Software Design Specifications

AttendanceEye

Version: [01.30]

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Document History

[Revision history will be maintained to keep track of changes done by anyone in the document.]

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1.0	Waleed Gul	26/11/23	*Document Created*
1.1	Waleed Gul, Mohsin Ali Mirza, Mehwish Sameer	26/11/23	*Diagrams are remaining, System Architecture also missing, References missing.*
			[Added Use Case x.x.xx]
1.2	Waleed Gul, Mohsin, Mehwish	5/12/23	Appendices missing
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Sir Waqas	*Supervisor*
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Definition of Terms, Acronyms and Abbreviations

[This section should provide the definitions of all terms, acronyms, and abbreviations required to interpret the terms used in the document properly.]

Term	Description
ASP	Active Server Pages
DD	Design Specification

Table of Contents

1 Introduction

1.1 Purpose of Document

The purpose of this document is to provide a detailed description of the design and implementation of the AttendanceEye system, a computer vision-based attendance tracking system. This document is intended for software engineers, system architects, and project stakeholders involved in the development and implementation of the AttendanceEye system. The design methodology is structural.

1.2 Intended Audience

This document is intended for stakeholders and professionals involved in organizational management, human resources, and technology implementation. It is designed to provide insights into the strategic significance of AI-driven attendance automation and its potential impact on employee management practices. Readers include executives, HR personnel, and technology enthusiasts seeking a deeper understanding of cutting-edge solutions in attendance tracking.

1.3 Document Convention

This document adheres to the following conventions:

- Font: Arial

- Font Size: 10 and 12

- Italic

1.4 Project Overview

This document serves as a comprehensive guide outlining the transformative approach of Computer Vision-driven attendance automation, integrating artificial intelligence (AI) and camera-based technology. It aims to elucidate the mechanisms, benefits, and implications of this innovative solution for workforce management, offering a detailed exploration of its advantages over traditional attendance tracking methods.

1.5 Scope

The project will focus on developing a fully automated attendance marking system that utilizes computer vision technology to identify and verify individuals. The system will be designed to work specifically with frontal or near-frontal views of faces.

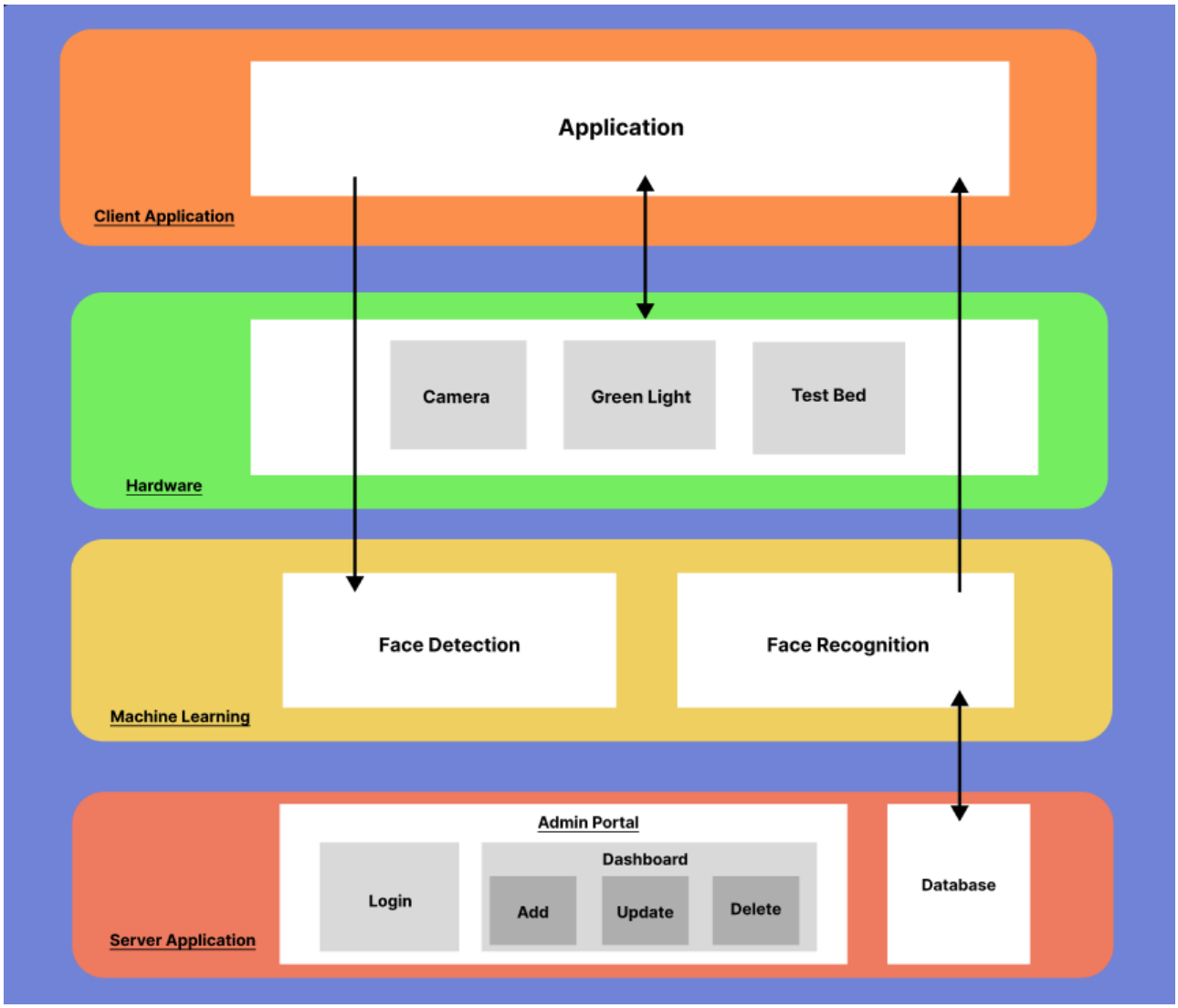
Limited to ideal lighting conditions: The system is designed to work best under ideal lighting conditions. However, it may still be able to function in less than ideal conditions, such as low-light environments.

