

WOLKITE UNIVERSITY

COLLEGE OF COMPUTING AND INFORMATICS

DEPARTMENT OF SOFTWARE ENGINEERING

PROJECT ON

FACIAL RECOGNITION BASED ATTENDANCE SYSTEM

BY

No	NAME OF THE STUDENTS	ID NO.
1	ABEBAYEHU ALARO	CIR/242/10
2	TIGIST ABERA	CIR/310/10
3	SARON DANIEL	CIR/300/10

PROJECT ADVISOR: MR. HAILEMICHAEL (MSC.)

WOLKITE UNIVERSITY, WOLKITE, ETHIOPIA

MAY 2021



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SUBMITTED TO DEPARTMENT OF SOFTWARE ENGINEERING IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF BACHELOR OF SCIENCE IN SOFTWARE ENGINEERING

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No	NAME OF THE STUDENTS	ID NO.
1	ABEBAYEHU ALARO	CIR/242/10
2	TIGIST ABERA	CIR/310/10
3	SARON DANIEL	CIR/300/10

PROJECT ADVISOR: MR. HAILEMICHAEL (MSC.)

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DECLARATION

This is to declare that this project work which is done under the supervision of Mr. Hailemichael and having the title Facial Recognition based Attendance System for Wolkite University is the sole contribution of Abebayehu Alaro, Tigist Abera, and Saron Daniel.

No part of the project work has been reproduced illegally (copy and paste) which can be considered as Plagiarism. All referenced parts have been used to argue the idea and have been cited properly. We will be responsible and liable for any consequence if violation of this declaration is proven. Date: _____

Group Members:

Full Name	Signature
ABEBAYEHU ALARO	_____
TIGIST ABERA	_____
SARON DANIEL	_____

APPROVAL FORM

This is to confirm that the project report entitled “Facial Recognition Based Attendance System” submitted to Wolkite University, College of Computing and Informatics Department of Software Engineering by: Abebayehu Alaro, Tigist Abera, and Saron Daniel is approved for submission.

Advisor Name	Signature	Date
Department Head Name	Signature	Date
Examiner 1 Name	Signature	Date
Examiner 2 Name	Signature	Date
Examiner 3 Name	Signature	Date

ACKNOWLEDGMENT

First of all, we praise God, the almighty and merciful, for providing us this opportunity and granting us the capability to proceed successfully. At the very outset, we express our deepest sense of gratitude to the college of Computing & Informatics and the Department of Software Engineering. We would like to express our deep thanks to our advisor Mr. Hailemichael for guiding us throughout this project. We would like to offer our sincere thanks to all of the software engineering staff members especially Mr. Sime for his valuable support. We would like to express our deep thanks to the students and other Wolkite University administrator staff that provided us with the requirement elicitation process while providing the currently available issues, weakness and the strength of the current working environment about the existing attendance system. We also extend our sincere thanks to those people who help us by sharing their idea to do this project. Last but not the least, we are thankful to all our family members whose constant support and encouragement in every aspect helped us to proceed with our project.

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LIST OF ABBREVIATIONS

No	Abbreviations	Descriptions
1	AI	Artificial Intelligence
2	CSS	Cascading Style Sheets
3	CNN	Convolutional Neural Network
4	CSRF	Cross-Site Request Forgery
5	G.C	Gregorian Calendar
6	Google Colab	Google Colaboratory
7	GPU	Graphics Processing Unit
8	HTML	Hypertext Markup Language
9	ML	Machine Learning
10	MVC	Model View Controller
11	MTCNN	Multi-task Cascaded Convolutional Neural Networks
12	No	Number
13	OMG	Object Management Group
14	RAM	Random Access Memory
15	RDBMS	Relational Database Management System
16	SQL	Structured Query Language

14	WKU	Wolkite University
15	UML	Unified Modeling Language

EXECUTIVE SUMMARY

Facial Recognition Based Attendance System is a machine learning-based system that handles and tracks the student attendance system using the web application and deep learning algorithms/models. It is a broad problem of identifying or verifying people in photographs and videos. In order to develop our proposed facial recognition system, we will use a deep learning approach which is currently the state of the art. Some of the main components of the proposed system are recognizing the Student Face and marking attendance of the recognized face. We will decompose the Student Facial Recognition Component into three phases. Basic Tasks that we are going to implement are Student Facial Recognition and Attendance Marking phase.

On the current system of attendance marking and management, there are issues raised which need to be solved, such as security, economic and performance issues. There is no computerized attendance management system for students of Wolkite University.

The proposed system is designed to solve this problem by developing software that can solve in raised problem issues that are existed in current system. The system is developed by using an agile software development model. Interview and literature review analysis techniques are used for data collection in order to prepare this document for developing the proposed system.

CHAPTER ONE

1. INTRODUCTION

Time is the essence and key thing to our lives, and it is crucial for development since the basis of one's country's development is the result of using time wisely. But in our country, punctuality is a great problem even when we compare it with the other African countries. Due to this, every person in every sector must use time efficiently to achieve sustainable development in one country. Due to the above reasons, we are motivated to seek a solution to address the problems raised.

Attendance System is the system that possesses capable of tracking the presence of students and employees in their working sector, and it is a necessary tool for marking attendance in any environment where attendance is critical. Every organization and institution uses either a manual, semi-automated, or automated attendance system to maintain a record of the presence of either students, employees, or students and employees. Wolkite University is one of the third generation universities in Ethiopia and it emphasizes using and producing the latest technology products. In the Wolkite University, Attendance Management System is a semi-automated system that operates manually using pen and papers and automated manner using fingerprint technology. The manual method includes pen and papers which consumes a lot of time and wastage of resources. Also, it has a risk of proxies and is subjected to human error. The Automated Attendance System includes many biometric schemes, and we are going to use the most efficient and latest Artificial Intelligence scheme, face recognition to handle the attendance system by recognizing a face of a person.

Generally, the proposed system has the capability of solving problems that exhibit in the existing attendance system using the latest biometric technology, Facial Recognition. It will work by replacing the current inaccessible, tiresome, unsecured, and economically infeasible attendance system with an automated attendance system.

1.1. Background of the Organization

Wolkite University (WKU) is one of the third-generation higher institutions in Ethiopia that have been founded in 2012 G.C. The university is located in the Southern Nation and Nationalities Regional state, in Gurage Zone, 158 km southwest of the capital city of Addis Ababa on the way to Jimma. It is situated at Gubure sub-town, 14 km away from Wolkite

town of the GubureButajira road. During this time 543 students joined the university. Enrolling the assigned students, the university started its academic journey with 13 academic programs under three colleges: College of Engineering and Technology, College of Computing and Informatics, and College of Natural and Computational Science.

1.2. Statement of the Problem

The Attendance System is a core activity that takes place in any Organization and Educational Institutions to track the presence of either their employees, their students, or their employees and students in their work sectors. In the Wolkite University, the Attendance System is a semi-automated system that checks the attendance of administrative staff using fingerprint technology and the rest of its communities using paper-based systems. Almost all tasks of the existing attendance system involve a lot of paperwork. As a result, it is time-consuming, tedious, and prone to human error as it is difficult to ascertain whether the calculation made (attendance report) was correct or not. Moreover, students or employees need to spend unnecessary time during class sessions or the work sector to sign on the attendance sheet respectively. This is also disturbing and students may lose focus when the attendance sheet is passing around during the class session. We explained the existing system problems one by one by the following categories.

1.2.1. Performance

1.2.1.1. Response Time

Wolkite University is still practicing the manual way of taking daily attendance for students. The existing attendance system involves a lot of paperwork and time-consuming tasks. As a result, its response time is slow. The following reasons illustrate why the response time of the existing system is slow specifically for the student.

- The existing attendance system hasn't had a computer-aided system that facilitates marking attendance. As a result, Lecturers distribute attendance sheets to be signed by the students during the class session or personally mark the attendance sheet one by one by calling out students' names or identification numbers.
- The existing attendance system doesn't generate reports for marked attendances. Therefore, Lecturer is obligated to manually analyze the number of absences and

calculate the percentage of presented students from the recorded attendance list to make sure which students can take their final exam for the respective subject.

- The existing system is intolerant of human errors. Thereby when mistakes are made or changes or corrections are needed, often a manual transaction must be completely redone rather than just updated.

1.2.2. Economy

The existing attendance system in Wolkite University is a semi-automated system. This signifies it operates in two modes either manually using paper-based works or using fingerprint technology. The manual-based attendance system is so costly since involves a lot of paper works, and an unnecessary number of employees to handle the attendance of students and employees. The automated one that uses fingerprint technology is so costly when we compare it with other biometric technologies (facial recognition). The current fingerprint-based attendance system is not fully accessible to everyone, failed for disabled persons, as well as it is very expensive technology. Apart from the fingerprint software cost, a university also has to buy high-quality fingerprint devices separately. As a result, the existing attendance system is economically inefficient.

1.2.3. Security

The existing attendance system handles its day-to-day activities in a semi-automated manner. It has drawbacks that related to security; we briefly illustrated its security problems in the following paragraph.

- The existing Attendance System doesn't effectively track the attendance of employees or students conveniently and securely. Though it is a semi-automated system, it possesses insecure handling of attendance records and unconfident tracking of marking attendance processes. In a paper-based attendance system, someone can mark attendance for many employees or students, and the attendance sheets or recorded attendance are highly exposed to loss and modify by unauthorized persons. Generally, the whole paper-based attendance process is tending to human mistakes. Consequently, data loss may happen and the data in the attendance list might be inaccurate due to deception. The existing Attendance System has many security issues that may lead to inefficient and unreliable tracking of human resources in institutions.

1.3. Objectives of the Project

1.3.1. General Objective

The main objective of this project is to develop a facial recognition-based attendance system for Wolkite University.

1.3.2. Specific Objective

- Exploring and studying the existing Attendance System.
- Selecting and implementing the face detection algorithm in order to isolate the actual face from the background of the image along with isolating each face from others found in the image.
- Selecting and implementing an algorithm that manipulates the preprocessing of face images.
- Selecting and implementing the classification algorithm to perform feature comparison among input face and face templates.
- Training a classification algorithm using the pre-trained model for classifying face in order to mark the presence of students.
- Designing and developing the database to store face templates, and recorded attendance.
- Developing special case attendance tracking component in order to take attendance for special cases (especially related with permissions), and ambiguous situation related with facial recognition.
- Developing report generator component that generate reports for the recorded attendance.

1.4. Feasibility Analysis

We examined the feasibility of our study from different perspectives like, from its technical, operational, economic, political, and schedule points of view.

1.4.1. Economic feasibility

Our system is economically feasible since it aims to reduce the cost and provide an efficient system. The proposed system will computerize and automate the existing system. Therefore,

the cost that is paid for materials that are used in the manual operations becomes reduced. We decomposed the economic feasibility into two categories.

Tangible benefits:

Resource Cost Saving

- It reduces unnecessary cost wastage for materials (paper and pen).

Process Improvements

- It makes the time needed to complete and analyze the attendance system is shorter.

Increase Productivity

- It enhances the productivity of people (directly involved in this system) by allowing them to work more or be rerouted to other areas.

Table 1.4.1.1. Materials cost for the existing system

Item	**Quantity per year**	**Unit price/salary**	**Total price/salary per year**
Paper	540 packets	170 birr	540 * 170 = 91,800 birr
Pen	20 packets	450 birr	20 * 450 = 9000 birr
Total cost			**100,800 birr**

Table 1.4.1.2. Materials cost for the proposed system

Item	**Quantity per year**	**Unit price/salary**	**Total price/salary per year**
Paper	1 packet	170 birr	170 birr
Pen	1 packet	450 birr	450 birr
Total cost			**620 birr**

Cost-Benefit Analysis

The existing system cost per year = **100,800 birr.** The proposed system cost per year = **620 birr**, Moreover, the proposed system will remove almost all usage of pen and paper in the existing attendance system. **Cost Reduction = 100,800 birr - 620 birr = 100,180 birr.**

The above cost prediction is only for one year but since our university will continue working for n years the cost will also be multiplied by n years. So we can say that the existing system is economically infeasible.

Intangible Benefits:

- Provide better and effective service.
- Contributes to the organizational strategy.
- Enhances User Experience
- Increases user satisfaction.

1.4.2. Behavioral/Political feasibility

Our proposed system is behaviorally feasible since it can not cause any harm to the environment. The project would be beneficial because it satisfies the objectives of the users and organization legally. The system was developed user-friendly and improves the working environment. Therefore we can say our system is free from any political and environmental difficulty.

1.4.3. Operational Feasibility

The proposed system does not face the usability problem as we used the agile software development model to develop the proposed system; the agile model allows the customer, developer, and product owner to interact regularly. Thus, users have involved in the development of this project by providing their opinions/feedback. As a result, they understand easily how it will be used and comfortably make their operations. Additionally, we have followed steps of how the existing system is working and we try to transform the existing system into a computerized and automated one. Thus, the proposed system operates user-friendly since it is not unfamiliar to users. The proposed system is also compatible with any web browser. Based on these points our proposed system is operationally feasible.

1.4.4. Technical Feasibility

Facial recognition based attendance system is a web-based system integrated with AI. The software development tools that we are using in development of the proposed system are freely available (open source) on the internet. The proposed system will run on the hardware, the university currently possesses, with a few advancements. Our development team has the required capabilities/skills to develop the proposed system and we are familiar with each of the development tools. When we analyze the required technology and resources, the proposed system is technically feasible.

1.5. Scope and Limitation of the Project

1.5.1. Scope of the Project

This project will develop a web-based facial recognition-based student attendance management system for the WOLKITE UNIVERSITY.

The facial recognition-based attendance system will perform the following activities:-

- Registering the basic information of students such as images, names and identification numbers.
- Marking attendance for students using facial recognition.
- Marking special case attendance for who have permission of absent, or ambiguous situations related with facial recognition.
- Preparing a report for the recorded attendance of students.

1.5.2. Limitation of the Project

This project will not implement the following activities.

- Attendance system for employees.
- The proposed system cannot accurately recognize the twine's face and face covered peoples.

1.6. Significance of the Project

After the completion of this project, it will provide the following significance to the organization and its community. The societal and technological importance of your project should be discussed in this part.

- Increases productivity of the organization by enabling utilization of resources effectively.
- Enhances resource cost saving in an organization by reducing the unnecessary cost expenditure for paper and manpower.
- Increases students' performance since the proposed system regularly controls their presence in their class session.
- Enhances the students focusing on their learning in their class session since it eliminates the disturbance of students while filling attendance.
- Enhances the work efficiency of instructors by eliminating their time wastage in analyzing the recorded attendance since it provides the report for recorded attendance.

1.7. The Beneficiary of the Project

1.7.1. Organization (Wolkite University)

The productivity of the organization increases if the organization is a comfortable area for employees and students to perform their tasks properly. The proposed system contributes to the productivity of the organization by making the attendance system is easier and secure.

1.7.2. Instructors

The proposed system helps the instructors in making the time-consuming and tedious attendance taking and analyzing process easier and comfortable.

1.7.3. Students

The proposed system helps the students in making marking attendance task simple and comfortable by eliminating time-consuming, boring, disturbing, and error-oriented attendance system using the most efficient technology.

1.8. Methodologies and Tools

1.8.1. Data Collection Tools/Techniques

Data collection is the most important part of the project to find the main requirement of the system and to understand how the system works. We are have used different methods to collect data for developing the proposed system. Among the different data collection techniques, we have been used the following.

Table 1.8.1.1. Data Collection Techniques

Data Collection Techniques	Description
Interview	An interview is a more flexible tool, so we have collected our data by interviewing lecturers, students, and different administrator bodies.
Observation	Our team have assessed the manual system by participating and watching the existing system.
Literature Survey	Although face recognition systems are known for decades, there is much active research and project works on the topic. To develop our system we have analyzed different work that has been conducted in our project area to have a great understanding of the area and to work the system efficiently.

1.8.2. System Analysis and Design

We have used the Object-Oriented System Analysis and Design approach to develop the proposed system due to the following reasons.

- It is easy to understand as a result we don't suffer from a misunderstanding of the system analysis and design to develop the proposed system.
- It is easy to maintain. Due to its maintainability, we can fix bugs that face when we develop the proposed system.
- It provides reusability. Due to its re-usability, we can develop another system that needs it as a component.
- It improves the quality of the system due to program reuse.

1.8.3. System Development Model

We are using the Agile Software Development Model to develop the proposed system due to the following core points in the Agile Model that fit with our proposed system.

- Customer satisfaction is rapid, continuous development and delivery of useful software.
- It emphasizes having efficient team members and enhancing communications among them is given more importance. It is realized that enhanced communication among the development team members can be achieved through face-to-face communication rather than through the exchange of formal documents.
- It continuously gave attention to technical excellence and good design.
- It enhances daily and close cooperation between customers and developers.
- Regular adaptation to changing circumstances. Thus, requirement change requests from the customer are encouraged and efficiently incorporated since our aims to change user needs to the software.

1.8.4. System Testing Methodology

Table 1.8.4.1. System Testing Methodology

Software Testing Techniques	**Description**
Unit testing	Unit testing is a level of software testing where individual units/components of the software are tested. We will use the unit testing due to the following reasons ➢ To validate that each unit of the software performs as designed. ➢ To reduce defects in the newly developed features or reduce bugs when changing the existing functionality. ➢ To improve the design and allow better refactoring of code

Integration Testing	After the unit testing, the components or modules are to be integrated which gives rise to integration testing. We will use integration testing to verify the function, performance, and reliability between the modules that are integrated. Moreover, we will use integration testing to validate interactions among different software system modules.
System Testing	We will use system testing to perform testing on a complete integrated system with the aim of evaluating the compliance of the system with the corresponding requirements. We will use the system testing due to the following reasons ➢ To detect defects within both the integrated units and the whole system. ➢ To test the design and behavior of the system and also the expectations of the users.

1.8.5. Development Tools and Technologies

1.8.5.1. Frontend Technologies

The Frontend technologies are technologies related to programming languages that are used in developing the user interface of the software system. We illustrated below the frontend technologies that we are going to use in developing the user interfaces of the proposed system.

HTML

- To define the content of web pages.

CSS

- To specify the layout of web pages.
- To style an HTML document.

JavaScript

- To program the behavior of web pages.

Bootstrap

- To create a responsive layout or responsive design in web pages, with much fewer efforts.

1.8.5.2. Backend Technologies

Django

We are going to use Django to backend management which is a Python-based free and opensource server-side web framework, which helps us to create complex, database-driven websites.

Why Django?

- It's fully loaded with extras and scalable, so we can make applications that handle heavy traffic and large volumes of information;
- It helps us in eliminating common security issues by providing multiple protections against Clickjacking, Cross-site scripting, Cross-Site Request Forgery (CSRF), SQL injection, and remote code execution.
- It is cross-platform, meaning that our project can be based on Mac, Linux, or Windows;
- It works with most major databases and allows using a database that is more suitable in a particular project or even multiple databases at the same time.
- It supports the MVC programming paradigm, as a result, we can do Model, View, and Controller independently.

Python

Python is an object-oriented, high-level programming language with integrated dynamic semantics primarily for web and app development. We are going to use python programming language for implementing face recognition processes' algorithms due to the following reasons.

- Python is easy to understand.

- Python has a large number of libraries and frameworks for making real-world machine learning and computer vision applications.
- We are going to use some of python libraries and frameworks for implementing face recognition processes' algorithms.
- Python allows easy and powerful implementation.
- Python has friendly syntax and human-level readability.
- Python is that both the standard library and the interpreter are available free of charge, in both binary and source form.

MySQL

MySQL is the most popular Open Source Relational SQL Database Management System. It is one of the best RDBMS being used for developing various web-based software applications.

Why MySQL?

- It is a database system used on the web
- It is ultimate for both small and large applications
- It is very fast, reliable, and easy to use
- It uses standard SQL
- It compiles on several platforms
- It is free to download and use
- It is supported officially by Django

1.8.5.3.Programming Language Editors and Server

- Pycharm
- Visual Studio
- Anaconda
- Xampp
- Google Colab (Colaboratory)

We will use the Google Colab for the following purposes

- To write and execute Python in our browser, with zero configurations required, free access to GPUs, and easy sharing.
- To import an image dataset, train an image classifier on it, and evaluate the model.

1.8.5.4.Documentation and Modeling Tools

Table 1.8.5.4.1. Documentation and Modeling Tools

Tool Name	**Description**
Microsoft word	We have used Microsoft Word to document and prepare our documentation.
Enterprise Architect	It is a visual modeling and design tool based on the OMG UML. We used Enterprise Architect for the following purposes: ➢ To design and construct a software system ➢ For modeling business processes ➢ For modeling industry-based domains.

1.8.5.5.Deployment Environment

We will deploy our system on localhost for training purposes, and we illustrated the hardware tools that we will use for deploying our system for training purposes.

Table 1.8.5.5.1. Deployment Environment

Hardware Type	**Specification**	**Description**
Computer Brand	Dell, Toshiba, and HP	We will deploy our system, for training purposes, on the computer brand on our hands.
Processor	Core(i3) or above with 2.5 GHz or above	The greater the speed of the processor, the faster the execution speed of our system.
RAM	4.00 GB or above	The larger the RAM, the faster the execution speed of our system.

