A

FINAL PROJECT REPORT

ON

Intelligent Video-Based Attendance Tracking with Machine Learning

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
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INFORMATION TECHNOLOGY

BY

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SCTR's PUNE INSTITUTE OF COMPUTER TECHNOLOGY
DEPARTMENT OF INFORMATION TECHNOLOGY

C E R T I F I C A T E

This is to certify that the final project report entitled
Intelligent Video-Based Attendance Tracking with Machine Learning
submitted by

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is a bonafide work carried out by them under the supervision of **Mr. Tushar Rane** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University for the award of the Degree of Bachelor of Engineering (Information Technology).

This project report has not been earlier submitted to any other Institute or University for the award of any degree or diploma.

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Acknowledgement

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Abstract

The real-time attendance management system is an innovative solution designed to record the attendance of individual students during lectures without physical contact. By utilizing multiple camera angles strategically positioned within the classroom, the system will capture a comprehensive view of the lecture space. Advanced face recognition technology will analyze real-time video feeds, identifying and matching student faces with a pre-registered database. This will ensure accurate attendance recording in real-time, eliminating the need for manual roll calls. The system will send email notifications to every registered student about their attendance. The system will be integrated with existing educational platforms and scaled to accommodate different classroom sizes and institutions. It will offer benefits such as contactless attendance tracking, time savings, and improved transparency. Overall, the real-time attendance management system will enhance safety, efficiency, and effectiveness in attendance management processes within educational institutions.

Keywords: face recognition technology, pre-registered database, contactless attendance tracking, attendance management system.

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Abbreviations

SVM	:	Support Vector Machine
MERN	:	MongoDB, Express, React, and Node.js
JWT	:	JSON Web Tokens
OpenCV	:	Open Source Computer Vision

1. Introduction

1.1 Background

In response to the evolving needs of educational institutions, a sophisticated real-time attendance management system has been carefully crafted, focusing on bolstering accountability within these environments. The fundamental objective of this system is to meticulously document students' attendance, tracking their presence during each lecture through the use of multiple camera angles, thereby ensuring a comprehensive and accurate record. A standout feature of this innovative system is its capability to automatically generate and dispatch personalized email notifications to students, delivering timely updates regarding their attendance status for each specific lecture, thereby allowing students to stay well-informed about their academic commitments and responsibilities.
Moreover, the implementation of this cutting-edge approach represents a pivotal stride towards fostering effective and efficient communication channels within educational settings. By providing students with immediate and regular feedback on their attendance, this system cultivates a heightened sense of responsibility among them, encouraging a proactive approach towards their educational journey. Furthermore, the emphasis on transparency and accountability within educational institutions is significantly reinforced through the consistent and reliable operation of this attendance management system, contributing to a more conducive and trustworthy learning environment for both students and faculty alike.

1.2 Motivation

To expedite the attendance-taking process, a primary goal is to minimize the time needed for this task. By doing so, educational institutions can allocate more time to actual teaching and learning. Additionally, focusing on reducing human error in attendance tracking is crucial. Automation and technology can significantly enhance the accuracy of record-keeping, ensuring that students' attendance is meticulously logged. Lastly, the ability to mark the attendance of multiple students simultaneously is vital for efficiency, making it more convenient and less time-consuming for educators.

2. Literature Survey

2.1 Existing Methodologies

Riaz Ullah Khan et al [1] conducted an evaluation of the ResNet model for image recognition tasks. Used two different datasets, one related to healthcare data and the other containing malware and benign files. Experiments involved predicting cancer and detecting malware using various ResNet models. The study showed that ResNet models, particularly ResNet152, demonstrated excellent performance for cancer prediction, but performance was less efficient in terms of runtime for malware detection. The authors concluded that ResNet is a promising recommendation predictor for cancer survival and noted the importance of a model's loss in assessing its performance.

Chaitra et al [2] delve deeply into the realm of attendance management systems driven by facial recognition. Comprehensive research revolves around three core processes that underpin the system's functionality. The initial phase involves facial detection, executed with the Viola-Jones algorithm. Following this, employ the Local Binary Pattern (LBP) technique for feature extraction. Finally, the system achieves face recognition through the utilization of the Support Vector Machine (SVM). This multifaceted approach not only contributes to the evolution of facial recognition technology but also offers profound insights with versatile applications that extend across diverse domains, making it a noteworthy contribution to the field of attendance management systems.

Yuan Xie et al [3] introduce an optimized face recognition algorithm for edge computing by replacing VGG16 with MobileNet for face detection, employing 2-D face key point detection for alignment, and retraining Sphere Face using FP16 for representation. This approach significantly enhances processing speed, achieving real-time recognition at 7.031 FPS with a 93 percent accuracy. Moreover, the system's low power consumption of 6.7W, 17 times lower than CPU and GPU-based solutions, makes it a promising and energy-efficient advancement for edge computing applications in resource-constrained scenarios. This algorithm revolutionizes edge facial recognition. With its ability to efficiently process and identify faces at the edge, this cutting-edge algorithm not only enhances security and convenience but also contributes to reducing data transfer and storage demands, making it a pivotal technology for the future of smart and connected devices.

J. C. Dela Cruz et al. [4] developed a Multiple Face Recognition Surveillance System with Real-Time Alert Notification, utilizing 3D Face Recognition Pattern and a combination of Haar Cascade, Position Map Regression Network (PRN), and Iterative Closest Point (ICP) algorithms. The system has shown promising results, capable of recognizing up to two faces simultaneously with an accuracy rate of more than 80database. However, it may face challenges in cases of occlusion, face coverings, or plastic surgery-induced changes. Nonetheless, it significantly enhances security measures, offering a more efficient solution, ensuring a faster response time, and improving public safety by promptly detecting and notifying the presence of known individuals.

X. Bai et al [5] designed an Attendance System Based on Face Recognition. The system incorporates the Ad boost cascade algorithm for precise face detection and utilizes the Local Binary Pattern (LBP) for robust face recognition. To evaluate their system's performance, they conducted experiments with the widely recognized ORL face database, demonstrating the reliability and effectiveness of their approach in developing an accurate attendance system based on facial recognition technology.

J. P. Jeong, et al [6] conducted research on an Automatic Attendance System featuring Photo Face Recognition. Their system employs the robust MTCNN for precise face detection. For Face Verification, they compared the performance of two prominent techniques, Google Net and VGG16. Notably, their findings revealed that Google Net outperformed VGG16 in this context. This indicates that Google Net, known for its deep learning capabilities, enhances the system's accuracy and reliability, making it a more effective solution for automatic attendance management. Their study provides valuable insights into optimizing attendance systems for various applications and settings, ensuring efficient and dependable operations.

S. Huang et al [7] developed an innovative Attendance System Based on Dynamic Face Recognition. The system employs the highly efficient MTCNN for precise face detection and leverages the FaceNet algorithm for face recognition. Through rigorous testing, they achieved impressive results, with a false acceptance rate and fault rejection rate both kept remarkably low, at just 2capability to accurately manage attendance by dynamically recognizing faces, ensuring security and reliability in various applications.