Strict face visibility: The system requires a clear and unobstructed view of the face in order to accurately identify and verify individuals.

Liveness detection: The system does not include real-time attendance tracking capabilities. Additionally, the system will not offer liveness detection mechanisms to verify that the presented face is from a living person.

Exclusion of caps: The system will not be able to accurately identify individuals who are wearing caps or other headwear that obscures their facial features.

Profile view requirement: The system is designed to work with frontal or near-frontal views of faces.



This block diagram presents the whole structure of our attendance system. The first step is to capture the user's image using a camera on the test bed ***[hardware component]****. The second step is for the face detection system to process the image and identify any faces in it.The third step is for the system to recognize the face* ***[Machine learning component].*** *This involves comparing the face to a database of registered faces. If the system finds a match, it will output the name of the person on the client application side****[client application]*** *plus green light on the test bed* ***[hardware component].****The server application is used to enter new registered users , delete or update users on the database.****[server application]****.*

2 Design Considerations

2.1 Assumptions and Dependencies

Assumptions

- *Facial Recognition Accuracy: The system assumes that the facial recognition algorithm will be able to accurately identify individuals with a high degree of confidence.*
- *Employee Cooperation: The system assumes that employees will be cooperative and will follow the instructions for using the system.*
- *Image Quality: The system assumes that the camera will capture clear and unobstructed images of individuals' faces.*
- *Lighting Conditions: The system assumes that the system will be used in a well-lit environment.*
- *Hardware Compatibility: The system assumes that the camera, Arduino/Raspberry Pi, LED lights, and computing hardware are compatible with the system software.*
- *Network Connectivity: The system assumes that the system will have reliable network connectivity to access the company's HR system.*

Dependencies

- *Company's HR System: The system is dependent on the company's HR system to store and manage attendance records*
- *Computing Hardware: The system is dependent on sufficient computing power to run the facial recognition algorithm and process the camera images*

2.2 Risks and Volatile Areas

Requirements

- *Changes in company policies or regulations related to attendance tracking may necessitate modifications to the system.*
- *Fluctuations in the number of employees or visitors could require adjustments to the system's capacity.*

Technology

- *Advancements in facial recognition technology could lead to the integration of more sophisticated algorithms for improved accuracy and efficiency.*
- *The development of new hardware, such as higher-resolution cameras or faster processors, could enhance the system's performance.*