System Type	64-bit Operating system	We will use a 64-bit processor to deploy our system because our system has AI features. Why a 64-bit processor? It is capable of storing more computational values, including memory addresses, which means it can access over four billion times the physical memory of a 32-bit processor. It has higher performance than a 32-bit processor.
Camera	8 Megapixels or above	We will use a webcam and mobile phone cameras to capture images.

We will deploy our system on the Wolkite University's Server for regular service, and we will use the hardware tools with high quality to increase the performance of our system since the efficiency of the Machine Learning Algorithms depend on the amount of dataset.

- Any Computer brands which possess Processors (64 bit) with Core i5 and 2.5 GHz or above, RAM with 8GB or above ,and GPU 6GB or above.
- Security Camera/IP Camera with 8 Megapixels or above.

1.9. Document Organization

Chapter One: - This chapter contains a range of parts that concerned with the proposed project such as the introduction of the proposed system, background of the organization, statement of the problem, objective of the project, the feasibility study, scope and limitation, significant, beneficiary, methodology, budget, and time schedule.

Chapter Two: - This chapter is mainly concerned with studying the existing system by elaborating its existing system, business rules, main functions, forms and other documents, and bottlenecks.

Chapter Three: - This chapter basically deals with the proposed system by deeply explaining its functional and non-functional requirements.

Chapter Four: - This chapter deals with the system model, object model, and dynamic model of the proposed system.

Chapter Five: - This chapter deals with the design goals of the proposed system, the proposed system's architecture (it includes subsystem decomposition, hardware, and software mapping), algorithm design, and user interface design of the proposed system.

CHAPTER TWO

2. DESCRIPTION OF EXISTING SYSTEM

2.1. Introduction of Existing System

Wolkite University has a semi-automated attendance system that facilitates in tracking attendance, managing the recorded attendance file, checking attendance of its communities, and making decisions especially related with attendance. The existing attendance system operates in two modes either manual, using paper based work, or automated manner, using fingerprint technology. Both modes of taking and managing attendance have their own bottlenecks. Thus, student attendance management system that operates manually using paper based work prone to human mistakes moreover it is time consuming, resource wasting and tedious task. The second mode, fingerprint based attendance system is automated system but it didn't consider all communities of the university so it cannot apply to all communities of the university. In the following categories, we enumerated both systems in detail.

2.1.1. Fingerprint-Based Attendance System

In Wolkite University, fingerprint-based attendance system uses the fingerprints of employees to verify who is clocking in and clocking out of work each day. The existing Fingerprint-Based Attendance System integrates fingerprint authentication into the process of attendance management for administrative staffs. It is made up of two processes namely; enrolment and authentication.

During enrolment, the biometrics of the user is captured and the minutiae data are extracted and stored in a database as a template for the subject along with the user's ID. The objective of the enrolment module is to admit a user using his/her ID and fingerprints into a database after feature extraction. These features form a template that is used to determine the identity of the user, formulating the process of authentication. The enrolment process is carried out by an administrator of the attendance management system.

During authentication, the biometrics of the user is captured again and the extracted features are compared with the ones already existing in the database to determine a match. After a successful match, attendance is marked against the user's id used in matching the templates.

The fingerprint based attendance system has fingerprint recognition and identification system as well as database to store user's information. The database comprises the fingerprint templates and other bio-data of the users together with the attendance records made by the users.

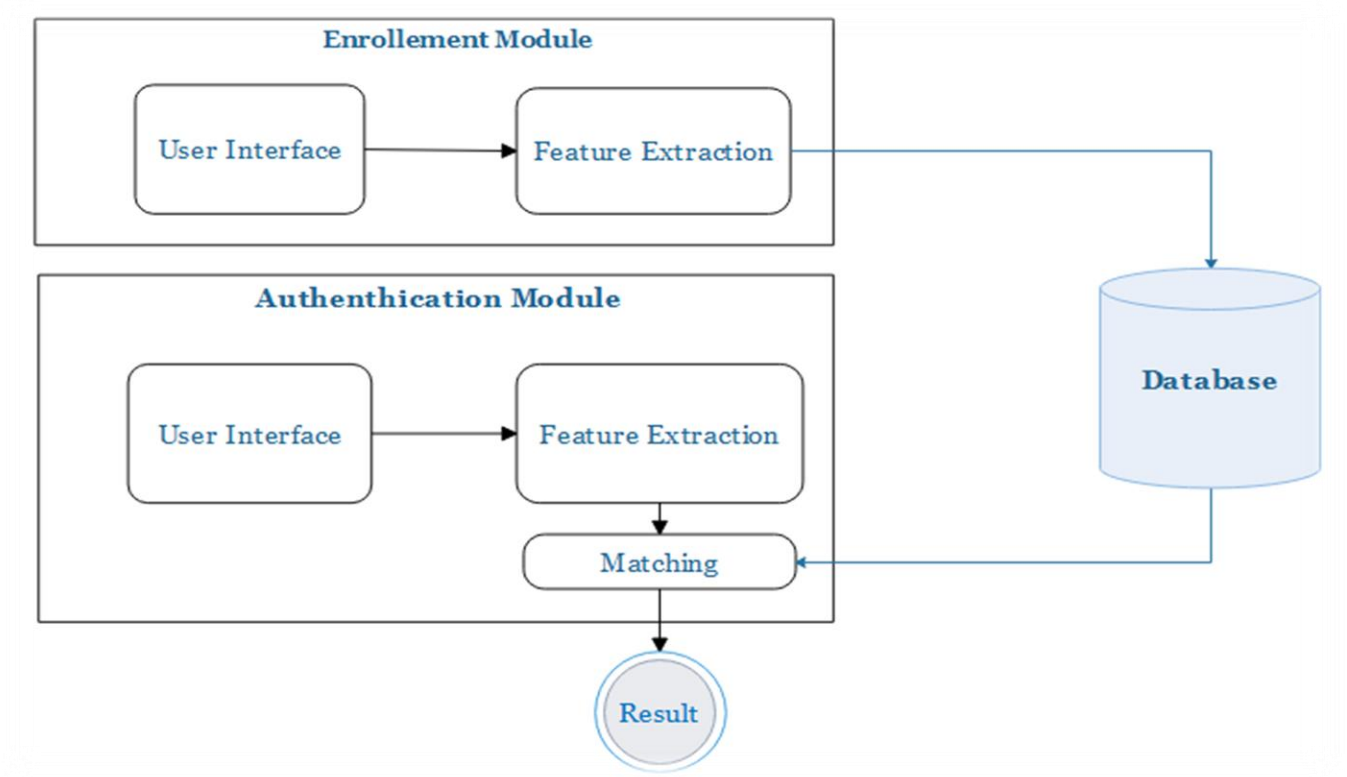


Figure 2.1. The architecture of the existing fingerprint-based attendance system

2.1.2. Paper-Based Current Attendance System

The paper-based student attendance system performs students' attendance tracking and handling the recorded attendance manually. In a paper-based student attendance management system, Lecturers distribute attendance sheets to be signed by the students during the class session or personally mark the attendance sheet one by one by calling out students' names or identification numbers. When the students sign on the attendance sheet, there are no mechanisms in order to track the attendance marking the way of students. As a result, students can mark for their colleagues who haven't presented in the class session. The recorded attendance sheets are stored on the lecturer's cabinets before he/she reports it to the department head. As a result, the recorded attendance of the students may be lost or modified by unauthorized bodies as well as it may be damaged due to different types of natural disasters. The Lecturer analyzes the recorded attendance sheets in order to determine who

properly attended his / her class or laboratory session, and to identify the students who can take the final exam. The ability to compute the attendance percentage becomes a major task as manual computation produces errors, and also wastes a lot of time. Finally, Lecturer sends the attendance report to the Head of the Department every Friday. Head of the department, Higher Administrative Staffs, or other external entities may need the attendance of the Students to make decisions for the specific situations.

2.2. Users of Existing System

Figure 2.2. The Office Structure of the Wolkite University

We enumerated the users of the existing system and their responsibilities in the following table.

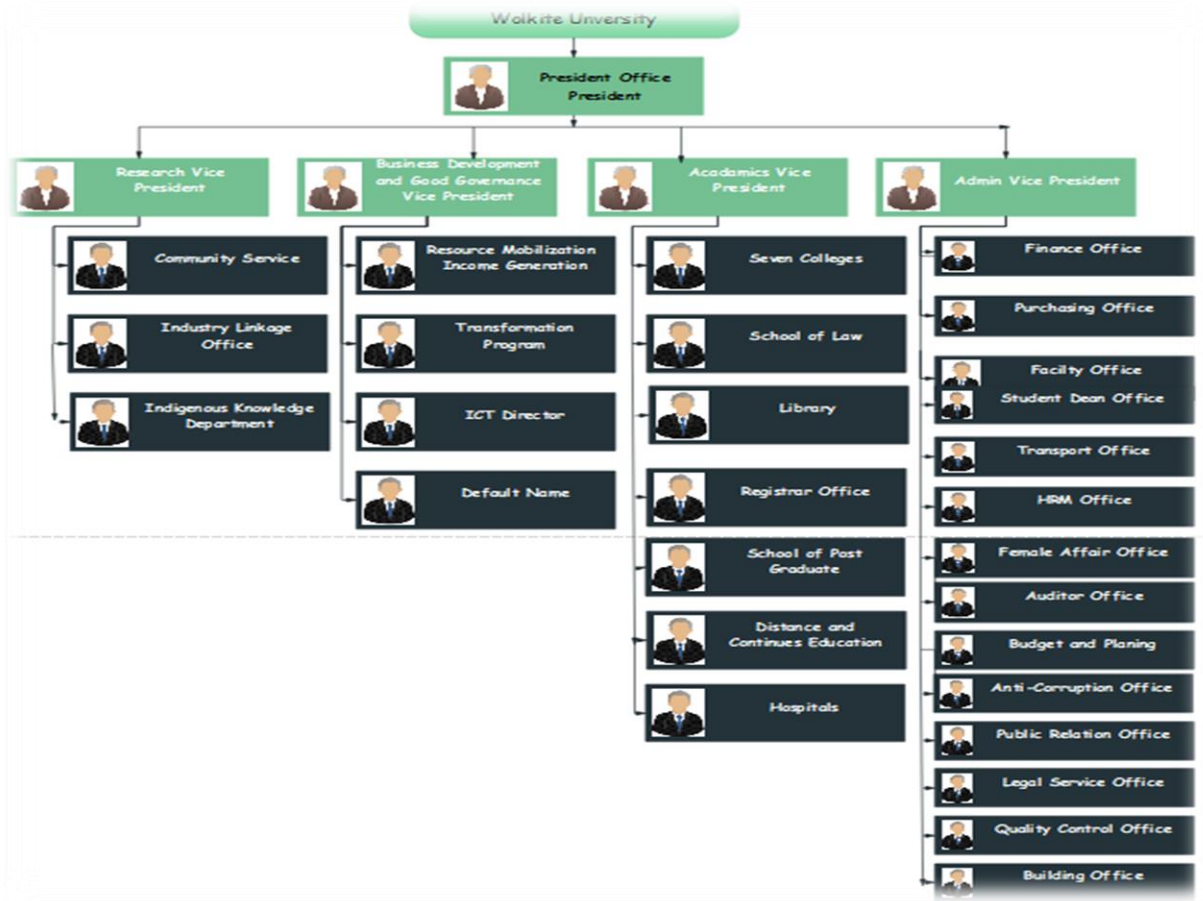


Table 2.2.1. The users of the existing system and their responsibilities

Users	Responsibility
Student	Students are responsible for filling

	attendance form in the class session.
Lecturer	The lecturer has the following responsibilities in the existing student management system. ➢ Preparing attendance form and make the students fill the form. ➢ Controlling the students when they are filling attendance forms, to control fraudulent tasks. ➢ Analyzing the recorded attendance of students. ➢ Reporting the recorded attendance forms to the Head of Department.
Head of Department	➢ Recording the copy of the attendance form that is recorded every day. ➢ Utilizing the students' attendance form in order to make decisions for specific situations.
Registrar, Higher Administrative Staffs, or External Entities	Utilizing the students' attendance form in order to make decisions, related to students, for specific situations.

2.3. Major Functions of the Existing System

2.3.1. Major Functions of the Existing Student Attendance System

i. Generating Attendance Form

The attendance form is prepared or generated from SIMS and printed by lectures then will give to students for marking attendance.

ii. Marking Attendance

Students fill the attendance by signing on the prepared attendance sheet or sometimes the lecture may fill the attendance by calling student's names one by one.

iii. Reviewing Attendance

This function is performed by a lecturer in the classroom for checking whether theft has occurred or not by filling attendance for absent students. In the existing student attendance system, there is no mechanism to check whether the signed attendance is signed by the correct student or not. Therefore to know if cheating is happened the lecture counts the attendance list and the number of students in a class is equal or not.

iv. Analyzing Attendance

The Lecturer analyzes the recorded attendance sheets in order to determine who properly attended his / her class or laboratory session, and to identify the students who can take the final exam.

v. Report

The course instructor prepares a report in order to give information to the department head. In some cases, the college dean and registrars may need the reports to make decisions therefore they can ask and get the attendance report.

2.3.2. The Major Functions of the Existing Fingerprint-Based Attendance System

We enumerated below the main functionalities of the existing fingerprint-based attendance system per module.

1. Department Management

This module provides with convenient to manage each department of employees, mainly add, cancel department, and enroll employee.

2. Employee Maintenance

i. Add New Employee

The system allows adding new employee by selecting the department which the employee is enrolled, then inputting employee's AC No., name and other related information about an employee. After adding the basic information about an employee, the fingerprint registration process will proceed. In order to register the employee's fingerprint on the system, the employee follows prompts or press fingerprint on the sensor face of the fingerprint device or fingerprint scanner. After pressing 3 times, the prompt informs the fingerprint registration completed successfully. After the registration complete, the system will add the user's information to data base and will match when employees give finger

print for the attendance system. We can continue to add all employees for the first time by following the above step. One machine supports to add a maximum of 3000.

ii. Add Batch Employees

When some departments need to add a lot of employees, the system provided this function to add employees, lighten an operator work.

iii. Modify Employee

Employee's AC No. is unchangeable. Avoid their information that doesn't match the corresponding information in the Device. The system allows for the modification of the employee's information.

iv. Transfer Employee

The system allows transferring employees from one department to another department.

3. Administrator Setting

i. Set administrator

To help protect the system's security, to prevent the data are changed by unauthorized personnel, this management module of the system provides the function to set administrator.

ii. Administrator's privilege

The system provides the functions that enable the Super Administrator to manage all employees, and the Department Administrator only to manage its department employee.

4. Maintenance Timetables

The system allows setting Timetable which is used to arrange employees' shifts. In the Maintenance Timetable module, the system allows configuring the following attributes.

- Late Time (Mins)
- Leave Early Time (Mins)
- Beginning /Ending In
- Beginning/Ending out
- Count as workday
- Count as minute
- Must Check/In and Must Check/Out
- Change the Display Color

5. Maintenance Shift Schedules

After setting Timetable, the system allows setting the Shift Schedule. In the Maintenance Shift Schedules module, the system allows configuring the following attributes.

- Shift Name
- Beginning Date(Application Beginning Date)
- Cycle Num
- Cycle Unit

6. Employee Schedule

The system allows scheduling the employee in order to statistic his/her Time Attendance records. If an employee has not been scheduled, then finally the system is unable to statistic the Time Attendance records. If an employee did not belong to shift, the system will be unable to distinguish his Time Attendance record which was going to work or gets off work and fail to count his Time Attendance.

In this module, the system provides the following functionalities

- Assign Employee Shift by department
- Normal Assign employee Shift
- Shift schedule regularly change
- Auto assign timetable

7. Attendance Report

The system generates the attendance records in different categories as described below.

- Daily Attendance statistical Report
- Attendance General Report
- Department Attendance Statistical Report
- Daily Attendance Overtime Report

Additional features on the existing fingerprint-based attendance system

Leave Setting: The system allows for leaving if the employee encounters serious problems like sick, and the employee needs a vacation. It is possible that when an employee encounters a serious problem and needs to ask for leave, due to different reasons. Asking for leave can be an automatic statistic in the system.

Count OT: The system allows counting over time for the employee. After choosing this item, it is possible to calculate the employee's working overtime.

Holidays: The system allows the employee for resting during the holiday. After choosing this item, this time the employee who has been assigned shift will rest in the holiday. If

he/she will go to work, his/her record will regard as working overtime. Otherwise, this time the employee who has been assigned shift have to go to work in holiday. If he/she does not go to work, his/her record will regard as an absence from work without excuse records.

Check Clock In/ Check Clock Out: The system can control the employee must check-in or checkout. This item can control the employee must check in or checkout, the setup privilege in the item is super than it in the shift schedule.

2.4. Forms and Other Documents of the Existing Systems

Some forms are used by the existing system. The forms are used during the period of the attendance filling process. In addition to this, there is a form used by the Lecturer to record information from attendance. Some of the forms are illustrated in **Appendix.**

2.5. Drawbacks of the Existing System

We categorized the drawbacks of the existing attendance management system as the bottlenecks of the manual and automated attendance system.

2.5.1. The Drawbacks of the Existing Student Attendance System

The existing student attendance system tasks have been performed manually. As a result, it has a lot of time-consuming, tedious, and incorrect tasks. We explained these problems one by one by the following categories.

2.5.1.1. Performance

Response Time

Wolkite University is still practicing the manual way of taking daily attendance for students. The existing attendance system involves a lot of paperwork and time-consuming tasks. As a result, its response time is slow. The following reasons illustrate why the response time of the existing system is slow specifically for the student.

- The existing attendance system hasn't had a computer-aided system that facilitates marking attendance. As a result, Lecturers distribute attendance sheets to be signed by the students during the class session or personally mark the attendance sheet one by one by calling out students' names or identification numbers.

- The existing attendance system doesn't generate reports for marked attendances. Therefore, Lecturer is obligated to manually analyze the number of absences and calculate the percentage of presented students from the recorded attendance list to make sure which students can take their final exam for the respective subject.
- The existing system is intolerant of human errors. Thereby when mistakes are made or changes or corrections are needed, often a manual transaction must be completely redone rather than just updated.

2.5.1.2. Economy

The existing student attendance system is a paper-based work that tracks and manages students' attendance manually. Since it is a paper-based work, it needs a high cost of buying resources (paper for attendance form, report form, and related things). Not only it has the cost of paper, but also it requires the cost of buying file cabinets in order to archive the recorded attendance documents. When we analyze the cost of these things, the existing system is economically inefficient.

2.5.1.3. Security

In the existing student attendance system, day-to-day attendance tracking and managing activities have been being occurring manually. It has many drawbacks related to security; we briefly illustrated its security problems in the following paragraph.

The existing Student Attendance System doesn't effectively track the attendance of students conveniently and securely. Since it is a paper-based system, it possesses insecure handling of attendance records and unconfident tracking of marking attendance processes. In a paper-based attendance system, someone can mark attendance for many students, and the attendance sheets or recorded attendances are highly exposed to be lost as well as can be modified by unauthorized persons. The whole paper-based attendance process is tending to human mistakes. Consequently, data loss may happen and the data in the attendance list might be inaccurate due to deception. Generally, the existing Student Attendance System has many security issues that may lead to inefficient and unreliable tracking of students' attendance.

2.5.1.4. Searching problem

Searching a record of a particular attendance from a big fat register, and a student from the attendance forms that are recorded on different days is certainly a very time-consuming and

tedious task. The searching procedure in the existing student attendance system requires looking for all existing attendance documents to find the needed attendance form or student information since the attendance documents are not organized conveniently. Generally, the existing student attendance system is difficult to perform searching for a particular purpose.

2.5.1.5. Retrieving problem

Retrieving an attendance file for a specific purpose from a file cabinet is exactly very time-consuming and wasting manpower task. This is because the attendance document is not completely indexed in the cabinet. Even if it is indexed, the lecture may review the whole files manually in that particular category to retrieve the specific record. Generally, the existing student attendance system is difficult to retrieve a specific file for a particular purpose.

Other additional existing system drawbacks are listed below:-

- When the lecturer analyzes the students' attendance manually, errors may occur.
- The Students' attention may lose when they accept the attendance paper to fill the attendance.

2.5.2. The Drawbacks of the Existing Fingerprint Based Attendance System

The existing fingerprint-based attendance system is an automated system that tracks the attendance of administrative staff. The existing fingerprint-based attendance system performs in a good manner and eliminates almost all tedious and time-consuming manual-based attendance works. Even though the existing fingerprint-based attendance system is solved almost all the bottlenecks exhibited in the manual work, it has some drawbacks.

