Software Requirement Specifications

Attendance Eye

Version: [00.04]

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Document Sign-Off

[The following table will contain sign-off details of the document. Once the document is prepared and revised, this should be signed off by the sign-off authority.

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1. Introduction

1.1. Purpose of Document

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.

1.2. 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 Abbreviations

MERN stands for MongoDB, Express, React, Node

1.4 Document Convention

This document adheres to the following conventions:

- Font: Arial

- Font Size: 10 and 12

- Italic

2. Overall System Description

2.1. Project Background

The project aims to develop a face recognition attendance system that will enhance attendance accuracy, increase efficiency, automate image capture, perform biometric verification, establish a real-world test bed, offer user convenience, promote environmental sustainability, improve record keeping, and contribute to hygienic attendance solutions.

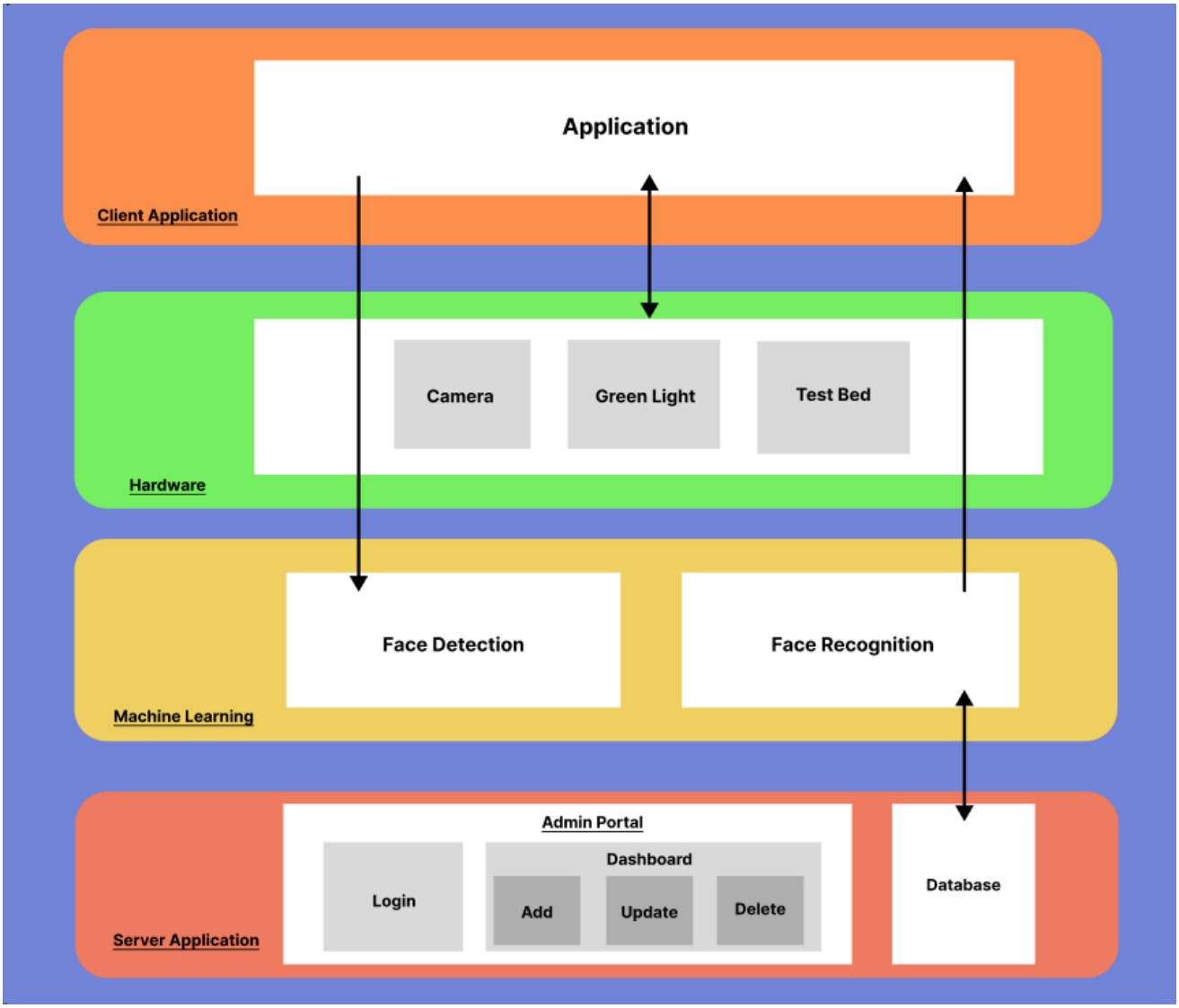
Traditional attendance recording methods, such as paper-based sign-in sheets or manual roll calls, are often plagued by inaccuracies, inefficiencies, and potential for human error. These manual methods can be time-consuming for both employees and administrators, leading to delays in work schedules and attendance data management. Additionally, manual attendance systems lack real-time data insights, making it challenging to monitor attendance patterns and identify potential issues promptly.

