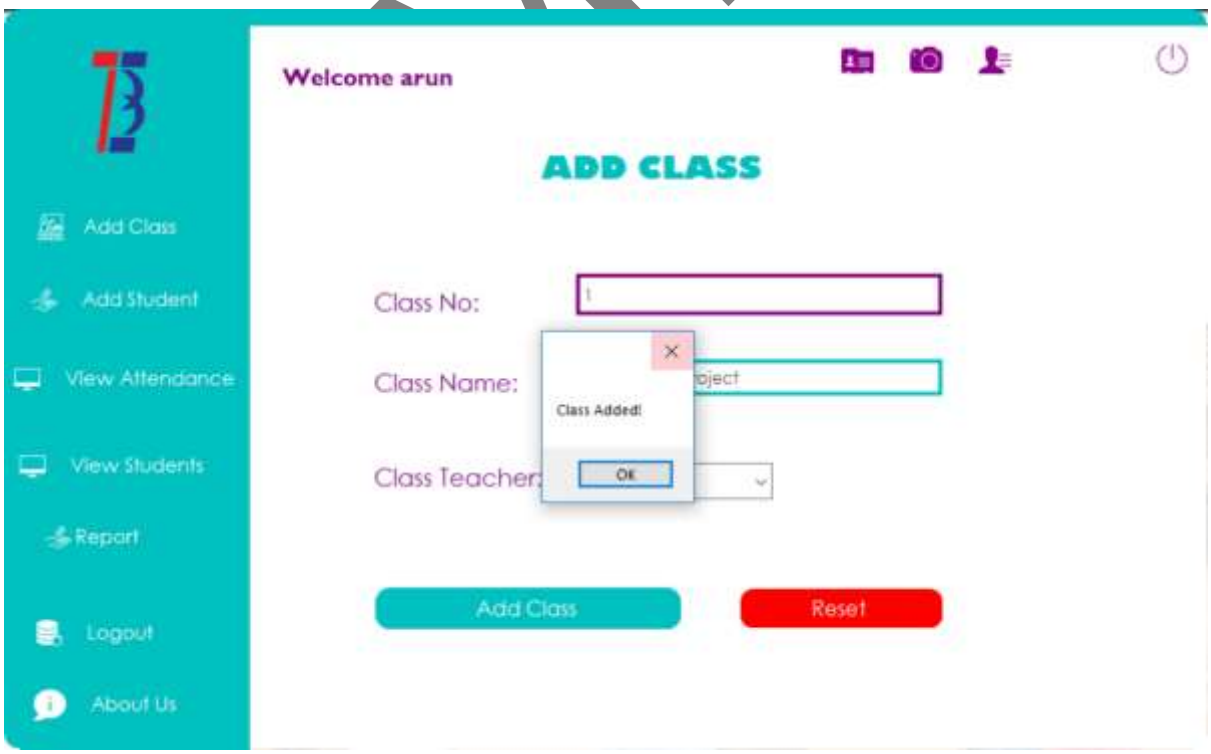

Figure: After a class is added, an alert box is shown saying so.

