NO TOUCH

Capstone Project Report

FINAL SEMESTER EVALUATION

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ABSTRACT

This capstone project, designed and made by CPG 35, is a contactless fingerprint verification-based attendance application. Matching contactless fingerprints or finger photos to contact-based fingerprint impressions has received increased attention in the wake of COVID-19 due to the superior hygiene of the contactless acquisition and the widespread availability of low-cost smartphones capable of capturing photos of fingerprints with sufficient resolution for verification purposes. Our application will allow students to mark their attendance from the convenience of their smartphones by collecting fingerprint selfies from them and processing these for verification and mark the attendance accordingly. Apart from maintaining hygiene, the use of our application will avoid unnecessary chaos in the classroom and in turn help in maintaining social distancing.

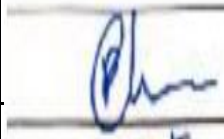
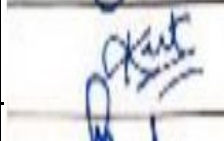
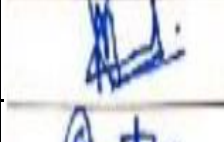
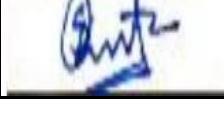
When a teacher initiates an attendance session, the student has to fill a form in the app and upload a finger photo. This finger photo is used to extract fingerprints using segmentation algorithms, after that the photo is used to extract minutiae points that are used for verifying the fingerprint.

Once attendance is marked, our application generates an attendance list that is emailed to the teacher taking the attendance helping them to keep track of the attendance conveniently.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled NoTouch is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Shalini Batra during 6th semester (2022).

Date:

NAME	**ROLL NO.**	Signatures
Dhruv Goel	102083029	
Kartik Gupta	102083047	
Rohan Matta	101903550	
Shashank Kirtania	101903006	

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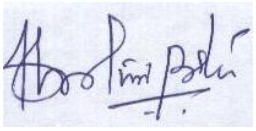

Dr. Shalini Batra

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ACKNOWLEDGEMENT

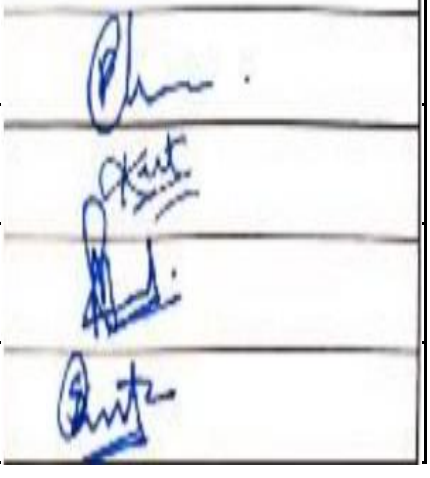
We would like to express our thanks to our mentor Dr. Shalini Batra. She has been of great help in our venture, and an indispensable resource of technical knowledge. She is truly an amazing mentor to have.

We are also thankful to the Computer Science and Engineering Department, entire faculty and staff of Computer Science and Engineering Department, and our friends who devoted their valuable time and helped us in all possible ways towards successful completion of this project. We thank all those who have contributed either directly or indirectly towards this project.

Lastly, we would also like to thank our families for their unyielding love and encouragement.

They always wanted the best for us and we admire their determination and sacrifice.

Date:29/12/2022

NAME	**ROLL NO.**	Signatures
Dhruv Goel	102083029	
Kartik Gupta	102083047	
Rohan Matta	101903550	
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LIST OF ABBREVIATIONS

Abbreviation	Full Form
ID	Identification
OTP	One Time Password
ISO	International Standard Organization
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
UTF-8	UCS Transformation Format 8

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INTRODUCTION

1.1 Project Overview

We propose to build an attendance application that collects fingerprint selfies, processes them for verification, and marks the attendance accordingly. Every student will have the mobile application installed on his or her mobile phones.

Students will be restricted from using saved photos in the gallery and will have to take live photos of their fingers during the class. We would provide a specific time duration in which students can upload their fingerprint photos after which we will process images to verify them and mark their attendance.

If a student successfully marks their attendance, then the student will get a confirmation of their attendance successfully and they will not be allowed to upload any other images after this to counter the problem of proxies. However, if the verification fails, students will be allowed to upload another image to repeat the process and verify them. This helps us to make sure every student is able to mark their attendance if they are present in the classroom.

On the other hand, the Professor will have an option to close the attendance portal for the class whenever they want to so that late comers will not be able to mark their attendance.

Meanwhile our application will upload all the images to our cloud server where we will process all the images in real time and extract fingerprints from them, this and cross verify fingerprints from the existing database of students' fingerprints. After the verification process is complete, the teachers will receive the list of students present in the lecture.

Requesting students' roll number to make their attendance alongside with their fingerprint will allow us to maintain a very precise log of attendance that will be helpful for both students and teachers to keep track of attendance.

1.1.1 Technical Terminology

Development Environment: It refers to the computer language and frameworks used for developing the said product. In this case, we are using Java Script and Python as languages for the development of this project and TensorFlow, PyTorch and React native as frameworks.

App Development: It refers to the development of the mobile application that will be used to record the attendance.

Fingerprint Selfies: These refer to the photos that the students will take of their fingerprint in order to mark their attendance.

Database: It refers to the server that will be used to store the student credentials and their fingerprint data.

Python- A high-level general-purpose language that is used to code the general object following the system in our case.

1.1.2 Problem Statement

Traditional attendance systems in institutions are time consuming, prone to proxies and hard to keep track of. Modern attendance systems like facial recognition and contact based fingerprint verification systems are less secure, unhygienic and have high capital and infrastructure needs.

There is no large-scale attendance system which provides a solution to these problems.

1.1.3 Goal

Develop an attendance system which is secure, efficient, fast and avoids physical contact to promote hygiene. The system needs to be scalable so that any institution or organisation can adopt it without high capital or infrastructure needs.

1.1.4 Solution

Develop a contactless fingerprint verification based mobile attendance application. The application will require the user to take a photo of their fingerprint which would be verified against their existing fingerprint data to mark their attendance.

1.2 Need Analysis

A common problem that colleges across India face is to maintain an attendance system which is efficient and easy to use. Traditional attendance systems that are currently in use involve roll calling and marking attendance on sheet, which is time consuming, prone to proxies and hard to keep track of.

To counter this problem, colleges have adopted systems like facial recognition and Contact based finger verification. Over the years fingerprint verification has proven itself to be more secure and accurate than facial based biometrics. However, in the wake of the pandemic hygiene has become a prime concern, making contact-based fingerprint scanners undesirable. Furthermore, these systems are not economical as they are heavily dependent on strong infrastructure and high maintenance cost.

NoTouch is a smart fingerprint verification-based attendance system that uses finger selfies to verify student's ID and match it with their existing fingerprint eliminating the need to physically touch any hardware device thereby promoting superior hygiene. Our proposal benefits from the widespread availability of low-cost mobile phones capable of capturing photos of fingerprints with sufficient resolution for verification purposes, reducing the implementation cost and making it more accessible.

Contact based fingerprint scanners are highly dependent on pressure applied and the angle of the finger placement. Apart from this the scanners fail to verify wet and dirty fingers. Our proposed idea overcomes these issues and is thus an ideal alternative.

1.3 Research Gap

Research work done on this is extensive and diverse in nature. However, it lacks the use of modern methods of pre-processing. We plan to apply modern techniques for pre-processing of image data to provide a solution for this particular use case.

1.4 Problem Definition and Scope

The problem is to develop a contactless fingerprint verification system-based attendance application which takes the input of fingerprint images and marks the attendance for the student and returns the list of attendees in a given lecture.

The scope of the problem is limited to a classroom in an educational institution.

1.5 Assumptions and Constraints

Table 1.5.1 Assumptions and Constraints

S.No	Assumption
1)	One of the assumptions is that the application will be run on mobile devices with sufficient hardware requirements. The hardware requirements include computing resources, which directly affect the performance of the application and a basic functional camera module with sufficient resolution.
2)	The quality of the input image does not solely depend on the quality of the smartphone camera but also the lighting available from the surroundings and the orientation of the fingerprint photo. We assume the student will click a photo in proper lighting and keep the finger photo upright and in focus.
3)	Since the application is cloud based it is assumed that a sufficient internet connection will be available to upload the finger photos to the cloud
4)	It is assumed that the fingerprint photo data will be provided during the completion of this project. Along with a fingerprint photo, the scanned fingerprint will also be provided.
5)	It is assumed that all the students mark the attendance in the classroom itself

1.6 Standards

ISO/IEC/IEEE 12207: This is an international standard for software lifecycle processes. This has been used for developing and maintaining all the software systems. This is used to encode all text

data in the project. **Hypertext Transfer Protocol** will be used for communication between the application and the server. **Unicode standard:** UTF-8 is a variable-length character encoding scheme capable of encoding all 1,112,064 **Unicode characters.**

1.7 Approved Objectives

Following is the list of objectives that we wish to achieve at the end of this capstone project:

Develop a robust, efficient and bug free application capable of running on a wide array of smartphones.

Extract the maximum features from the input image while minimizing the computation cost.

Verify the extracted features with existing fingerprint data with high precision.

Secure the attendance system against proxy attendance attempts by providing necessary features to restrict the student from marking their attendance more than once.

1.8 Methodology

We first plan to collect a dataset of both contactless and contact-based fingerprints. This includes the already existing datasets which have been used and maintained in the previous literature cited above, as well as the real-life photos which we will use to test our application in real time.

The early part of the implementation involves developing a data preprocessing pipeline which consists of segmentation, enhancement, scaling, distortion correction, representation extraction and matching of features in the finger selfies.

We will then implement various algorithms, to extract features from fingerprint data and verify them against the student database, based on the work done in existing literature and then fine tune an algorithm that works well on our dataset.

Thereafter we will develop an application that compiles all the steps in one package and is able to take attendance of a class efficiently.

1.9 Project Outcomes and Deliverables

We will build an application, which will successfully verify fingerprints to mark attendance and maintain the log for attendance for a class.

Shashank Kirtania- Image pre-processing

Rohan Matta- Application Development

Dhruv Goel - Fingerprint Verification

Kartik Gupta – Backend server

1.10 Novelty of Work

Pre-existing attendance system are either: Not as secure as biometric based systems. Biometric based but require high-level sensors. These sensors if installed at a place would cause commotion and disregard social distancing. Our app uses fingerprints, which is one of the most secure biometrics known to humankind. Facial recognition-based attendance systems exist but fall short when extended to a large scale with cameras of varying qualities. Our app can function with the image qualities provided by regular smartphones beating facial recognition-based systems and hence do not require separate high level sensors also leading to reduction of cost. As each student can record attendance using his or her own smartphone, social distancing would also be maintained in the classroom.

We propose a novel Deep Learning architecture for fingerprint enhancement. The Image enhancement algorithms work on image processing however we propose use of neural networks trained on special dataset containing fingerprints using sensor and the image of fingerprint, this allows us to map fingerprint photos to fingerprint retrieved using the sensor-based devices. The Deep Neural Network will work in two stages: (i) encoder (ii) decoder. This allows us to optimize our images for various smartphone cameras so as to improve the quality of retrieved fingerprints.

Requirement Analysis

2.1 Literature Survey

Table 2.1.1 Literature Survey

Year	Research Location	Paper Name	Broad Area/Domain
2021	Michigan, United States of America	C2CL: Contact to Contactless Fingerprint Matching	Use of contactless fingerprint photos for fingerprint matching
2021	Darmstadt, Germany	Mobile Touchless Fingerprint Recognition: Implementation, Performance and Usability Aspects	Fingerprint selfies for verification using mobile devices.
2021	Tamil Nadu, India	Fingerprint Recognition Technology Using Deep Learning: A Review	Review of methods for minutiae point extraction using deep learning methods

2020	Rajasthan, India	On Matching Finger-selfies using Deep Scattering Networks	Fingerprint segmentation using Saliency mask, Deep scatter networks for matching
2017	California, United States of America	SegNet: A deep con-volutional encoder–decoder architecture for image segmentation	Segmentation of objects from background using VAE
2015	Beijing, China	Salient object detection: A benchmark	Detection methodology for segmentation of salient objects for generating saliency masks
2015	California-Michigan, United States of America	Longitudinal study of fingerprint recognition	Comparison of change in ridges of fingerprint with respect to time
2010	Beijing-Michigan	Fingerprint Matching	Use of Minutiae points for matching fingerprints, automatic fingerprint verification for

			identifying user identity

2.1.1 Theory Associated With Problem Area

1) Use of fingerprint as a method of biometric verification using the fingerprint ridges and minutiae points.