Moreover, traditional attendance methods, such as fingerprint scanning and eye scans, have faced hygiene and discomfort challenges, especially during the COVID-19 pandemic. To address these issues,we aim to develop a cost-effective facial recognition attendance system using Computer Vision technology. The system captures individuals' images and cross-references them with a database to ensure accuracy. Testing showed that the technology-driven system outperforms traditional methods.

Project 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.*



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]****.*

2.2. Not In Scope

- ***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.*

2.3. Project Objectives

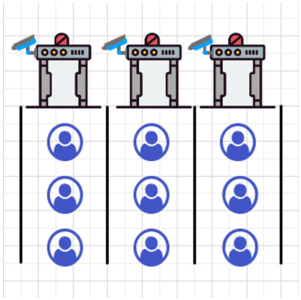
1. Enhance Attendance Accuracy: T*he primary objective is to improve the accuracy of attendance tracking by implementing a face recognition system. This will reduce the likelihood of errors and inaccuracies associated with manual methods (Human-error).*

2. Increase Efficiency: *Implement an efficient and automated attendance recording process that saves time for both attendees and administrators. This includes eliminating the need for manual data entry and paperwork.*

3. Automated Image Capture: *The system incorporates face detection capabilities through a camera at the entry gate, automatically capturing images of individuals as they approach.*

4. Biometric Verification*: Using computer vision and a database of registered employees' images, the system performs face recognition to verify the identity of the person. Successful recognition is indicated by a green light.*

5. Real-world Testing Environment: *To ensure the system's reliability and effectiveness, a real-world test bed* ***[fig 1]*** *is established at the entry gate. It allows for practical testing and validation of the face detection and recognition components in a live operational setting.*



[Fig 1]

6. Offer User Convenience: *Ensure that the face attendance system is user-friendly and convenient for attendees. This includes easy enrollment and a seamless attendance-checking process.*

7. Promote Environmental Sustainability: *Contribute to environmental sustainability by reducing paper usage through the replacement of paper-based attendance sheets.*

8. Improve Record Keeping: *Simplify attendance record keeping by providing long-term storage and easy retrieval of attendance records for historical reference.*

2.4. Stakeholders

FAST University: *As the commissioning party, FAST University has a vested interest in the system's success. They will benefit from improved data collection efficiency, enhanced student engagement, and valuable insights into student participation.*

Students: *The students participating in the data collection are directly impacted by the system. They will utilize the system to record their attendance.*

Potential stakeholders*: Other individuals or groups within FAST University or external partners may be interested in the system's capabilities. This could include researchers seeking access to anonymized data, administrators interested in monitoring overall participation trends, or external organizations collaborating on data collection projects.*

2.5. Operating Environment

Hardware platform: *The system will be deployed on a Metal Gate and will require an Arduino/ Rasberry Pie and a LED light. The system will also require 3 cameras.*