Madhusmita Sahu et al [8] conducted a comprehensive analysis of different approaches. They made several significant observations that contribute to our understanding of these methods. Firstly, the skin color model-based algorithm, while effective, had a drawback of occasionally producing false positives, potentially impacting its reliability. Secondly, they found that Ada-boost, while a viable option, exhibited slower training and increased sensitivity to noise. However, the most intriguing discovery was that Ada-boost outperformed the skin color model-based algorithm in terms of accuracy, despite the trade-off in speed. This research underscores the importance of carefully selecting the appropriate face recognition technique based on the specific requirements of an application, taking into account the trade-offs between performance and complexity.

Sudha Sharma et al [9] have proposed an innovative face recognition system, incorporating machine learning algorithms alongside principal component analysis (PCA). This approach was rigorously tested against a backdrop of various machine learning techniques, including linear discriminant analysis, multilayer perceptron, Naive Bayes, and support vector machine. Remarkably, the system achieved an outstanding recognition accuracy of 97 percent and a flawless 100 percent success rate when applying PCA in conjunction with linear discriminant analysis. This research significantly advances the field of face recognition, especially in addressing the complex real-world challenges characterized by factors such as partial facial occlusion, variations in illumination, and changes in posture. Work underscores the robustness and efficacy of the proposed methodology, holding promising implications for practical applications of face recognition technology.

Lim et al. [10] present a pioneering methodology for human face classification, leveraging the capabilities of a 61 GHz millimeter-wave radar sensor. This innovative approach is underpinned by the extensive utilization of deep neural networks (DNN), where the input data is derived from concatenated signals originating from multiple antenna elements. A distinctive emphasis in research is placed on the pivotal parameter of range resolution within the domain of face classification, highlighting its significance for enhancing the accuracy and precision of this classification process. Work heralds a new era in advanced applications of face recognition and surveillance, thereby expanding the horizons of radar technology integration to achieve superior performance in diverse contexts.

Smitha et al [11] presented a face recognition-based attendance management system. The system utilizes face detection and recognition, making it a non-invasive and efficient method for marking attendance in educational institutions. It addresses the time-consuming nature of traditional attendance processes and the potential for proxy atten-

dance. While the specific accuracy achieved is not mentioned in the paper, the advantages of using face recognition technology in educational settings are emphasized. The system has the potential to streamline attendance tracking, reduce administrative burden, and enhance overall efficiency in educational institutions. However, further details on the system's performance and accuracy would provide a more comprehensive understanding of its practical implications.

A. Bhat et al [12] introduced an innovative face recognition-based attendance system designed to streamline attendance management in educational institutions. Novel system architecture incorporates a self-trained face recognition model and a face-matching algorithm, offering a practical and efficient solution. Leveraging the one-shot learning technique, the system excels in achieving remarkable accuracy rates, including 97 percent on the LFW dataset and 85 percent on a public student class photo dataset. With its potential to accommodate many students while requiring minimal data, the research underscores the system's reliability and adaptability in facilitating hassle-free attendance tracking within educational environments.

Soundarya S et al [13] embarked on a profound exploration of Harr Cascade, seeking to amplify its potential in image recognition and processing. What emerged from rigorous research was a groundbreaking revelation: incorporation of Convolutional Neural Networks (CNN) triggered a substantial leap in accuracy. CNN, a deep learning approach celebrated for prowess in deciphering intricate patterns, served as the catalyst for heightened performance in domains of image recognition and processing. This study showcases power of merging traditional techniques with cutting-edge deep learning to achieve remarkable results.

Khawla Alhanaee et al [14] explored Face Recognition Smart Attendance System, achieving remarkable results in face detection. Adoption of Multi-Task Cascade Convolution Neural Network (MTCNN) resulted in impressive accuracy rate of 98.87 percent. The system exhibited true positive rate of under 1/1000, underlining precision, albeit with relatively high false positive rate of 93.7 percent. Additionally, investigation into CNN cascade for face detection yielded commendable accuracy of 95.02 percent, emphasizing potential of system for efficient attendance tracking and management [14].

Ramadan TH et al [15] conducted comprehensive research study focusing on Face Detection and Recognition, with specific emphasis on utilization of OpenCV. The essence of investigation revolved around critical revelation: OpenCV outperforms dlib in terms

of accuracy in this context. Through rigorous experimentation and evaluation, the study produced noteworthy results. OpenCV, when employed for face detection, exhibited a highly commendable accuracy rate of 83 percent. In contrast, Haar Cascade method, widely recognized face detection technique, achieved accuracy rate of 80 percent. By showcasing OpenCV's prowess in achieving such accuracy, study reinforces notion that OpenCV stands as robust and dependable tool for face detection and recognition tasks. This insight is of particular significance in various domains, including security systems, attendance tracking, and human-computer interaction applications, where precise and reliable face detection is a fundamental requirement.

M. Geetha et al [16] is remarkable contribution in realm of online education and examination monitoring. This study focuses on enhancing face recognition precision using Eigenface and Support Vector Machine (SVM) techniques. Objective is to improve face recognition for online examination proctoring. Authors delve into feature extraction, SVM model training, and face recognition methods employing triplet loss function. Eigenface is used for feature extraction, and SVM for classification and face detection. Paper delves into core modules, such as extraction of 128D feature vectors using Caffe-based deep learning face detector and PyTorch embedder. [16] works exemplifies how advanced Machine Learning algorithms can address real-world challenges in the education sector, potentially making online proctoring systems more robust, accurate, and efficient.

Prof. Kalpana Malpe et al [17] delved into realm of face recognition techniques, employing system that ingeniously combines Raspberry Pi 4 and OpenCV. What sets research apart is the ability of systems to facilitate real-time video streaming via internet, enabling users to access live video feeds remotely. This technological feat holds immense promise, particularly in the domain of security and surveillance systems, where seamless remote access to live video streams is of paramount importance. The significance of their work extends beyond the realms of convenience and accessibility. It showcases the viability of harnessing cost-effective and compact hardware like the Raspberry Pi for applications that traditionally required larger and more expensive setups. In doing so, their research not only reduces the economic barriers to implementing sophisticated security and surveillance systems but also opens up opportunities for innovation and integration in various fields. The fusion of Raspberry Pi and OpenCV demonstrates the endless possibilities that arise from merging affordable hardware with powerful software, making advanced technological solutions more accessible to a wider range of users.

Muhammad Haikal Mohd Kamil et al [18] successfully developed a prototype system for online attendance records based on facial biometrics. Web-based application simplifies attendance tracking by utilizing face recognition and face mask detection, crucial for public safety during COVID-19 pandemic. Although the system showed promise, authors acknowledged that accuracy would improve with larger dataset of user face samples. Project not only addresses attendance management but also contributes to health monitoring in rapidly evolving world where contactless and safe solutions are becoming increasingly important. With further refinement and expanded dataset, the system holds potential to provide efficient and reliable solution for attendance management, particularly in times of crisis.