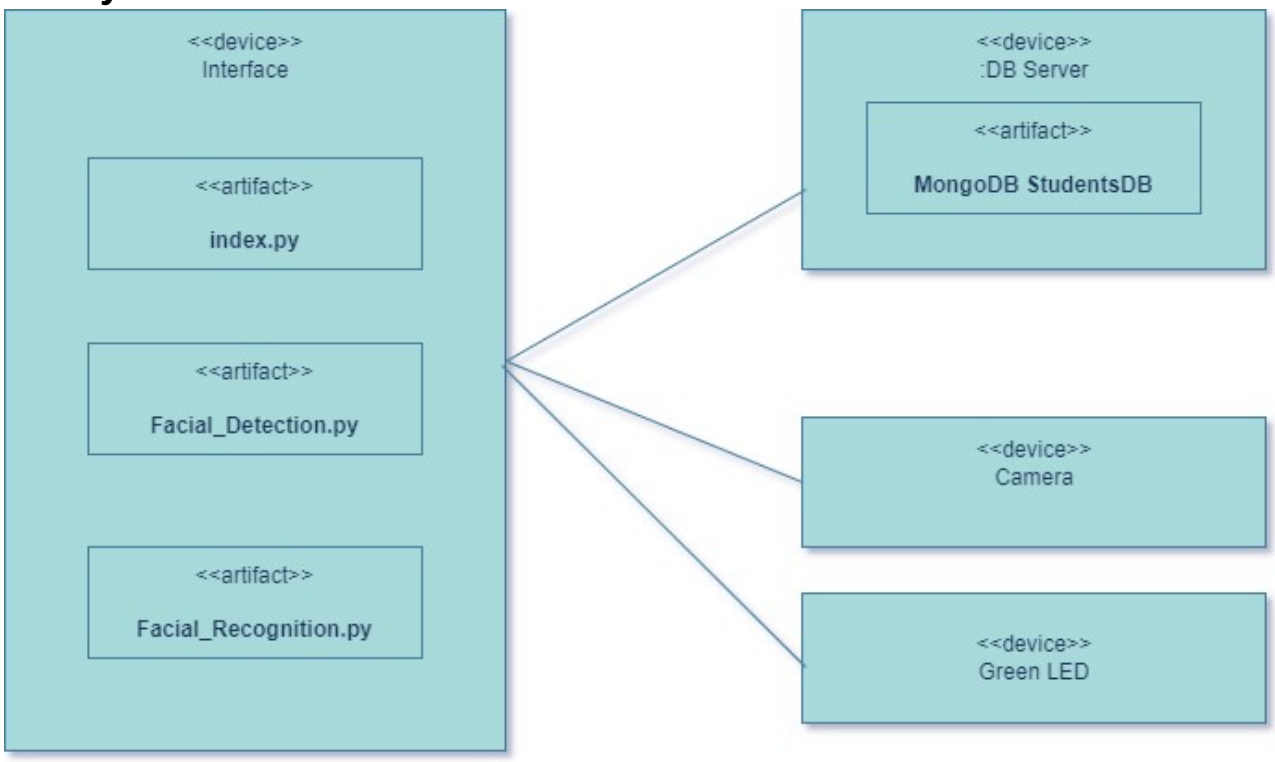
- *Changes in software frameworks or programming languages may require updates to the system's codebase.*

Other Risks

- *Cybersecurity threats, such as data breaches or unauthorized access, could compromise the integrity of attendance records.*
- *Privacy concerns surrounding the collection and storage of facial data may necessitate additional security measures.*
- *Environmental factors, such as varying lighting conditions or extreme temperatures, could affect the system's ability to accurately recognize faces.*

3 System Architecture

3.1 System Level Architecture



3.2 Software Architecture

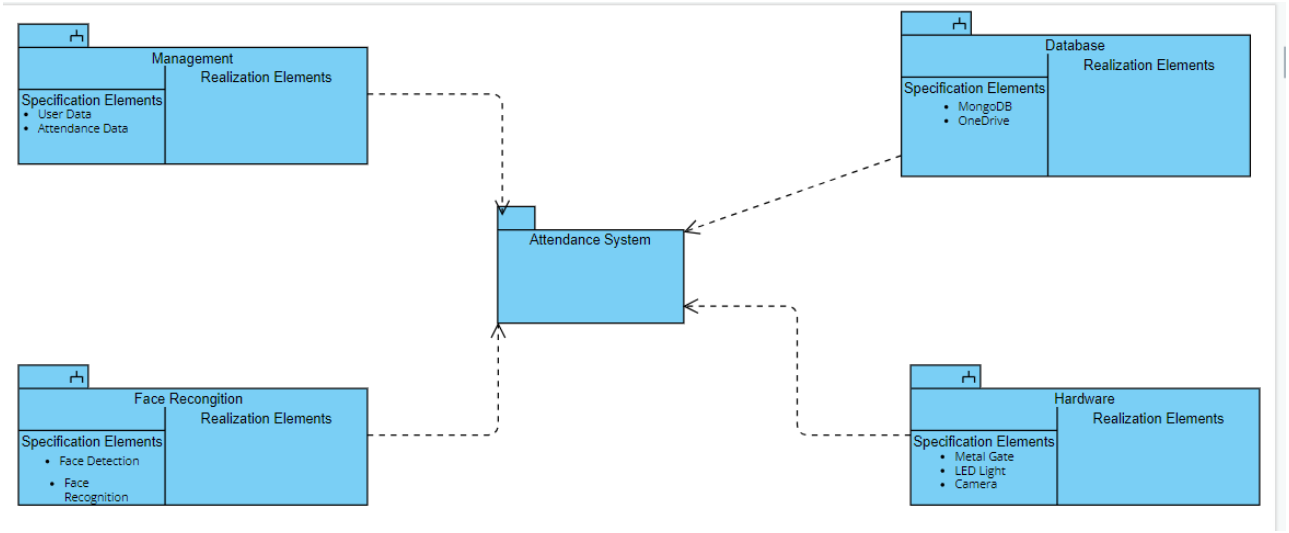
3. System Architecture

<u>System Level Architecture</u>

The Camera-Based Attendance System is architecturally designed to encompass three main layers: the User Interface Layer, the Middle Tier, and the Data Access Layer. These layers work in concert to facilitate seamless interaction, data processing, and storage within the system.

UML Diagrams

<u>Component Diagram:</u>
The main system component is the attendance system which uses a database all the time. Moreover it uses hardware wherever required. The user data and attendance data is managed all the time. Whenever we use a face recognition system we need the hardware as well.