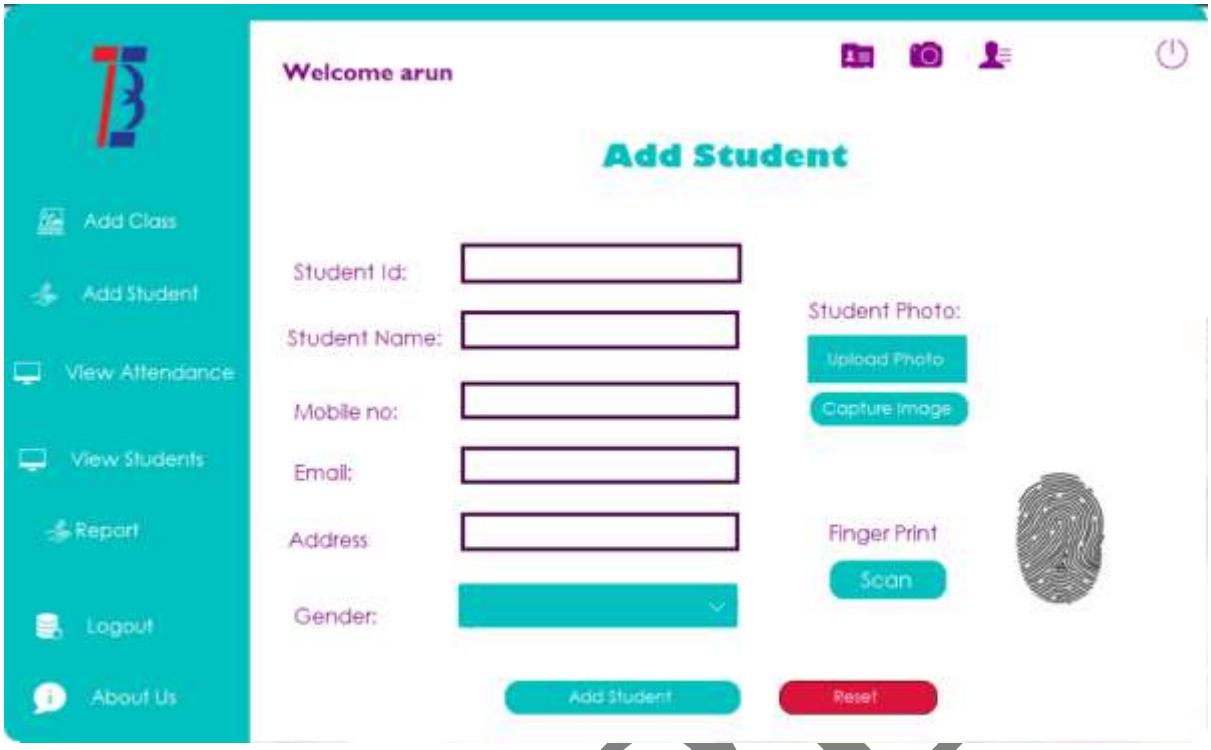

Figure: An admin can add students through this form.

Figure: After filling in all the details the admin can simple click 'Add Student' button to register the student in the database.

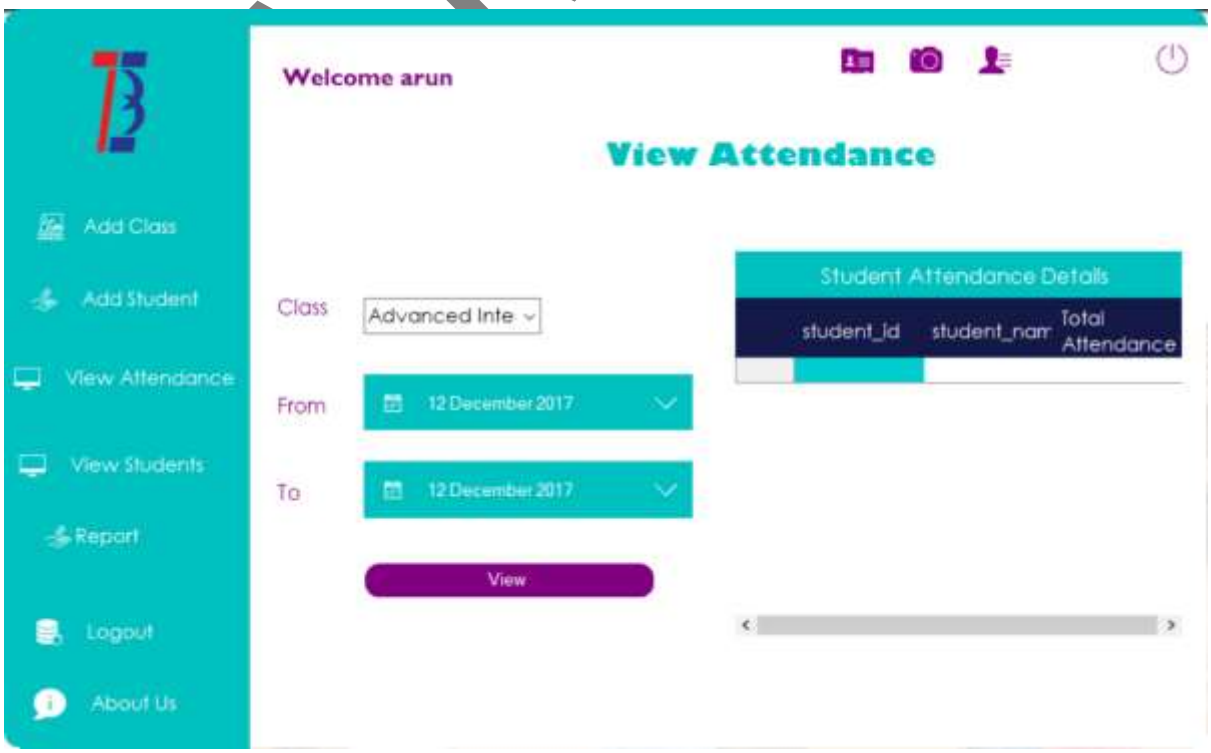

Figure: The teacher can view attendance of any class by selecting the date and clicking on 'View'.