Prof. Yogesh Kadam et al [19] conducted a comprehensive exploration of the MERN (MongoDB, Express, React, Node.js) stack and various technologies associated with modern web development. Research unearthed compelling insights that shed light on advantages of this technology stack. React, a JavaScript library, emerged as standout component in MERN stack, offering efficient component-based architecture, benefits of virtual DOM for enhanced performance, and streamlined development process. This finding highlight Reacts superiority over traditional HTML/CSS in many aspects, making it an asset for web developers. Research revealed that MongoDB outperformed SQL databases in terms of speed and flexibility. Its ability to handle unstructured or semi-structured data made it a favorable choice for contemporary web development projects. This insight underscores the importance of selecting the right database technology to optimize web application performance and scalability. findings provide valuable guidance to developers and businesses seeking efficient and robust solutions for modern web development.

2.2 Research Gap Analysis

1. **Integration with Existing Systems:**
   The seamless integration of an intelligent attendance system utilizing face recognition technology into pre-existing systems is a critical domain that necessitates thorough research and gap analysis. This integration strives to harmoniously assimilate the new technology into established educational or organizational structures. The primary research gap pertains to the identification of potential challenges and areas requiring enhancements in the integration process.

2. **Insufficiency in Comprehensive Performance Evaluation of Face Recognition Techniques:**

   The absence of comprehensive performance evaluations across a range of methodologies in the field of face recognition highlights a significant knowledge gap in current research. Such evaluations are pivotal for advancing the cutting-edge in facial recognition systems and optimizing their effectiveness. Currently, the majority of studies tend to concentrate on individual or specific approaches, limiting our comprehensive understanding of how different techniques compare in terms of accuracy, computational efficiency, and robustness.

3. **Scalability Challenges in Face Recognition Systems for Larger Institutions:**

   The scalability of face recognition systems for larger institutions presents a pertinent research gap analysis when considering the implementation of an intelligent attendance system using face recognition. Addressing these scalability issues is essential for the successful adoption of face recognition technology in expansive educational institutions.

3. Requirement Specification and Analysis

3.1 Problem Definition

In modern educational settings, the traditional method of manual attendance tracking poses several challenges, including inaccuracies, time inefficiencies, and susceptibility to errors. Moreover, the recent global health crisis has underscored the importance of minimizing physical contact and implementing contactless solutions to ensure the safety of students and educators alike. Thus, there is a pressing need for a reliable, efficient, and secure attendance management system that can seamlessly adapt to the dynamic nature of classrooms while prioritizing health and safety concerns. This system must leverage advanced technologies such as facial recognition, machine learning, and real-time data processing to automate attendance tracking, enhance accuracy, and provide transparent communication channels. Addressing these challenges and requirements is paramount to optimizing educational processes, streamlining administrative tasks, and fostering a conducive learning environment for all stakeholders involved, ultimately enhancing the overall educational experience.

3.2 Scope

The scope of our project encompasses the development and implementation of a comprehensive real-time attendance management system for educational institutions. This system will leverage cutting-edge technologies such as facial recognition, machine learning algorithms, and advanced database management to automate attendance tracking, enhance efficiency, and ensure security. It will involve the creation of a robust dataset, the integration of various software components including image processing, feature extraction, and database management, as well as the development of user-friendly interfaces for both administrators and students. Additionally, the project will explore the integration of notification systems and seamless compatibility with existing educational platforms to facilitate communication and streamline workflows.

3.3 Objectives

- Develop and implement facial recognition algorithms leveraging cutting-edge technologies to ensure accurate attendance tracking in real-time.
- Integrate machine learning techniques such as deep learning to enhance the system's ability to identify students with high precision and reliability.
- Optimize database management protocols to efficiently store and manage attendance records while ensuring data security and integrity.
- Create intuitive and user-friendly interfaces for both administrators and students to facilitate easy access and interaction with the attendance management system.
- Implement notification systems to provide transparent communication with students regarding their attendance status, enhancing accountability and awareness.
- Ensure seamless compatibility with existing educational platforms and systems to facilitate easy integration and streamline workflows for educators and administrators.

3.4 Proposed Methodology

The methodology involves the following key steps:

1. **Classification**
    - OpenCV: OpenCV is used for image capturing and processing
    - Dlib: Used to find encodings from image
    - REST API: Used for triggering Modules
    - MongoDB: Used to store database
    - Python : Used as a programming language
    - SVM: For classification
    - Decision Tree Classifier: For classification
    - Random Forest Classifier: For classification
2. **Mail Notification**
    - SMTP : Simple Mail Transfer Protocol(SMTP) is used to send email notification.

3. **Portal**

   - MongoDB : MongoDB is used to store data required for the project
   - Express : Express is used as a middleware in the admin portal
   - React : React is used for devlopment of frontend
   - Node.js : NodeJS is used for backend

3.5 Project Requirements

3.5.1 Datasets

- **Dataset 1**
  It comprises individual photos of each student, capturing diverse angles and expressions. With a minimum of 200 students' data, this collection ensures robust model training by covering various facial features and lighting conditions.

- **Dataset 2**
  It consists of group photos featuring 20 to 30 students per image, replicating real classroom scenarios. Taken during regular class activities, these photos enable the system to learn to detect multiple faces concurrently, enhancing its efficiency in tracking attendance in dynamic environments.

3.5.2 Functional Requirements

1. **Communication Protocol:**
   Power Automate for Email Notifications is used. Power Automate makes email notifications highly flexible and automated. It simplifies the process of sending tailored messages, which can be triggered by various events and criteria, and it can be a valuable tool for improving communication and efficiency within organizations.

2. **Data Transfer:**
   Including low-latency communication to support real-time applications and high data throughput is essential for many modern technologies and systems. Low latency refers to the minimal delay or lag in data transmission, while high data throughput pertains to the ability to handle and process a significant amount of data rapidly.

3. **API Support:**

   Well-defined APIs are the linchpin for efficient and effective data flow between models, databases, and hardware. They promote modularity, consistency, and abstraction while offering advantages in terms of compatibility, scalability, security, and performance. APIs are crucial for modern software, enabling cohesive system functionality and adaptability.

4. **Real-time Capabilities:**

   Ensuring low-latency data transfer is crucial for applications that demand quick response times, such as real-time communication systems, financial trading platforms, online gaming, and autonomous vehicles. Low latency refers to minimizing the delay or lag in transmitting data from a source to a destination.

5. **Compatibility:**

   To achieve compatibility with both Ubuntu and Windows, system developers need to consider the differences in system architecture, libraries, and system calls between the two operating systems. The use of cross-platform development frameworks, virtualization, containerization technologies, and thorough testing is often necessary to ensure seamless compatibility.

6. **Load Balancing:**

   Load balancing is a pivotal consideration in requirement analysis, particularly for applications, systems, or networks that anticipate managing fluctuating levels of traffic, diverse workloads, and dynamic user interactions. It ensures optimal resource utilization, minimizes response times, and enhances overall system performance and reliability.

7. **Security:**

   Security is a pivotal aspect in requirement analysis, serving as the cornerstone for constructing systems and applications that prioritize the protection of sensitive data, mitigate the risk of unauthorized access, and uphold the overall integrity of the software environment.

8. **Scalability:**

   Scalability in requirement analysis refers to the ability of a system or solution to adapt and grow in response to changing needs, increased demand, or evolving user requirements. It involves evaluating and designing a solution that can accommodate growth while maintaining performance and functionality.