These UML diagrams will provide a visual representation of the system's architecture, aiding in a better understanding of the relationships and responsibilities of different components.

4 Design Strategy

Modular Design for Flexibility and Extensibility

To facilitate future system extension or enhancement, the AttendanceEye system will employ a modular design approach. This involves dividing the system into independent, cohesive components with well-defined interfaces. Each module will encapsulate a specific function or responsibility, such as image capture, facial recognition, and attendance recording. This modularity provides several advantages:

Independent Development and Testing: Modules can be developed and tested independently, reducing development time and improving overall system reliability.

Ease of Integration: New modules or functionalities can be seamlessly integrated into the system without disrupting existing components.

Maintenance and Enhancement: Modifications or updates to specific modules can be implemented without affecting the rest of the system.

2. ***Reusable Components:***
- To promote system reuse, components such as the face recognition algorithm, data access layer, and user interface modules are designed to be reusable. This not only enhances maintainability but also allows for the potential reuse of these components in other projects or modules within the organization.

User Interface Design for Simplicity and Usability

The user interface (UI) will be designed with simplicity and usability in mind, adhering to the following principles:

Minimalist Design: The UI will present only essential information and functionalities, minimizing cognitive load and reducing user error.

Intuitive Navigation: Users should be able to easily navigate through the system and find the desired actions without extensive training or documentation.

Data Management Strategy for Efficiency and Security

Data management will be a critical aspect of the AttendanceEye system, ensuring data integrity, security, and efficient retrieval. The following strategies will be employed:

Centralized Data Storage: Attendance records will be stored centrally in a secure, managed database, ensuring data consistency and accessibility.

Data Access Control: Access to sensitive attendance data will be restricted to authorized personnel, complying with privacy regulations.

4. ***Efficient Data Management:***
- The Data Access Layer incorporates efficient data management strategies. The use of a reliable database system (MongoDB or Firebase) ensures secure storage and retrieval of employee images and attendance records. Data is organized in a structured manner to support quick queries and facilitate the real-time processing of attendance information.

Concurrency and Synchronization
-to be decided

Trade-offs

The system's design decisions were made with careful consideration of the trade-offs between performance, accuracy, and security. For example, the system uses a lightweight facial recognition algorithm that provides a balance between accuracy and processing speed.

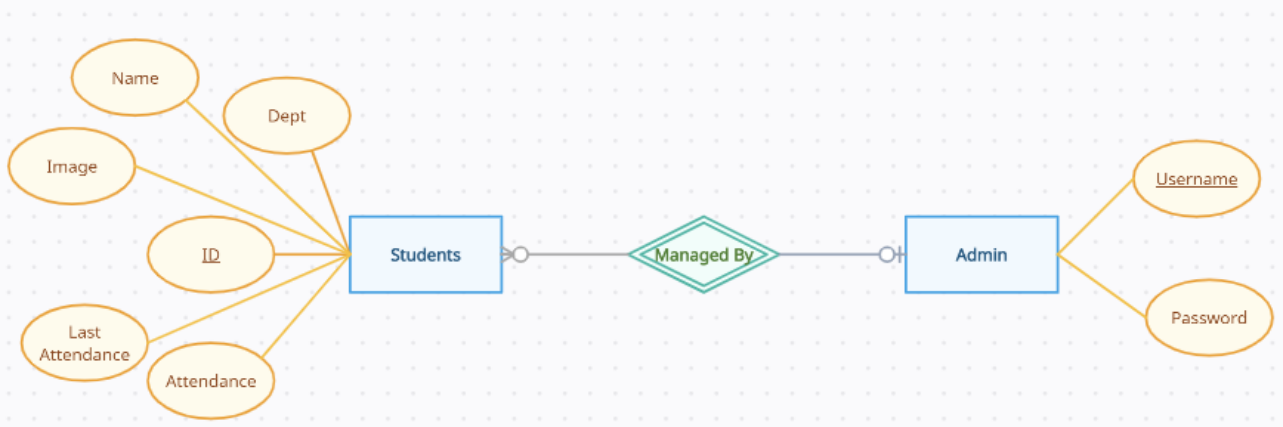
These design strategies collectively contribute to the creation of a reliable, extensible, and user-centric Camera-Based Attendance System, addressing the identified project goals and principles. Each decision is made with a balance between functionality, usability, and future scalability, ensuring that the system can adapt to evolving needs and technological advancements.

5 Detailed System Design

5.1 Database Design

5.1.1 ER Diagram

[Entity Relationship Diagram of the system with description]



There will be numerous students in the database who can be managed by one admin.