2) Schematic segmentation of objects from images using deep neural networks.

3) Use of U-net architecture of schematic segmentation.

4) Extraction of data from both distributed and relational tables to servers.

2.1.2 Existing Systems and Solutions

Existing systems are very precise but lack connections between different works in the field of fingerprint matching and remote fingerprint matching. Even today most of the research based on fingerprints is restricted to use of classical techniques for matching of minutiae points however recent researches have advanced in the field of fingerprint segmentation using deep scatter networks.

2.1.3 Research Findings for Existing Literature

Research in the field of fingerprints has tremendous merits. Most of the work related to fingerprints is restricted to extraction and matching of minutiae points. In recent years deep learning architectures have turned out to be really effective to complete the above tasks. With the rise of COVID-19 research focus shifted to verification of fingerprints using the images of fingerprints.

2.1.4 Problem Identified

Extensive research has been carried out in the field of fingerprint verification however the use of deep neural networks to verify fingerprints is still a novel approach in this problem area. Different lighting conditions and camera quality have hampered the results of image segmentation tasks when dealing with fingerprint images. General Image enhancement methods have been used to

enhance the fingerprint selfies, however no method has been developed to fingerprint image data enhancement specifically. Fingerprint Verification methods based on physical scanners have failed to account for different pressure and foreign particles of each fingerprint impression recorded by scanners.

2.1.5 Survey of Tools and Technologies Used

For our project we have used different technologies for both deployment and development listed below:

Python (openCV, pandas, TensorFlow, PyTorch)

ReactNative

Django

Cloud Server

2.2 Software Requirement Specification

2.2.1 Introduction

2.2.1.1 Purpose

Our project aims to develop a contactless fingerprint verification system based mobile attendance application for a class at the university. Since it is based on contactless fingerprint verification , it is hygienic as it eliminates a common touch point.

2.2.1.2 Intended Audience and Reading Suggestions

Educational Institutions are our target audiences that are in the need of an attendance system

2.2.1.3 Project Scope

The scope of the project is limited to developing a working application for a classroom of students that is able to mark the attendance for the class using their fingerprint photos. The application also enables the teacher to obtain the list of attendees in the classroom.

2.2.2 Overall Description

2.2.2.1 Product Perspective

The software perspective contains frameworks like Pytorch, Tensorflow and React native while the hardware component only consists of the user mobile phone.

2.2.2.2 Product Features

The product features included are:

Mobile application: the user to upload the fingerprint photos to mark attendance will use this application. It will also be used to obtain the list of attendees.

2.2.3 External Interface Requirements

2.2.3.1 User Interfaces

The only user interface is through the mobile application. These are the proposed user interfaces:

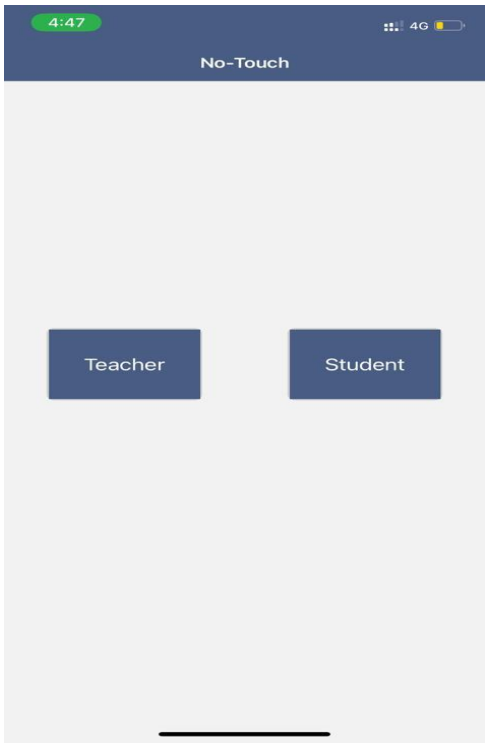


Fig 2.2.3.1.1

Fig 2.2.3.1.2

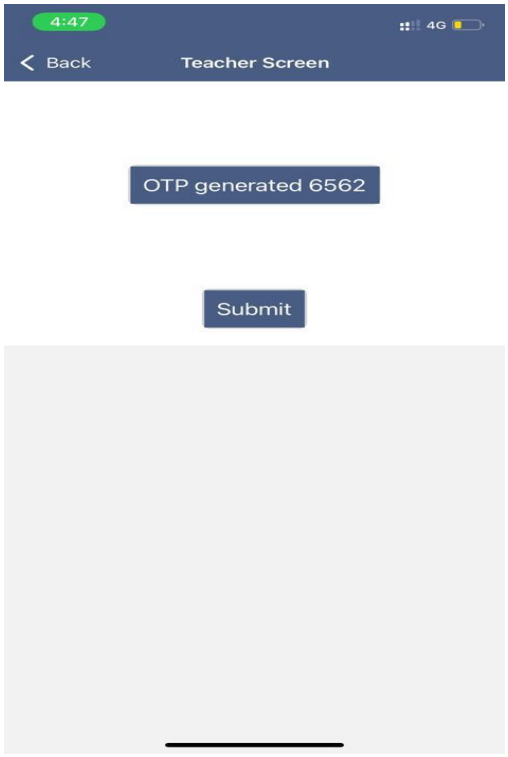


Fig 2.2.3.1.3

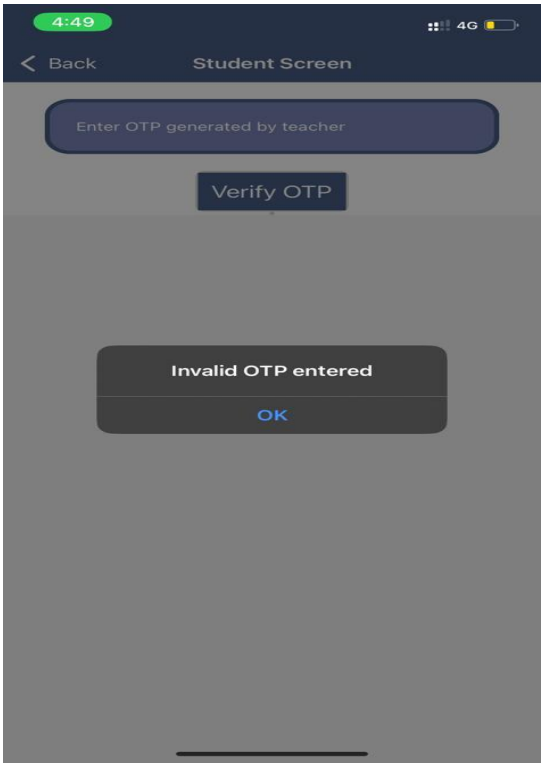
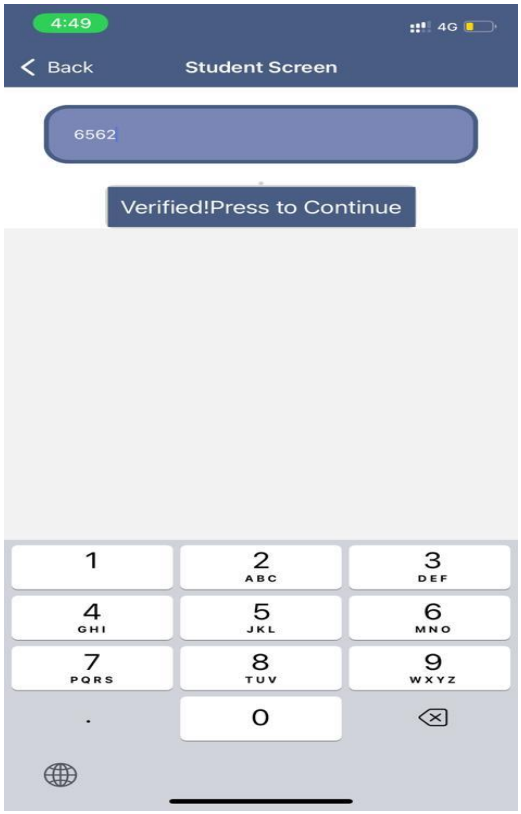


Fig 2.2.3.1.4



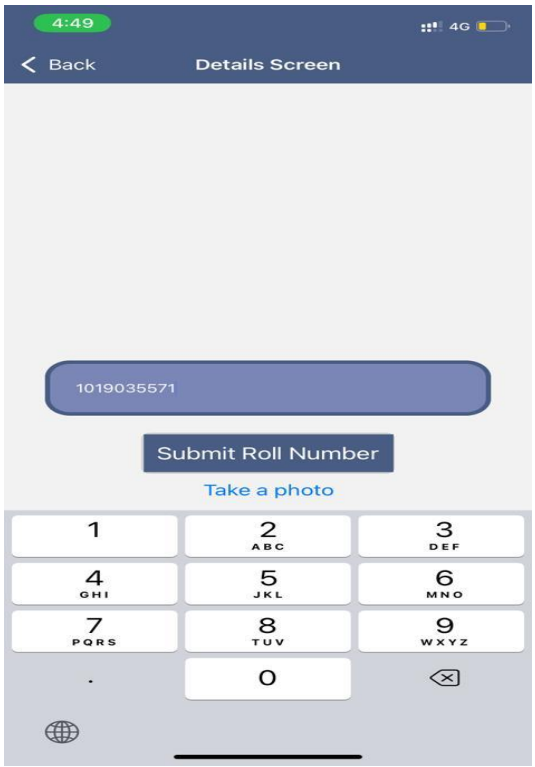


Fig 2.2.3.1.5 Fig 2.2.3.1.6

2.2.3.2 Hardware Interfaces

There are no hardware interfaces. However, for the initial database collection we will require a physical scanner.

2.2.3.3 Software Interfaces

The software interface contains frameworks like Pytorch, Tensorflow and React native. The programming languages used are Java Script and Python and the database will be made using Django.

2.2.4 Other Non-functional Requirements

2.2.4.1 Performance Requirements

The application must be capable of handling a great number of requests, as well as big volumes of data and demands from several users at the same time. Fast execution and sufficient storage capacity are essential. The application should be functional for low-resolution images as well.

The processing time for verification of fingerprint data should be around 5 minutes.

2.2.4.2 Safety Requirements

In case the fingerprint of a student fails to be verified, a contingency pipeline must be developed in order to ensure every student is able to mark the attendance.

2.2.4.3 Security Requirements

The database used for the application should be secure and provide protection against unauthorized access. There should be proper user authentication and no user should be able to access the data of other users. Furthermore, only the developers should have access to the database. Proper error messages should be displayed whenever a user tries to perform some unauthorized action. Active Internet connection is required to login.

2.3 Cost Analysis

Since this project is a pilot project, it is being implemented on a small scale so the cloud services required would be met by free subscriptions.

Table 2.3.1 Cost Analysis

Item	Quantity	Cost(Rs.)
Fingerprint Scanner	1	2500
Cloud Services	-	0
Total		2500

2.4 Risk Analysis

Table 2.4.1 Risk Analysis

Risk	Consequences	Mitigation Strategy
Bugs	The project will not run	Extensive Testing
Failure to meet the deadline	Partial Completion of Project	Proper workflow structure and management
Lack of Knowledge	The project may not be up to the standards	Extensive research and proper communication

Fingerprint Verification Failure	The Student attendance will not be marked	Extensive Testing and finding out the core reason
High Runtime	The application will take excess time to process images	Optimizing the fingerprint verification pipeline and preprocessing the existing images.