Operating system: *The system will be compatible with Windows*

Network environment: *The system will be connected to a LAN or WAN network.*

Software Components: *The system will be developed using a combination of TensorFlow, Pytorch, Python, and JavaScript, employing the MERN Stack development approach. It will utilize object detection libraries such as yoloV8, OpenCV, or more advanced alternatives. Additionally, face recognition libraries like deepface, dlib, face-recognition, or superior models will be incorporated to enhance its capabilities.*

2.6. System Constraints

Software constraints: *The system will be developed using a combination of TensorFlow, Pytorch, Python, and JavaScript, employing the MERN Stack development approach.It will run on Windows It will utilize object detection libraries such as yoloV8, OpenCV, or more advanced alternatives. Additionally, face recognition libraries like deepface, dlib, face-recognition, or OpenCV or superior models will be incorporated to enhance its capabilities. It will run on low-end devices and not on very powerful GPU systems which may affect the accuracy of the model.*

Hardware constraints: *The system will require 3 cameras, LED lights, Arduino/Raspberry Pie and sufficient computing power.*

Cultural constraints: *The system will be designed to work only with the English language and for the south asian community.*

Legal constraints: *The system will comply with all privacy regulations.*

Environmental constraints: *The system will work best in ideal lighting conditions and when the face is clearly visible and unobstructed. The system will not be able to identify individuals who are wearing caps or other headwear that obscures their facial features, or who are presenting their faces in profile*

view.

User constraints: *The system will be designed with user convenience in mind, providing a user-friendly interface and a seamless attendance-checking process. Users will be required to show their unobstructed face to the camera for the recognition to occur. The system will require capturing the User's pictures which will be stored in the database for the face-recognition system.*

Off-the-shelf components: *The system will utilize off-the-shelf components such as camera hardware and face recognition libraries. If the face detection performance surpasses the face recognition performance, the overall system performance may deteriorate. Additionally, some face recognition models already include integrated face detection capabilities. Network connectivity, whether LAN or WAN, can also influence the face recognition model's performance since IP cameras rely on network APIs.*

2.7. Assumptions & Dependencies

Assumptions: The system will be used in a well-lit environment. The system will be used by employees who are willing to cooperate. The system will be used to mark attendance.

Dependencies: *The system will depend on the availability of a camera,Arduino/Raspberry Pie, LED lights, and sufficient computing power and sufficient network hardware. The system will depend on the company's HR system to store attendance records.*

3. External Interface Requirements

3.1. Hardware Interfaces

The system will interact with the following hardware components:

Camera Systems: *The system interfaces with camera systems installed at entry gates. These cameras capture facial images for attendance tracking. The hardware characteristics include imaging capabilities and the ability to operate under ideal lighting conditions.*

Green Light Indicator: *Upon successful face recognition, the system(Raspberry Pie/Arduino) triggers a green light indicator. This interface is crucial for signaling attendees with approved access..*

Metal Gates: *The system is integrated with metal gates, each equipped with a dedicated camera. These gates provide the physical structure for the three-lane testbed, facilitating the detection and recognition of individuals.*

3.2. Software Interface

The system will interact with the following software components:

Web User Interface: *An intuitive user interface allows administrators to register users and manage system settings. The interface is designed to be user-friendly, contributing to efficient system administration.*

Facial Recognition Algorithm: *The core software interface involves the Facial Recognition Computer Vision Algorithm. This algorithm is responsible for processing facial input, cross-referencing it with the database, and determining user existence.*

Database (MongoDB)*: The system interfaces with a robust database (MongoDB) to store and retrieve employee information. The database facilitates the comparison of captured facial images with registered user data.*

Client Application: *The client side application will receive the feed from the cameras and utilize the facial recognition algorithm to recognize the user from the registered Database(previously entered by the admin via the Web User Interface).*

3.3. Communications Interfaces

The system relies on communication interfaces to enable data exchange and system operation. These interfaces include:

Camera-to-Application Communication: *Cameras transmit captured facial images to the application for processing. This communication ensures that real-time data is available for facial recognition.*

Application-to-Database Communication: *The application communicates with the database to retrieve employee images for comparison during the recognition process. This interface supports the seamless integration of the facial recognition algorithm with the employee database.*