9. **Documentation:**

   Requirement analysis and documentation improve system adoption and user understanding. It helps ensure that users have the tools and knowledge they need to effectively utilize your solution, leading to a more positive user experience and successful implementation.

3.5.3 Non Functional Requirements

1. **Performance:**

   The system should have low-latency face recognition, with quick and accurate attendance recording. It should be able to handle a large number of users or students and scale efficiently as the user base grows. The system should support high data throughput to process attendance for multiple classes or sessions simultaneously.

2. **Accuracy:**

   The face recognition algorithm must have a high level of accuracy, ensuring minimal false positives and false negatives in attendance recording. The system should consistently identify students in various lighting conditions, angles, and appearances.

3. **Security:**

   Ensure that facial data is securely stored, transmitted, and encrypted to protect the privacy and security of users. Implement robust access control mechanisms to prevent unauthorized access to attendance records and system settings.

4. **Usability:**

   The system should have an intuitive user interface for administrators and users to easily access attendance information and settings. Users should require minimal training to effectively use the system.

5. **Reliability:**

   The system should be available and reliable, with minimal downtime to prevent disruptions to attendance recording. Effective error-handling mechanisms should be in place to address issues promptly and minimize system failures.

3.5.4 Hardware Requirements

- Camera: High-Resolution Super Wide Angle Camera
- Server: Multi-core CPU and a dedicated GPU

- GPU: NVIDIA GeForce GTX or Quadro series
- Memory (RAM): 8GB+ RAM
- Storage (SSD): Fast SSD + Additional HDD

3.5.5 Software Requirements

- MongoDB
- Express JS
- React JS
- Node JS

3.6 Project Plan

3.6.1 Project Resources

1. **Human Resources**
    - Project Manager
      Oversees the entire project, sets goals, and manages the project team.
    - Developers
      Software engineers and programmers responsible for developing the face recognition software.
    - Database Administrators
      Manage the attendance database and ensure data integrity.
    - Quality Assurance/Testers
      Test the system for accuracy, reliability, and usability.
    - UX/UI Designers
      Design the user interface for administrators and end-users.
2. **Hardware and Software Resources**
    - Cameras
      High-quality cameras with appropriate specifications for capturing facial images.
    - Server Infrastructure
      Powerful servers or cloud resources for face recognition processing.

- Storage
  Sufficient storage capacity for storing attendance records and facial images.
- Face Recognition Software
  Pre-existing face recognition libraries or custom-developed software.
- Development Tools
  Integrated development environments (IDEs), software libraries, and tools for software development.

3. **Data Resources**

- Face Datasets
  High-quality face image datasets for training the face recognition model.
- Attendance Data
  Historical attendance records, if available, for testing and system training.

4. **Project Management Tools**

- Project Management Software
  Tools like Jira, Trello, or Microsoft Project for managing tasks, timelines, and resources.
- Communication Tools
  Collaboration and communication tools like Slack, Microsoft Teams, or Zoom for team interaction.

5. **Testing Equipment**

- Test Cameras
  Cameras for testing and calibrating the system's performance.
- Devices for User Testing
  Devices that end-users will use for testing the system.

3.6.2 Module Split-up

1. **Frontend**

(a) **Admin Login Page Module**

- Responsible for providing a user interface for administrators to log in securely.
- Upon successful login, redirect the user to the admin dashboard.

(b) **Student Registration Page Module**

- Provides a form for students to register themselves in the system.
- Collects necessary information such as student ID, name and images with different angles.
- Submits the registration data to the backend for processing and storage.

2. **Backend**

(a) **Admin Login API Module**

- Handles incoming requests from the frontend for admin login authentication.
- Implements security measures.

(b) **Student Registration API Module**

- Processes incoming requests from the frontend for student registration.
- Inserts the student information into the database for future reference.

(c) **Model Training Module**

- Responsible for training the machine learning model used for attendance recognition.
- Implements various machine learning algorithms for classification.
- Fine-tune the model parameters to achieve optimal performance and accuracy.
- Saves the trained model for later use in the attendance system.

(d) **Data Preprocessing Module**

- Handles preprocessing tasks necessary for preparing input data for model training.
- Performs feature extraction and selection to identify relevant attendance features.
- Splits the data into training and testing sets for model evaluation and validation.

3.6.3 Functional Decomposition

1. **Project Management**

- Define the project's goals, scope, and limitations.

- Develop a project schedule outlining timeframes, milestones, and resource allocation.
- Establish procedures for communication and reporting.

2. **Requirement Analysis**
   - Evaluate the current performance of smart attendance systems.
   - Identify any bottlenecks and performance-related issues.
   - Collect both functional and non-functional requirements.
3. **Research**
   - Investigate best practices for enhancing video-based attendance tracking systems.
   - Compare existing solutions and attendance systems from competitors.
   - Identify potential techniques and technologies for implementation.
4. **Scalability Improvements**
   - Ensure that the performance of the video-based attendance tracking system can scale with increasing workloads.
   - Implement enhancements for both horizontal and vertical scalability.
   - Optimize the system's ability to handle increased loads.
5. **Resource Optimization**
   - Fine-tune memory usage for efficiency.
   - Minimize CPU overhead to enhance performance.
   - Make efficient use of GPU resources.

3.6.4 Project Team Role and Responsibilities

1. **Neeraj: Backend Development of portal**
   - Neeraj's responsibility is the development of backend of portal.
   - He has used Express and Node.js for development.
   - He ensures high performance and responsiveness of the backend system.

2. **Sahil: Model Building**
    - Sahil focuses on building a model for face detection and classification.
    - He has used Dlib library.
    - He used Support Vector Machine(SVM), Decision Tree Classifier and Random Forest Classifier models for classification
3. **Tanisha: Frontend Development and Mail Notification Feature**
    - She has done frontend development using React technology
    - She has used SMTP to develop a feature of sending mail to students regarding their attendance.
4. **Mahek: Data Collection and Preprocessing**
    - She has collected data of student‘s face from different angles to train the model.
    - She has used MongoDB to store data
    - She used Dlib library for preprocessing of data

3.6.5 Project Plan 3.0

PHASE-1:Project Initiation

- Define project scope, objectives, and success criteria
- Identify key stakeholders, including project team members and users.
- Develop a project charter.
- Secure necessary approvals and funding.

PHASE-2:Requirements Analysis

- Conduct detailed requirement gathering with educational institutions.
- Document functional and non-functional requirements.
- Define use cases and system specifications.
- Create a system architecture and design overview.

PHASE-3 Technology Selection and Procurement

- Select appropriate facial recognition technology and hardware.

- Procure necessary hardware and software components.
- Ensure compatibility with both Windows and Ubuntu platforms.

PHASE-4:System Development

- Set up the development environment
- Develop the face recognition algorithm.
- Create a user-friendly web-based interface.
- Implement database and data storage solutions.
- Integrate system with camera hardware.
- Implement API for data flow.