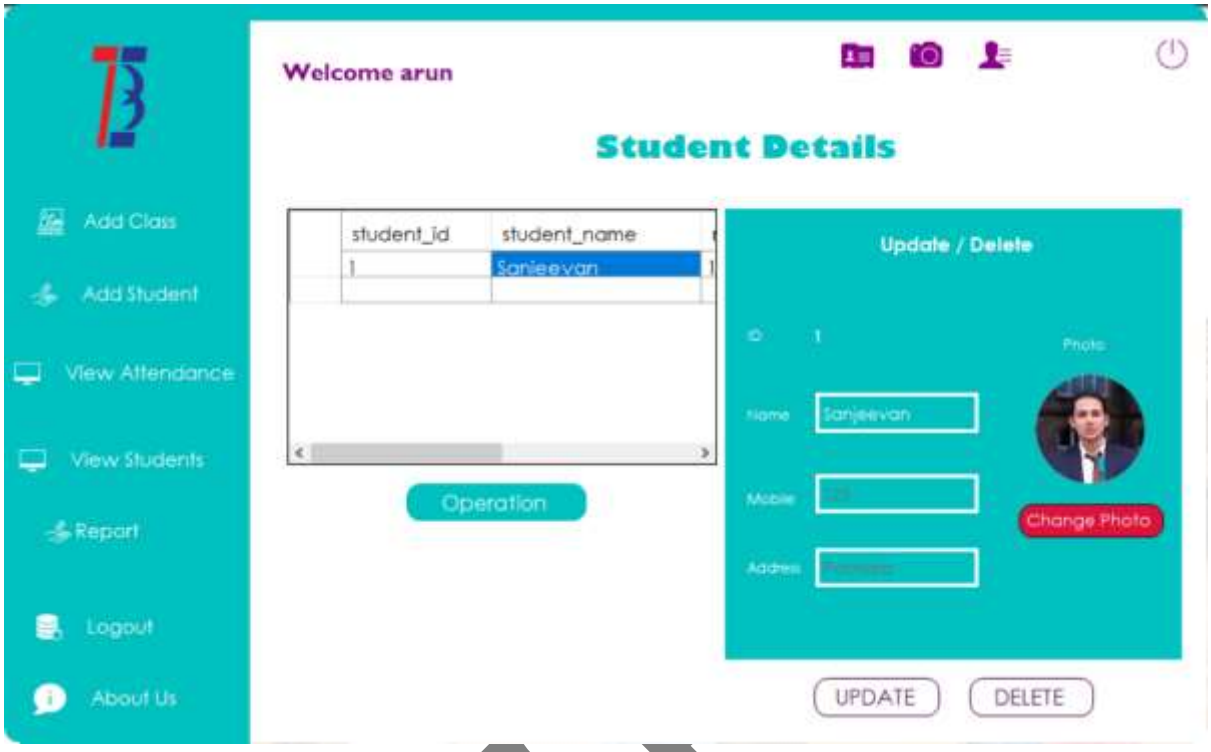

Figure: The student details can be changed by the admin except the student ID which is a primary key.

Figure: Here we can see the phone number being updated and an alert box saying the task has been done successfully.

Figure: Let's register a new teacher account.

Figure: With proper credentials, the signup is successful.

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Figure: After logging in as a teacher, he/she is redirected to this teacher dashboard.