- The existing fingerprint-based attendance system is a desktop-based application. As a result, the application should be installed on the clients. Though there is a central database system that stores all data of the attendance system, the data are stored on each client desktop and the clients can access it.
- The software of the existing fingerprint-based attendance system isn't allowed to be modified. As a result, we cannot add some functions to the existing fingerprint-based attendance system. Since the source code of the software of the existing fingerprint-based attendance system is not available.
- The existing fingerprint-based attendance system is not fully accessible. Thus, the system is not applicable to finger related disabled persons,

- The existing fingerprint-based attendance system requires finger contact in order to track the attendance of the users. Thus, it can spread communicable diseases that can transmit through body contact.

Even though the existing fingerprint-based attendance system is pretty good, it is only applied to track the attendance of administrative staff. Is it possible to apply the existing fingerprint-based attendance system in the student attendance management system? No, because the existing fingerprint-based attendance system is developed based on the business rule and requirements gathered only from the administrative staff, and it operates under the business rule of the administrative staff's attendance management system. Since the business rules of student and employee attendance systems are strictly different.

2.6. Business Rules of the Existing System

Business rules are the rules and regulations by which the users of the existing system are governed. Wolkite University has the following business rules for performing the student attendance system. BR stands for Business Rule.

Table 2.6.1. The business rule for BR1

Item	Detail
Name	The Student Eligibility
Id	BR1
Description	The students must be registered for that specific class or laboratory in order to mark the attendance.

Table 2.6.2. The business rule for BR2

Item	Detail
Name	Identification Card
Id	BR2
Description	The students must have an identification card in order to get into the class or

	laboratory session.

Table 2.6.3. The business rule for BR3

Item	Detail
Name	Attendance Marking Situation
Id	BR3
Description	The Students should fill the attendance only when there is a class otherwise they are not obliged to fill the attendance.

Table 2.6.4. The business rule for BR4

Item	Detail
Name	Attendance Marking Situation
Id	BR4
Description	The department head must allow for each added course and the course instructor get the students' record from SIMS out of a batch section in order to instruct the added students.

Table 2.6.5. The business rule for BR5

Item	Detail
Name	Controlling Attendance Marking
Id	BR5
Description	The Lecturer should control the attendance tracking mechanism in his/her lecturing

	session.

Table 2.6.6. The business rule for BR6

Item	Detail
Name	Attendance Report
Id	BR6
Description	The lecturer should make attendance reports weekly to the head of the department.

Table 2.6.7. The business rule for BR7

Item	Detail
Name	Percentage of Attendance in the Class Session
Id	BR7
Description	A student should attend 80% of the lecture class to take the final exam. Even if the amount of attendance time required for lecture class is depended on the curriculums.

Table 2.6.8. The business rule for BR8

Item	Detail
Name	Percentage of Attendance in the Laboratory Session
Id	BR8

Description	A student should attend 100% laboratory sessions to take the final exam. Even if the amount of attendance time required for lab class is depended on the curriculums.

Table 2.6.9. The business rule for BR9

Item	Detail
Name	External Bodies
Id	BR9
Description	The attendance report will give to other external bodies if and only if they come with following legal procedures.

Table 2.6.10. The business rule for BR10

Item	Detail
Name	Access Privilege
Id	BR10
Description	The instructor can only view the attendance of the students that he/she instructs.

Table 2.6.11. The business rule for BR11

Item	Detail
Name	Access Privilege
Id	BR11
Description	The Head of the department can only view the attendance of the students that enrolled in

		his/her department.

CHAPTER THREE

3. THE PROPOSED SYSTEM

Facial Recognition Based Attendance System is a machine learning-based system that handles and tracks the student attendance system using the web application and deep learning algorithms/models. Face recognition is a broad problem of identifying or verifying people in photographs and videos. In order to develop our proposed face recognition system, we will use a deep learning approach which is currently the state of the art. Some of the main components of the proposed system are recognizing the Student Face and marking attendance of the recognized face. We will decompose the Student Face Recognition Component into three phases. We explained below the basic concepts and algorithms that we will need to implement these 3 phases of the Student Face Recognition, and Attendance Marking phase in detail.

i. Face Detection

Face detection is the non-trivial first step in face recognition. It is the process of detecting all human faces in an image or video and extracting (cropping) these faces. There are many types of face detection methods, from these, we will use a feature-based face detection method that is CNN. The reasons why we selected the feature-based face detection method:- they are very effective in reducing the number of parameters without losing on the quality of models, automatic feature extractors from the image, and provide us with high quality and accurate results.

There are different types of CNNs, we will use Multi-task Cascaded Convolutional Neural Networks (MTCNN) for the purpose of Face Detection. It is a state-of-the-art deep learning model for face detection. MTCNN is a type of CNN that follows the principle of Multi-Task learning. In other words, it is able to learn multiple tasks at the same time, thus supporting the simultaneous detection of multiple faces. Thus, it enables the proposed system to detect multiple faces of students simultaneously in one shoot without spending its execution time. Using the MTCNN algorithm, we detect the bounding boxes of faces in an image, along with 5-point facial landmarks for each face (the simplest model, which detects the edges of the eyes and the bottom of the nose). The detection results are improved progressively bypassing the inputs through a CNN, which returns candidate bounding boxes along with their

probability scores. Further, because it is the first step in a broader face recognition system, face detection must be robust. For example, a face cannot be recognized if it cannot first be detected. Thus, we selected the MTCNN algorithm for the purpose of making the face detection of the proposed system robust. The performance and accuracy of the MTCNN algorithm are tested using Intel i7-3612QM CPU @ 2.10GHz, with a CPU-based TensorFlow 1.4.1, and it achieved the best accuracy in face detection as stated on the PyPI Website.

The following tables show the benchmark of this MTCNN implementation running on an Intel i7-3612QM CPU @ 2.10GHz, with a CPU-based TensorFlow 1.4.1. [1]

Table 3.0.1 Pictures containing a single frontal face.

Image size	**Total pixels**	**Process time**	**FPS**
460x259	119,140	0.118 seconds	8.5
561x561	314,721	0.227 seconds	4.5
667x1000	667,000	0.456 seconds	2.2
1920x1200	2,304,000	1.093 seconds	0.9

Table 3.0.2. Pictures containing 10 frontal faces.

Image size	**Total pixels**	**Process time**	**FPS**
474x224	106,176	0.185 seconds	5.4
736x348	256,128	0.290 seconds	3.4
2100x994	2,087,400	1.286 seconds	0.7

ii. Pre-Processing of Face Images/ Preparing the Dataset

Pre-Processing of Face Images is the process of categorizing and normalizing the dataset (student's face images) in order to train a machine learning model. This step is to pre-process the extracted faces in order to make the training and classifying phase of the model easier and improve the probability to recognize a person correctly. The training data will be standardized. Not all the pictures have the same zoom on the face and have maybe not all the same size. The proposed model for facial recognition requires the same size for the entire

training set and classification purpose. This phase of the proposed system will perform the preprocessing of face images or preparing of the dataset in order to make the dataset fit with the model and improve the accuracy of the face recognition. We will develop this part of the proposed system mainly employing different kinds of tools provided by the Keras deep learning framework, and other deep learning (machine learning) libraries. [3]

iii. Face Recognition

Face Recognition is a technique that is used to recognize a person from his/her face that has been previously trained from a dataset. The proposed system will use transfer learning with the VGG16 Model (pre-trained VGG16) for face Verification. Transfer learning is the reuse of a pre-trained model on a new problem. It's currently very popular in deep learning because it can train deep neural networks with comparatively little data. In transfer learning, the knowledge of an already trained machine learning model is applied to a different but related problem. With transfer learning, we basically try to exploit what has been learned in one task to improve generalization in another. The main reason why we use transfer learning is we have low computing power and a little dataset in order to train the model. As a result, we were obligated to use the pre-trained model that trained on millions of images and achieved remarkable accuracy.

VGG16 is a convolutional neural network model proposed by K. Simonyan and A. Zisserman from the University of Oxford in the paper "Very Deep Convolutional Networks for Large-Scale Image Recognition". The model achieves 92.7% top-5 test accuracy in ImageNet, which is a dataset of over 14 million images belonging to 1000 classes. It was one of the famous models submitted to ILSVRC-2014. It makes the improvement over AlexNet by replacing large kernel-sized filters (11 and 5 in the first and second convolutional layer, respectively) with multiple 3×3 kernel-sized filters one after another. The 16 in VGG16 refers to it has 16 layers that have weights. This network is a pretty large network and it has about 138 million (approx) parameters. VGG16 was trained for weeks and was using NVIDIA Titan Black GPUs.

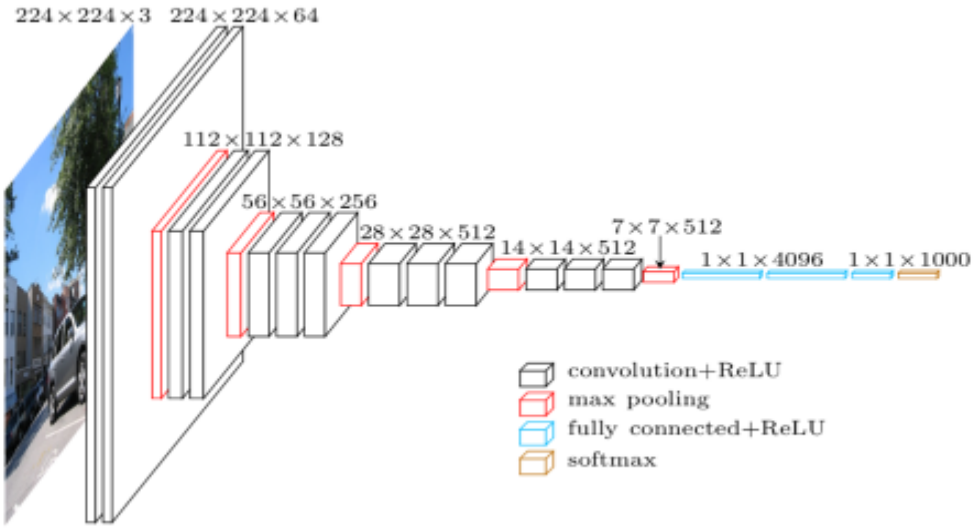


Figure 3.0.1. The Architecture of VGG16 [2]

We'll use VGG16 as the base model and derive from it a new CNN – VGGNet. This new CNN will have the layers and weights of VGG16 plus some modifications in the input layer (to adapt it to our image width, height, and color scheme), as well as in the output layer (to adapt it to our number of classes).

Attendance Marking

Attendance marking is the process of marking the attendance of students in the database according to the prediction of the pre-trained model. After the recognition process, the students recognized are searched in the database and their attendance is marked.

We explained below the proposed system functional and nonfunctional requirements in detail.

3.1. Functional Requirements

The proposed system is expected to provide student attendance system-related functionalities like marking attendance using face recognition and making the report for the recorded attendance. For a better understanding of our system, we divided the functionalities of our system by modules. The proposed system is expected to provide the following services.

Admin Module / Super Administrator

ID: ADMFREQ_1

Name: The system shall allow the admin to enter all the new users' (students, lecturers, department heads, and admins) information.

ID: ADMFREQ_2

Name: The system shall allow the admin to delete the users(student/s, lecturer/s, department head/s, and admin/s) that ceased their enrollment in the attendance workflow.

ID: ADMFREQ_3

Name: The system shall allow the admin to add the departments and colleges.

ID: ADMFREQ_4

Name: The system shall allow the admin to delete the departments and colleges.

ID: ADMFREQ_5

Name: The system shall allow the admin to give the role for the lecturer as department administrator or department head.

ID: ADMFREQ_6

Name: The system shall allow the admin to upload the new students' images in order to preprocess them and store them on the database.

ID: ADMFREQ_7

Name: The system shall allow the admin to train the model on the newly uploaded images of students.

ID: ADMFREQ_8

Name: The system shall allow the admin to initialize the attendance system by configuring the basic attendance settings like Late Time (Mins), Beginning/Ending In Time, etc.

ID: ADMFREQ_9

Name: The system shall allow the admin to view the attendance tracking status of the system.

ID: ADMFREQ_10

Name: The system shall allow the admin to log into and log out from the system.

ID: ADMFREQ_11

Name: The system shall enable the admin to update their profiles.

Student Module

ID: STUFREQ_1

Name: The system shall allow the students to view their attendance status of the specific course.

ID: STUFREQ_2

Name: The system shall allow the students to log into and log out from the system.

ID: STUFREQ_3

Name: The system shall enable the students to update their profiles.

The Department Head Module / Department Administrator

ID: DHFREQ_1

Name: The system should allow the Head to view his/her students' attendance status.

ID: DHFREQ_2

Name: The system should allow the Head to register courses' information.

ID: DHFREQ_3

Name: The system should allow the Head to register students for the specific courses.

ID: DHFREQ_4

Name: The system should allow the Head to assign an instructor to a course/courses that he/she is going to instruct and control the attendance tracking.

ID: DHFREQ_5

Name: The system should allow the Head to delete the assigned instructor to a course or courses due to the special case that made the instructor cease instructing that course/courses.

ID: DHFREQ_6

Name: The system should allow the Head to set up the attendance rule for the specific course.

ID: DHFREQ_7

Name: The system should allow the Head to set up the schedule for the specific course.

ID: DHFREQ_8

Name: The system shall allow the Head to log into and log out from the system.

ID: DHFREQ_9

Name: The system shall enable the Head to update his/her profile.

Instructor Module

ID: INSFREQ_1

Name: The system shall allow the Academic Staff to configure the basic settings for the attendance that is going to be taken.

ID: INSFREQ _2

Name: The system shall allow the Academic Staff to initiate the attendance tracking of the specific section.

ID: INSFREQ _3

Name: The system shall allow the Academic Staff to cease the attendance tracking of the specific section.

ID: INSFREQ _4

Name: The system shall allow the Academic Staff to view the attendance status of students that he/she instructs.

ID: INSFREQ _5

Name: The system shall allow the Academic Staff to handle the special case attendance of students.

ID: INSFREQ _6

Name: The system shall allow the Academic Staff to log into and log out from the system.

ID: INSFREQ _7

Name: The system shall enable the Head to update his/her profile.

Report Module

ID: REPFREQ_1

Name: The system shall generate the Daily Attendance Statistical Report that lists the definite section daily attendance status for the specific course in the assigned time in the table.

Viewers: Instructor, Head of the Department, and Admin

ID: REPFREQ_2

Name: The system shall generate an Attendance General Report that is used to show the sum computation of the definite section individual student attendance statistical status for the specific course in the assigned time.

Viewers: Head of the Department, and Admin

ID: REPFREQ_3

Name: The system shall generate the Department Attendance Statistical Report that shows the sum total of all students' attendance status of the specific department in the assigned time.

Viewer: Admin

ID: REPFREQ_4

Name: The system shall generate the specific student attendance report that shows the specific student attendance status of the specific course in the assigned time.

Viewer: Student

ID: REPFREQ_5

Name: The system shall generate the final taking student list for the specific course.

Viewers: Instructor, Head of the Department, and Admin

ID: REPFREQ_6

Name: The system shall generate for the special purpose recorded student attendance list.

Viewers: Instructor, Head of the Department, and Admin

3.2. Non-Functional Requirement

In this section, we have discussed the quality attributes in which our system should have to perform the functional requirements.

3.2.1. User Interface and Human Factors

The User Interface of the proposed system will be simple to understand, the user interface components are leading and action indicators. Thus, the users of the proposed system can easily perform the tasks that they intended to do. Every component of the user interface is

arranged based on understanding our users in terms of their goals, skills, preferences, and tendencies. The proposed system's user interface can be easily operated by a user since most of the users of the proposed system have basic knowledge in related systems like SIMS.

3.2.2. Hardware Consideration

The hardware required to deploy the proposed system is basically the following: -

Table 3.2.2. The hardware requirements

Number	Item	Specification
1	Computer Brand	Dell, Toshiba, HP, etc.
2	Processor	Core(i7) or Core(i5) with 2.5 GHz and above
3	RAM	16 GB of RAM and above
4	System Type	64-bit Operating system
5	Camera	8 Megapixels and above
6	GPU	4 GB and above

3.2.3. Security Issues

The golden rule of Web application security is to never trust data from untrusted sources. Sometimes it can be useful to pass data through an untrusted medium. Cryptographically signed values can be passed through an untrusted channel safe in the knowledge that any tampering will be detected. Django provides both a low-level API for signing values and a high-level API for setting and reading signed cookies. The proposed system will be developed using the Django framework. As a result, it has no security-related problems since Django provides different kinds of APIs in order to eliminate the security problems that face web applications. Moreover, the proposed system verifies the users by their username and password to check whether they are authorized or not. Generally, the proposed system will not be suffered from security problems.

3.2.4. Performance Consideration

The proposed system will be developed by using efficient deep learning algorithms/models, Django server-side framework, and MySQL database. Thus, it can perform computations efficiently, handle heavy traffic and large volumes of information, and it has proven

performance, reliability, and ease of use. Since the deep learning algorithms/models efficiently perform computations, MySQL is designed to meet even the most demanding applications while ensuring optimum speed, full-text indexes, and unique memory caches for enhanced performance, and Django is fully loaded with extras and scalable, the proposed system has a better response time and it can support many users concurrently.

3.2.5. Error Handling and Validation

The proposed system will check user inputs to the system to handle errors. It handles and shows errors in a user-friendly manner, without exaggerating the user. We use front-end validation to reduce the loading time of pages and load on the server. If there is any server-side error, it is only visible on the server log, they are not visible to the user. All the users will be notified that there was a server error. All the details will be kept in the logs for the developers.

3.2.6. Backup and Recovery

The system includes a secondary database, a copy of the original database, for backup purposes. If the original database fails or is damaged by any man-made or natural disasters, then a secondary database will be used for recovery purposes.

3.2.7. Resource Issues

Since the proposed system is a machine learning system, it needs high computing power in order to behave efficiently and in a good performance. We will use the concept of transfer learning with deep learning models in order to reduce the computing power that the system consumes and to increase the efficiency and performance of the proposed system. Even though we efficiently can reduce the computing power, the performance of the proposed system is dependent on the computing power such as RAM, Processor, GPU, and the Quality of the Camera.

CHAPTER 4

4. SYSTEM ANALYSIS

In this dynamic world, the subject of System Analysis mainly deals with software development activities. we conducted it for the purpose of studying our system or its parts in order to identify its objectives. System Analysis is a problem-solving technique that improves the system and ensures that all the components of the system work efficiently to accomplish their purpose. This chapter explains the System analysis by designing use case diagrams, use case description for each use case identified in the use case diagram, object model class diagram, sequence diagram, activity diagram, and statechart diagram.

4.1. System Model

To produce a model of the system which is correct, complete, and consistent we need to construct the analysis model which focuses on structuring and formalizing the requirements of our system. The analysis model contains three models: functional model this model deals with the functionality of the system, what is expected from the system, the services that are given by the system. The functional model is generally described by the use case diagram. Object model this model describes the structure of the system. The object model includes attribute, object, and association. Dynamic models deal with the internal behavior of the system and also how one-use case executes, series of activities that one-use case executes as well as the state. The dynamic model is described by the sequence, state chart, and activity diagrams.

4.1.1. Use Case Model

The Use Case Model describes the functionality of the facial recognition-based attendance system. It represents a discrete unit of the interaction of a user (actors of the system) with the face recognition-based attendance system. Use Case has a description that describes the functionality that will be built in the proposed system. Use Cases are typically related to 'actors', that is a human or machine entity that interacts with the system to perform meaningful work. But in our proposed system there is no need to interact with other external systems and due to this, our actors are only humans who will use the system.

4.1.1.1. Use Case Diagram

We have used use case diagrams in order to capture the functional requirements of the system. It is the functionality of the system or the service provided by the system. In our use case diagram, we have considered the following elements.

- Use Case: This is the functionality of our facial recognition-based attendance system which has a direct interaction with the user.
- Actor: any entity that interacts with our system.
- A relationship between the use cases.

We identified both actors and use cases (functionalities) that exist in the Facial Recognition Based Attendance System as the following:

Actors

- System Admin
- Head of Department
- Academic Staff
- Student

System Admin

- System Admin can log in to the system and log out from the system.
- System Admin can update his/her profile.
- System Admin can manage users' information.
- System Admin can manage the departments' and colleges' information.
- System Admin can give the role to the users.
- System Admin can upload the students' images.
- System Admin can train the model.
- System Admin can initialize the attendance system.
- System Admin can view the attendance status.

Head of Department

- Head can log in to the system and log out from the system.
- Head can update his/her profile.
- Head can view attendance status.
- Head can manage courses' information.

- Head can register students for the specific courses.
- The Head can manage the instructor's assignment.
- The Head can set up the attendance rule for the specific course.
- The Head can set up the schedule for the specific course.

Instructor

- The instructor can log in to the system and log out from the system.
- The instructor can update his/her profile.
- The instructor can configure the basic attendance settings.
- The instructor can initiate the attendance tracking.
- The instructor can cease the attendance tracking.
- The instructor can view the attendance status.
- The instructor can handle the special case attendance.

Student

- Students can log in to the system and log out from the system.
- Students can update their profiles.
- Students can view the attendance status.