System-to-Green Light Indicator Communication: *Upon successful recognition, the system communicates with the green light indicator to trigger the display of a green light, indicating approved access.*

Web User Interface Communication: *The web user interface allows administrators to interact with the system, providing inputs for user registration.*

Camera To Network Communication: *The system's cameras may require a high LAN network to support the transmission of real-time facial image data to the application for processing. The bandwidth requirements for transmitting high-resolution images can be significant, and a high LAN network will ensure that the data transfer is smooth and efficient to avoid delays or disruptions in the facial recognition process.*

Electronic Consent Form For Data Collection: *The system's use of facial data for recognition necessitates obtaining informed consent from the individuals whose facial images will be captured and processed. Electronic consent forms provide a convenient and secure way to collect this consent, ensuring that individuals are aware of and agree to the purposes and methods of data collection.*

4. Functional Requirements

4.1. Functional Hierarchy

Face Recognition Attendance System

1.1 Image Capture

1.1.1 Acquire facial images from cameras in real-time

1.2 Face Detection

1.2.1 Identify and locate faces in captured images

1.3 Face Recognition

1.3.1 Compare captured faces against a database of registered employee images

1.3.2 Determine attendance status based on recognition results

1.4 Attendance Management

1.4.1 Record attendance records for each employee

1.4.2 Provide user interface for administrators to manage attendance records

1.5 Access Control

1.5.1 Trigger green light indicator upon successful recognition for authorized access

1.6 Data Security

1.6.1 Implement secure data storage and transmission protocols

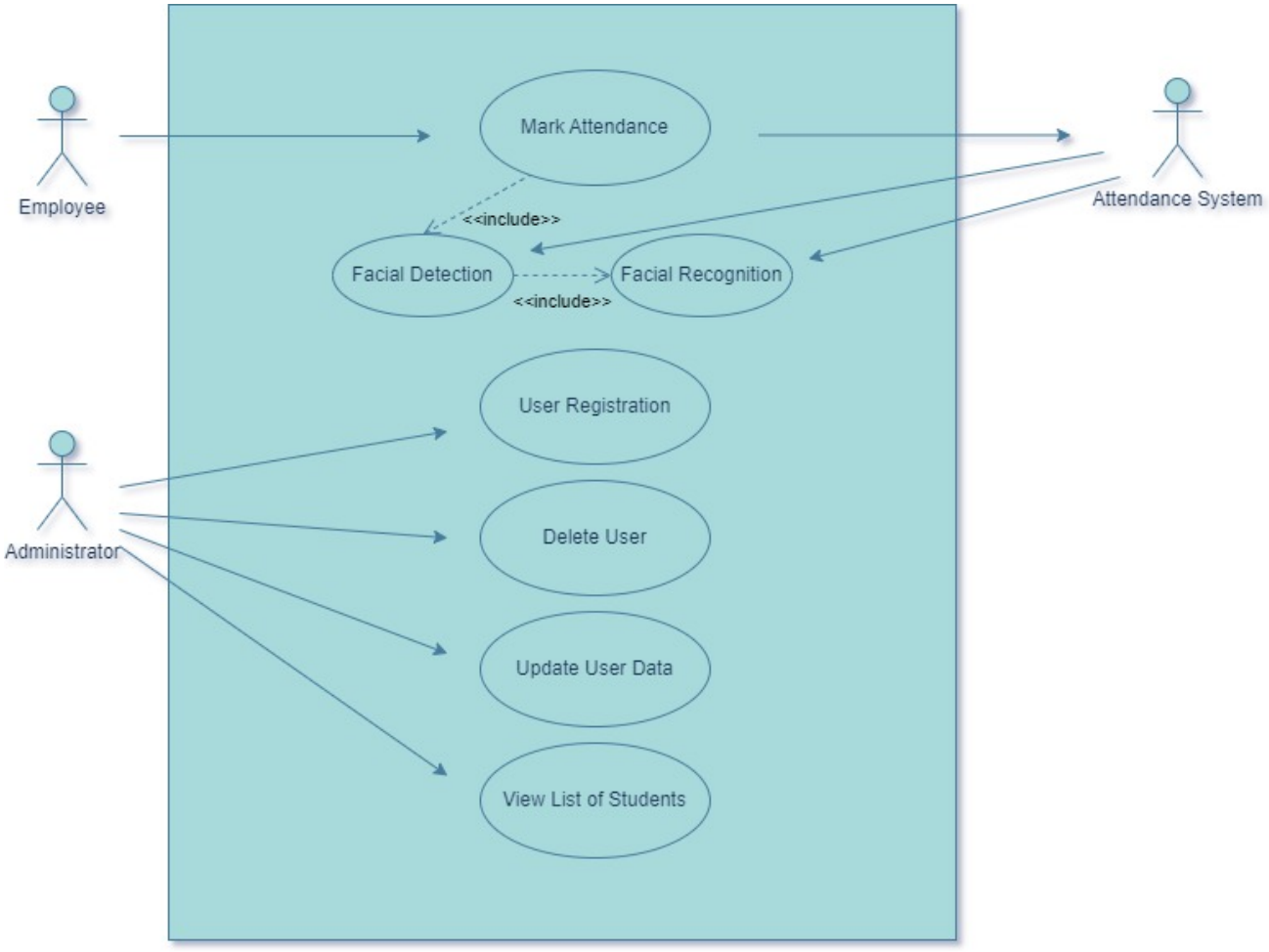
1.7 Data Collection

1.7.1 Obtain electronic consent forms from individuals for data collection

1.7.2 Comply with data privacy regulations

4.2. Use Cases

4.2.1. Overall Diagram



Use Case 1: Mark Attendance

Use case Id: AE01	
Actors: Employee, Administrator	
Feature: Face Recognition Attendance System	
Pre-condition:	1. The facial recognition system is properly installed and configured. 2. Employees' facial images are registered in the system database. 3. The metal gate and cameras are operational.