3.1 Investigative Techniques

In our Project, Experimental Investigative techniques have been used with the initial idea of contributing toward building a much more secure and hygienic way of marking attendance. We have used Experimental Investigative techniques to develop a mobile application for marking the attendance of students using their fingerprint selfies. The project will be tested for a classroom of students.

3.2 Proposed Solution

We propose to build an attendance application that collects fingerprint selfies, processes them for verification, and marks the attendance accordingly. Every student will have the mobile application installed on his or her mobile phone. The following flowchart describes the working of the project:

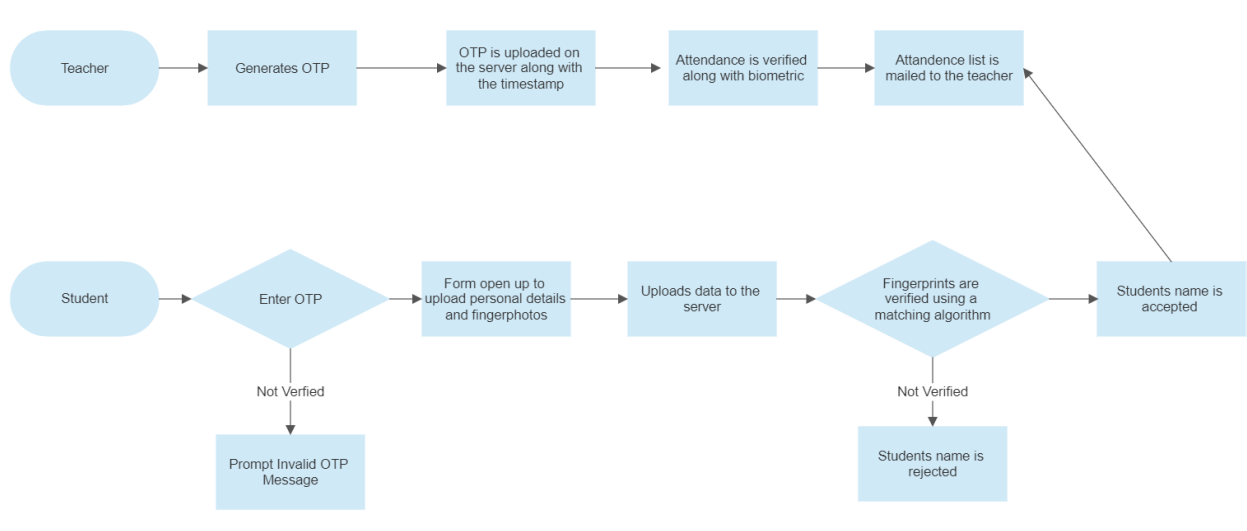


Fig 3.2.1 Block Diagram

3.3 Work Breakdown Structure

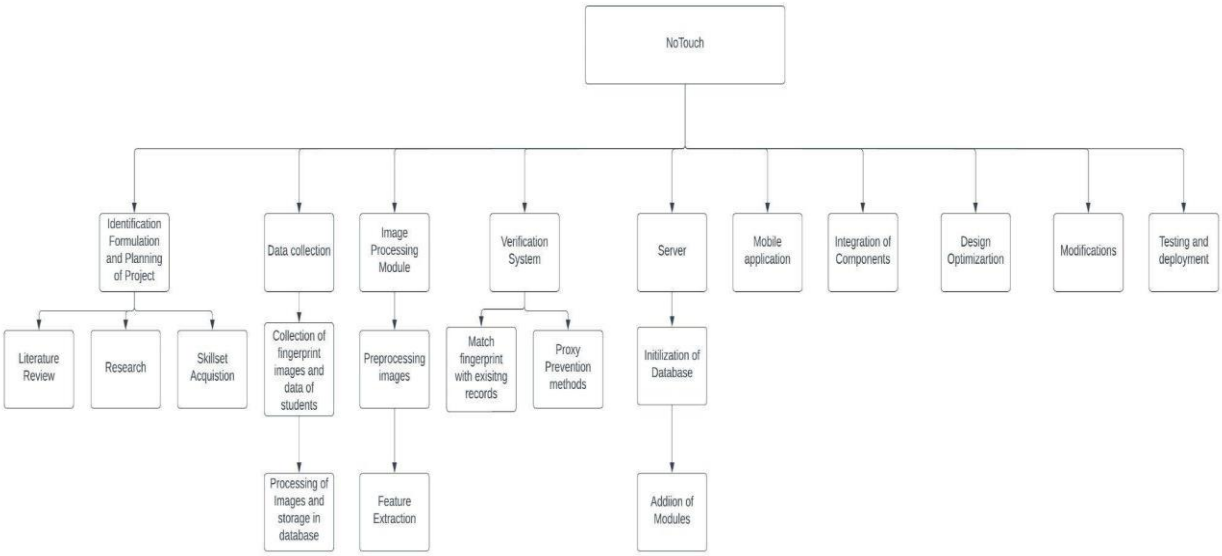


Fig 3.3.1 Work Breakdown Structure

Identification Formulation and Planning of Project: This is the module in which we will conduct literature review, research and skill set acquisition to identify the work already done in this field and identify the skill sets needed to implement the project. We will also learn the various skills required to work on the project that our team lacks

Data Collection: This module is concerned with creating a database of fingerprint images, which will be used to test the various components of our project.

Image Processing Module: This module deals with pre-processing of images to extract information from the fingerprint images, which will be used by the verification system.

Verification System: This module matches the fingerprint images to the existing database and verifies if the same person is marking the attendance.

Server: All the data and image processing pipelines are stored on this server. The mobile application is connected to this server, through which it sends and receives data.

Mobile Application: This is the main user interface, which will be used by the students and teachers to mark the attendance and obtain the list of attendees.

Integration of Components: This module deals with the linkage of all the modules to enable them to work together.

Design Optimization: After all the components are integrated, the system will be optimized to minimize the time taken by the application

Modifications: Final modifications will be made to make the application more user friendly.

Testing and Deployment: This is the final module where the application will be tested for a classroom of students and upon successful trials deployed for use.

3.4 Tools and Technology

Python: A high-level language used largely in Automation, Machine Learning, and Data Analytics. It is one of the most popular languages amongst solo developers as well as large enterprises for its pool of functionalities due to a large number of libraries. The following libraries are used: Pytorch, Keras, TensorFlow, NumPy, Pandas, scikit-learn, matplotlib, Sci-Py, OpenCV.

React Native: It is a JavaScript framework used widely for cross platform mobile application development.

Firebase: It is a platform developed by Google for mobile and web application development. It will be used to develop the backend for our application