5.1.2 Data Dictionary

5.1.2.1 Data 1

Student						
Name	Student					
Alias	.					
Where-used/how-used	Used to store the students Information. It is managed by the Admin					
Content description	Student					
Column Name	**Description**	**Type**	**Length**	**Null able**	**Default Value**	**Key Type**
ID	*Unique ID of the student given*	*String*		*No*		*PK*

Name	*Name of the student*	*String*		*No*		
Dept	*The department the student belongs to [CS, SE, AI]*	*String*		*No*		
Attendance	*Attendance Count of the student*	*Int*		*Yes*	*0*	
Last Attendance	*Date of the last attendance marked*	*Date*		*Yes*		
Image	*Image of the student (URL PATH)*	*String*		*No*		

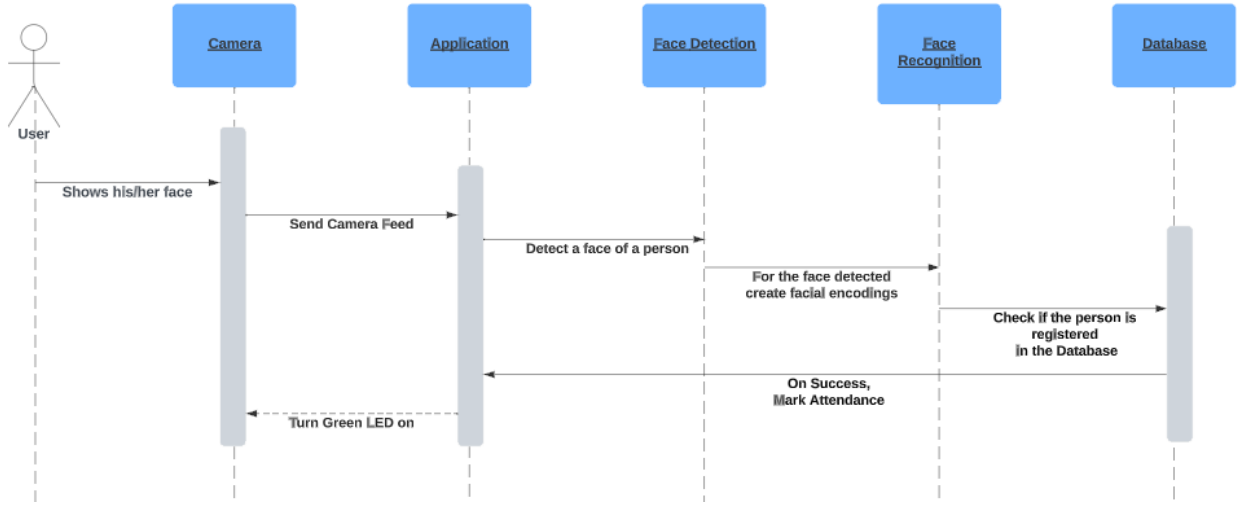
5.1.2.2 Data 2

Admin						
Name	Admin					
Alias	.					
Where-used/how-used	Used to manage the student's information and apply CRUD operations.					
Content description	Admin					
Column Name	**Description**	**Type**	**Length**	**Null able**	**Default Value**	**Key Type**
Username	*username of the admin*	*String*		*No*		*PK*
Password	*Password of the admin*	*String*		*No*		

5.2 Application Design

5.2.1 Sequence Diagram

5.2.1.1 Client Side



The diagram you sent is a flow diagram showing the steps of a facial recognition system. The system begins by capturing an image of the user. The image is then processed by a face detection algorithm to identify the presence of a face in the image. If a face is detected, the face recognition algorithm is used to compare the face to a database of known faces. If a match is found, the user is identified and granted access to the system. If no match is found, the user is denied access

5.2.1.2 Data Collection

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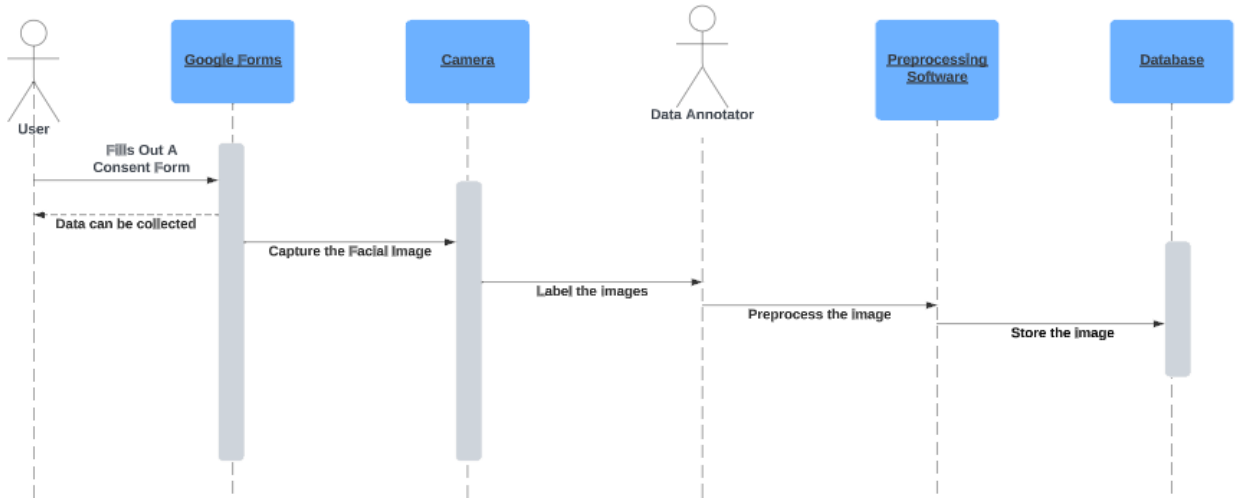

Consent Form: Fill out a Consent form by the volunteers to have their consent for taking their data.