Scenarios

Step#	***Action***	***Software Reaction***
1.	Camera captures the employee's facial image.	Image is passed for detection and recognition.
2.	Employee approaches the entry gate.	
3.	System performs facial recognition using the database.	
4.	If recognized, the system triggers a green light.	
5.	Administrator receives real-time attendance data.	Data is updated

Alternate Scenarios:

1a: Employee's face is not recognized.

- *System triggers a red light.*
- *Administrator receives notification of unrecognized face.*
- *Employee may need manual verification.*

Post Conditions

Step#	***Description***
1.	Employee attendance is marked in the system.
2.	Timestamp of employee's arrival is recorded.
3.	Green light indicates successful recognition.

Use Case Cross referenced	Use Case 2: User Registration

Use Case 2: Face Detection		
Use case Id: AE02		
Actors: Employee, Attendance System		
Feature: Face Recognition Attendance System		
Pre-condition:	1. The facial detection system is properly installed and configured. 2. Employees' facial images are registered in the system database. 3. Employee should adjust their face infront of camera.	
Scenarios		
Step#	***Action***	***Software Reaction***
1.	Camera captures the employee's facial image.	
2.	System performs face detection.	
3.	Administrator receives real-time face detection data.	Real-time face detection data is displayed to the Administrator.
Alternate Scenarios:		
1a: System fails to detect a face. ● *System triggers an alert or notification.*		
Post Conditions		
Step#	***Description***	
1.	Face image is captured by the camera.	
2.	Face detection is performed by the system.	
Use Case Cross referenced	Use Case 1: Mark Attendance Use Case 2: User Registration Use Case 3: Face Recognition	

Use Case 3: Face Recognition

Use case Id: AE03	
Actors: Employee, Administrator	
Feature: Face Recognition Attendance System	
Pre-condition:	1. The facial recognition system is properly installed and configured. 2. Employees' facial images are registered in the system database. 3. The metal gate and cameras are operational.

Scenarios

Step#	***Action***	***Software Reaction***
1.	Camera captures the employee's facial image.	
2.	System performs facial recognition.	
3.	If recognized, the system triggers a green light.	
4.	Administrator receives real-time attendance data.	Real-time face detection data is displayed to the Administrator.