Django: It is an open-source back-end server side web framework

4.1 System Architecture

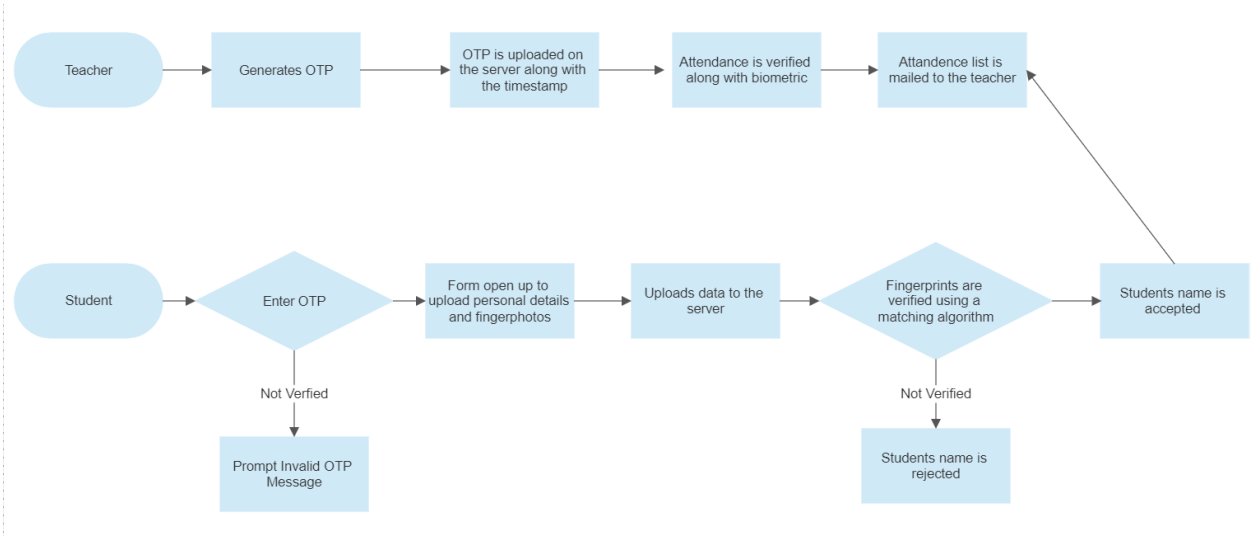


Fig 4.1.1.1 Block Diagram

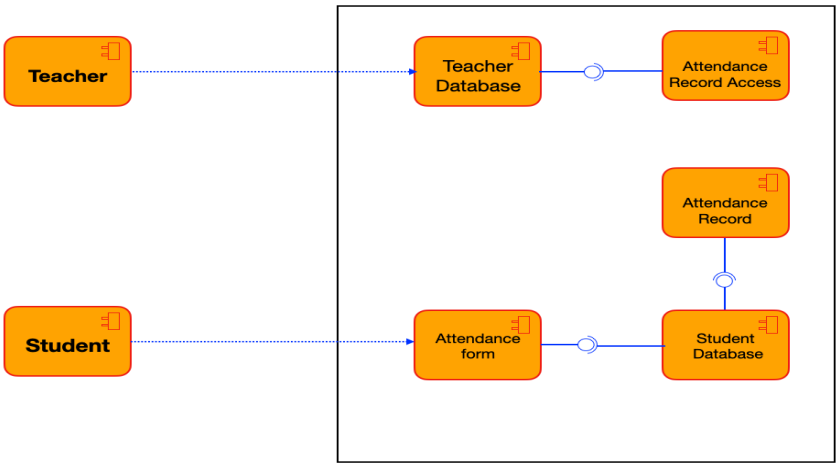


Fig 4.1.2.1 System Architecture

4.2 Design Level Diagrams

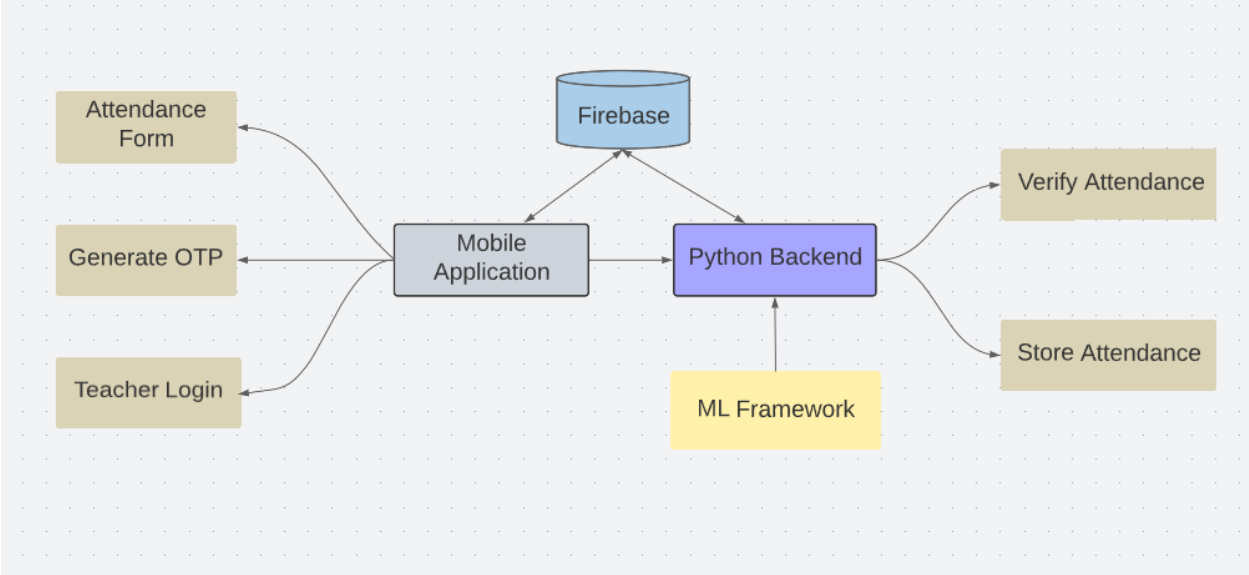


Fig 4.2.1.1 System Overview

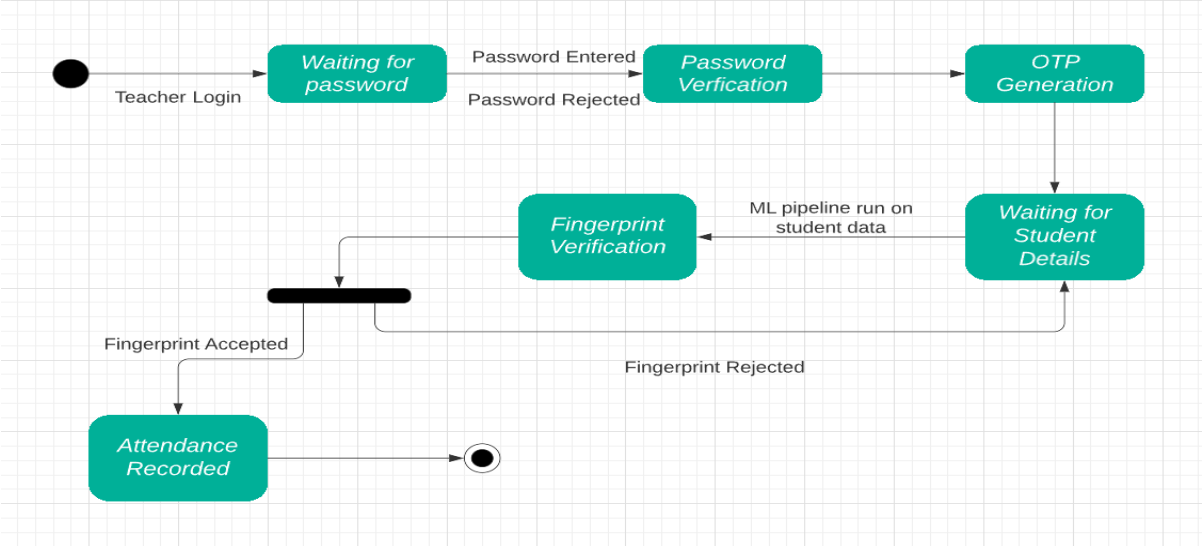


Fig 4.2.1.1 State Chart Diagram

4.2.3 Swimlane diagram

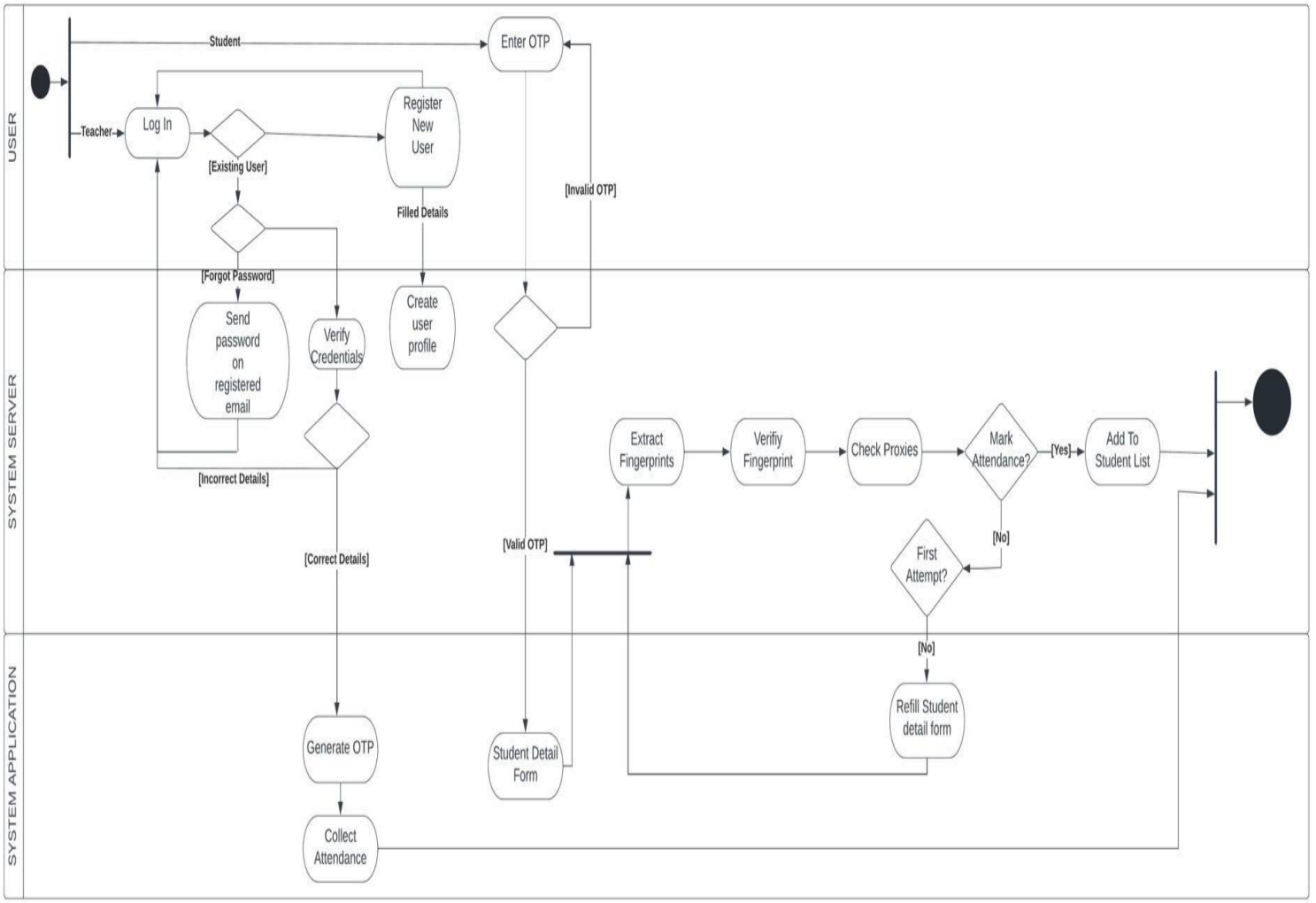


Fig 4.2.3.1 Swimlane diagram

4.2.4 Class Diagram

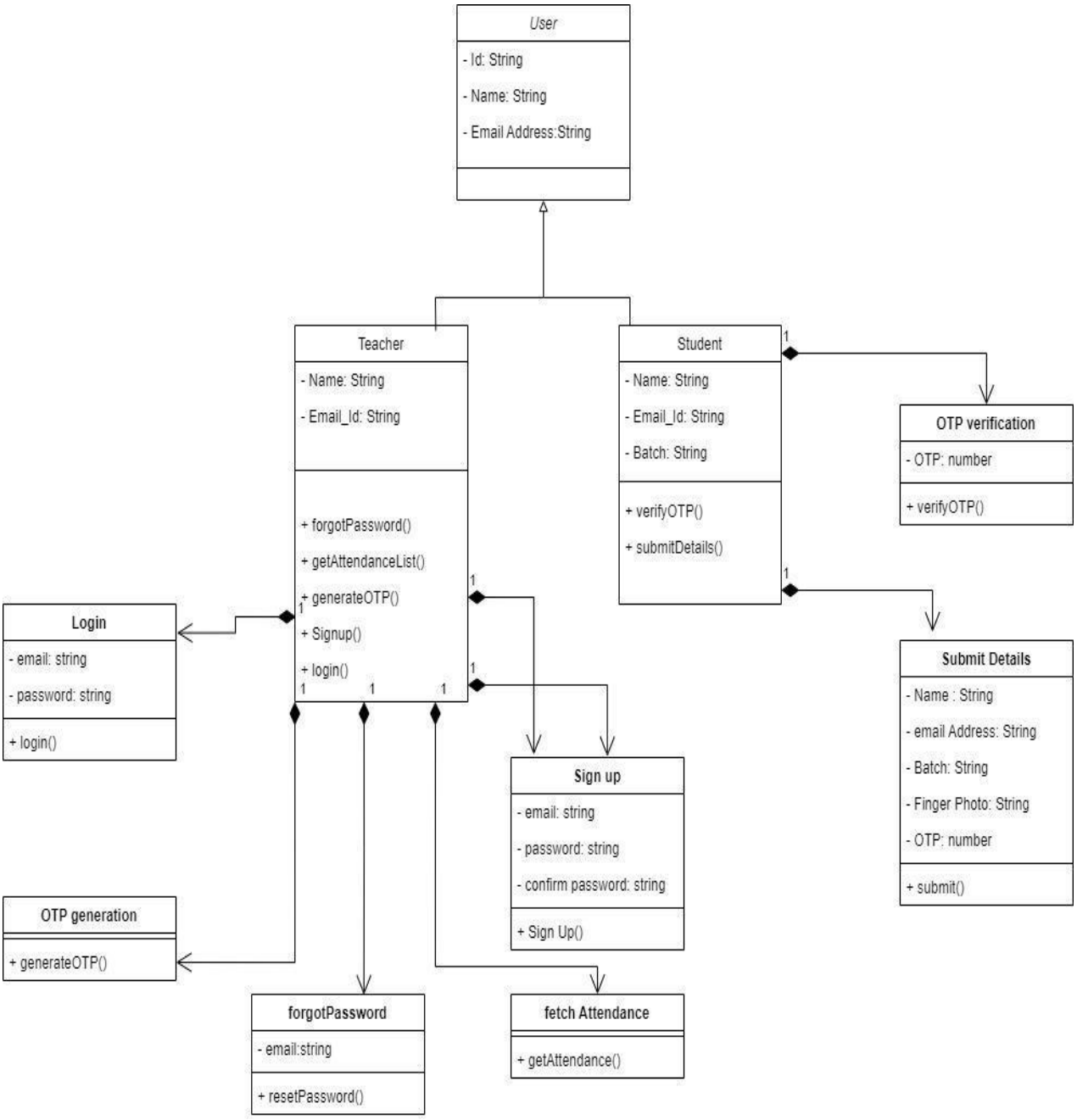


Fig 4.2.4.1 Class Diagram

4.2.5 Use Case Diagram

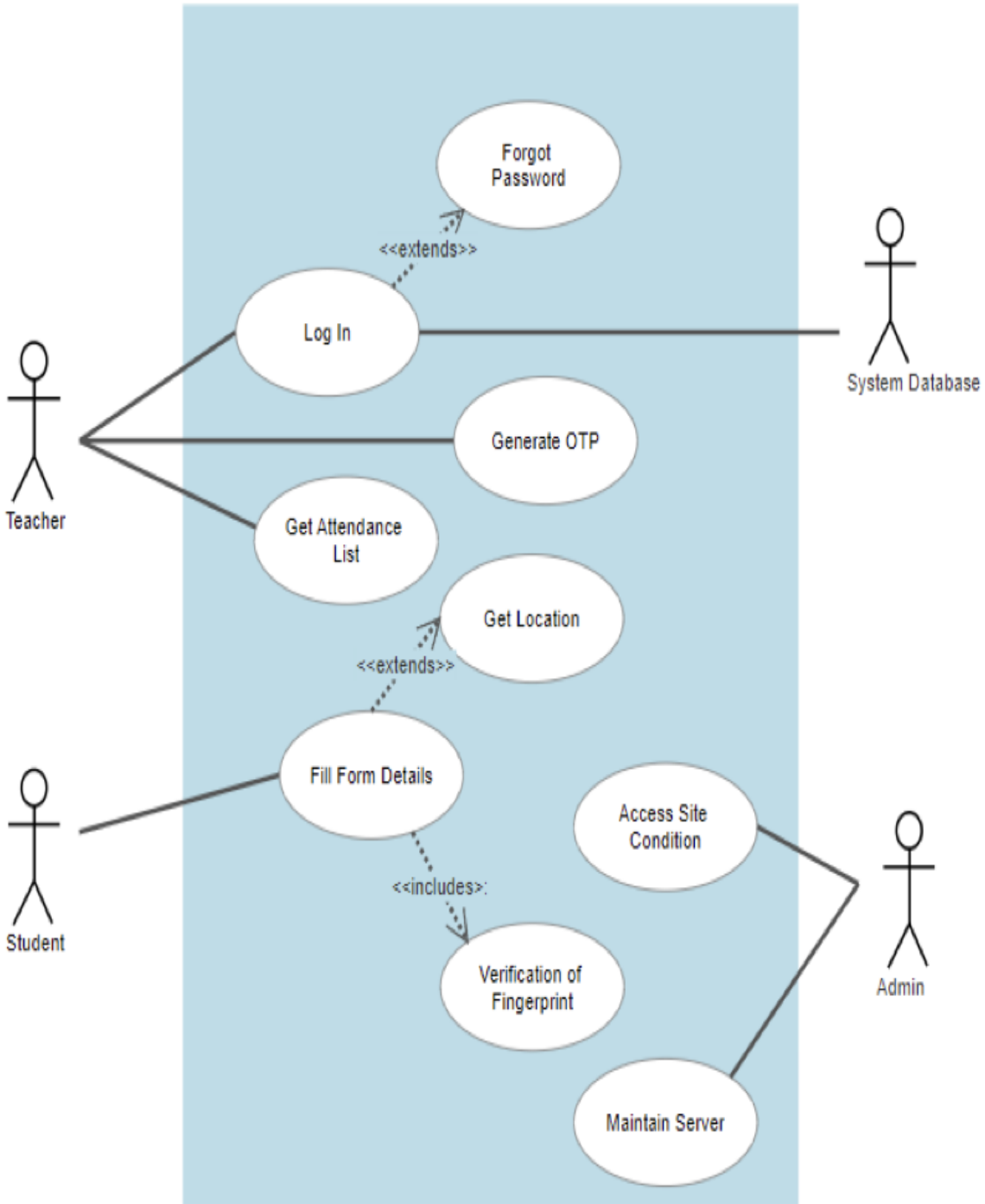


Fig 4.2.5.1 Use Case Diagram

4.2.6 Entity-Relation Diagram

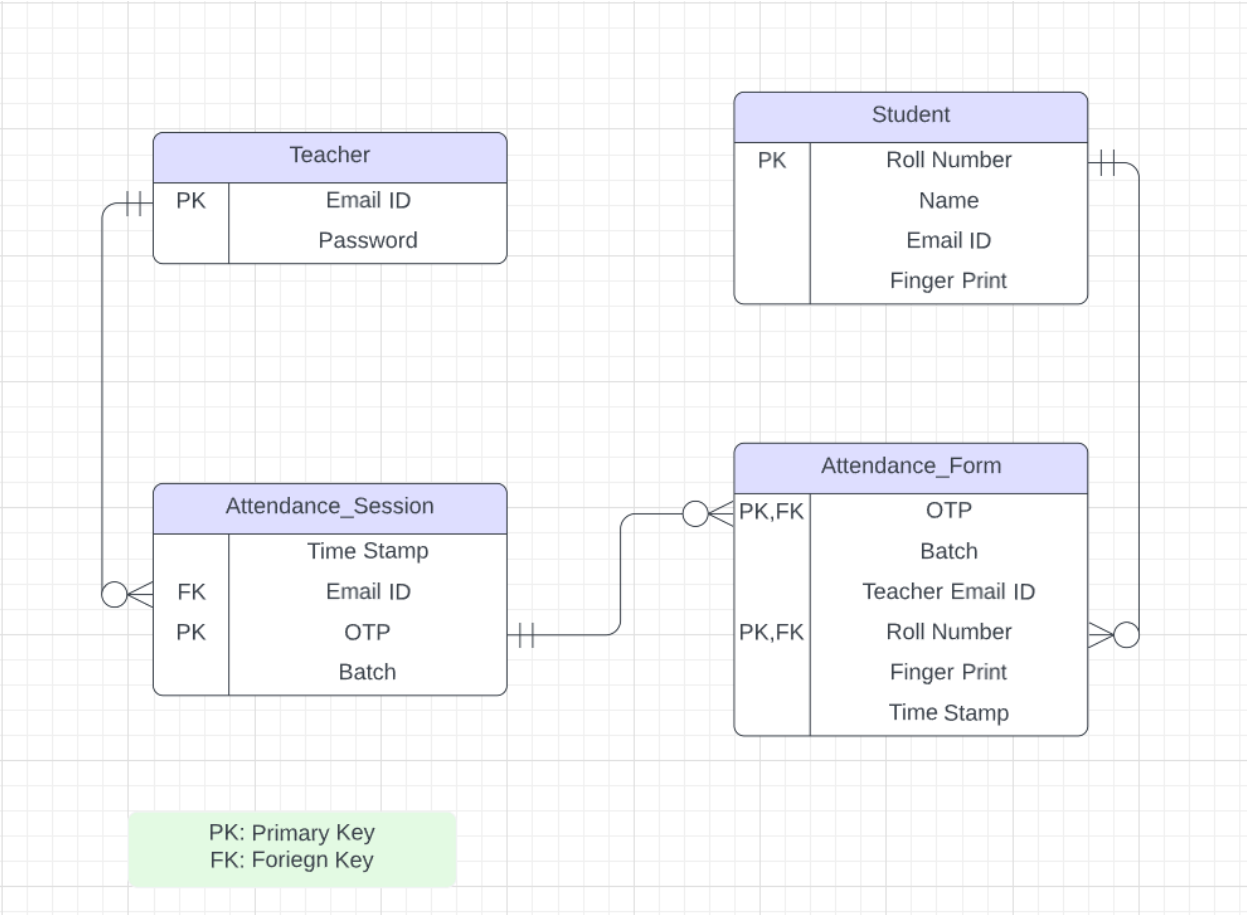


Fig 4.2.6.1 Entity-Relation Diagram

The database design consists of 4 data frames:

Teacher: Login details of teachers with their email-id as the primary key.

Student: Credentials of each student registered in the attendance system with their roll number as the primary key.