Capture high-quality facial images: Collect well-lit and focused images of individuals' faces from various angles and expressions.

Preprocess facial images: Enhance the quality of the captured images by resizing, converting to grayscale, or removing noise to improve feature extraction accuracy.

Label facial images: Annotate the images with bounding boxes around each face, manually or using automated object detection algorithms.

Data Storage:Implement a secure and organized data storage system.

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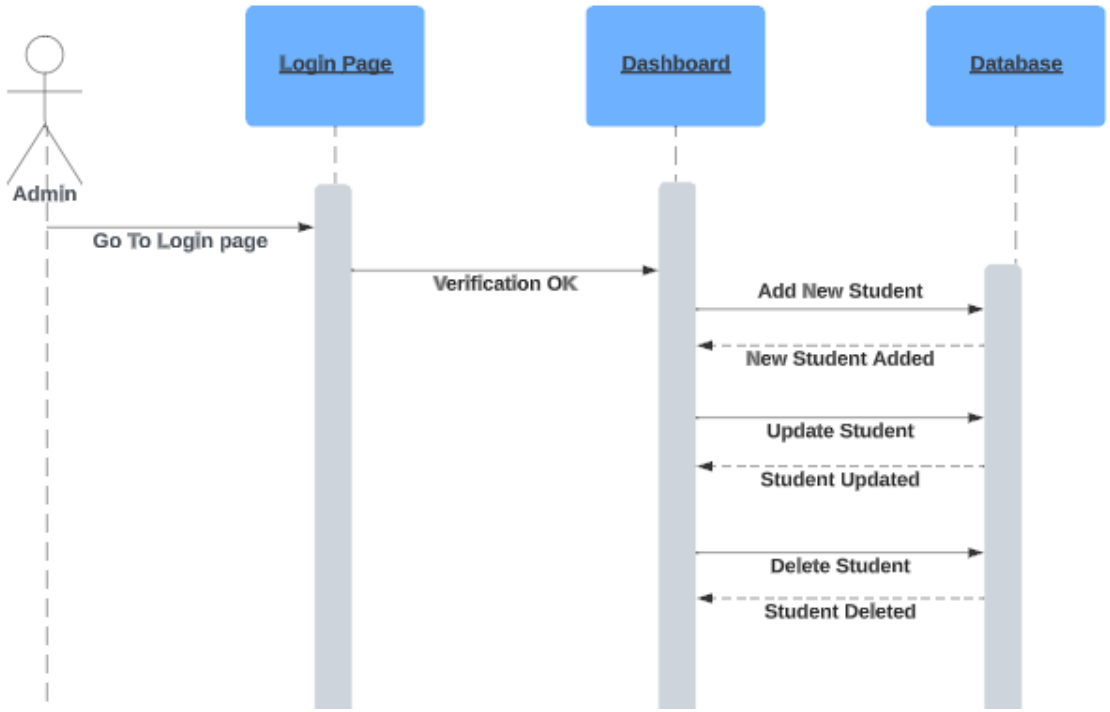
5.2.1.3 Admin Side