PHASE-5:Testing

- Perform unit testing, integration testing, and system testing.
- Verify the accuracy, security, and scalability of the system
- Resolve identified issues and bugs
- Conduct user acceptance testing (UAT)

PHASE-6:Documentation

- Create installation guides for both Windows and Ubuntu users.
- Develop comprehensive API documentation.
- Provide clear usage examples for administrators and users.

3.6.6 PERT Table

Task Description	Estimated Date	Completion Date
Project Start	15-08-2023	15-08-2023
Understanding of Project Scope and Objective	19 -08-2023	19-08-2023
Requirements Gathering and Environment Setup	28-08-2023	29-08-2023
Project Workflow Creation	05-09-2023	07-09-2023
frontend creation	14-09-2023	18-09-2023
backend creation	05-10-2023	05-10-2023
Implementation of face recognition	19 -10-2023	22-10-2023
testing face recognition	08-11-2023	11-11-2023
Survey Paper Publishing	20-12-2023	30-12-2023
Sem 2 started	01-01-2024	01-01-2024
Exploration of different	10-01-2024	15-01-2024
models for face recognition	19-02-2024	27-02-2024
Setting up different models	9-03-2024	15-03-2024
pre-processing data for the models	17-03-2024	22-03-2024
Testing face recognition with different models	05-04-2024	09-04-2024
Removing bugs	15-04-2024	20-04-2024
Report Completion, Research Paper Publishing and Final Conclusion	15-04-2024	20-04-2024