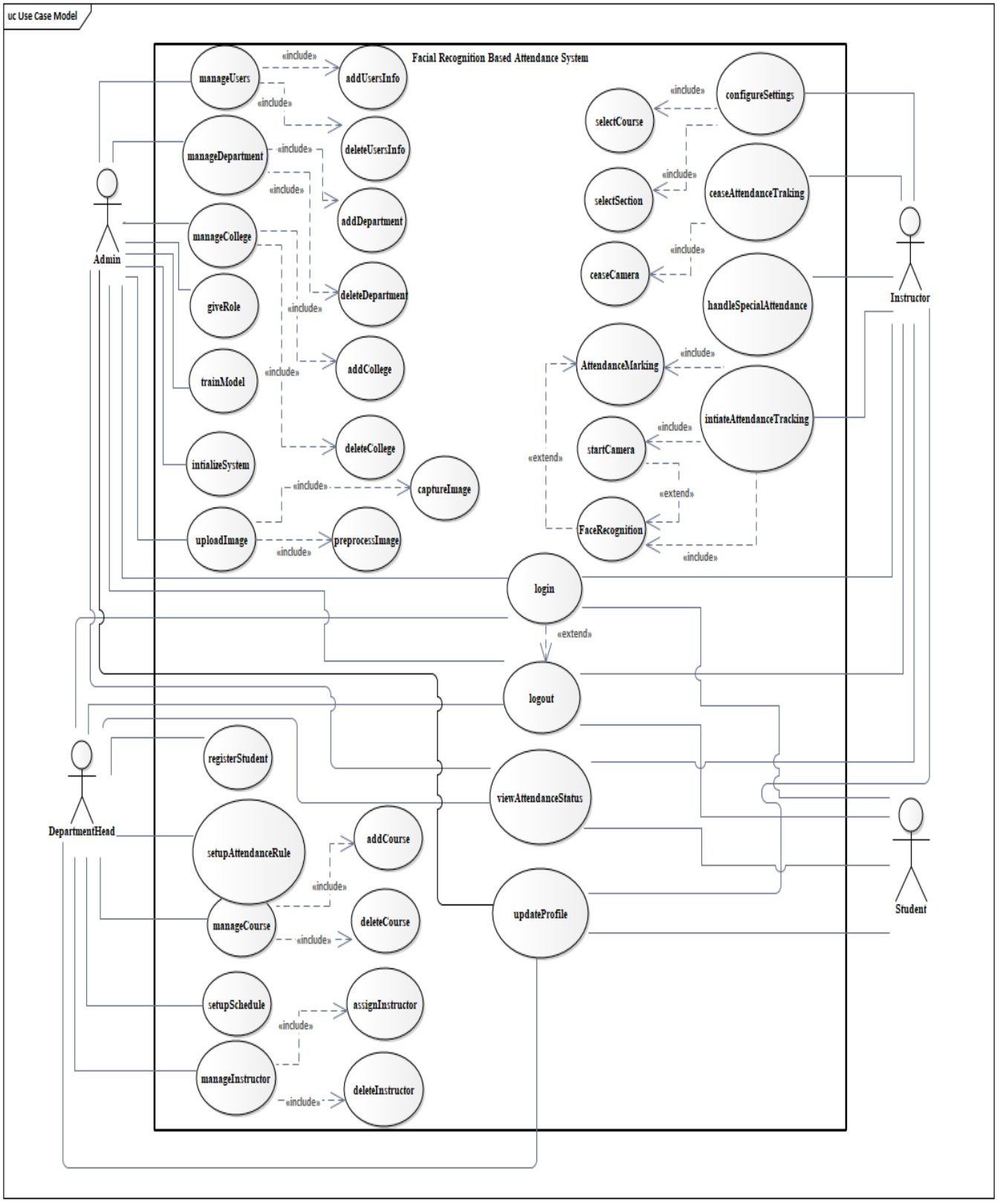


Figure 4.1. Use Case Diagram for the Facial Recognition based Attendance System

4.1.1.2. Use Case Description

The use case description is used to detail the description of the use case and how the use case works in order to perform user and system functionality. We discussed in detail the use case description as shown in table 4-1 to table 4-16 below.

Table 4-1. Login use case description

Use case name	Login	
Identifier	UC 01	
Description	User login to the system.	
Actors	Admin, Head of Department, Instructor and Student	
Preconditions	The user must have an account.	
Basic Flow	Actor action	Attendance System response
	1. User clicks on the login link from the home page. 3. The user enters his/her username, password, and user type and clicks on the login button.	2. The system displays the login form page. 4.The system validates the entered value. 5.The system displays its landing page. 6. Use case end
Alternative flow	4.1. Invalid username and password: In step 4 of the basic flow of the login use case, if the user enters invalid (i.e. empty/wrong) information, then the system indicates the user whether to fill the form left empty or redirects to re-enter username and password.	
Postconditions	Users can access his/her accounts.	

Table 4-2. Manage Users use case description

Use case name	Manage Users	
Identifier	UC 02	
Description	The manage users use case describes how the Admin manages users.	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the manage users option on his/her home page. 3. The user selects the management option that he/she wants to manage from the given option. 5. The user performs the required operation (update, delete, view) on the users' information. 7. Use case ends.	2. The system displays the management options. 4. The system displays the option selected by the user. 6. The system updates the data that the operation is performed.
Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.	
Postconditions	5.2. Management Success: the management process ends with a successful operation. 5.3. Management fails: the process ends with failure if the Admin cancels the management process.	

Table 4-3. Manage department use case description

Use case name	Manage department	
Identifier	UC 03	
Description	The manage department use case describes how the Admin manages the department.	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the manage department option on the home page. 3. The user selects the management option that he/she wants to manage from the given option. 5. The user performs the required operation (update, delete, view) on the department. 7. Use case ends	2. The system displays the management options. 4. The system displays the option selected by the user. 6. The system updates the data that the operation is performed.
Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.	
Postconditions	5.2. Management Success: the management process ends with a successful operation. 5.3. Management fails: the process ends with failure if the	

	Admin cancels the management process.

Table 4-4. Manage College use case description

Use case name	Manage College	
Identifier	UC 04	
Description	The manage use case describes how the Admin manages the college.	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the manage college option on the home page. 3. The user selects the management option that he/she wants to manage from the given option. 5. The user performs the required operation (update, delete, view) on college. 7. Use case ends	2. The system displays the management options. 4. The system displays the option selected by the user. 6. The system updates the data that the operation is performed.
Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.	
Postconditions	5.2. Management Success: the management process ends with a successful operation.	

	5.3. Management fails: the process ends with failure if the Admin cancels the management process.

Table 4-5. Give Role use case description

Use case name	Give Role	
Identifier	UC 05	
Description	The give role use case describes how the Admin gives privileges to users of the attendance system.	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the give role option on the home page. 3. The user selects the one role to give specified users. 6. Use case end	2. The system displays the option that contains different kinds of roles (Instructor, student, Department Head, and Admin). 5. The system updates the data that the operation is performed.
Alternative flow	5.1. Wrong giving of roles: the system displays the wrong information and directs to give role again.	
Postconditions	5.2. Success: the management process ends with a successful operation. 5.3. Fails to give role: the process ends with failure if the Admin cancels the process.	

Table 4-6. Upload Images use case description

Use case name	Upload Images	
Identifier	UC 06	
Description	The Upload Image use case describes how the Admin Uploads the image of students in the database.	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the upload image button on the home page. 3. The user will write the label and upload the image or capture the image in order to upload it into the database. 6. Use case ends	2. The system displays the interface for uploading the image. 4. The system performs face detection algorithms and preprocesses the uploaded or captured images. 5. The system displays the successful message.
Alternative flow	3.1. User enters incorrect image type or left fields. i. The system displays a message that contains “enter the correct image type or you entered wrong value” will be displayed. ii. User repeat 3	
Postconditions	The image will be uploaded into the database.	

Table 4-7. Train model use case description

Use case name	Train model	
Identifier	UC 07	
Description	The train use case describes how the Admin Trains the model with student's information (image, different kinds of user information).	
Actors	Admin	
Preconditions	The user must log in to the system with the Admin role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the train model option on the home page. 5. Use case ends	2. The system displays the training page. 3. The system displays the training process. 4. The system will display the successful message.
Alternative flow	1.1. Wrong Training: the system displays the wrong information and directs to train again.	
Postconditions	1.2. Training Success: the training process ends with a successful operation. 1.3. Training fails: the process ends with failure if the Admin cancels the training process.	

Table 4-8. Manage attendance tracking use case description

Use case name	Manage attendance tracking
Identifier	UC 08
Description	The manage attendance tracking use case describes how

	the instructors manage the attendance tracking.	
Actors	Instructors	
Preconditions	The user must log in to the system with the Instructor role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the manage attendance option on the screening page. 3. The user selects the data he/she wants to manage from the given option. 5. The user performs the required operation (Cease, initiate, handle special attendance). 7. Use case end	2. The system displays the management options. 4. The system displays the data selected by the user. 6. The system updates the data that the operation is performed.
Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.	
Postconditions	5.2. Management Success: the management process ends with a successful operation. 5.3. Management fails: the process ends with failure if the Instructor cancels the management process.	

Table 4-9. View Attendance Detail use case description

Use case name	View Attendance Detail

Identifier	UC 09	
Description	Viewing attendance detail information	
Actors	Admin, Head of Department, Instructor, Student	
Preconditions	The user must log in to the system with the Admin, Head of Department, Instructor, or Student role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the view option on the home page based on their role. 3. The user selects as they want to view the detail he/she wants to view based on their role. 5. The user can view, edit and print the report based on their authority.	2. The system displays the view page. 4. The system displays the attendance list and other related information to the authorized users. 6. The system will give access to view and print the attendance and related data.
Alternative flow	Nothing	
Postconditions	5.2. Success: the process to view ends with a successful operation. 5.3. Fails to give role: the process ends with failure if the Admin cancels the process.	

Table 4-10. Register Student use case description

Use case name	Register Student

Identifier	UC 10	
Description	This use case enables the Department Head to register students for the courses.	
Actors	Department Head	
Preconditions	The user must log in to the system with the Department Head role and should be on the home page.	
Basic flow	Actor action	Attendance System response
	1. The user clicks on the register students for the course button. 3. The user fills in all required information and clicks submit button.	2. The system displays a registration form. 4. The system checks the validity of the input data and also whether the student is already registered for the course or not. 4. The system displays the registration success message. 5. Use case ends.
Alternative Flow	4.1. User enters wrong input or attempt to register the registered student. i. The System displays messages that contain "you entered the wrong data or the student is already registered." will be displayed. ii. The user repeats step 3.	
Postconditions	The student is successfully registered for the course.	

Table 4-11. Set Up schedule use case description

Use case name	Set Up schedule	
Identifier	UC 11	
Description	The set-up schedule use case describes how the head of the Department set up the schedule for the courses.	
Actors	Department Head	
Preconditions	The user must log in to the system with the Department Head role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the Set-Up Schedule option on the page. 3. The user fills in all required information, the schedules of every course in the given department, in the provided form and clicks on the Set Up Schedule button or edit schedule button.	2. The system displays the Set Up Schedule page option. 4. If the user clicks on the setup schedule button, the system will display a "The schedule successfully inserted" message. If the user clicks on the update schedule button, the system will display the "The schedule successfully updated" message. 5. Use case ends.
Alternative flow	3.1. The user enters the wrong input or lefts blank fields. i. The System displays messages that contain either "field cannot be empty" or "you entered the wrong input". ii. The user repeats step 3.	
Postconditions	Either the schedule data will be inserted into the database or previously existing product information will be updated.	

Table 4-12. Configure Setting use case description

Use case name	Configure Setting	
Identifier	UC 12	
Description	The Configure Setting use case describes how the Instructor configures settings like the course and section selection for taking attendance.	
Actors	Instructor	
Preconditions	The user must log in to the system with the Instructor role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks on the Configure Setting option on the page. 3. The user configures settings, like selecting courses and sections, for taking attendance and clicks on submit button.	2. The system displays the configure setting option. 4. The system validates the inserted data and displays a "you can initiate attendance tracking" message. 5. Use case ends.
Alternative flow	3.1. Wrong configuration of settings: i. The system displays the message "Please correct the configuration" ii. The user repeats step 3.	
Postconditions	3.2. Configuration settings Success: the configuration process ends with a successful operation. 3.3. Configuration setting fails: the process ends with failure if the Instructor cancels the configuration process.	

Table 4-13. Set Up attendance rule use case description

Use case name	Set Up Attendance Rule	
Identifier	UC 13	
Description	The setup rule use case describes how the Head of Department set up the attendance rule for the specific course.	
Actors	Department Head	
Preconditions	The user must log in to the system with the Department Head role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the Set Up attendance rule option on the page. 3. The user fills the attendance rule in the provided page for the specific course and either click on submit button or edit the schedule button.	2. The system displays the Set Up attendance rule page. 4. The system validates the inputted data. 5. The system displays either the "Successfully set the attendance rule" or "The attendance rule successfully updated" message. 6. Use case ends.
Alternative flow	3.1. The user entered the wrong input or left blank fields. i. The System displays messages that contain either "field cannot be empty" or "you entered the wrong input". ii. The user repeats step 3.	

Postconditions	3.2. Set Up Attendance Rule Success: the Setup process ends with a successful operation. 3.3. Set Up Attendance Rule fails: the process ends with failure if the department Head cancels the Setup process.

Table 4-14. Manage Course use case description

Use case name	Manage Course	
Identifier	UC 14	
Description	The manage course use case describes how the Department Head manages course data.	
Actors	Department Head	
Preconditions	The user must log in to the system with the Department Head role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the manage course option on the home page. 3. The user selects the option he/she wants to manage from the given option. 5. The user performs the required operation (add, delete, edit, view) on course data.	2. The system displays the course management options. 4. The system displays the option selected by the user. 6. The system validates the data and displays the successful message. 7. Use case ends
Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.	

Postconditions	5.2. Management Success: the management process ends with a successful operation. 5.3. Management fails: the process ends with failure if the Department Head cancels the management process.

Table 4-15. Manage Instructor use case description

Use case name	Manage Instructor	
Identifier	UC 15	
Description	The manage instructor use case describes how the Department Head assigns the instructor and deletes the assigned instructor for the specific course.	
Actors	Department Head	
Preconditions	The user must log in to the system with the Department Head role and should be on the home page.	
Basic Flow	Actor action	Attendance System response
	1. The use case begins when the authorized user clicks the manage Instructor option on the home page. 3. The user selects the option that he/she wants to manage from the given options. 5. The user performs the required operation (assign and delete) on the Instructors.	2. The system displays the management options. 4. The system displays the option selected by the user. 6. The system validates the data and displays the successful message. 7. Use case ends.

Alternative flow	5.1. Wrong Management: the system displays the wrong information and directs to manage again.
Postconditions	5.2. Management Success: the management process ends with a successful operation. 5.3. Management fails: the process ends with failure if the Department Head cancels the management process.

Table 4-16. Logout use case description

Use case Name	Logout	
Identifier	UC 16	
Actor	Admin, Head of Department, Instructor Student	
Description	Exiting from the system	
Precondition	Login into the system.	
Basic flow	Actor action	Attendance System response
	1. User clicks on the (log out) button on the home page.	2. The system exits the user from the system. 3. Use case ends.
Alternative Flow	There is not any alternative course of action under this use case.	
Postcondition	Log out from the system.	

4.1.1.3. Use Case Scenario

In this section, we have written a real-world scenario that can explain the main activities of our proposed system in a narrative style. The name of persons used here is randomly our names that can represent users in the real world. Thus, use case scenarios are used for the example of users interacting with a facial recognition-based attendance system to register

users, login, upload images, and set up a schedule. Each Scenario step is linked to relevant actions.

Scenario name: Login.

Participating actors: Mr. Django.

Initial assumption: power and connection are available. Also, the browser is open.

The normal flow of events:

- Mr. Django clicks on the (login) link on the home page.
- The System displays the login page.
- Mr. Django fulfills the username, password, and role type and then clicks on the (Login) button.
- The System validates input value.
- Mr. Django has access to his account (logged in).
- The use case ends.

Alternative flow:

- The System displays Messages that contain “field cannot be empty or you entered wrong username or password” will be displayed.

Scenario name: Register.

Participating actors: Mr. Abebayehu

Initial assumption: Face recognition-based attendance system should be first displayed.

The normal flow of events:

- Mr. Abebayehu clicks on the (register) link on the home page.
- The System displays the registration page.
- Mr. Abebayehu fulfills the information that the systems request and click on the (register) button.
- The System validates entered value from the user.
- The system registers Honey and displays a successfully registered message.
- The System displays the home page.
- Use case ends.

Alternative flow:

- Mr. Abebayehu enters incorrect information and the System displays a message that contains “field cannot be empty or you entered wrong value” will be displayed.

Scenario name: Set up a schedule

Participating actors: Mrs. Tigist.

Initial assumption: Mrs. Tigist must have a user account and role as head of the department. Also, she is logged into the system and on the head of the department page.

The normal flow of events:

- Mrs. Tigist clicks on the (set up schedule) link on the page provided for the head of the department.
- The System display set up schedule page.
- Mrs. Tigist fulfills the required input for setting up the schedule and then clicks on the (Set up) Button.
- The System validates input value.
- The system displays the setup schedule page.
- Use case ends.

Alternative flow:

- Mrs. Tigist enters incorrect information and the System displays a message that contains “field cannot be empty or you entered wrong value” will be displayed.

Scenario name: Upload image

Participating actors: Mrs. Saron.

Initial assumption: Mrs. Saron must have a user account and role for Admin. Also, she is logged into the system and on the Admin page.

The normal flow of events:

- Mrs. Saron clicks on the (upload image) link on the page provided for Admin.
- The System display page for uploading the image.
- Mrs. Saron will upload the student image and then click on the (upload) Button.
- The System preprocesses the input images and stores them in the database.
- The use case ends.

Alternative flow:

- Mrs. Saron enters incorrect image type and the System displays a message that contains “enter the correct image type or you entered wrong value” will be displayed.

4.2. Object Model

An object model is a description of an object-oriented architecture, including the details of the object structure, interfaces between objects, and other object-oriented features and functions. In this section, we discuss the object model class diagram and data dictionary. In the class diagram, we have described diagrammatically the conceptual relationship among objects and class of the proposed system (facial recognition-based attendance system). Metadata that describes the database of facial recognition-based attendance system that includes data ownership, data relationships to other objects, and other data; thus, metadata are discussed under data dictionary.

4.2.1. Class Diagram

The class diagram represents the static view of a facial recognition-based attendance system. The class diagram is not only used for visualizing, describing, and documenting different aspects of our system but also for constructing executable code of the proposed system. The class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of object-oriented systems because they are the only UML diagrams that can be mapped directly with object-oriented languages.

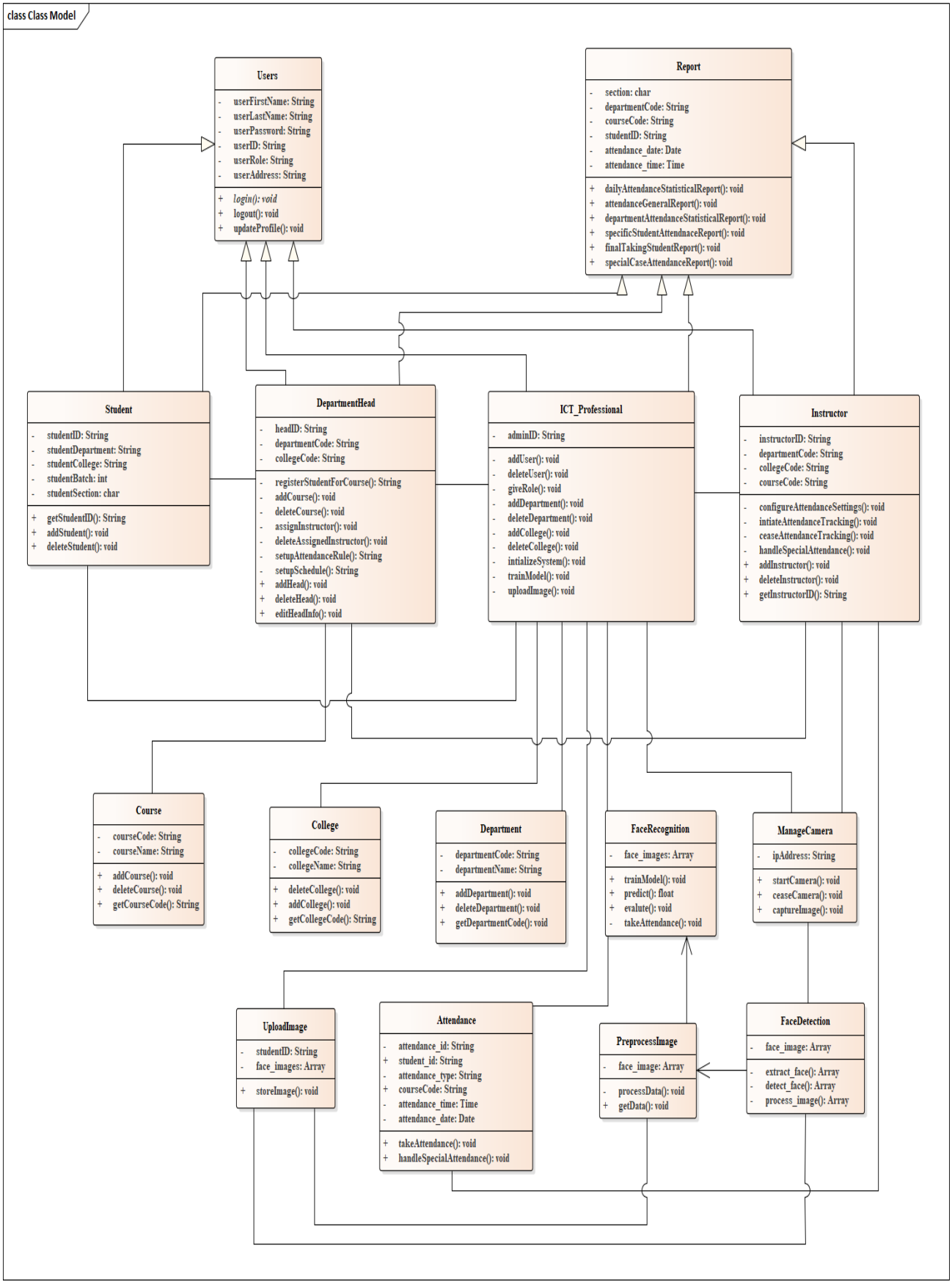


Figure 4.2.1. Class Diagram for Facial Recognition based Attendance System

4.2.2. Data Dictionary

Table name: Student

Primary key: student_id

Description: This table uses to store student's information.