Attendance Session: Details of an attendance session that are initiated by the teacher. The OTP produced in the app is the primary key for each session and the teacher's email id (who initiated the session) as the foreign key to the 'Teacher' table.

Attendance Form: Information submitted in the attendance form by students with OTP and roll number of a student as a primary key (composite key). OTP and roll number individually are the foreign keys to the tables ‘Attendance Session’ and ‘Student’ respectively.

4.2.7 Data Flow Diagram

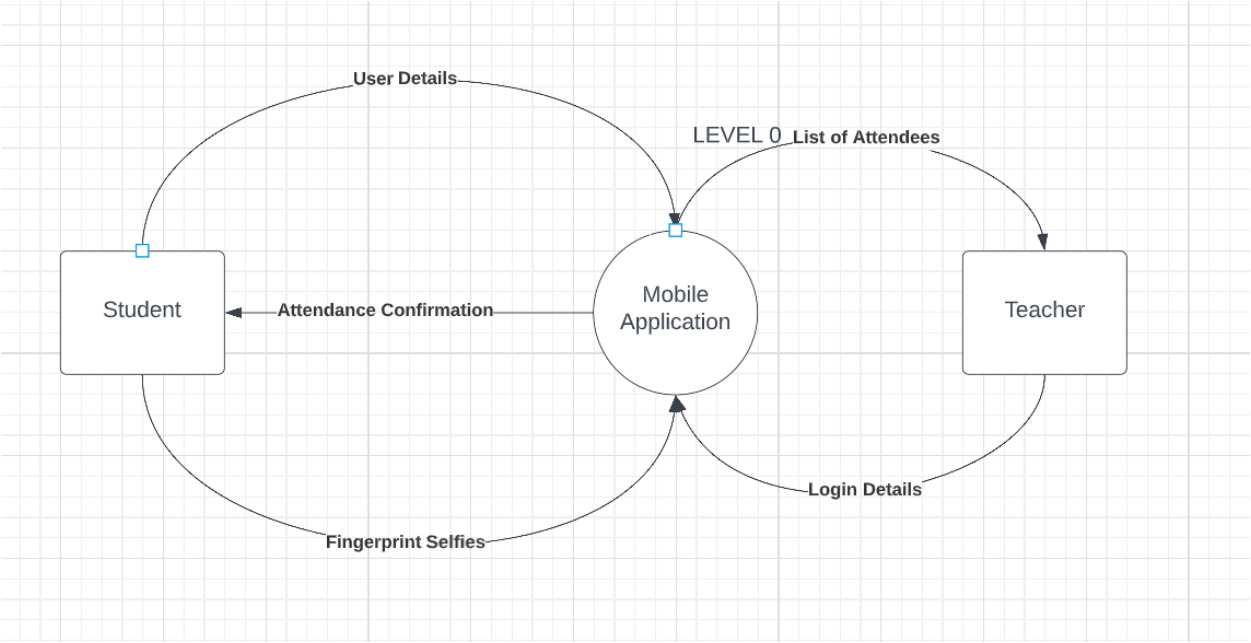


Fig 4.2.7.1 DFD Level 0

Level 0 Data flow diagram gives the basic overview of the flow of data between the application and the users that are Students, Teachers.

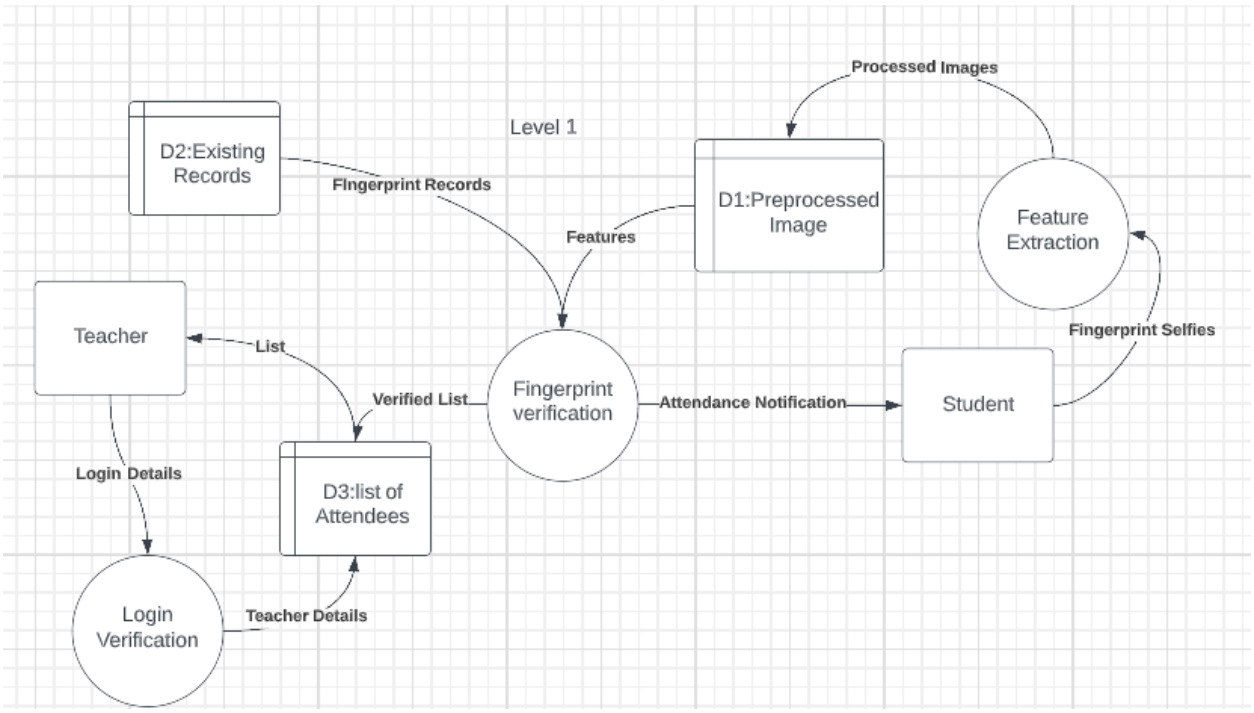


Fig 4.2.7.2 DFD Level 1

Level 1 Data flow diagram gives an in-depth overview of the flow of data between the various processes of the application and the users that are Students, Teachers.