Figure 3.1: PERT Table

3.6.7 PERT Diagram

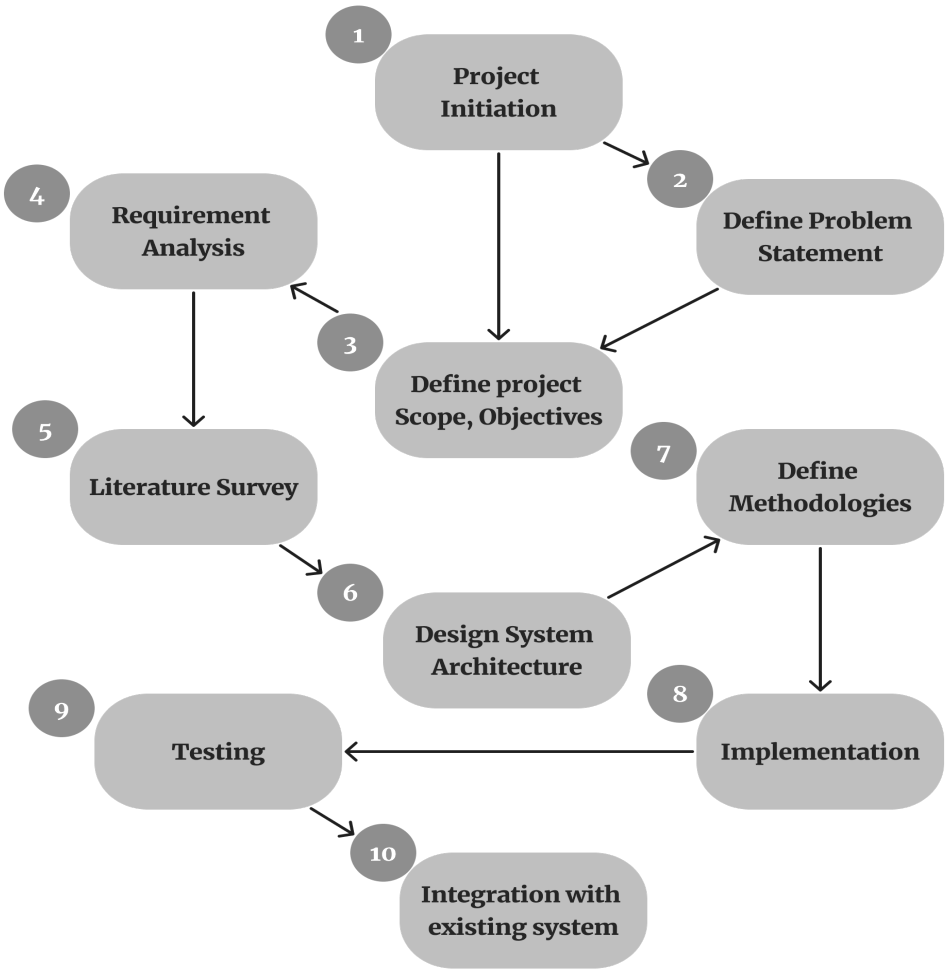

Figure 3.2: PERT Diagram

4. System Analysis and Design

4.1 System Architecture

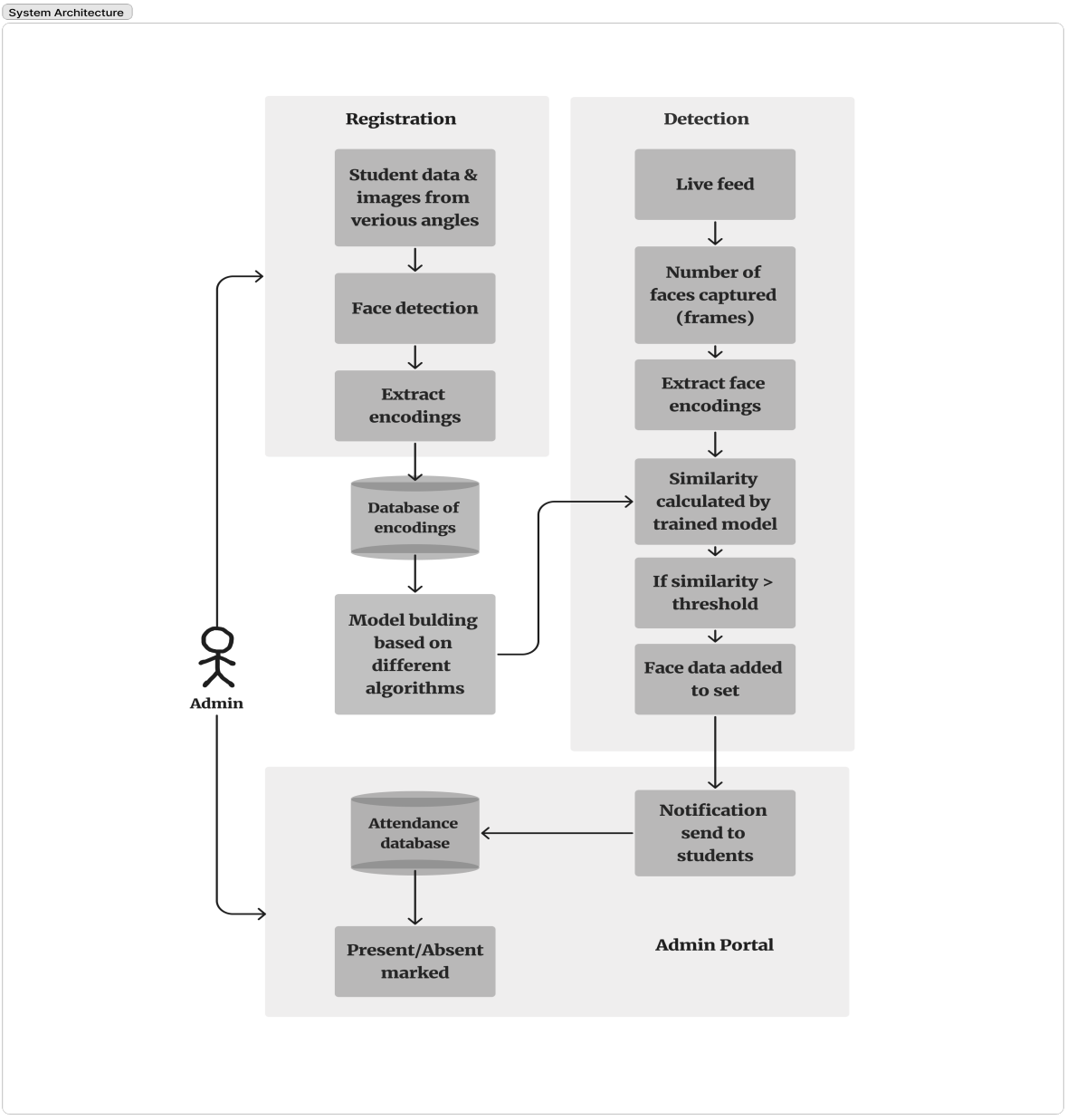

Figure 4.1: System Architecture

The system architecture seamlessly integrates image processing, machine learning, database management, and web technologies into three core components: Registration, Detection, and the Admin Portal, automating attendance tracking and empowering administrators in educational environments.

- **Registration Module**

  In the Registration module, student data including names, roll numbers, email addresses, and photos from various angles are collected through a form submission process. The collected images undergo face detection using OpenCV, followed by the extraction of face encodings using Dlib's face recognition library. These face encodings, representing unique facial features, are stored in a MongoDB database for efficient data management and retrieval. The admin manages this registration process through the Admin Portal, which serves as a central interface for system management.

- **Detection Module**

  The Detection module operates in real-time, capturing live camera feeds from classrooms using OpenCV for image capturing and processing. Faces are detected and extracted from the captured frames, and their face encodings are generated using Dlib's face recognition library. These face encodings are then passed to the trained machine learning model, which includes algorithms like SVM, Decision Tree Classifier, and Random Forest Classifier, for facial recognition and matching. If a match is found above a certain similarity threshold, the system marks the attendance in the attendance database and sends email notifications to students regarding their attendance status using SMTP.

- **Admin Portal**

  The Admin Portal serves as the backend interface for administrators and educators to manage the system. MongoDB is used as the backend database system for storing student data, encodings, attendance records, and administrative information. Express acts as middleware in the Admin Portal, facilitating communication between the frontend (built with React for dynamic and responsive interfaces) and backend (powered by Node.js for server-side logic and database interactions). Administrators can use the Admin Portal to add new students, view attendance records, update system settings, and generate reports based on attendance data.