Table 4.2.2.1. Shows the student table

Attributes	**Data type**	**Data size**	**Key Constraint**
student_id	VARCHAR	15	Primary key
student_batch	INT	1	Not null
student_firstname	VARCHAR	20	Not null
student_lastname	VARCHAR	20	Not null
departmentCode	VARCHAR	30	Foreign key
collegeCode	VARCHAR	30	Foreign key
student_section	VARCHAR	1	Not null
courseCode	VARCHAR	30	Foreign key

Table name: Instructor

Primary key: staffID

Description: This table uses to store academic staff's information.

Table 4.2.2.2 . Shows the Instructor table

Attributes	**Data type**	**Data size**	**Key Constraint**
staffID	VARCHAR	30	Primary key
staff_firstName	VARCHAR	20	Not null
staff_lastName	VARCHAR	20	Not null
departmentCode	VARCHAR	30	Foreign key
collegeCode	VARCHAR	30	Foreign key

courseCode	VARCHAR	30	Foreign key

Table name: Attendance

Primary key: attendance_id

Description: This table uses to record attendance.

Table 4.2.2.3. Shows the Attendance table

Attributes	**Data type**	**Data size**	**Key Constraint**
attendance_id	VARCHAR	30	Primary key
student_id	VARCHAR	15	Foreign key
attendance_type	VARCHAR	20	Not null
courseCode	VARCHAR	30	Foreign key
date	Date		Not null
start_time	DateTime		Not null
end_time	DateTime		Not null
attendance_status	String	7	Not null

Table name: DepartmentHead

Primary key: headID

Description: This table uses to store the department head's information.

Table 4.2.2.3. Shows the DepartmentHead table

Attributes	**Data type**	**Data size**	**Key Constraint**
headID	VARCHAR	30	Primary key
head_firstName	VARCHAR	20	Not null
head_lastName	VARCHAR	20	Not null
departmentCode	VARCHAR	30	Foreign key

collegeCode	VARCHAR	30	Foreign key

4.3. Dynamic Model

The dynamic model shows the behavior and collaboration between objects found in the facial recognition-based attendance system. Under this model, we have discussed two of these dynamic model diagrams, which are sequence, and activity diagrams.

4.3.1. Sequence Diagram

A sequence diagram is emphasizing the time ordering of messages. We have tried to show the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario in the facial recognition-based attendance system.

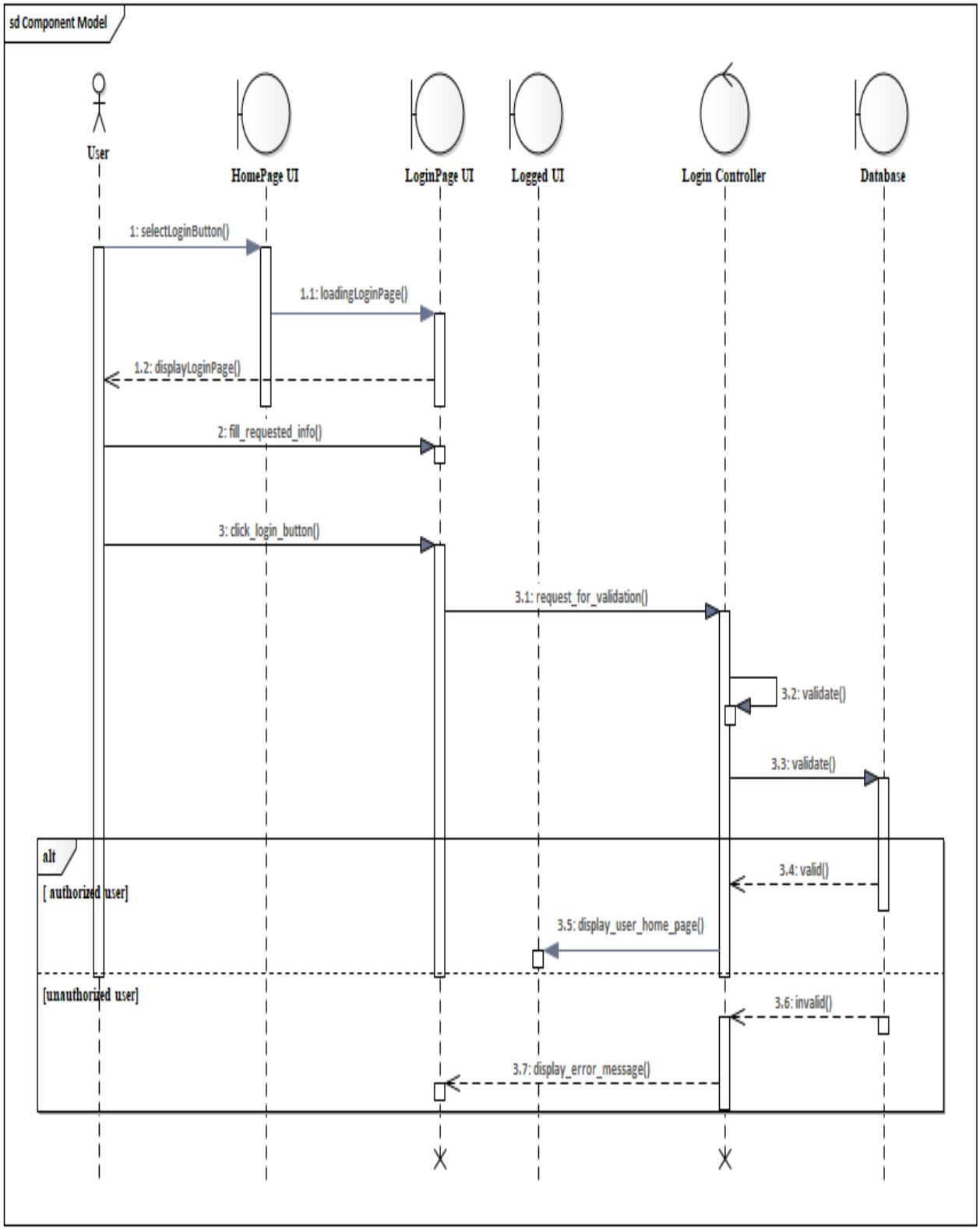


Figure 4.3.1.1. Sequence Diagram for login

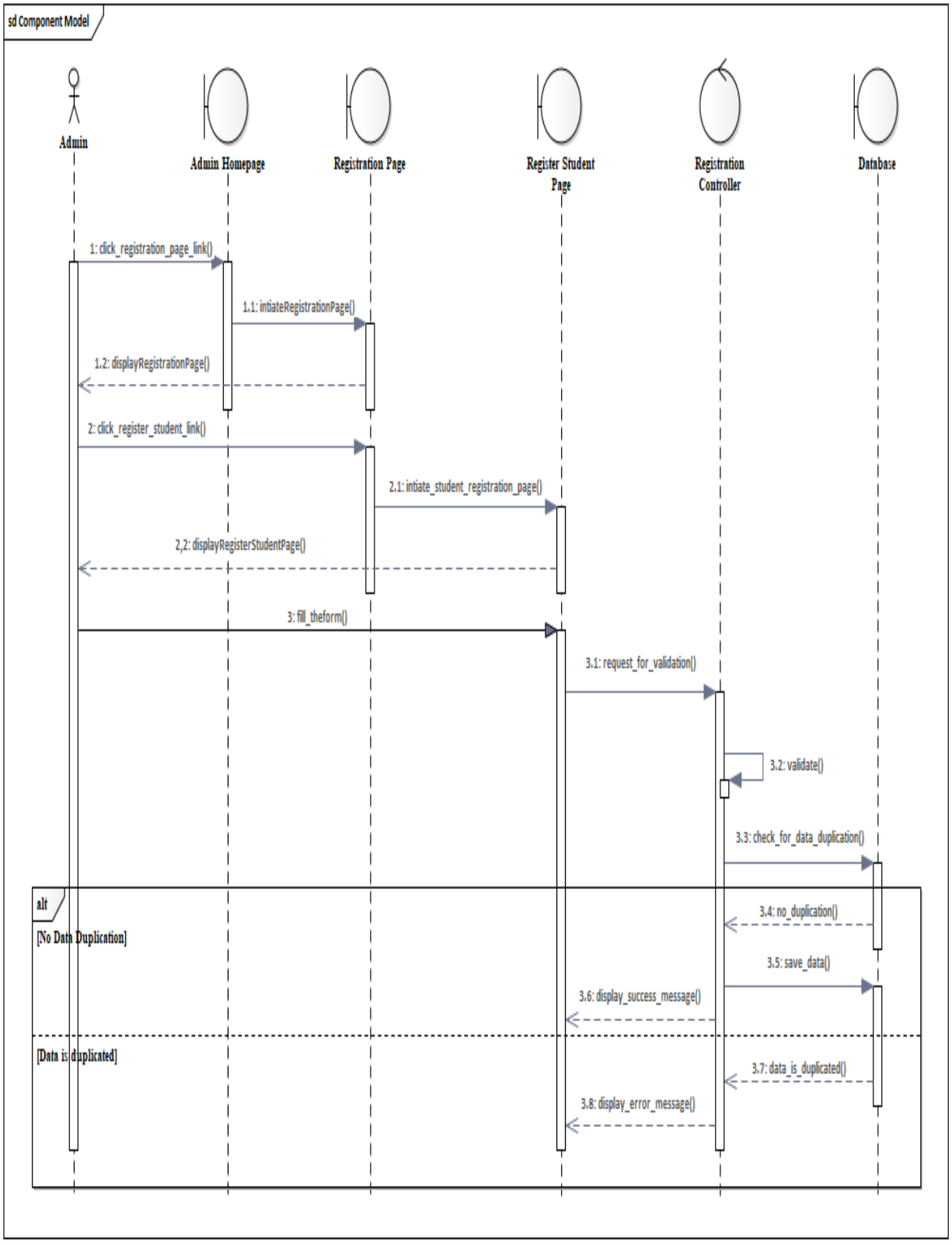


Figure 4.3.1.2. Add User(Student) Sequence Diagram

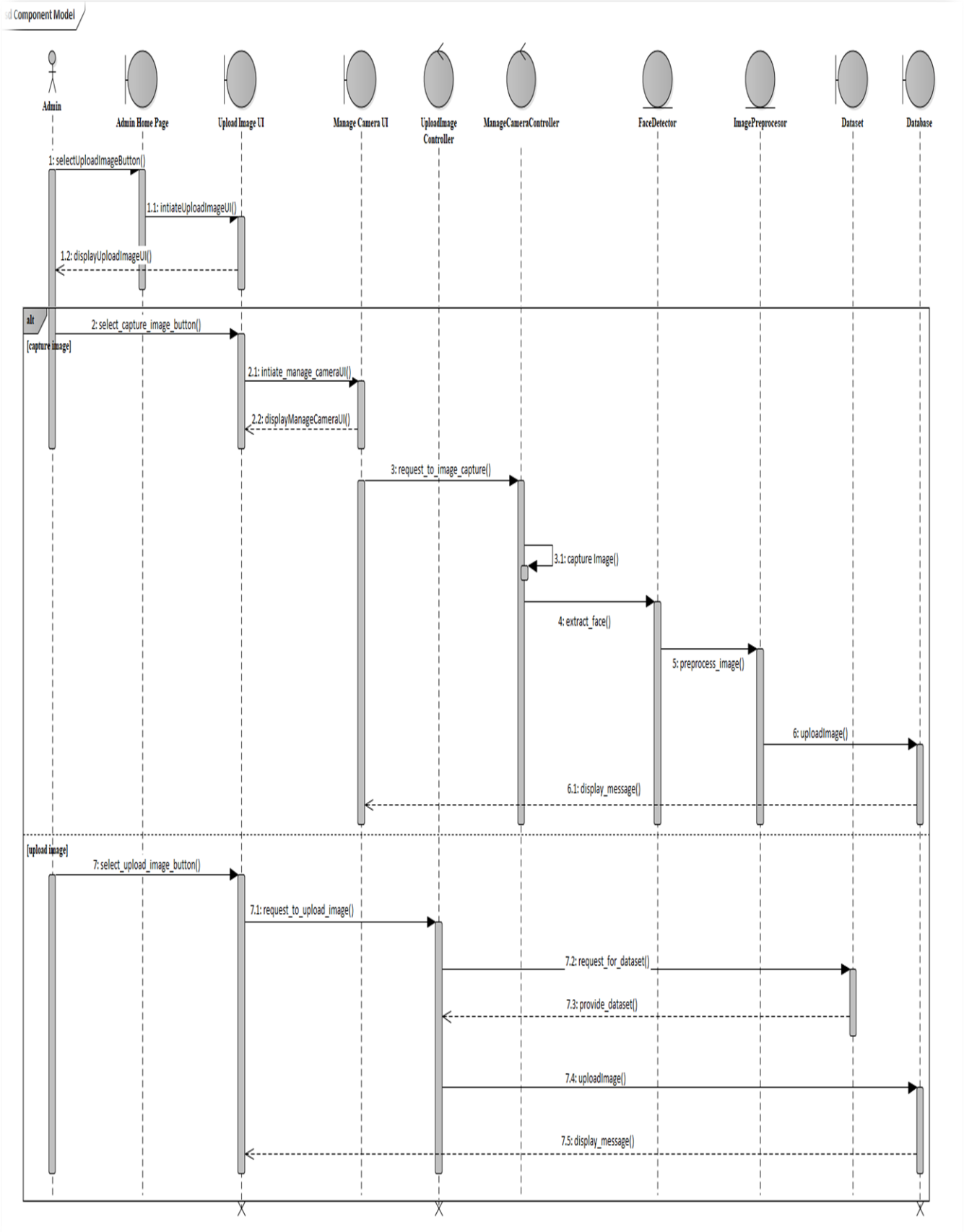


Figure 4.3.1.3. Upload Image Sequence Diagram

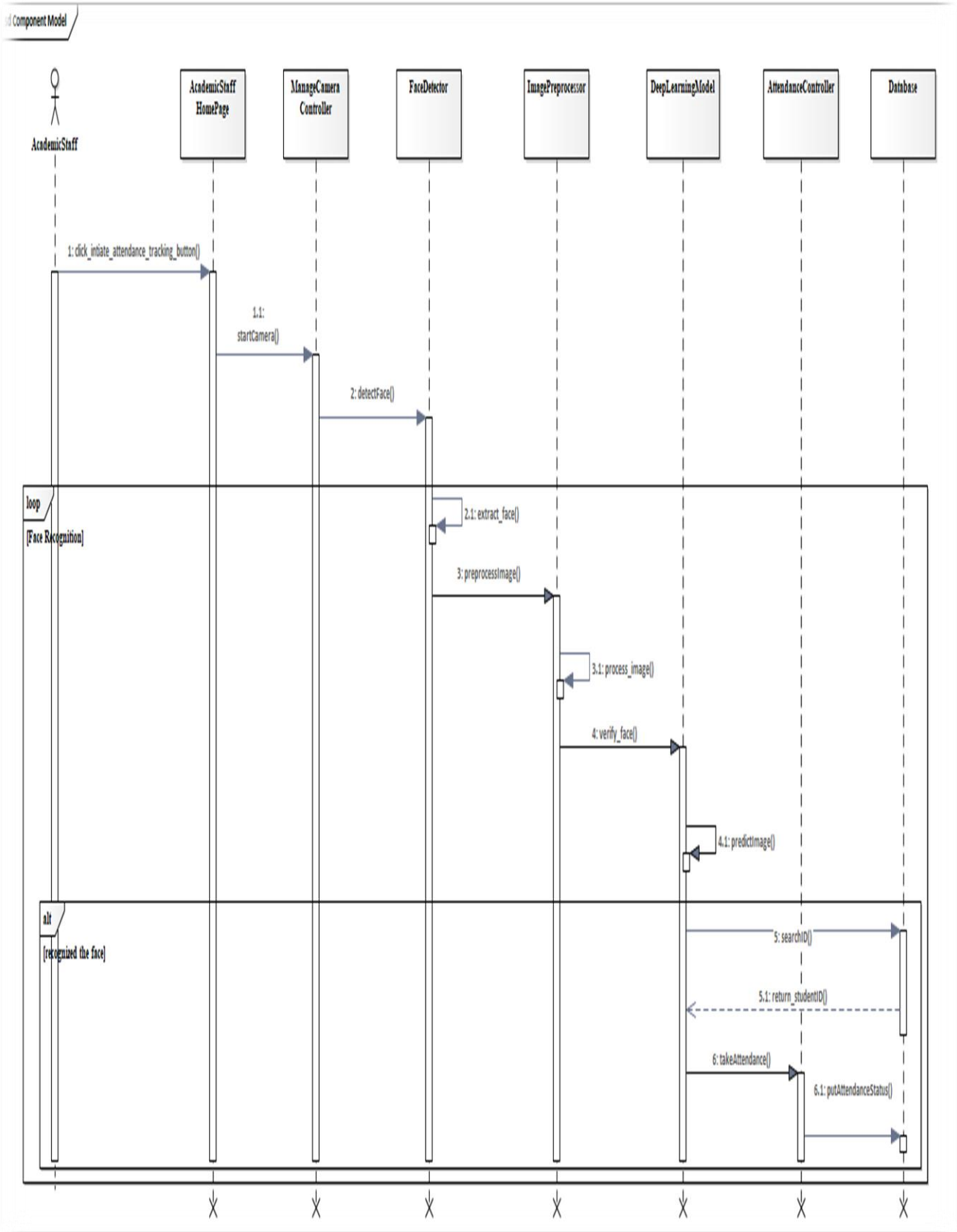


Figure 4.3.1.4. Take Attendance Sequence Diagram

4.3.2. Activity Diagram

An activity diagram is a flow chart to represent the flow from one activity to another activity. We have described the Admin and Department Head activity diagrams in order to show the operation of the system to perform tasks done by actors of a facial recognition-based attendance system.