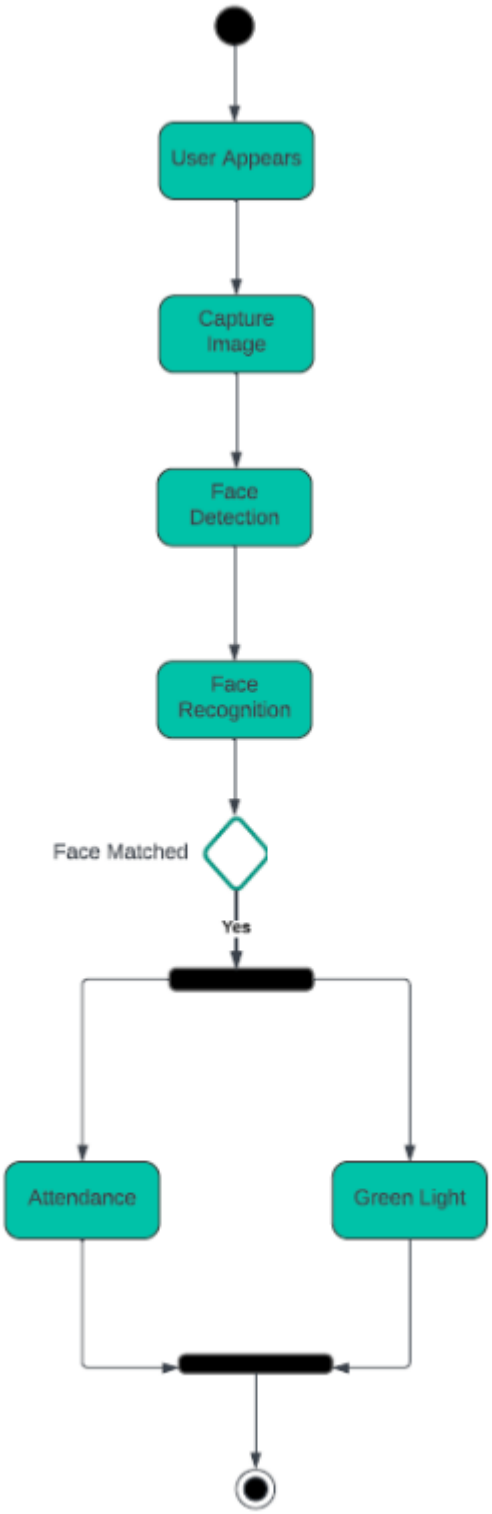


The admin logins to the main website of Attendance AI where the admin can either view the students profile on the dashboard or ADD/ UPDATE/ DELETE any Student's profile which will be reflected in the Database.

5.2.2 State Diagram

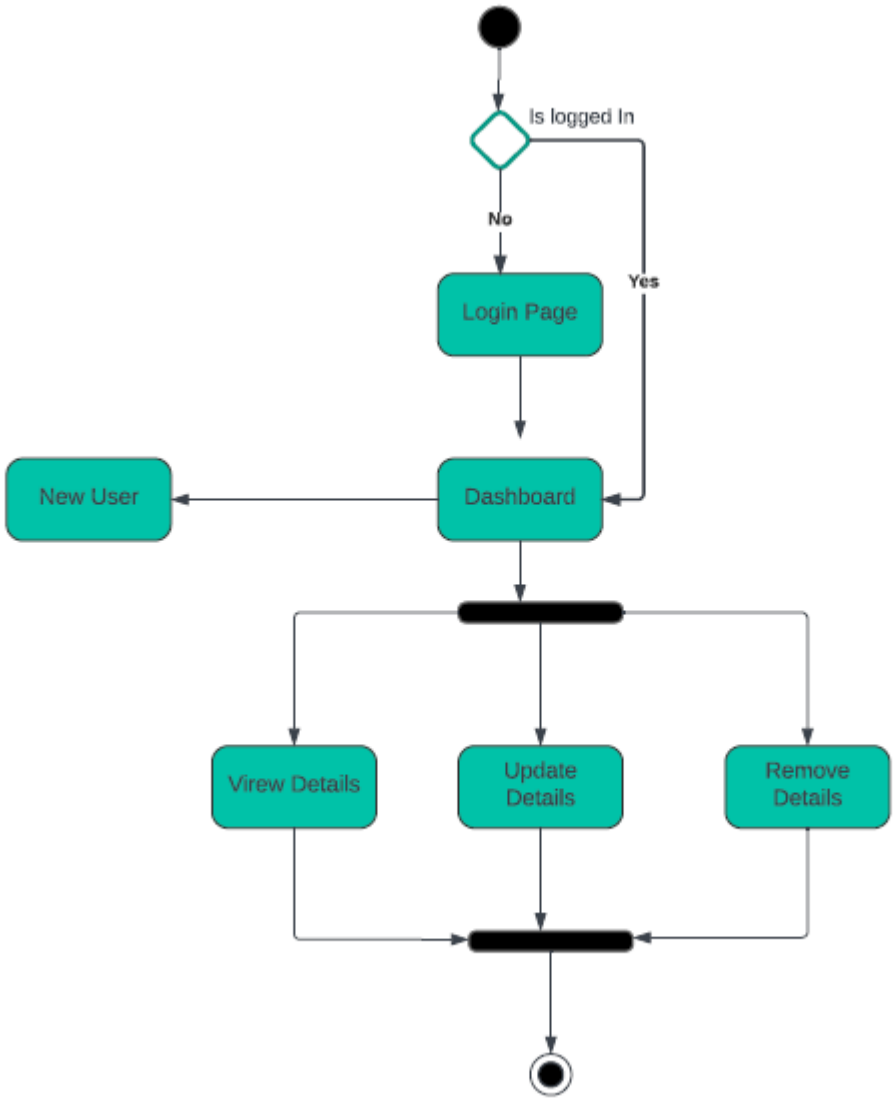
5.2.2.1 Face Recognition System

The diagram you sent is a flow diagram showing the steps of a facial recognition system. The system begins by capturing an image of the user. The image is then processed by a face detection algorithm to identify the presence of a face in the image. If a face is detected, the face recognition algorithm is used to compare the face to a database of known faces. If a match is found, the user is identified and granted access to the system. If no match is found, the user is denied access



5.2.2.2 Admin Portal

.The process begins with the user visiting the login page. The user then enters their username and password. The system then checks to see if the username and password are valid. If they are valid, the user is logged in and redirected to the dashboard. If the username and password are not valid, an error message is displayed and the user is given the opportunity to try again.