4.2 Necessary UML Diagrams

4.2.1 Use Case Diagram

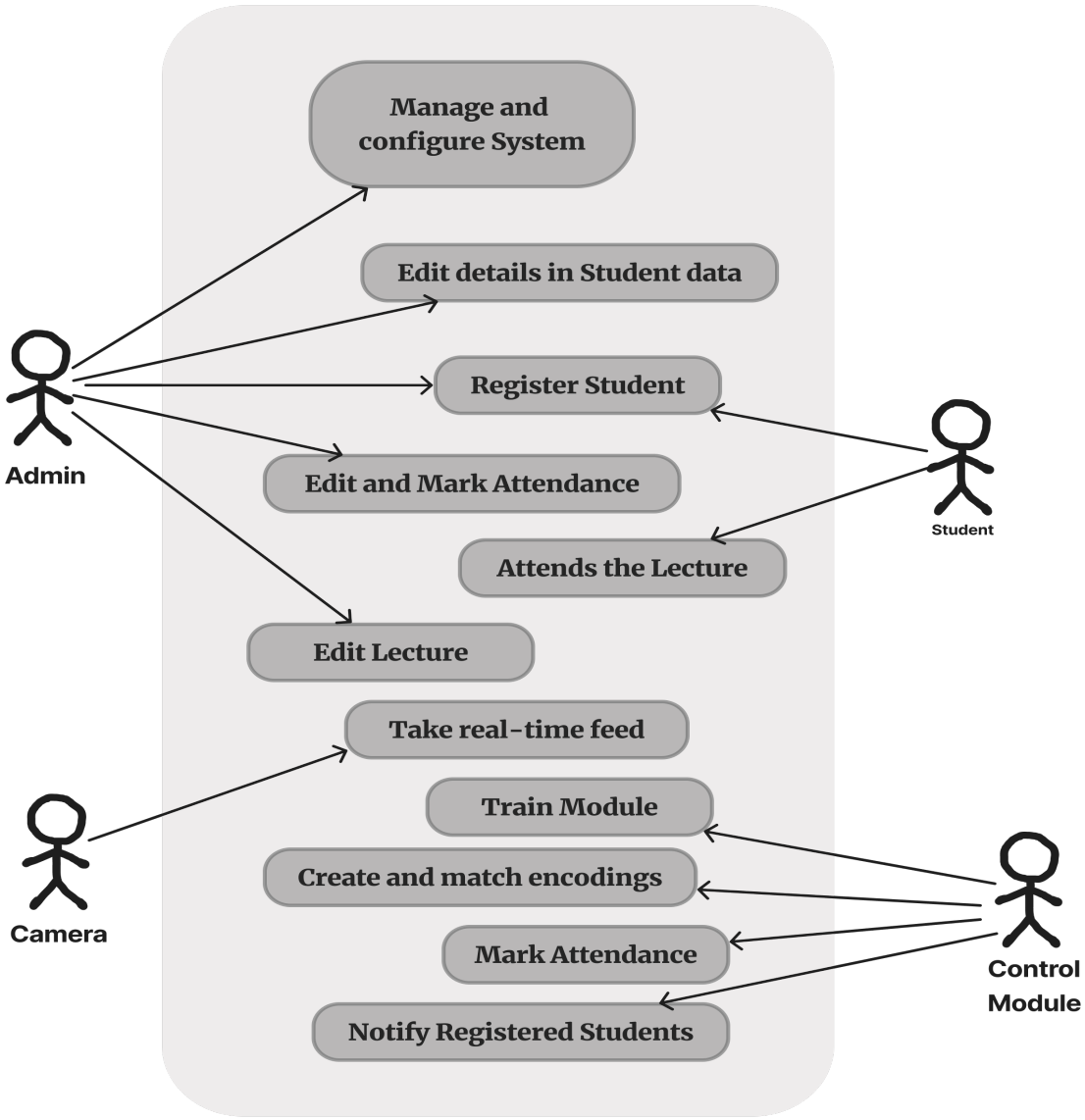

Figure 4.2: Use Case Diagram

4.2.2 Data Flow Diagram

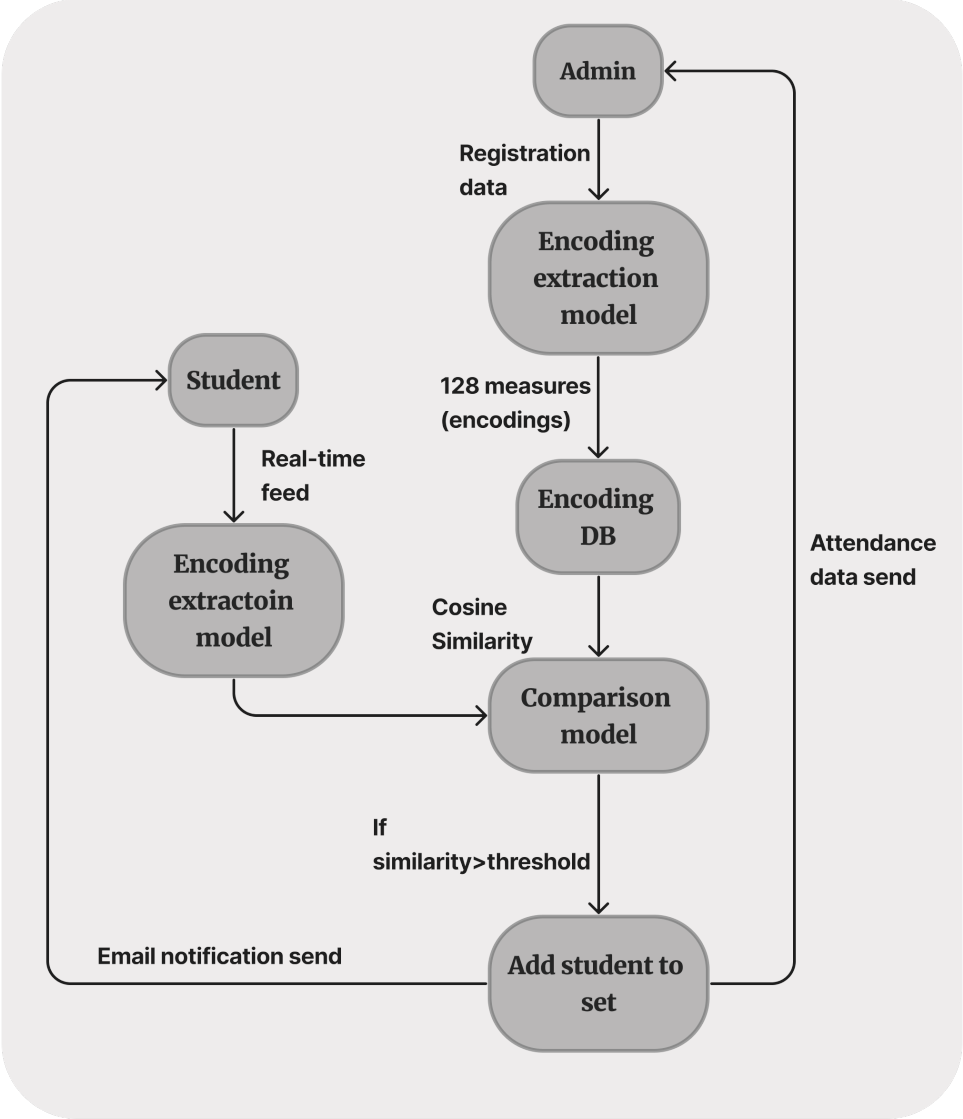

Figure 4.3: Data Flow Diagram

4.2.3 Activity Diagram

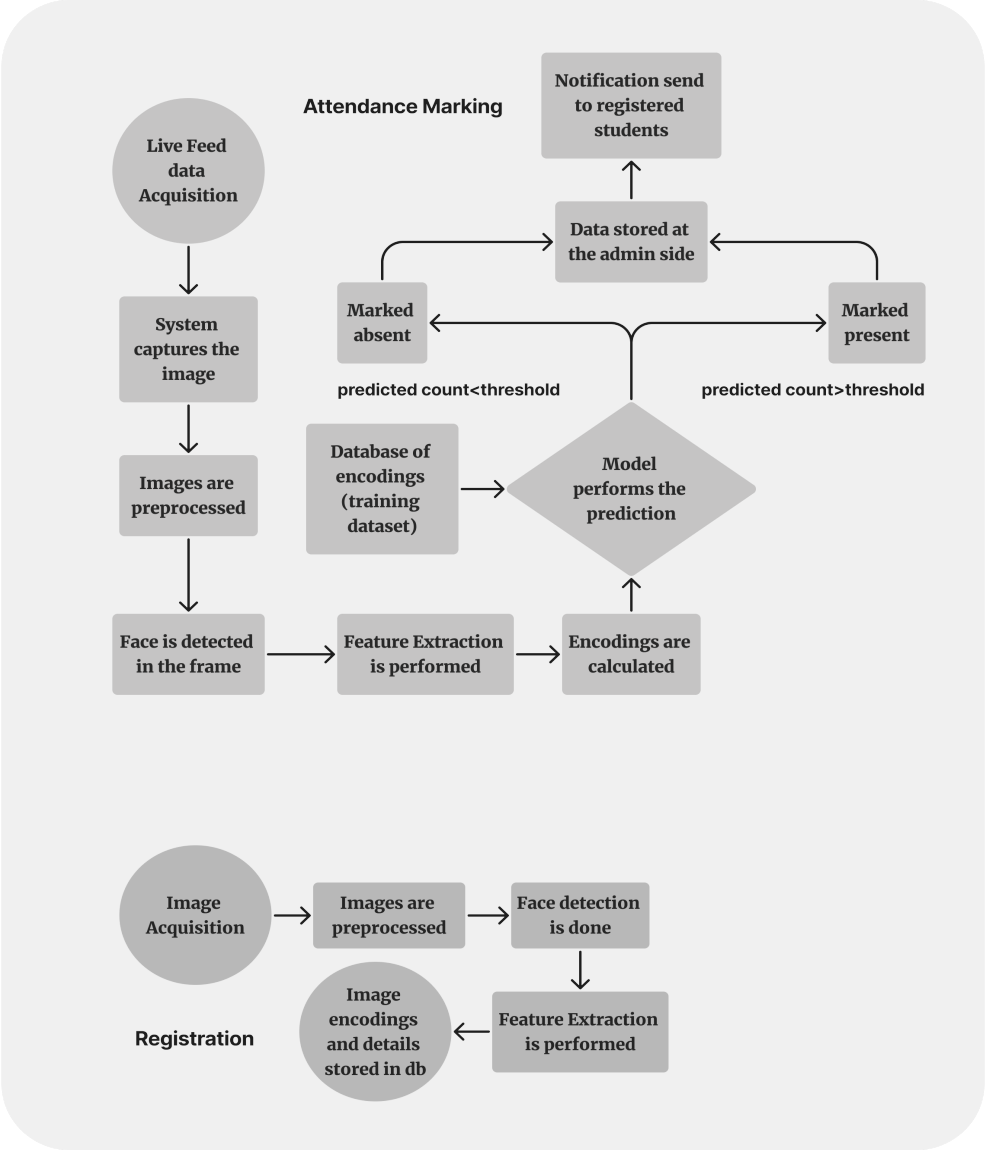

Figure 4.4: Activity Diagram

4.2.4 Sequence Diagram

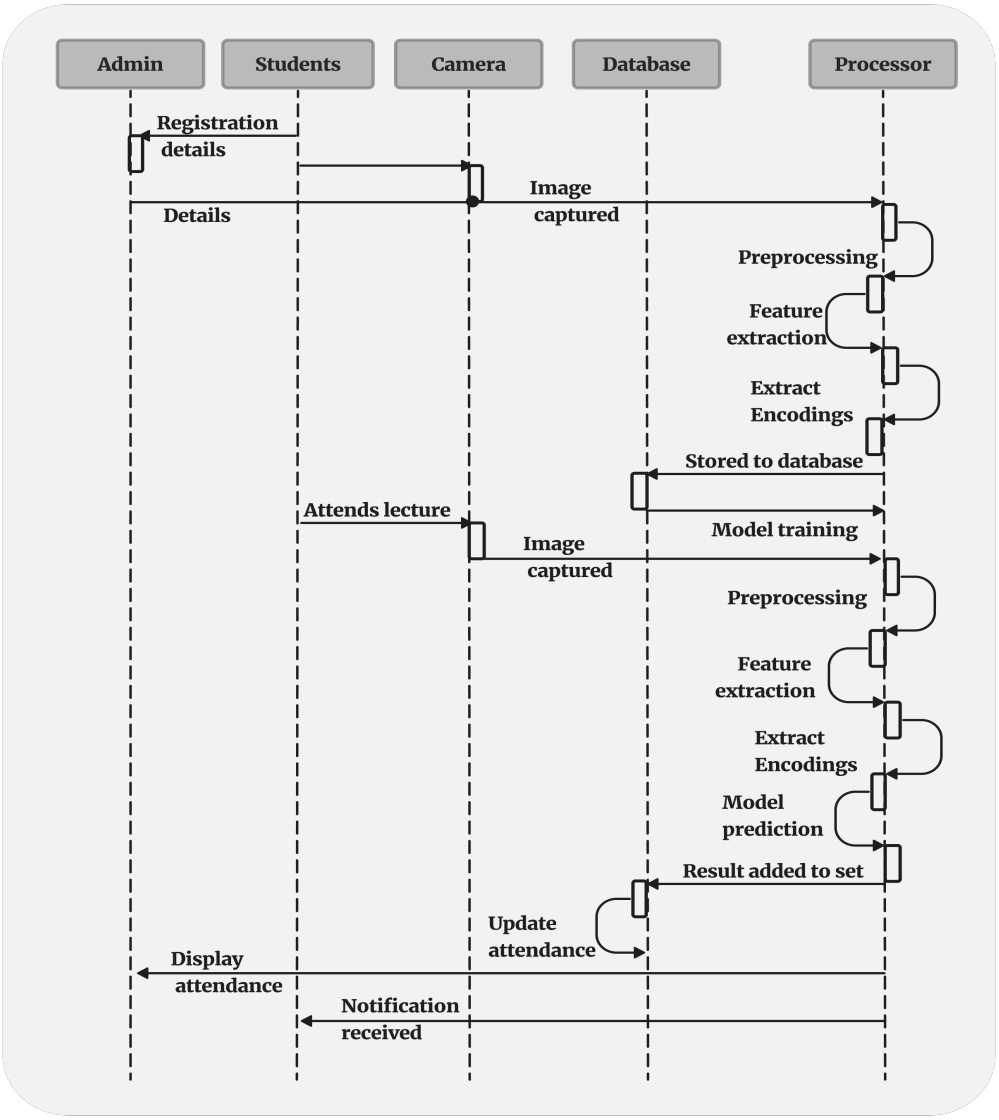

Figure 4.5: Sequence Diagram

4.3 Algorithm and Methodologies

4.3.1 Classification

1. **OpenCV**

   OpenCV, known as Open Source Computer Vision Library, plays a vital role in the attendance marking system by providing a versatile toolkit for image capturing and processing. It serves as a comprehensive solution for various image-related tasks.OpenCV serves as a foundational component in developing the attendance marking system, providing essential tools for capturing, processing, and analyzing images. Its versatility and performance contribute significantly to accurate and efficient facial recognition-based attendance management.

   - **Image Capturing**

     OpenCV's APIs enable the system to interface with cameras, allowing it to capture live video feeds or images. This capability is crucial for gathering visual data, such as students' faces during attendance sessions.The system can configure parameters like resolution, frame rate, and image format using OpenCV's camera functionalities, ensuring optimal quality and compatibility.

   - **Image Processing**

     OpenCV offers a wide range of image processing functions, from basic manipulations like resizing, cropping, and rotation to advanced techniques such as filtering, edge detection, and feature extraction.In this project, image processing functionalities are utilized for tasks such as face detection within captured images or video frames, preprocessing images to enhance facial features or remove noise, and extracting rele vant information from images for input into machine learning models.

   - **Real-time Processing**

     OpenCV's efficient algorithms and optimized implementations enable real-time image processing, making it suitable for applications requiring timely responses.For the attendance system, real-time processing capabilities allow continuous monitoring of camera feeds, instant face detection, and seamless integration with other modules for attendance recording.

- **Integration with Machine Learning**