Alternate Scenarios:

1a: System fails to recognize a face.

- *System triggers an alert or notification.*
- *Manual verification may be required.*

Post Conditions

Step#	***Description***
1.	Green light indicates successful recognition.

Use Case Cross referenced	Use Case 1: Mark Attendance Use Case 2: User Registration

Use Case 4: User Registration

Use case Id: AE04	
Actors: Administrator	
Feature: User Management	
Pre-condition:	1. The system is properly installed and configured. 2. Administrator is logged in.

Scenarios		
Step#	***Action***	***Software Reaction***
1.	Administrator accesses the system.	
2.	Enters employee details and captures facial image.	
3.	System adds the employee to the database.	Data is saved

Alternate Scenarios:

2a: Administrator encounters an issue during registration.

- System provides an error message.
- Administrator troubleshoots and retries the registration.

Post Conditions	
Step#	***Description***
1.	Employee is successfully registered in the system database.
2.	Facial image and details are stored for recognition.

Use Case Cross referenced	

Use Case 5: Delete User

Use case Id: AE05	
Actors: Administrator	
Feature: User Management	
Pre-condition:	1. The system is properly installed and configured. 2. Administrator is logged in.

Scenarios

Step#	***Action***	***Software Reaction***
1.	Administrator selects a user for deletion.	
2.	System prompts for confirmation.	
3.	If confirmed, system deletes the user.	User data is removed from the system.
4.	System triggers a notification.	Notification of successful user deletion is sent.

Alternate Scenarios:

1a: Administrator cancels deletion

- *Deletion is aborted. No user data is removed.*

.***2a: System triggers a notification of canceled deletion.***

- *Notification of canceled deletion is sent.*

Post Conditions

Step#	***Description***
1.	User data is deleted from the system.
2.	Notification of successful deletion is triggered.

Use Case Cross referenced	

Use Case 6: Update User Data

Use case Id: AE06	
Actors: Administrator	
Feature: User Management	
Pre-condition:	1. The system is properly installed and configured. 2. Administrator is logged in.

Scenarios

Step#	***Action***	***Software Reaction***
1.	Administrator selects a user for update.	
2.	System prompts for updated data.	
3.	Administrator provides updated data.	User data is modified with the provided updates.
4.	System triggers a notification.	Notification of successful user update is sent.

Alternate Scenarios:

1a: Administrator cancels update

- *Update is aborted. No user data is updated.*

.***2a: System triggers a notification of canceled update.***

- *Notification of canceled update is sent.*

Post Conditions

Step#	***Description***
1.	User data is updated from the system.
2.	Notification of successful update is triggered.

Use Case Cross referenced	

Use Case 7: View List of Students

Use case Id: AE07		
Actors: Administrator		
Feature: User Management		
Pre-condition:	1. The system is properly installed and configured. 2. Administrator is logged in.	
Scenarios		
Step#	***Action***	***Software Reaction***
1.	Administrator navigates to the list of students.	
2.	System displays the list of students.	List of students is presented to the Administrator.
Alternate Scenarios:		
Post Conditions		
Step#	***Description***	
1.	Administrator views the list of students.	
Use Case Cross referenced		

5. Non-functional Requirements

5.1. Performance Requirements

Speed: *The system should be able to process captured facial images and perform face recognition in real-time to maintain a smooth and efficient attendance-checking process.*

Precision: *The system should achieve a moderate degree of accuracy in face recognition.*

Concurrency: *To be decided*

Capacity: *The system should be able to store a large number of employee facial images in the database to accommodate a growing workforce.*

Safety: *The system should operate safely and without causing any harm to individuals or property. It should not cause any distractions or interfere with other operations in the workplace.*

Reliability: *The system should be reliable and operate consistently, minimizing downtime and ensuring uninterrupted attendance tracking.*

5.2. Safety Requirements

Safeguards: *The system should implement safeguards to prevent potential harm or damage. This includes:*

- *Ensuring that the cameras are mounted securely and do not pose any tripping or collision hazards.*
- *Protecting the power supply to prevent electrical hazards.*

Actions: *The system should take appropriate actions to prevent dangerous situations. This includes:*

Alerting security personnel or administrators in case of unauthorized access attempts.