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5.2.2.3 Data Collection

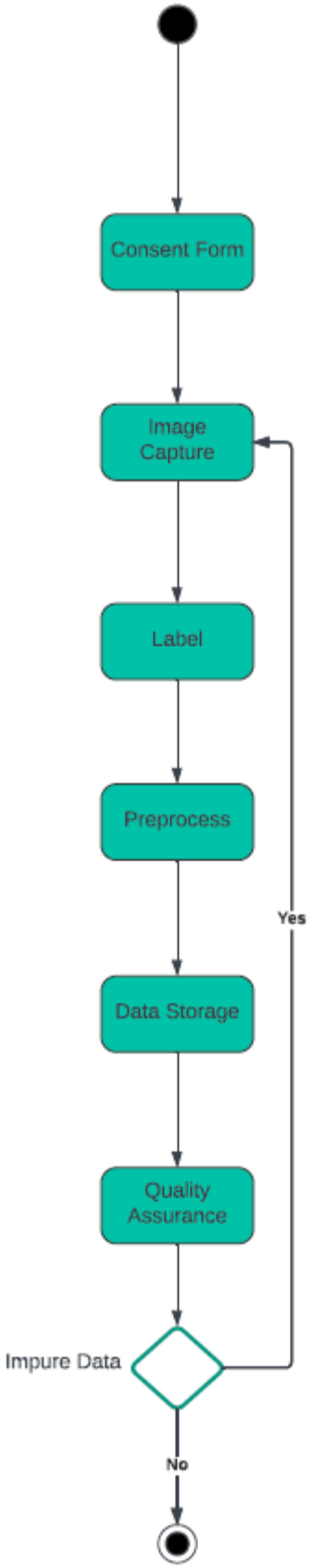
Capture high-quality facial images: Collect well-lit and focused images of individuals' faces from various angles and expressions.

Preprocess facial images: Enhance the quality of the captured images by resizing, converting to grayscale, or removing noise to improve feature extraction accuracy.

Label facial images: Annotate the images with bounding boxes around each face, manually or using automated object detection algorithms.

Data Storage:Implement a secure and organized data storage system.

Data Quality Assurance: Implement data quality control measures to ensure dataset integrity. if quality data is not collected repeat the whole process


Consent Form
Image Capture
Label
Preprocess
Data Storage
Quality Assurance
Impure Data
Yes
No

6. References

You may also provide the names of the people and their contact information that you have consulted.

List all the sources, books, papers, and websites you have consulted for your project.

IEEE Reference and Citation guideline

[1] Paul P. Oroceo,Jeong-In Kim,Ej M. Francisco, Sang-Ho Kim,Sang-Ho Kim,"Optimizing Face Recognition Inference with a Collaborative Edge–Cloud Network ",1 November 2022
[2] B.Ali Abdalkarim - "A Literature Review on Smart Attendance Systems"July 2022
[3] W.Chen, H.Huang, S.Peng, C.Zhou , C. Zhang,- "YOLO-face: a real-time face detector",March 2020
[4] S.Khan,A Akram,N. Usman, "Real Time Automatic Attendance System for Face Recognition",March 2020
[5] Dr. A. Babu Karuppiah, M. Jeyalakshmi, L. Johnsilin Shiny, B. Sri Devi,"Online Attendance System",2017

Appendices

Glossary:

AttendanceEye System: A computer vision-based attendance tracking system that utilizes facial recognition technology to identify and verify individuals.

User Interface Layer (UI): *The front-end of the system, providing a user-friendly interface for administrators to interact with the attendance system.*

Data Access Layer (DAL): *Responsible for interacting with the database to store and retrieve employee images and attendance records.*

Data Access Control: *Access to sensitive attendance data is restricted to authorized personnel.*

Lightweight Facial Recognition Algorithm*: Provides a balance between accuracy and processing speed.*

System Configuration

Cameras *: High-resolution cameras for capturing facial images.*

LED light: *Lights to illuminate the entry gates for optimal image capture.*

Computing Device : *Arduino or Raspberry Pi for running the face recognition algorithm.*

Network Connectivity:*High-speed LAN for real-time data transmission between cameras and device*

UML Diagrams

Package Diagram: *Illustrates the organization of major system components and their relationships.*

Component Diagram: *Showcases the main components within each layer and their interactions.*

Sequence Diagram: *Depicts the interactions between different components during the attendance marking process.*

State Transition Diagram: *Shows the possible states of the system and the transitions between them.*

Data Dictionary

Data Entity: *Student*

Data Description: *Represents a student enrolled in the system.*

Attributes:

ID: *Unique identifier for the student.*

Name*: Name of the student.*

Dept*: Department the student belongs to.*

***Attendance**: Attendance count for the student.*
***Last Attendance:** Date of the last attendance marked.*
***Image:** URL path to the student's image.*
Data Entity: Admin

***Data Description**: Represents an administrator with access to the system.*

Attributes:

***Username:** Username for logging into the system.*
***Password:** Password for logging into the system.*