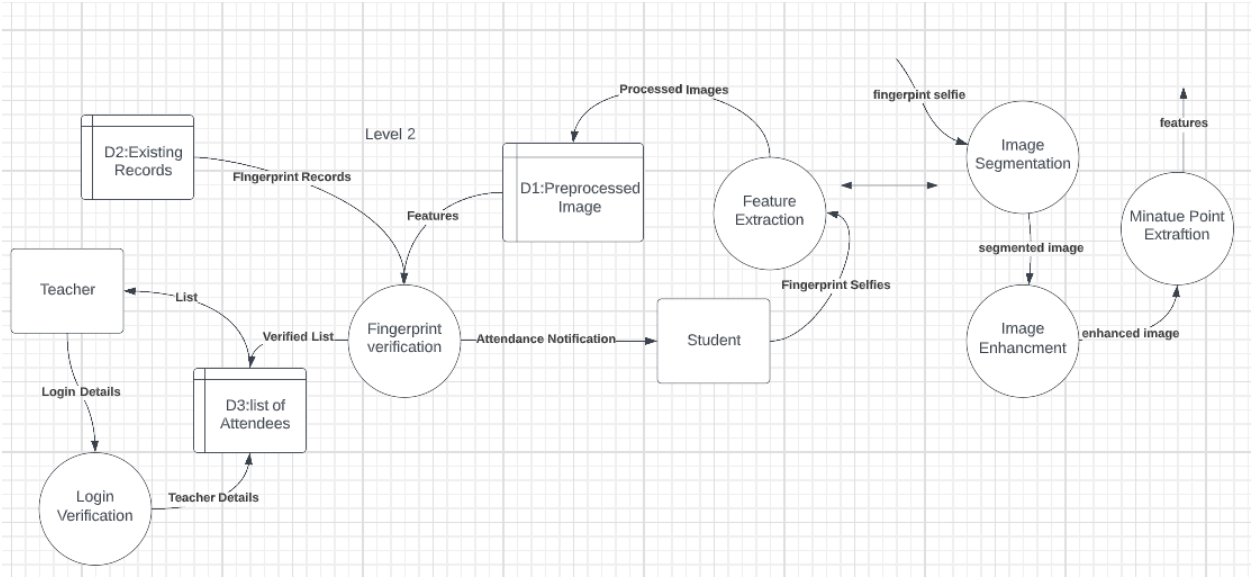


Fig 4.2.7.3 DFD Level 2

Level 2 data flow diagram gives further details about the sub processes of the feature extraction process.

4.3 Use Case Templates

Table 4.3.1 Use Case Templates

ID:	1
Title:	Log in

Description:	With log in teachers can initiate the process of taking attendance
Primary Actor:	Teacher, System Database
Preconditions:	An existing account must exist in the database.

Post conditions:	The user will be given an option to generate an OTP for their class.
Main Success Scenario:	If the user is successful, they will be able to generate an OTP.
Extensions:	If authentication fails, the user will be given the option of "Forgot password."

ID:	2
Title:	Generate OTP
Description:	The user will be able to generate an one-time code to record attendance to the class

Primary Actor:	Teacher
Preconditions:	The user must be logged in.
Post conditions:	An OTP would be generated and displayed on the user's screen
Main Success Scenario:	OTP is generated and displayed.
Extensions:	The application might fail to load

ID:	3
Title:	Get attendance list

Description:	The user receives the attendance list for the class for which it had generated the OTP
Primary Actor:	User
Preconditions:	The process of verification and marking of attendance should have been completed
Post conditions:	Attendance list is fetched from the system database and displayed
Main Success Scenario:	Attendance list is displayed on the user's screen
Extensions:	The database may fail to respond to requests due to poor connection.

ID:	4
Title:	Fill form details
Description:	Users must fill the form and upload a photo of their finger. While filling the form the present location of the user is also recorded and all these credentials are used to determine whether the attendance is genuine or a proxy.
Primary Actor:	Student
Preconditions:	An OTP must be generated by the teacher
Post conditions:	Response gets recorded and the finger photo and location is matched with the already existing data in database
Main Success Scenario:	The finger photo gets matched and the student's attendance gets recorded

Extensions:	The finger photo might not have been clicked properly and might fail to be recognized by the backend algorithm. The database may fail to respond to requests due to poor connection.

ID:	5
Title:	Access site condition
Description:	Admin uses this feature to monitor the general health of the application.
Primary Actor:	Admin

Preconditions:	Admin must be logged in using their admin account.

Post conditions:	A general report of the website is displayed.
Main Success Scenario:	Admin has special privileges that allow them to monitor the application’s condition.
Extensions:	Due to some unprecedented error, the site condition may fail to load.

ID:	6

Title:	Maintain Server
Description:	Admin can monitor the database.
Primary Actor:	Admin
Preconditions:	Admin must be logged in using a special admin account.
Post conditions:	The current state of the database is known to the admin.
Main Success Scenario:	Admin logs in and monitors the database conditions and then can choose to proceed accordingly.

Extensions:	The database may fail to reload due to poor connection.