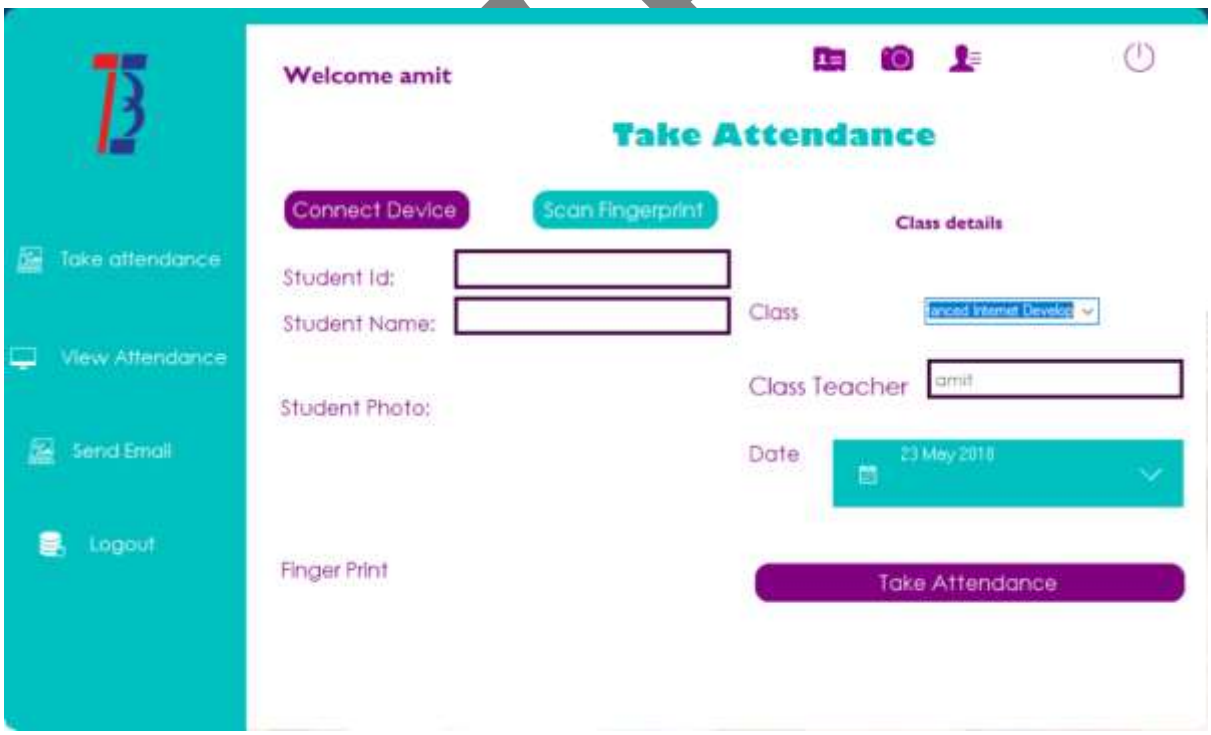

Figure: This is the page where the attendance is taken.

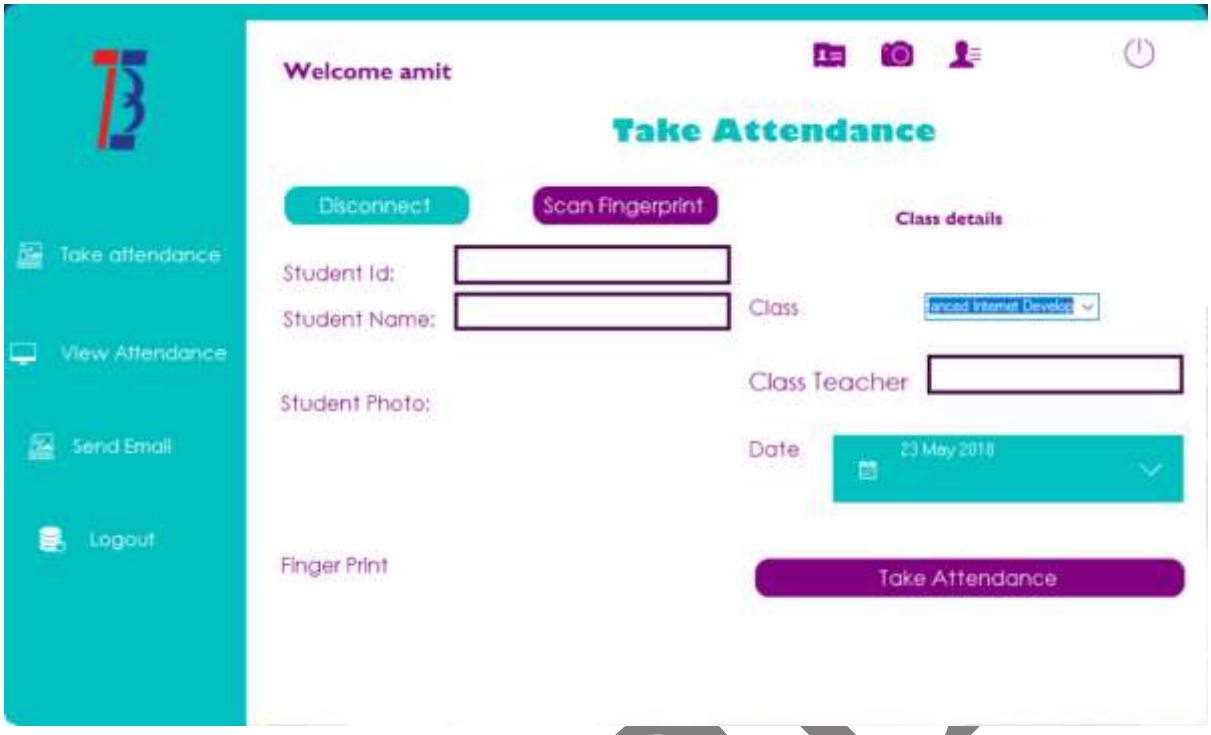

Figure: The teacher should connect the device by clicking on 'Connect Device'. After some seconds the machine will beep, indicating the device has been connected.