Certifications: *The system should comply with relevant safety certifications and standards, such as those for electrical safety and electromagnetic emissions.*

5.3. Security Requirements

1. Admin Authentication:

- *Requirement:Implemented robust admin authentication mechanisms to ensure that only authorized individuals can access the system. Authentication may involve username/password credentials*

***2. Privacy Compliance**:*

***Requirement:** Adhere to privacy regulations and guidelines to protect the privacy rights of individuals. Ensure that the system complies with relevant data protection laws, and consider obtaining necessary consents for data processing.*

3. Secure Database Access:

***Requirement:** Implemented secure database access controls to restrict unauthorized access to the attendance records database.*

4. Legal and Ethical Considerations:

***Requirement:** Ensure that the system operates within legal and ethical boundaries. Respect user privacy, adhere to applicable laws, and obtain necessary permissions for the collection and processing of biometric data.*

5.4. User Documentation

1. User Manual:

Comprehensive document providing step-by-step instructions on system installation, configuration, and usage. Includes detailed explanations of each module, user interfaces, and troubleshooting guides.

2. Software Setup

Detailed guide outlining the various elements of the Attendance eye, including login, database, and facial recognition configuration. Helping businesses to easily integrate the software in their work environment.

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
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[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

7. Appendices

Appendix A: Data Collection Plan

1. Data Collection Objectives

The primary objective of data collection for this project is to gather a comprehensive dataset of facial images for training and evaluating the face recognition algorithm. The dataset should encompass a diverse range of individuals, representing various ethnicities, ages, genders, and facial features. This diversity will ensure that the algorithm can accurately identify individuals under various conditions and across different populations.

2. Data Collection Sources

To achieve the desired diversity in the dataset, facial images will be collected from multiple sources, including:

Publicly available datasets: Open-source facial image datasets, such as the Labeled Faces in the Wild (LFW) dataset and the CelebA dataset, will be utilized to provide a baseline collection of images.

Consent-based individual contributions: Individuals will be invited to voluntarily contribute their facial images through a secure online platform. Informed consent will be obtained prior to image collection.

3. Data Collection Procedures

To ensure the quality and consistency of the collected data, the following procedures will be implemented:

Image capture guidelines: Standardized guidelines for image capture will be established, specifying factors such as lighting, background, pose, and facial expression.

Image annotation: Facial images will be annotated with relevant information, such as individual identifiers, facial features

Data quality control: Data quality checks will be performed regularly to identify and remove low-quality or irrelevant images.

4. Data Storage and Security

Collected facial images will be stored securely on a cloud-based storage platform with robust access control mechanisms. Data access will be restricted to authorized personnel involved in algorithm development and evaluation.

Appendix B: System Evaluation Plan

1. Evaluation Metrics

The performance of the face recognition algorithm will be evaluated using a set of metrics, including:

Accuracy: *The percentage of times the algorithm correctly identifies an individual.*

False Acceptance Rate (FAR): *The percentage of times the algorithm incorrectly identifies an unauthorized individual as authorized.*

False Rejection Rate (FRR): *The percentage of times the algorithm incorrectly fails to identify an authorized individual.*

Precision: *The ratio of correctly identified individuals to the total number of individuals identified.*

Recall: *The ratio of correctly identified individuals to the total number of individuals in the dataset.*

2. Evaluation Datasets

A dedicated evaluation dataset will be created from a subset of the collected facial images. This dataset will be distinct from the training dataset to ensure unbiased evaluation.

3. Evaluation Methodology

The algorithm will be evaluated using a variety of testing scenarios, including:

Ideal conditions: *Testing under ideal lighting, background, and pose conditions.*

Real-world testing: *Deploying the system in a real-world setting to assess its performance in a practical environment.*

4. Evaluation Results Analysis

Evaluation results will be analyzed to identify areas for improvement and refine the algorithm accordingly. Iterative evaluation will be conducted until the desired performance metrics are achieved.