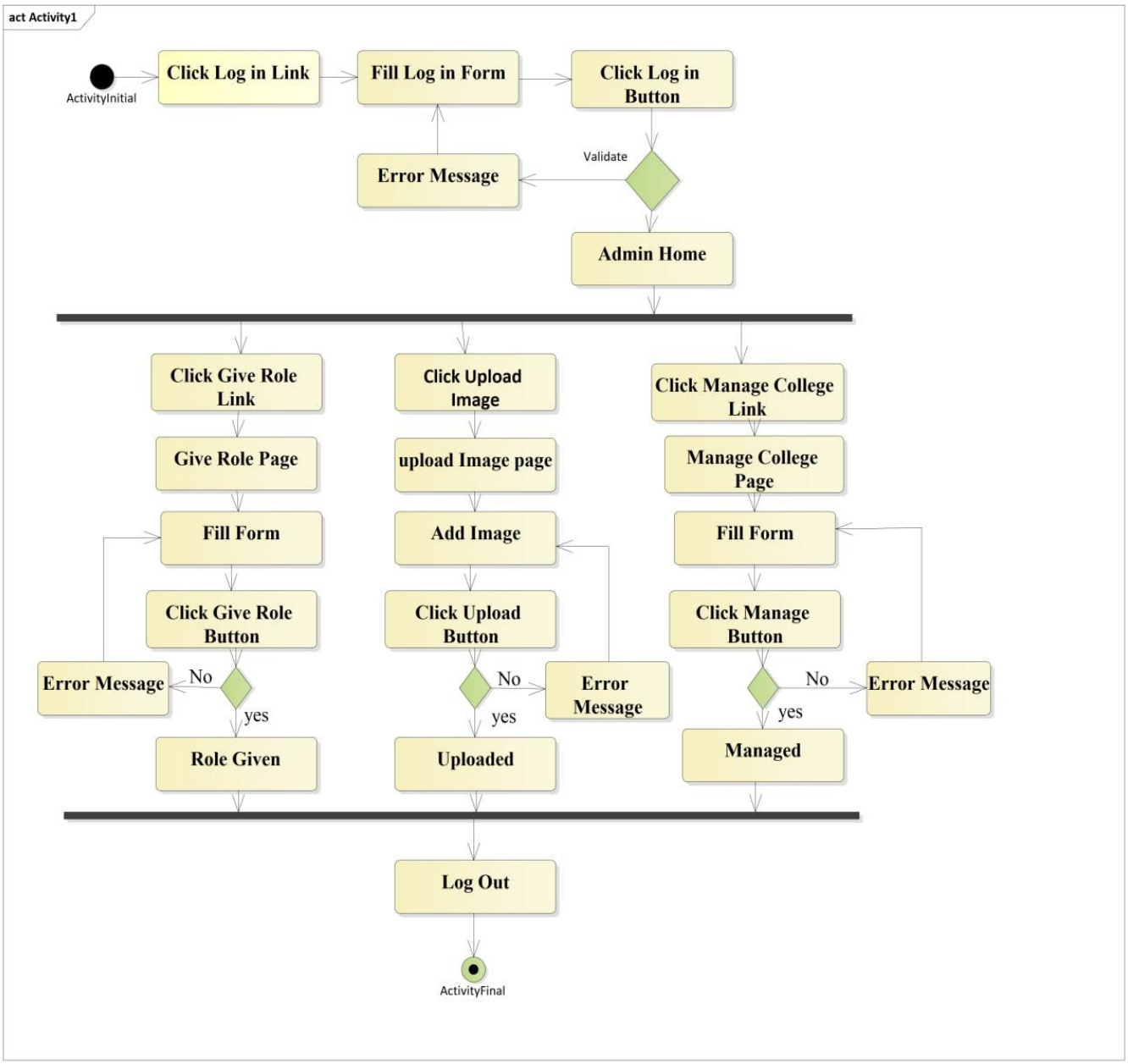


Figure 4.3.2.1. System Admin Activity Diagram

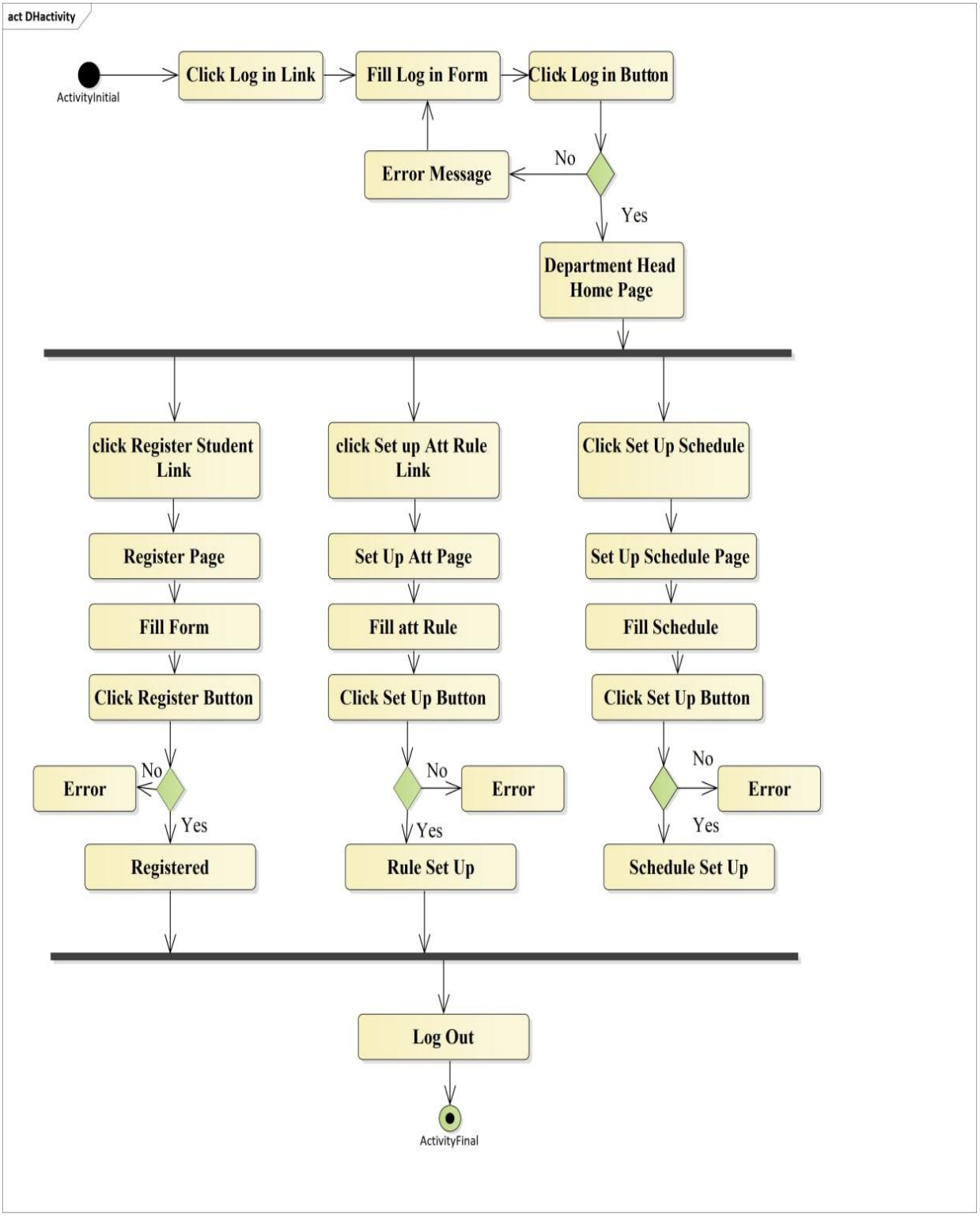


Figure 4.3.2.2. Department Head Activity Diagram

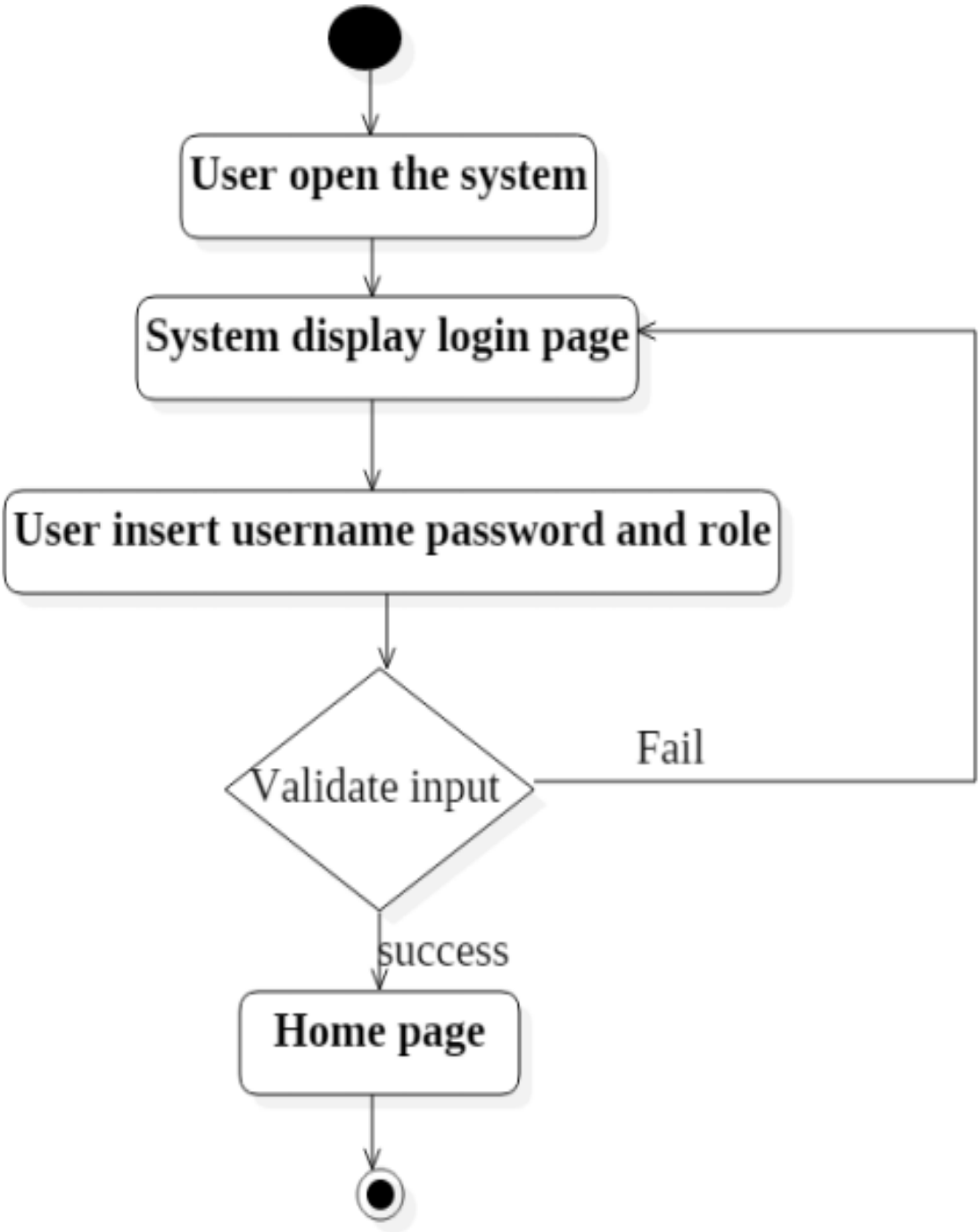


Figure 4.3.2.3. Login Activity Diagram

CHAPTER FIVE

5. SYSTEM DESIGN

The Systems design of this project defines the elements of the facial recognition-based attendance system like modules, architecture, components, and their interfaces and data for a system based on the specified requirements. It is the process of defining, developing, and designing systems that satisfy the specific needs and requirements of the stakeholder and also defines the coherent and well running system.

5.1. Design Goals

The design goals are derived from the non-functional requirements of the system, which describes the facial recognition-based attendance system that specify the qualities of the system that should be achieved and addressed during the design of the system.

5.1.1. User Interface and Human Factors

The User Interface of the proposed system will be simple to understand, the user interface components are leading and action indicators. Thus, the users of the proposed system can easily perform the tasks that they intended to do. Every component of the user interface is arranged based on understanding our users in terms of their goals, skills, preferences, and tendencies. The proposed system's user interface can be easily operated by a user since most of the users of the proposed system have basic knowledge in related systems like SIMS.

5.1.2. Security Issues

The golden rule of Web application security is to never trust data from untrusted sources. Cryptographically signed values can be passed through an untrusted channel safe in the knowledge that any tampering will be detected. Django provides both a low-level API for signing values and a high-level API for setting and reading signed cookies. The proposed system will be developed using the Django framework. As a result, it has no security-related problems since Django provides different kinds of APIs in order to eliminate the security problems that face web applications. Moreover, the proposed system verifies the users by their username and password to check whether they are authorized or not. Generally, the proposed system will not be suffered from security problems.

5.1.3. Performance Consideration

The proposed system will be developed by using efficient deep learning algorithms/models, Django server-side framework, and MySQL database. Thus, it can perform computations efficiently, handle heavy traffic and large volumes of information, and it has proven performance, reliability, and ease of use. Since the deep learning algorithms/models efficiently perform computations, MySQL is designed to meet even the most demanding applications while ensuring optimum speed, full-text indexes, and unique memory caches for enhanced performance, and Django is fully loaded with extras and scalable, the proposed system has a better response time and it can support many users concurrently.

5.1.4. Error Handling and Validation

The proposed system will check user inputs to the system to handle errors. It handles and shows errors in a user-friendly manner, without exaggerating the user. We use front-end validation to reduce the loading time of pages and load on the server. If there is any server-side error, it is only visible on the server log, they are not visible to the user. All the users will be notified that there was a server error. All the details will be kept in the logs for the developers.

5.1.5. Design Trade-Offs

We have considered our project design trade-off like the following list. In order to avoid a situation that involves losing one quality or aspect of something in return for gaining another quality or aspect.

Performance vs. Security: - Our system selects Performance compares to Security but it doesn’t mean our system doesn’t care about security issues. We don’t use a complex security system that affects the proposed System performance. Only we use simple encryption for username and password, and Django Framework for back end web development for more security that doesn’t more affect the proposed system performance. We lose some advanced security algorithms to increase the proposed system performance because we don’t have much sensitive user data to care about.

Performance vs. Usability: - When we compare performance with the usability of the system, the system is easy to learn and operate. The User interface for this system will be simple and clear, and we decrease the size of the image to load in time and increase performance.

Security vs. User interface and human factors: - The User Interface of the proposed system will be simple to understand, the user interface components are leading and action indicators. Thus, the users of the proposed system can easily perform the tasks that they intended to do. Every component of the user interface is arranged based on understanding our users in terms of their goals, skills, preferences, and tendencies. The proposed system's user interface can be easily operated by a user and they will not affect the security of the system.

5.2. Proposed System Architecture

The System Architecture Consists of basically three layers that are, the Presentation Layer, Application Processing Layer, and the Data Management layer.

i. Presentation Layer

This layer is concerned with presenting the results of a computation to system users and with collecting user inputs. In this layer, the users view the user interface according to the provided user role, the results of a computation related to attendance, and input the requested data. Moreover, the authorized user captures the frames and using a web app can upload the file to the server.

ii. Application Processing Layer

This layer is concerned with providing application-specific functionality. This is the layer where processing such as attendance computation, face detection, preprocessing image, and face recognition is performed. MTCNN, VGG 16 model, and different python machine learning (deep learning) related libraries are used for face detection, face recognition, and image preprocessing respectively.

ii. Data Management Layer

The Data Management Layer is a centralized database system which consists of students' dataset, users' information and students' attendance. The students' face images are stored in the database

after the face detection and preprocessing image. These stored images are henceforth used for training the face recognition algorithm. After successful recognition of the face, attendance is updated to the database.

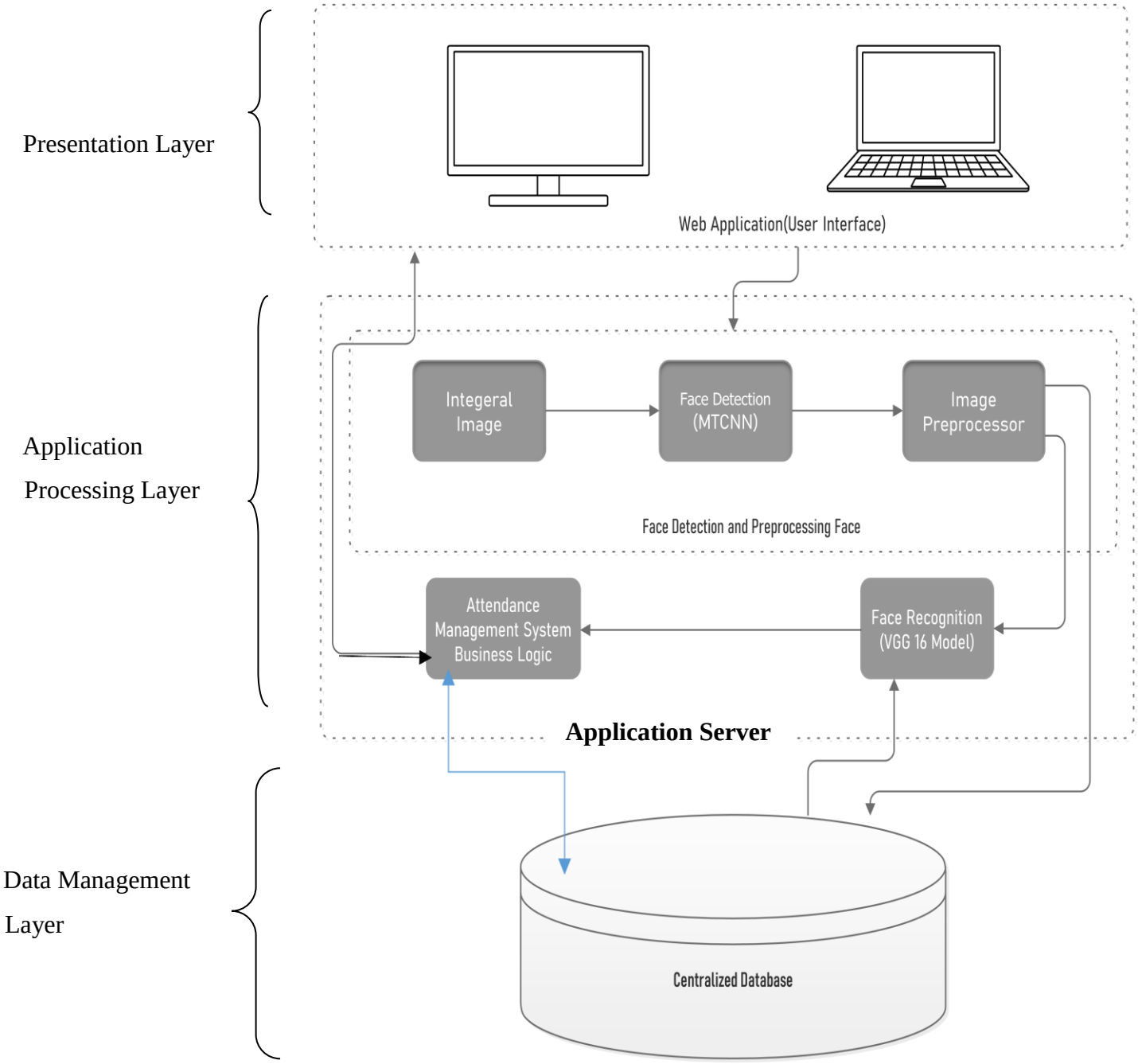


Figure 5.2. Proposed System Architecture

5.2.1. Subsystem Decomposition and Description

Subsystem decomposition is the process of dividing the facial recognition-based attendance system into manageable subsystems from the analysis model of the system. Our goal in the subsystem decomposition is to reduce the complexity of the design model of a facial recognition-based attendance system and to distribute the class of the system into large-scale and cohesive components. The different components of our system are likely to interact while the system is in operation to provide the expected services. In our system the following subsystems are available.

- **System Administration Subsystem**
  - Manage colleges
  - Manage departments
  - Manage users
  - Role assignment
  - Update profile.
  - Initialize the system.
- **Department Administration Subsystem**
  - Manage courses
  - Register students for the specific courses.
  - Manage instructor's Assignment.
  - Set up the attendance rule.
  - Set up the schedule.
  - Update profile
- **Instructor Subsystem**
  - Configure attendance settings.
  - Initiate the attendance tracking.
  - Cease the attendance tracking.
  - Update profile.
- **Student Subsystem**
  - Update profile.
  - View the attendance status.
- **Face Recognition Subsystem**
  - Face Detection

- Preprocess Image
- Train model
- Face Identification

❖ **Attendance Subsystem**

- Take Attendance
- Attendance Report
- View Attendance Report
- Handle Special Case Attendance

❖ **Manage Image Subsystem**

- Start camera
- Cease camera
- Capture image
- Upload image

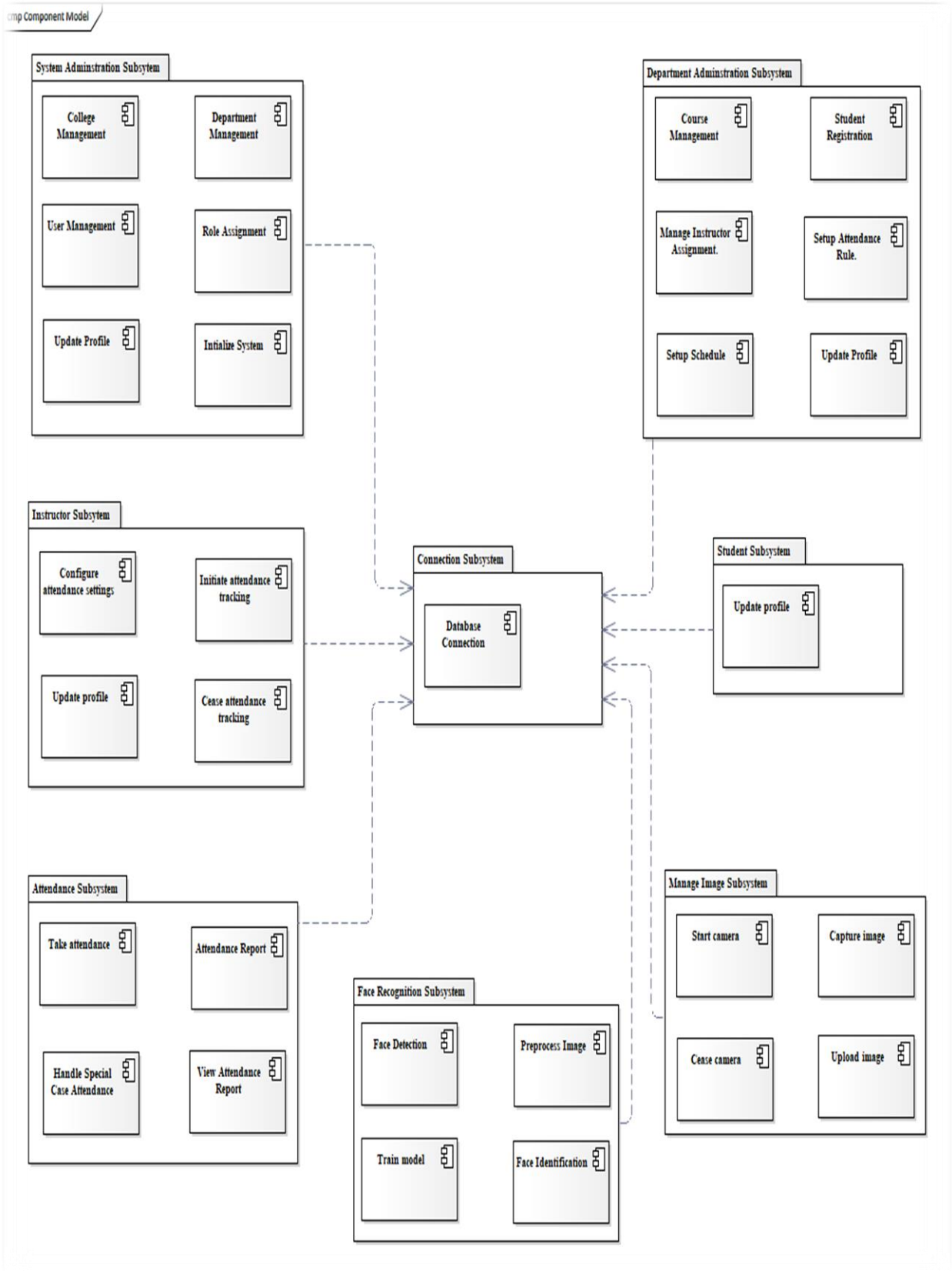


Figure 5.2.1. Component Diagram for Facial Recognition based Attendance System

5.2.2. Hardware/Software Mapping

The hardware/software map shows how the face recognition-based attendance system and the hardware components are work together. Their interaction can be shown by using a deployment diagram which shows a static view of the run-time configuration of processing nodes and the components that run on those nodes.