Figure: When a fingerprint is scanned, the personal identification is made.

Figure: Then the teacher can click the 'Take Attendance' button to mark the student present.

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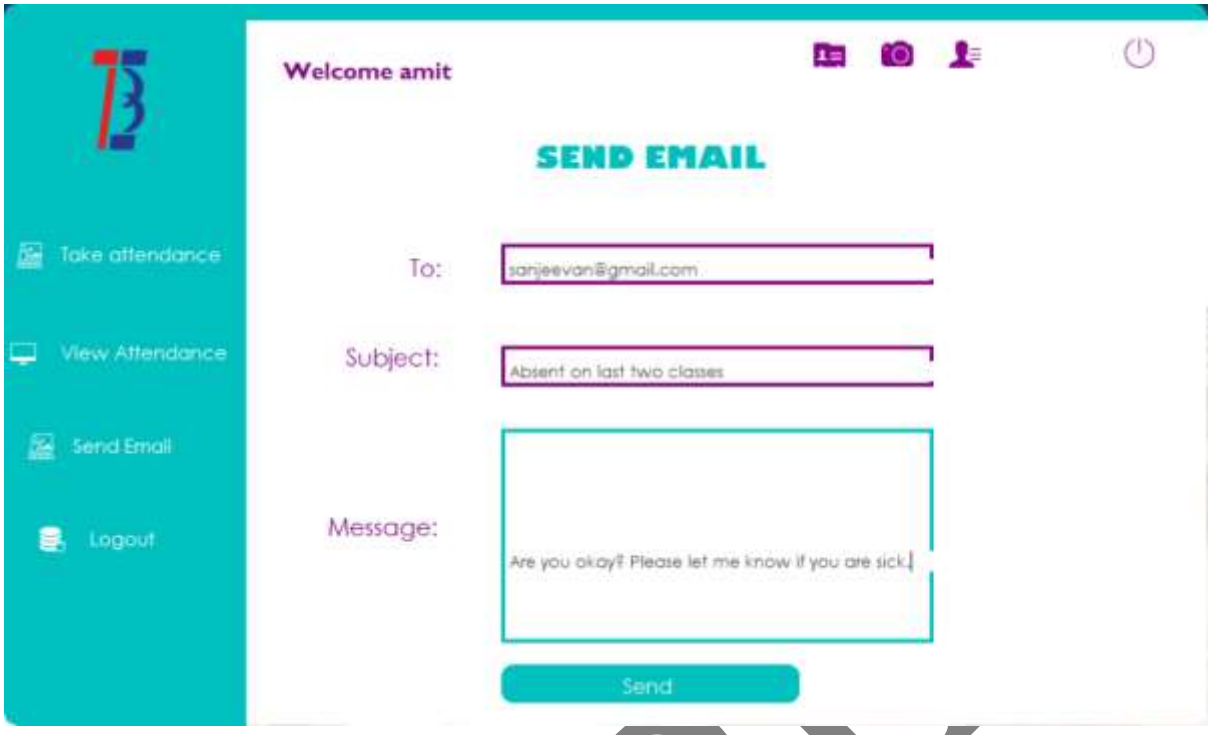

Figure: The teacher can notify a certain through email if they are absent or just need to contact.

9. CONCLUSION

This project mainly encompassed the development of fingerprint identification system and attendance management system. This system is very helpful in saving valuable time of teachers and students, paper and generating report at required time. This project can be implemented seamlessly into the college without any hassle with immediate effect. The system designed is very efficient and fast. The developed product was able to meet all the objectives set at the time of project planning. Here are some things that I achieved while doing this project:

- [redacted]Skills and self-confidence in coding and working with software like Visual Studio were [redacted]

10. RESEARCH OPPORTUNITIES AND FUTURE OF BIOMETRICS

Seeing the attendance management system developed for this project, there are some things that could be done to improve the performance and effectiveness of the program. These points are noted down for any further updates or improvements in this area. One of the major

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improvements that could be made is the usage of wireless system instead of LAN cable but these [redacted]

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