4.4 Snapshots of Working Prototype

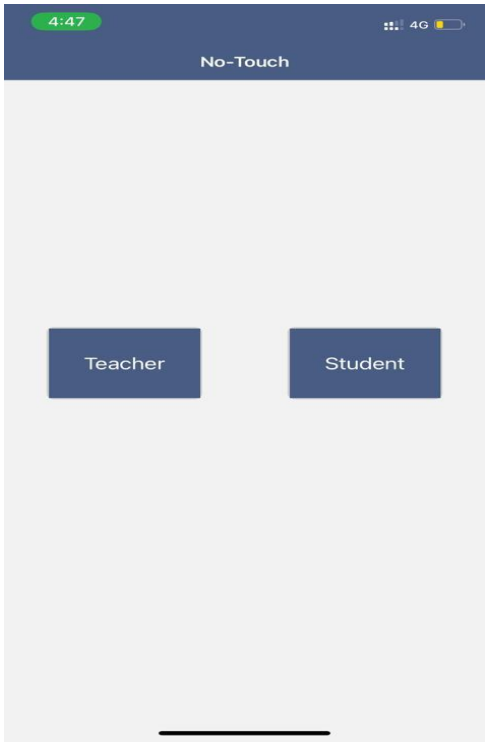


Fig 4.4.1

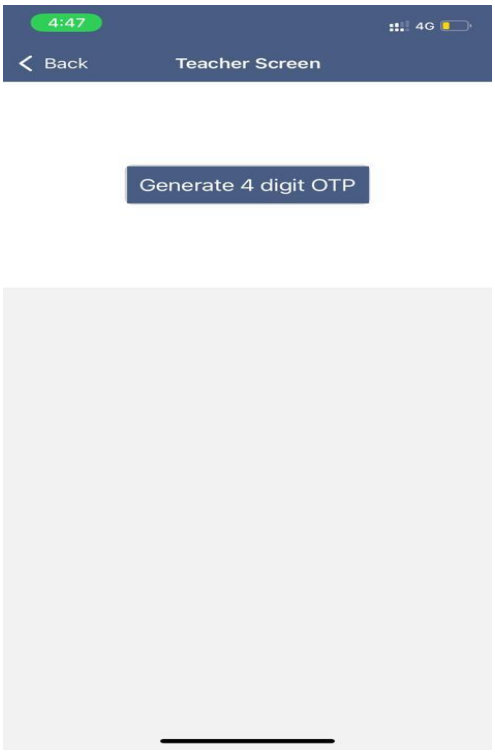


Fig 4.4.2

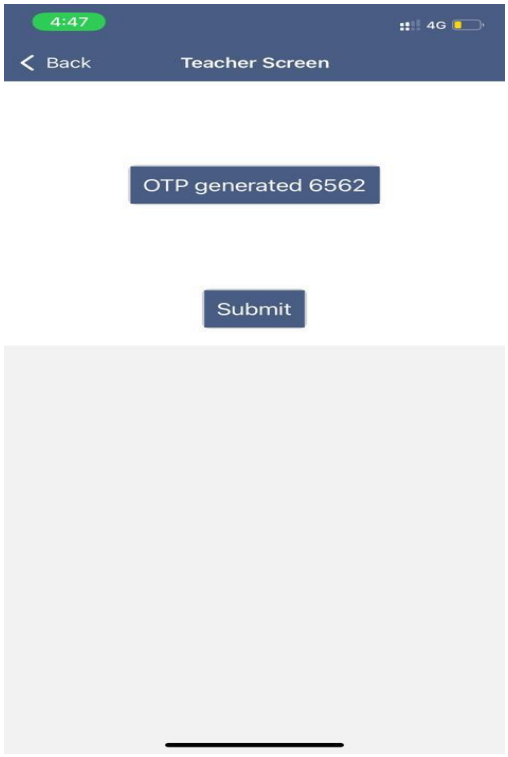


Fig 4.4.3

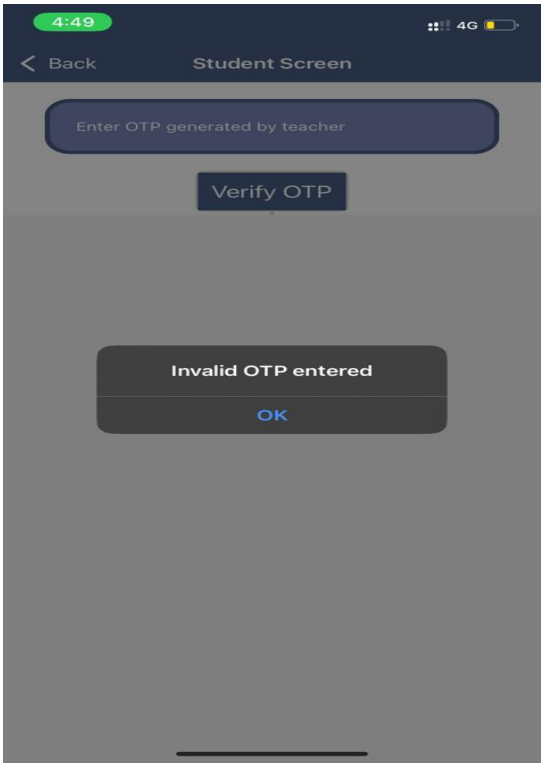


Fig 4.4.4

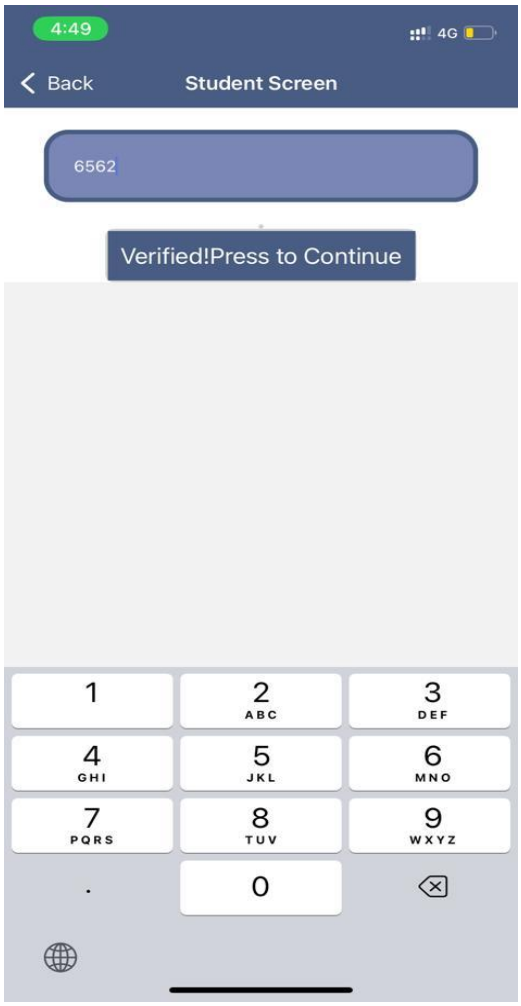


Fig 4.4.5

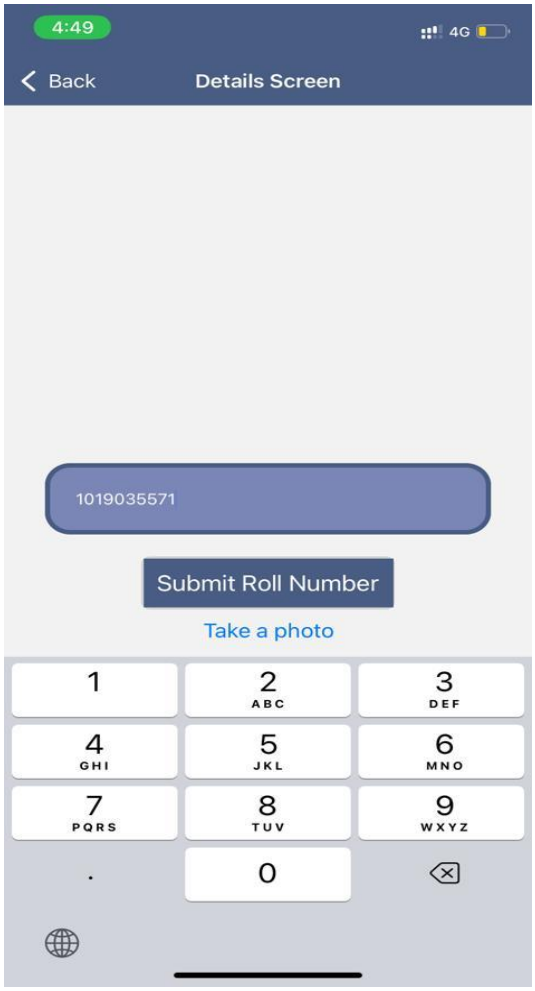


Fig 4.4.6

5.1 Experimental Setup

The main objective of this object is to verify a student's identity and add their name to the attendance list. To test the application, we created a database of 10 students representing a classroom. We processed and stored their fingerprint photos, which will be used to verify their identities later on. The system will be considered to be working properly if it is able to add the name of any of the 10 students, we used to create the class and not add the name of someone who does not belong to the class and still tries to mark their attendance.

5.2 Experimental Analysis

5.2.1 Data

The following datasets were used for training and testing the application:

ISPFDv2: Used to train the image processing pipeline models

PolyU Contactless Fingerprint to Contact based Fingerprint Database: Used to train the image processing pipeline models.

Classroom: The dataset we created of 10 students that will be used to test the application.

5.2.2 Performance Parameters

The performance of the application depends on the following modules:

Mobile Application: should be able to generate OTP for the teachers and record details of the student who entered the correct OTP and send them to the backend server.

Image Processing Pipeline: should be able to extract fingerprint impressions from fingerprint images with sufficient accuracy to verify them successfully.

Image Verification pipeline: should be able to accurately verify the input image against the image in the classroom dataset.

5.3 Working of the Project

5.3.1 Procedural Workflow

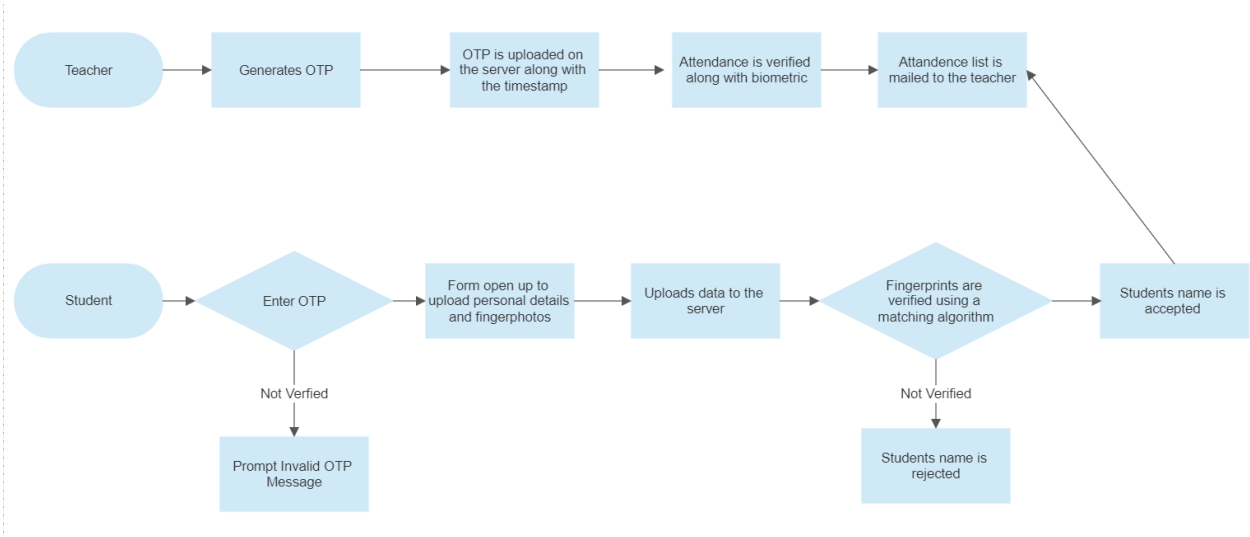


Fig 5.3.1.1 Procedural Workflow

5.3.2 Algorithmic Approaches Used

Image Segmentation: For Implementing Image Segmentation, we have used Histogram Thresholding

Image Pre-processing: We have applied Gaber Filters, Gaussian Blur, Sobel Filter and Skeletonize for Pre-processing for uploaded images

Feature Extraction: We identify the endpoints of the generated images and these endpoints act as the miniature points for feature extraction

Fingerprint Verification: For verification, we generate encodings for input image and database image by using the encodings generated by a CNN based encoder and compute their cosine similarity and the pair of images with cosine similarity higher than a threshold are a a match.