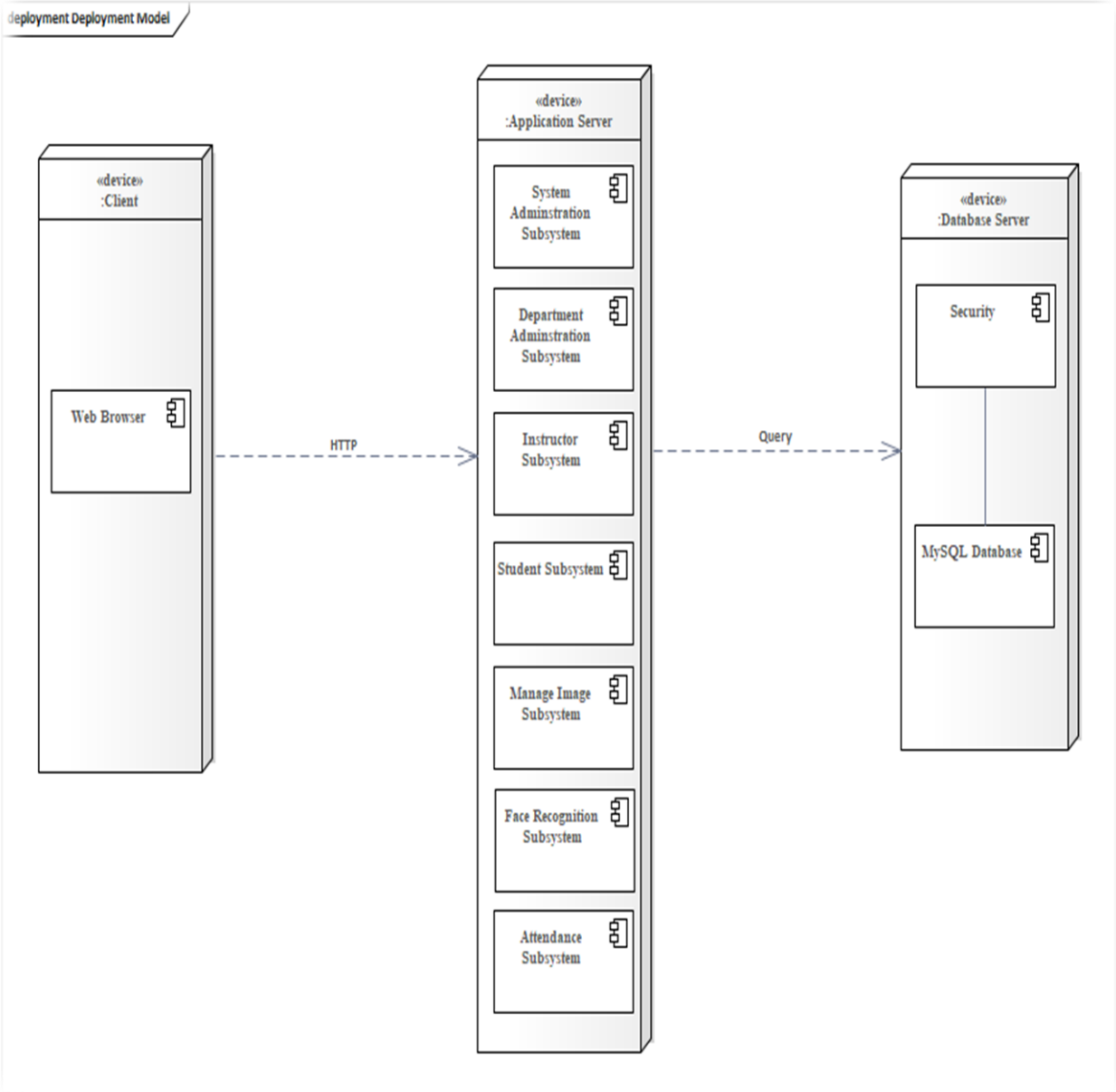


Figure 5.2.2. Facial Recognition Based Attendance System Deployment Diagram

5.2.3. Detailed Class Diagram

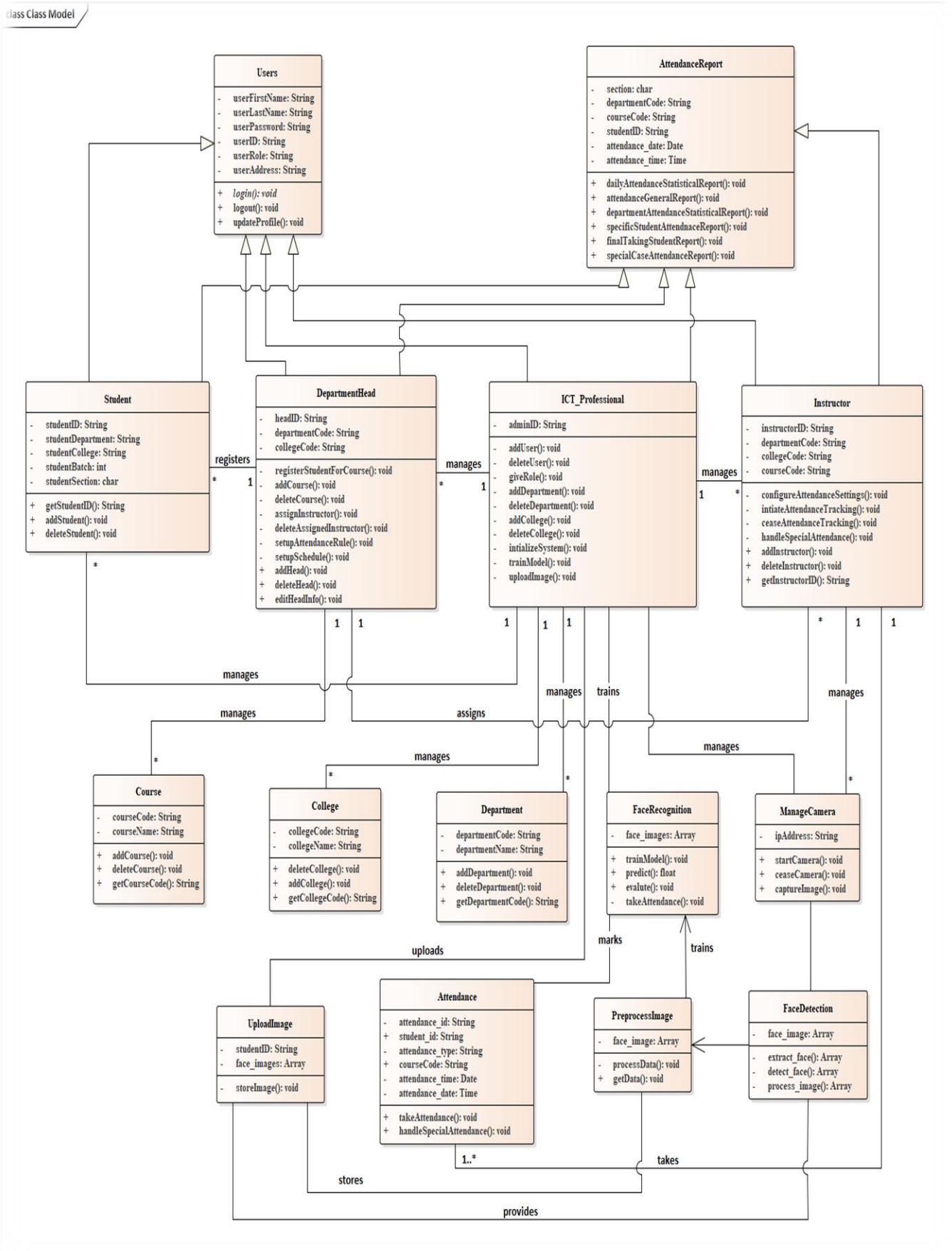
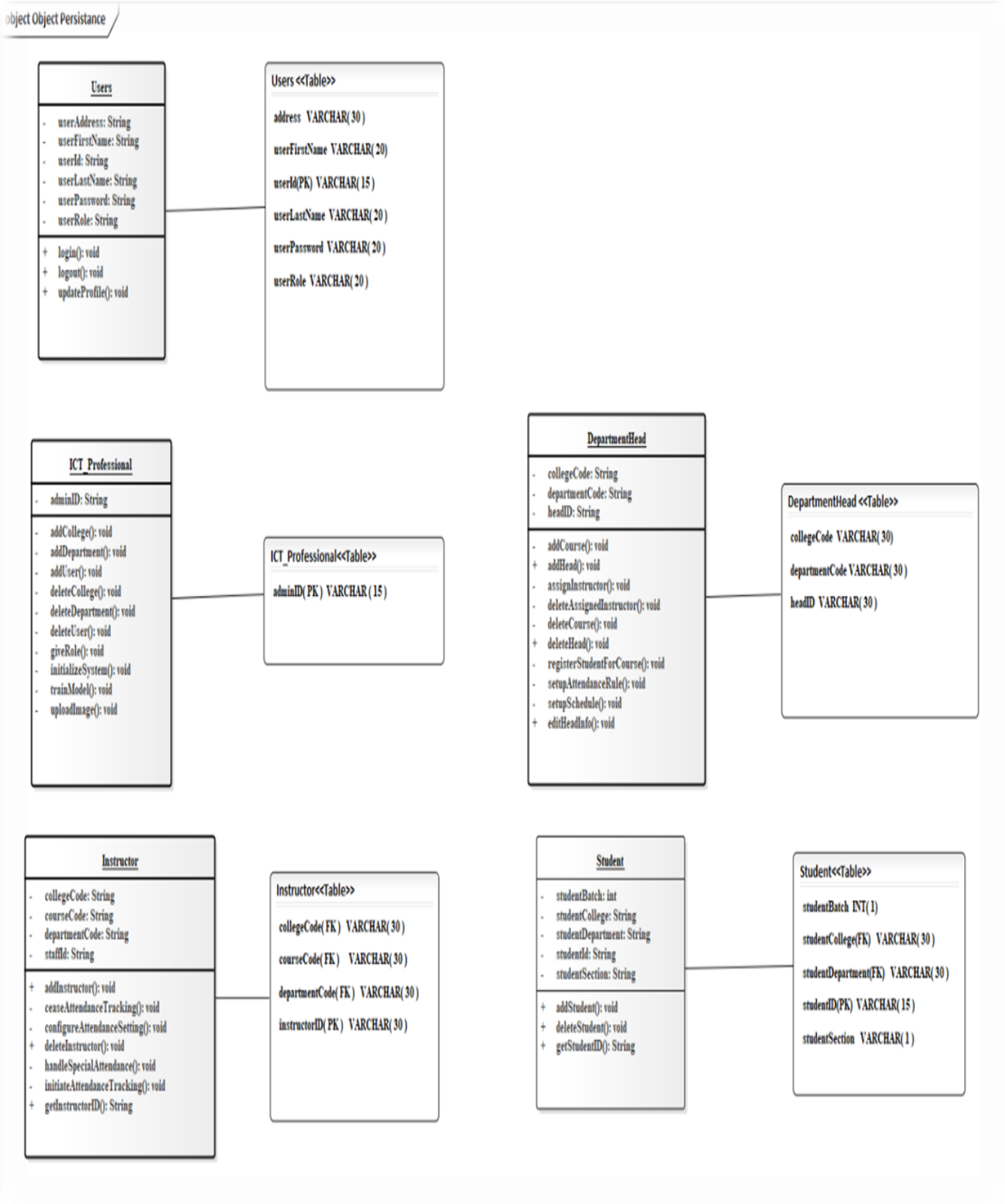


Figure 5.2.3. Detailed Class Diagram for Facial Recognition based Attendance System

5.2.4. Persistent Data Management



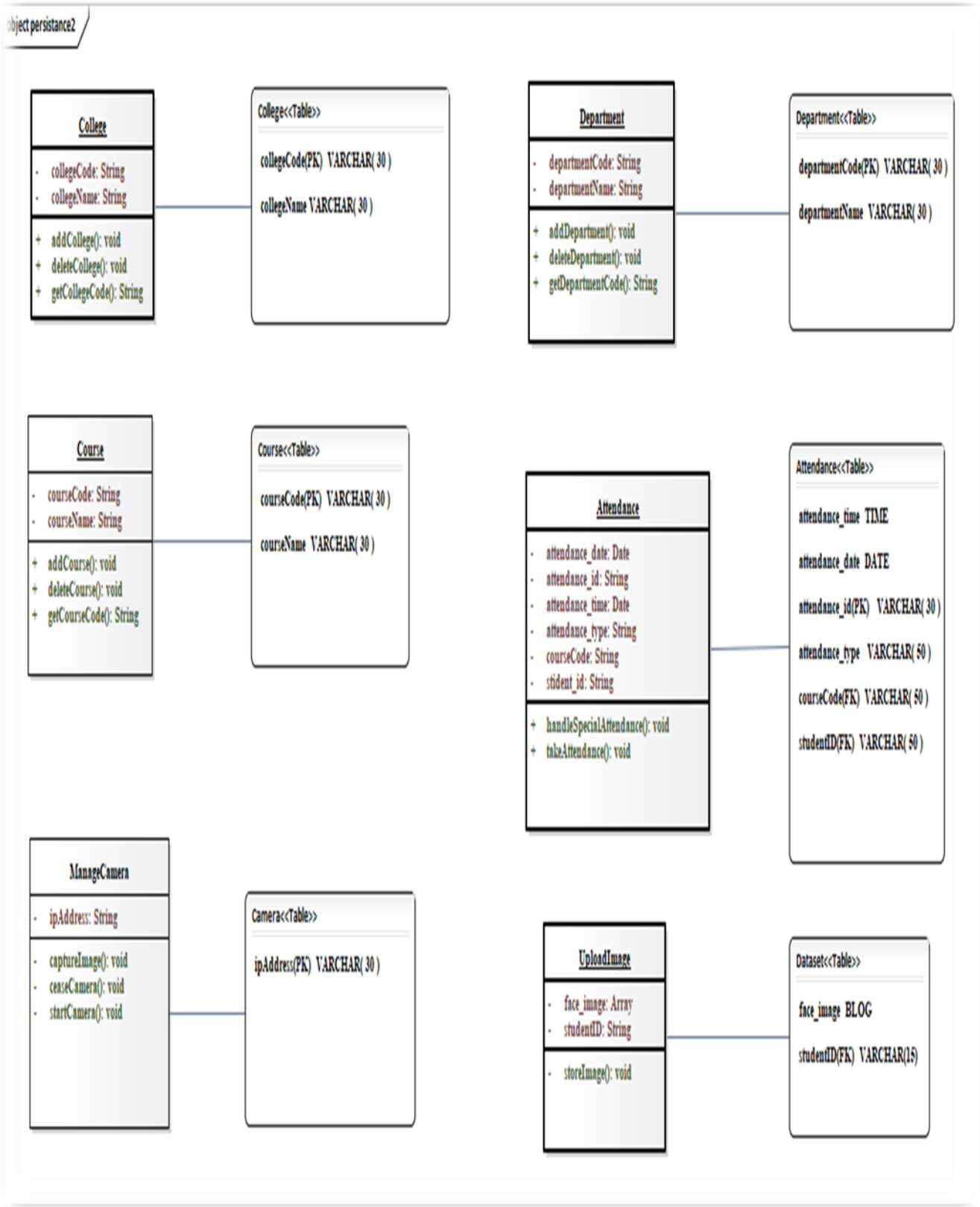


Figure 5.2.4. Persistent Data Management for Facial Recognition Based Attendance System

5.2.5. Access Control and Security

The proposed system will be implemented using the Django framework. As a result, it has no critical security-related problems since Django provides different kinds of APIs in order to eliminate the security problems that face web applications. Moreover, the proposed system verifies the users by their username and password to check whether they are authorized or not.

Table 5.2.5. Access control

Actors	**Operations**								
	Manage User Account	Assign Instructor	Manage Course	Manage Attendance	Manage Camera	Manage Department	Manage College	Train Model	Upload Image
System Admin	CRUD	--R--	--R--	--R--	CRUD	CRUD	CRUD	CR-D	CR-D
Head	--RU-	CRUD	CRUD	--R--	----	--R--	--R--	----	----
Instructor	--RU-	--R--	--R--	CRUD	CRUD	--R--	--R--	----	----
Student	--RU-	--R--	--R--	--R--	----	--R--	--R--	----	----

5.3. Packages

Package diagrams of Facial recognition-based Attendance System reflect the organization of packages and their elements and provide a visualization of their corresponding namespaces. The following figure represents the general package diagram of the Facial recognition-based Attendance System.