5.3.3 System Screenshot

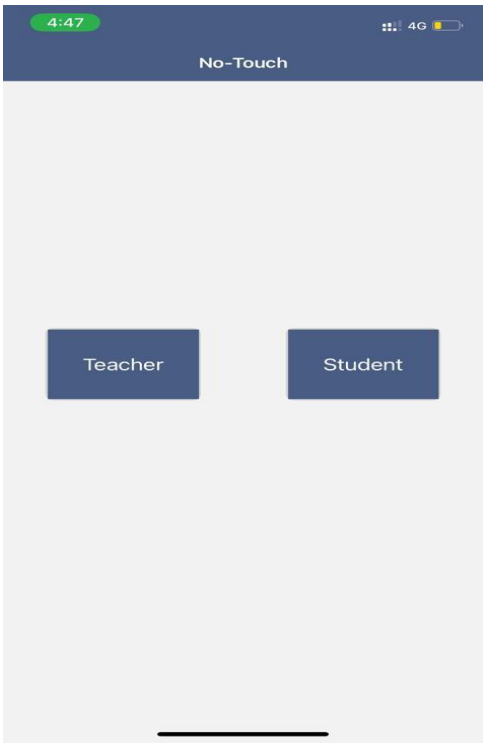


Fig 5.3.3.1

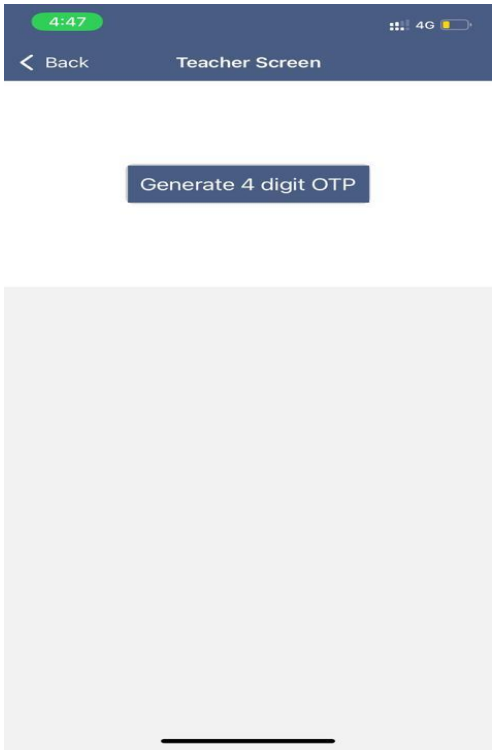


Fig 5.3.3.2

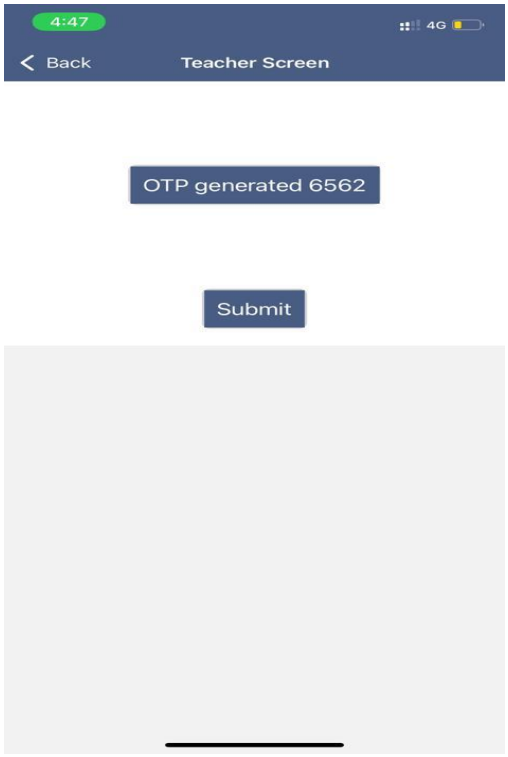


Fig 5.3.3.1

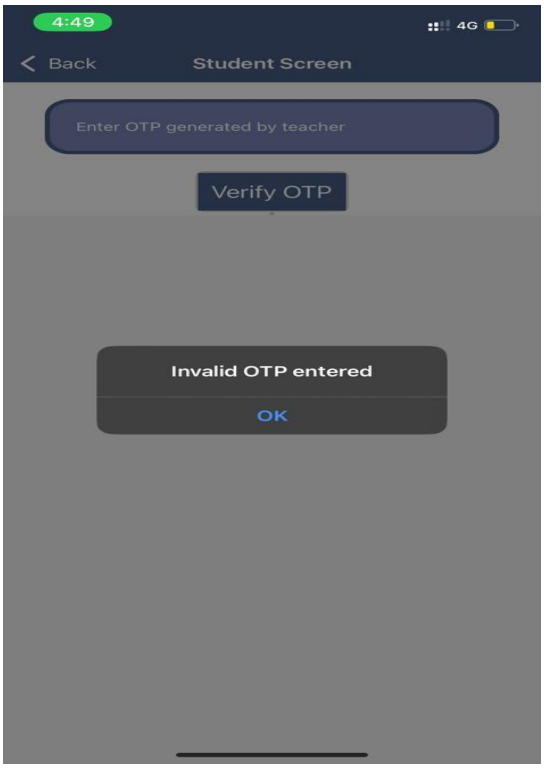


Fig 5.3.3.2

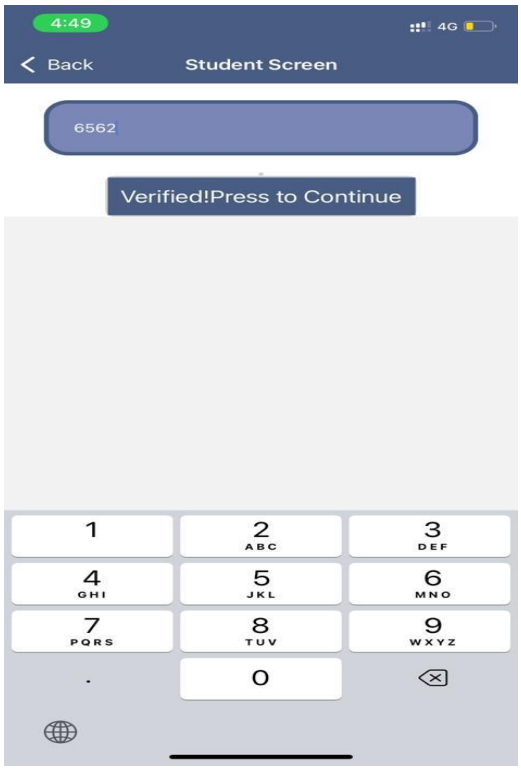


Fig 5.3.3.5

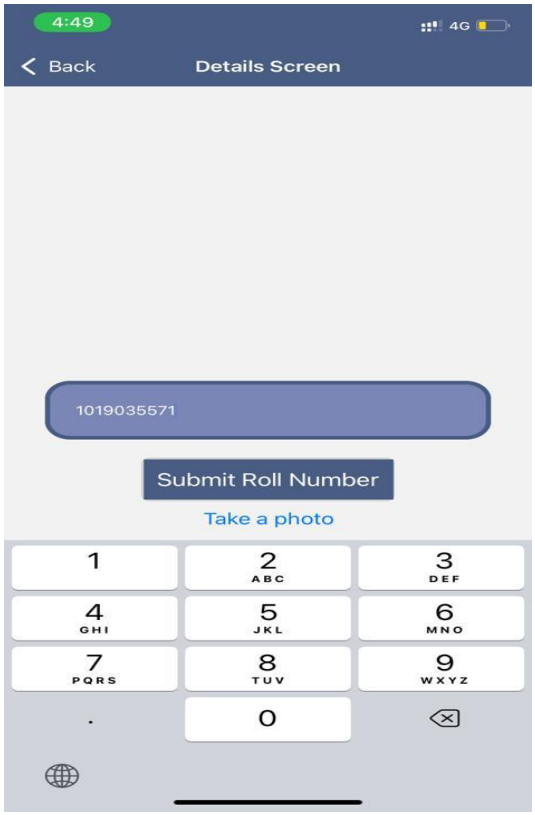


Fig 5.3.3.6

5.4 Testing Process

5.4.1 Testing Plan

The testing plan is fairly simple and straightforward. Each component will be tested individually so that every component is working properly. After integration, the application will be tested for a class of 10 students. The application should be able to identify the student's fingerprints and reject any other input photos.

5.4.1.1 Features to be tested

The major feature to be tested is the fingerprint verification module, which verifies the input image against the classroom database. Some other features to be tested are the OTP Verification system and the creation and sending of attendee list to the teacher.

5.4.2 Test Cases

There are 3 test cases which will test the entire application:

Invalid OTP: If a student enters the wrong otp , the application should prompt an invalid otp message

Verify a student's record: If a student belonging to the class tries to mark their attendance, he should be able to successfully do so and their name must be returned in the attendance list.

Detect Imposters: If a person not belonging to the class tries to mark their attendance, he should not be able to do so and their name must not be returned in the attendance list.

5.4.3 Test Results

The application is working properly.

OTP verification is working as expected.

Student attendance list is being generated for verified students.

No one other than the students are able to mark their attendance.

5.5 Results and Discussions

The test results prove that a working prototype of a fingerprint-based attendance system has been created. The main objective of the project has been successfully achieved. The system was able to verify a student's identity by using their fingerprint photos.

6.1 Work Accomplished

We have started the development of our mobile application using React Native. We have developed our Landing page, which gives the option to proceed to the student or teacher page. On clicking the student button, the user is navigated to the student page where they enter the OTP (one time password) provided by their respective teachers for the particular class they are attending. On entering the correct OTP, users will be allowed to enter details like Name, roll number and upload their finger selfie.

We have also started the development of the feature extraction pipeline responsible for extracting minatue points from the fingerprint selfies. We have implemented the image segmentation pipeline, which isolates the fingerprint from the background. This segmented image will be further processed to access the minatue points for a given image.

6.2 Reflections

We have made the following conclusions:

Using **U net** helped us generate finger photos, which are comparable to fingerprints generated using fingerprint scanners.

Instead of opting for **Otsu Thresholding**, using schematic segmentation using skin colour and saliency-based masks gives better results for segmenting the image from the background

6.3 Environmental Benefits

By developing an application, which verifies the identity with the help of finger selfies, we are eliminating the use of a fingerprint scanner. Therefore, we are eliminating the use of hardware resources.

6.4 Future Work Plan

We plan to extend our project by building a robust application that allows organisations or institutions to verify the user in a safe and hygienic manner. To do that we will have to make sure that our remote servers work efficiently and maintain a proper log of attendance for teachers.

We believe in the future this project can also be used to do remote KYC for verifying a person for official jobs like remote opening of bank accounts, verifying yourself for the 'living certificate'. To incorporate features we would need to implement an encrypted system that can be mapped with ADHAAR information, for which we would require even better cloud servers and databases.

7.1 Challenges Faced

Clash of ideas - Brainstorming always leads to a fruitful outcome. Initially, we had many discussions on the domain area and problems to work on. However, analysing the scope and benefits and with the consent of all members, we finally took the problem of vanquishing fear and apathy among individuals.

Substantiation of the project - A project needs to be well documented. It helps us to ensure efficiency and consistency among everyone working towards the common goal. The task to document all the working modules consumed a good effort.

Integration of project - Integrating different components of the project was a challenge as each individual was not familiar with all the frameworks used by other team members.

7.2 Relevant Subjects

Table No 7.2.1 Relevant Subjects

Subject Code	Subject Name	Description
UCS503	Software Engineering	To verify, validate, abstract, plan, develop and manage a large software
UCS522	Computer Vision	To understand and apply basic concepts of Computer Vision.
UCS310	DBMS	To establish and maintain our database
UCS611	Machine Learning	Understanding the basics of ML Models.

7.3 Interdisciplinary Knowledge Sharing

Most of the work and objectives were accomplished using the knowledge gained from the Domain of computer science and software engineering. Software Engineering helped us formulate a plan of action with all kinds of diagrams at hand making sure that we don't miss out on an imperative step. It made sure that we stayed on an iterative path. Computer Vision helped us to process the fingerprint images to extract information for matching two similar fingerprints. DBMS helped us develop a database to store and process all the fingerprint images in a fast and secure manner

7.4 Peer Evaluation Matrix

Table No 7.4.1 Peer Evaluation Matrix

		Evaluation of			
		S1	S2	S3	S4
Evaluation by	S1	-	5	5	5
	S2	5	-	5	5
	S3	5	5	-	5
	S4	5	5	5	-

Table No 7.4.1 Key for peer evaluation matrix

Student Key	Roll No	Name
S1	102083029	Dhruv Goel

S2	101903306	Shashank Kirtania
S3	101903550	Rohan Matta
S4	102083047	Kartik Gupta

7.5 Role Playing and Work Schedule

Contribution of individual team members:

Shashank Kirtania- Image segmentation and pre-processing

Rohan Matta- Application Development

Dhruv Goel - Fingerprint Verification Pipeline

Kartik Gupta - Backend Server Development

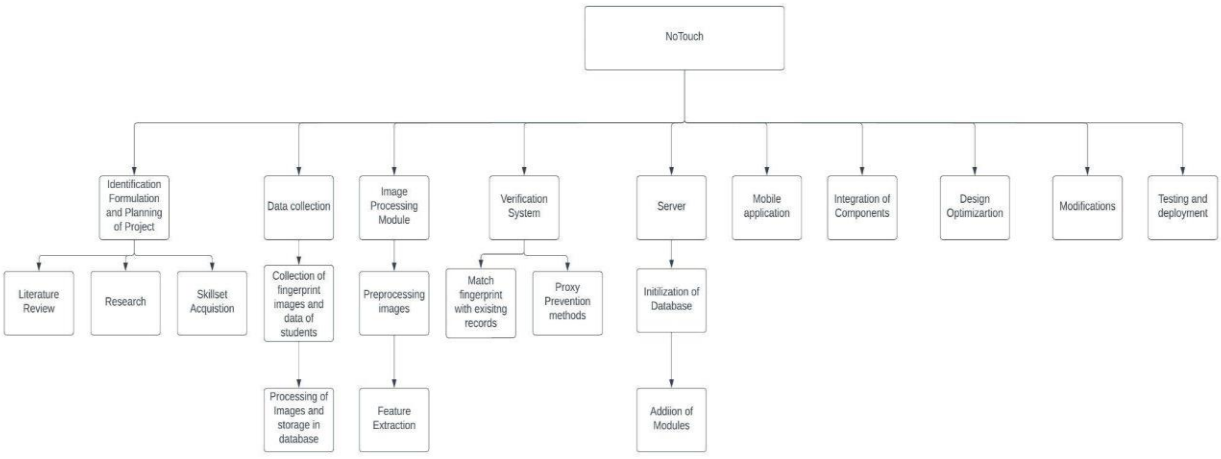


Figure 7.5.1 Work Schedule

7.6 Student Outcome

Table No 7.6.1 Student Outcome

SO	SO Description	Outcome
1.1	Ability to identify and formulate problems related to the computational domain	The major problem faced was to extract the fingerprint from finger photos with enough accuracy to gather minatue points from it
1.2	Apply engineering, science, and mathematics to obtain analytical, numerical, and statistical solutions to solve engineering problems.	Used computer vision concepts in training the model to verify finger photos.
2.1	Design computing system(s) to address needs in different problem domains and build prototypes, simulations, proof of concepts, wherever necessary, that meet design and implementation specifications.	Various models were trained and tested for developing the image processing pipeline. Multiple backend services were tested for optimum performance
2.2	Ability to analyse the economic trade-offs in computing systems.	We had to decide between computation time vs accuracy of our system.

3.1	Prepare and present a variety of documents such as project or laboratory reports according to computing standards and protocols.	Create the diagrams, SRS document and the report as per the IEEE format.
3.2	Able to communicate effectively with peers in well organized and logical manner using adequate technical knowledge to solve computational domain problems and issues	When someone got stuck in their module then we organized a meet and solved it together with the help of our mentor.
4.1	Aware of ethical and professional responsibilities while designing and implementing computing solutions and innovations.	Biometric data of a person is highly confidential so we designed a system that isolates the user data from outsiders
4.2	Evaluate computational engineering solutions considering environmental, societal, and economic contexts.	We aimed our project to be a user-friendly system and cheap.
5.1	Participate in the development and selection of ideas to meet established objectives and goals.	Our team had both regular and emergency meets to solve the problems and establish the road map for future development on a regular basis.
5.2	Able to plan, share and execute task responsibilities to function effectively by creating a collaborative and inclusive environment in a team.	The team spent a significant amount of time planning the future work and helping each

		other realize each other's respective tasks.
6.1	Ability to perform experimentations and further analyse the obtained results.	The Image processing model was developed over several weeks and experimented with a lot of different models to reach the optimal accuracy
6.2	Ability to analyze and interpret data, make a necessary judgement(s), and draw conclusion(s).	Based on the available resources and knowledge satisfactory results were achieved.
7.1	Able to explore and utilize resources to enhance self-learning.	We have used multiple courses from YouTube and from udemy and various websites in the learning and development phase.

Appendix A: References

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[4] C. C. Dr. R Porkodi, “Fingerprint Recognition Technology Using Deep Learning: A Review,” Internatinal Journal Creative Research Thoughts, 2021.

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[7] S. Y. A. K. Jain, “Longitudinal study of fingerprint recognition,” Proceedings of National Academy of Sciences, 2015.

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Appendix B: Plagiarism Report

Document Information

Analyzed document	FInal Report CPG 35 (2).pdf (D155213219)
Submitted	2023-01-09 10:00:00
Submitted by	Sbatra
Submitter email	sbatra@thapar.edu
Similarity	3%
Analysis address	sbatra.thapar@analysis.urkund.com

Sources included in the report

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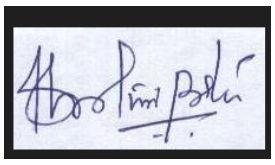

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