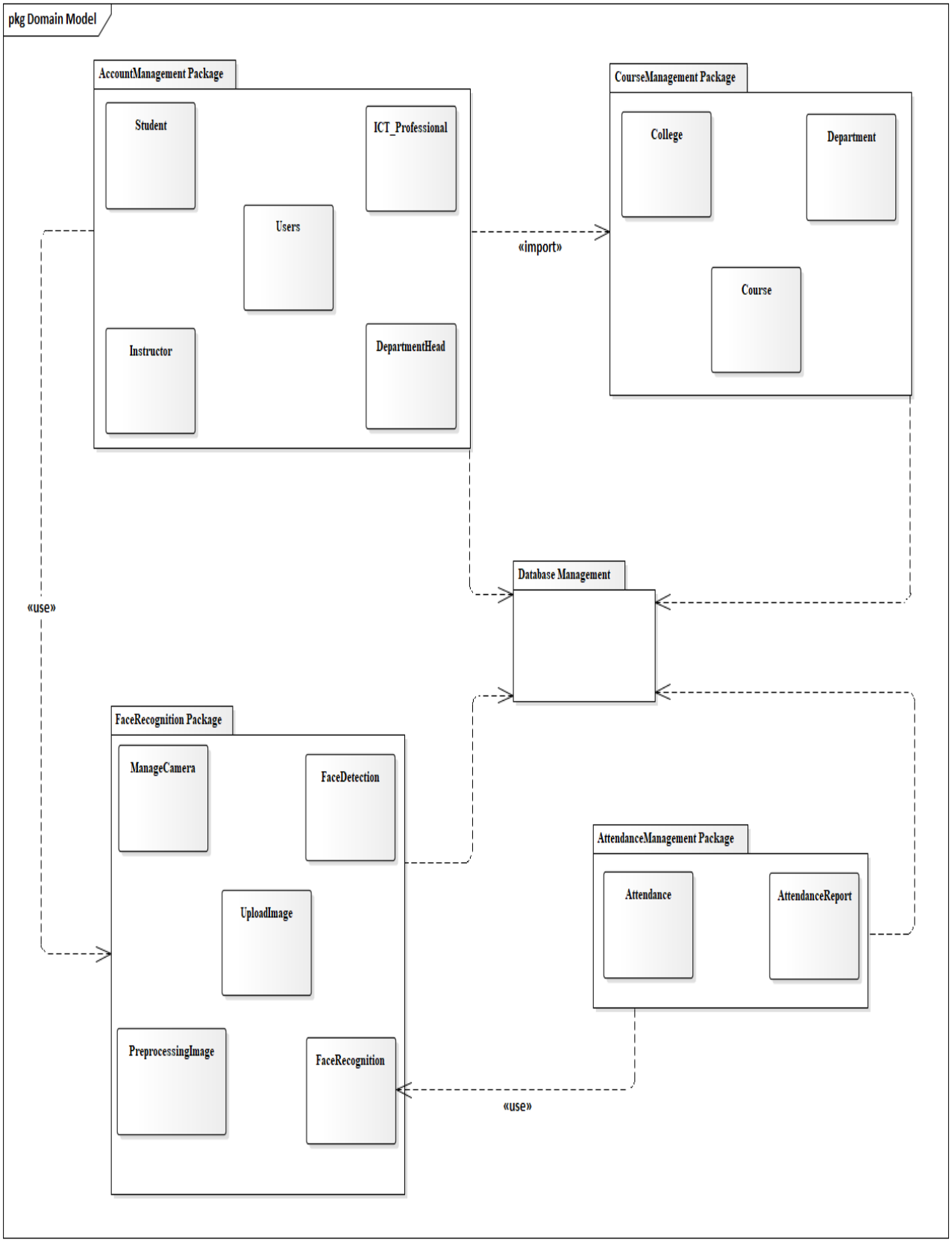


Figure 5.3. Package Diagram for Facial Recognition Based Attendance System

5.4. Algorithm Design

❖ **Login**:

- Home page displayed
- User clicks the login link
- System display login page
- A user enters a username, password, and select user role
- **If the** username and password are correct, **then**
- If the user role is an administrator, **then** the system displays the admin page
- **Else if** the user role is department Head, **then** the system displays the department Head page
- **Else if** the user role is Instructor, **then** the system displays the Instructor page
- **Else if** the user role is Student, **then** the system displays the Student page
- **Else** username and password are incorrect, **then** the system displays an error message and redirects to the login page.

❖ **Create User Account:**

- System Admin Home page displayed.
- System Admin clicks on to create an account link.
- The System displays the account creation page.
- System Admin fulfills information about the user and adds a role for he/her.
- If the entered information is correct, then the system displays a successful message.
- Else user information is not correct, and then the system displays an error message.

5.5. User Interface Design

With the focus on maximizing the user experience, we have designed the user interface diagram. We put some user interface simulations for our facial recognition-based attendance system. We design the user interface of our system to make the user's interaction as simple and efficient as possible. The following are some user interfaces of our system.



Figure 5.5.1. Admin Homepage for Facial Recognition based Attendance System



Figure 5.5.2. Admin Homepage for Facial Recognition based Attendance System

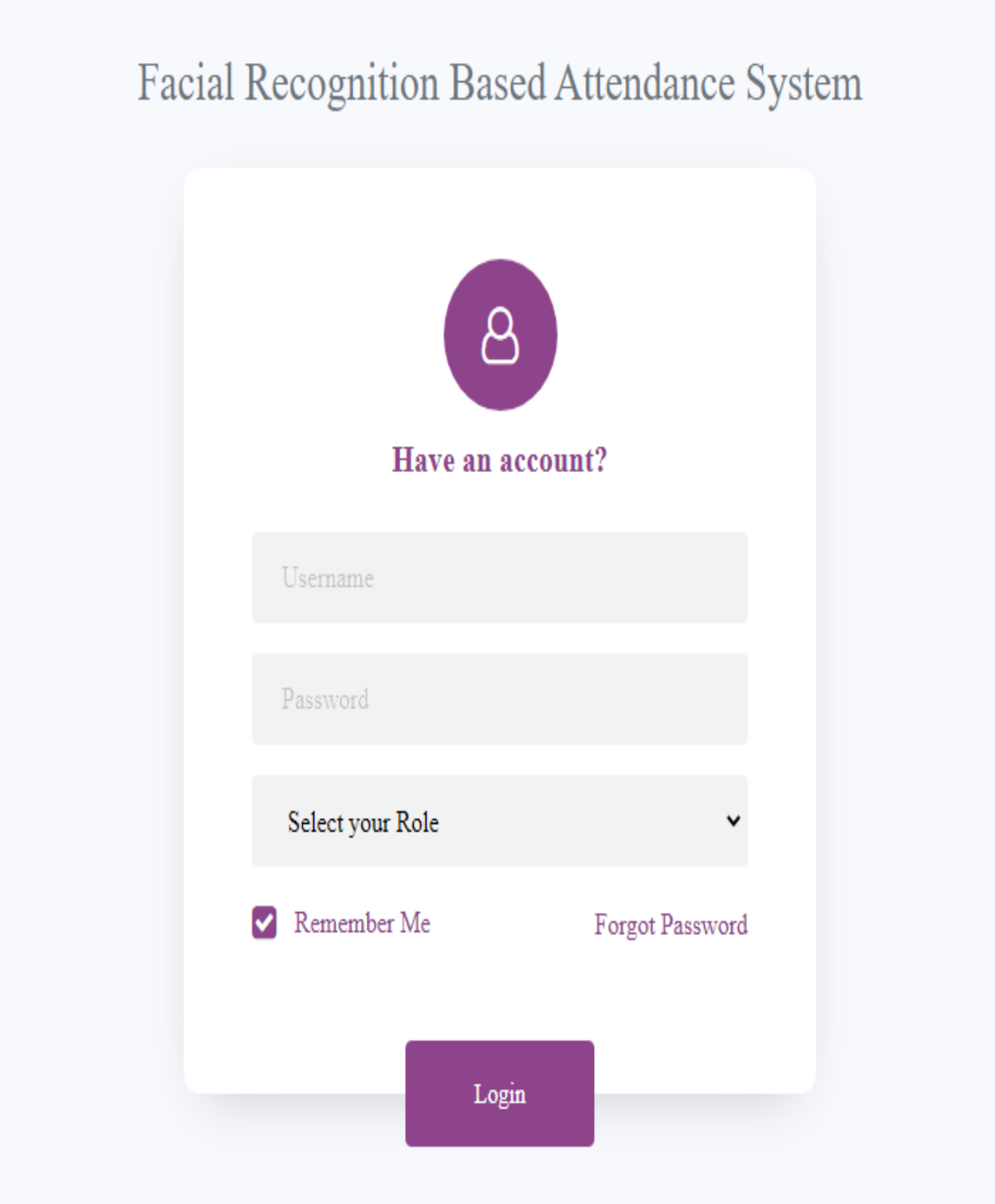


Figure 5.5.3. Login Page for Facial Recognition based Attendance System

REFERENCES

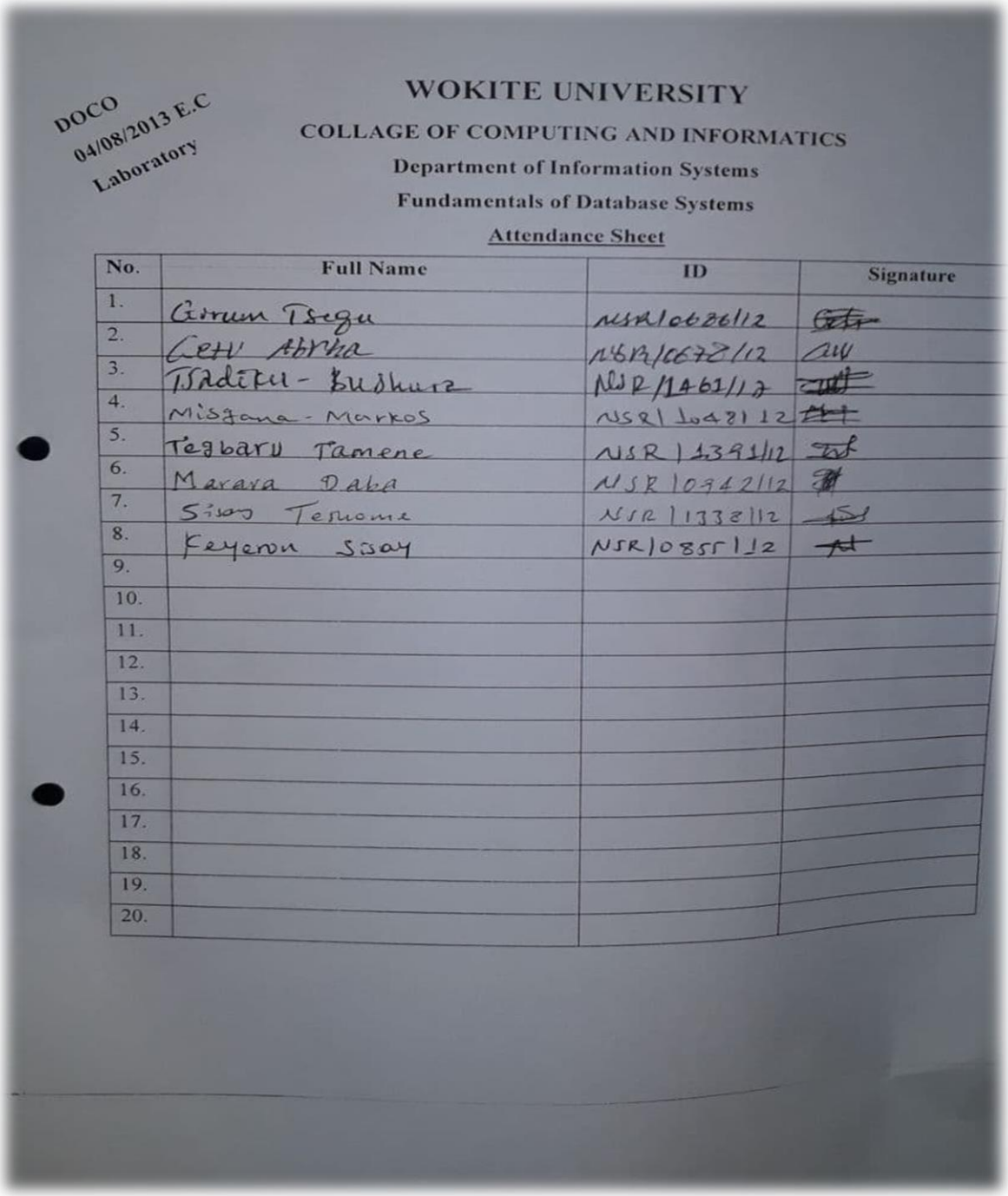
[1] PYPI, "mtcnn . PyPI," 14 Nov 2019. [Online]. Available: https://pypi.org/project/mtcnn/. [Accessed 22 4 2021].

[2] A. P. Castaño, "CodeProject," CodeProject, 31 Jul 2020. [Online]. Available: https://www.codeproject.com/Articles/5275259/Face-Detection-with-AI. [Accessed 5 26 2021].

[3] S. Srivastava, "Face Recognition Using Transfer Learning with VGG16," Medium, 23 Jun 2020. [Online]. Available: https://medium.com/@shikharsrivastava_14544/face-recognition-using-transfer-learning-with-vgg16-3caeca4a916e. [Accessed 28 4 2021].

APPENDIX

Appendix A. Forms used for Student Attendance.



DOCO
04/08/2013 E.C
Laboratory

WOKITE UNIVERSITY

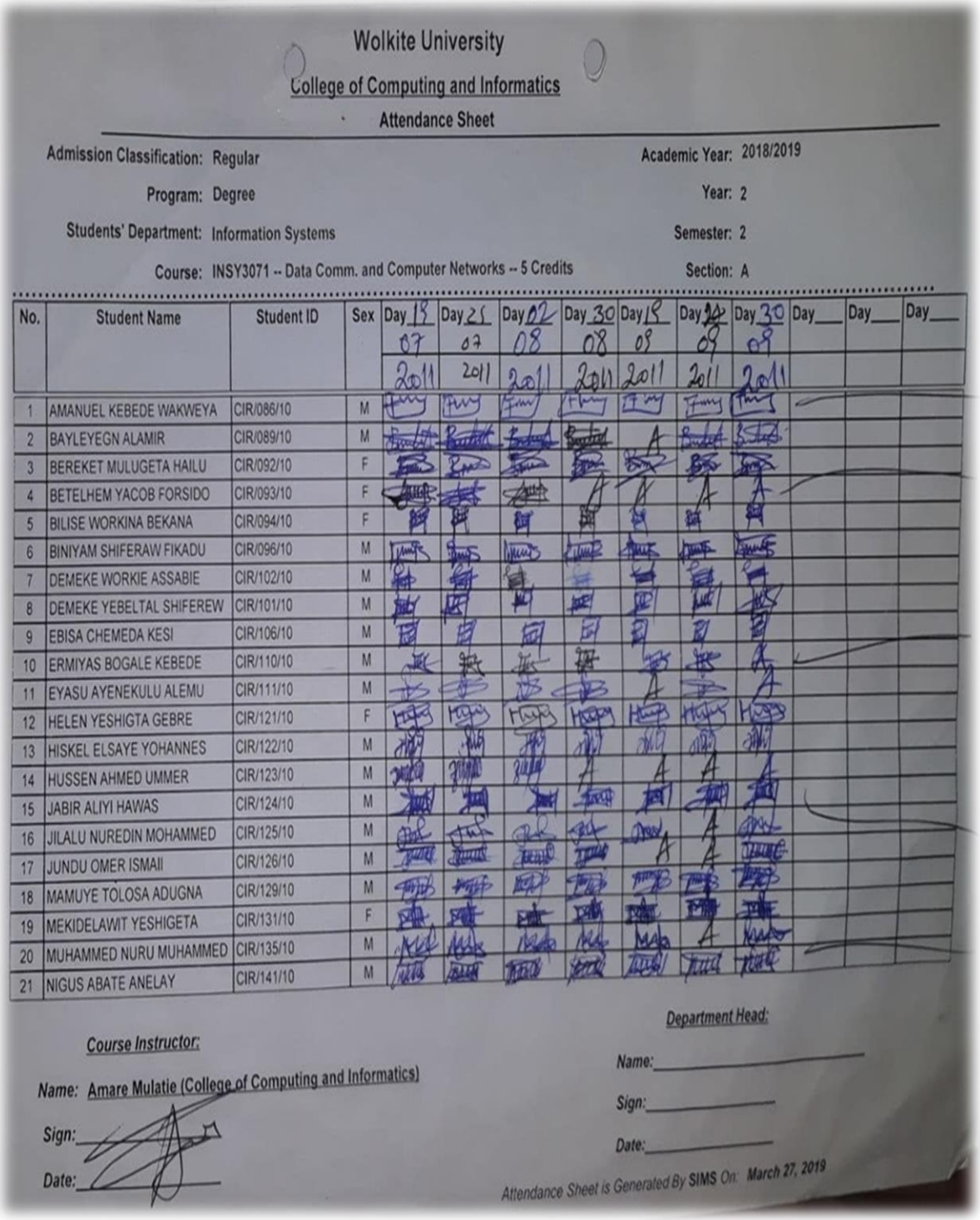
COLLAGE OF COMPUTING AND INFORMATICS

Department of Information Systems

Fundamentals of Database Systems

Attendance Sheet

No.	Full Name	ID	Signature
1.	Girum Tsegu	NSR/0626/12	
2.	Geti Abriha	NSR/0672/12	
3.	Tsadiku - Bushura	NSR/1461/12	
4.	Misgana - Markos	NSR/1048/12	
5.	Tegbaru Tamene	NSR/1391/12	
6.	Marara Daba	NSR/0942/12	
7.	Sisay Temoma	NSR/1338/12	
8.	Feyera Sisay	NSR/0855/12	
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Wolkite University

College of Computing and Informatics

Attendance Sheet

Admission Classification: Regular — Academic Year: 2018/2019

Program: Degree — Year: 2

Students' Department: Information Systems — Semester: 2

Course: INSY3071 -- Data Comm. and Computer Networks -- 5 Credits — Section: A

No.	Student Name	Student ID	Sex	Day 18 07 2011	Day 25 07 2011	Day 02 08 2011	Day 30 08 2011	Day 18 09 2011	Day 25 09 2011	Day 30 09 2011	Day___	Day___	Day___
1	AMANUEL KEBEDE WAKWEYA	CIR/086/10	M										
2	BAYLEYEGN ALAMIR	CIR/089/10	M					A					
3	BEREKET MULUGETA HAILU	CIR/092/10	F										
4	BETELHEM YACOB FORSIDO	CIR/093/10	F				A	A	A	A			
5	BILISE WORKINA BEKANA	CIR/094/10	F										
6	BINIYAM SHIFERAW FIKADU	CIR/096/10	M										
7	DEMEKE WORKIE ASSABIE	CIR/102/10	M										
8	DEMEKE YEBELTAL SHIFEREW	CIR/101/10	M										
9	EBISA CHEMEDA KESI	CIR/106/10	M										
10	ERMIYAS BOGALE KEBEDE	CIR/110/10	M										
11	EYASU AYENEKULU ALEMU	CIR/111/10	M					A		A			
12	HELEN YESHIGTA GEBRE	CIR/121/10	F										
13	HISKEL ELSAYE YOHANNES	CIR/122/10	M										
14	HUSSEN AHMED UMMER	CIR/123/10	M				A	A	A	A			
15	JABIR ALIYI HAWAS	CIR/124/10	M										
16	JILALU NUREDIN MOHAMMED	CIR/125/10	M						A	A			
17	JUNDU OMER ISMAIL	CIR/126/10	M					A	A				
18	MAMUYE TOLOSA ADUGNA	CIR/129/10	M										
19	MEKIDELAWIT YESHIGETA	CIR/131/10	F										
20	MUHAMMED NURU MUHAMMED	CIR/135/10	M						A				
21	NIGUS ABATE ANELAY	CIR/141/10	M										

Course Instructor:

Name: Amare Mulatie (College of Computing and Informatics)

Sign:

Date:

Department Head:

Name:

Sign:

Date:

Attendance Sheet is Generated By SIMS On: March 27, 2019

Department _____ Course _____ Year : IV Sec: B A

CIR/002/10	ABDULKERIM	MOHAMMED										
CIR/004/10	ABEBE	TARIKU										
CIR/007/10	ABINET	GETACHEW										
CIR/008/10	ADDISU	CHOLO										
CIR/009/10	AJAHIB	ABARAYA										
CIR/014/10	ASTER	DEJENE										
CIR/015/10	BAYE	AMANO										
CIR/022/10	BORU	TADICHA										
CIR/023/10	DANIEL	DAGNE										
CIR/024/10	DESALEGN	ENDIRU										
CIR/025/10	EDEN	MARE										
CIR/026/10	FAIZA	ASSEN										
CIR/029/10	GEBEYAW	FENTE										
CIR/030/10	GEMECHU	AMEYOU										
CIR/031/10	HABTAMU	AYALEW										
CIR/032/10	HABTAMU	GEMECHU										
CIR/035/10	HUNDE	FAYE										
CIR/037/10	KALEAB	TILAHUN										
CIR/038/10	KALEYESUS	ENDALE										
CIR/050/10	MOHAMMED	DEMISSIE										
CIR/051/10	MULU	BISRAT										
CIR/052/10	MUSTEFA	ALIYI										
CIR/404/11	NEJATO	ALIYE										
CIR/053/10	OBSA	BEKELE										
CIR/056/10	RIYAD	AMAN										
CIR/058/10	SEGN	AYNALEM										
CIR/059/10	SEMIRA	ZERIHUN										
CIR/061/10	SINTAYEHU	MITIKE										
CIR/063/10	TEMESGEN	BEDADA										
CIR/068/10	TOFIK	MOHAMMED										
CIR/070/10	WESILA	WABELA										
CIR/075/10	YENESEW	ASAYE										
CIR/076/10	YODESA	TAYE										
CIR/078/10	YONAS	WODAY										
CIR/079/10	YOSEF	DEMESEW										

Appendix B: Interview question for Instructors

Interview Questions And Answers We Have Examined

Interviewer: Instructors

1. What is your role in the existing system?
   - Attendance Management
   - Preparing Attendance form
2. What the existing system looks like?
   - I write the name, id, date, and batch column on the attendance form.
   - I should make an attendance report in every Friday.
   - A student should attend 85% in order to take the final exam.
3. To whom you send the report?

Head of Department

4. What are the bottlenecks of the existing student attendance system?
   - The recorded attendance sheets are exposed to be lost.
   - There is a searching problem in the existing system.
   - The existing system cannot control students regularly. As a result, students are not regularly attending the class.
   - The existing system is time-consuming since I analyze the presence of students manually
   - The existing system is exposed to a fake task. i.e. students can mark for their colleagues.
5. What are your expectations in order to fix the bottlenecks of the existing system?
   - Digitalizing the current system
   - Developing the system that can generate the attendance of the students weekly.
   - Developing a system that can control the marking attendance of other colleagues.
   - Developing the system that can decrease the workload of the instructors
   - Developing a system that can control the attendance of students efficiently.