  OpenCV seamlessly integrates with machine learning libraries like Dlib (used for face encodings) to create robust solutions combining computer vision and AI techniques.OpenCV preprocesses images before feeding them into machine learning models, ensuring that the input data is appropriately formatted and optimized for classification tasks.

2. **Dlib**

   Dlib, a robust machine learning library, is employed in the attendance marking system project to extract facial encodings from images. This library offers sophisticated algorithms and tools specifically designed for tasks related to face recognition and feature extraction.Dlib's role in the system is crucial for accurate and efficient face recognition. Its ability to extract detailed facial features and generate compact encodings facilitates the development of a robust attendance marking system that relies on facial recognition technology.

   Dlib's functionalities are harnessed in the following ways:

   (a) **Facial Feature Extraction**

   Dlib's algorithms can accurately detect and locate facial landmarks, such as eyes, nose, mouth, and jawline, within an image.By identifying these key facial features, Dlib can generate unique encodings (128-dimensional arrays) that represent the distinctive characteristics of an individual's face.

   (b) **Encoding Generation**

   Once facial landmarks are identified, Dlib computes the facial encodings by quantifying the spatial relationships and patterns among these landmarks. These encodings serve as compact and informative representations of facial features, suitable for comparison and recognition tasks.

   (c) **Integration with Image Processing**

   Dlib seamlessly integrates with image processing pipelines, allowing it to operate on images captured or processed using tools like OpenCV.In the attendance marking system, Dlib can be used after OpenCV captures images of students. It processes these images to extract facial features and generate corresponding encodings.

(d) **Face Recognition**

The generated encodings are utilized for face recognition tasks, enabling the system to identify individuals based on their unique facial characteristics.Dlib's encodings are linked with student details (such as registration IDs) and stored in the database for attendance tracking.

3. **Support Vector Machine(SVM)**

Support Vector Machine (SVM) is a powerful machine learning algorithm used for classification tasks within the attendance marking system. SVM operates by finding the optimal hyperplane that best separates different classes in the feature space, making it particularly effective for binary and multi-class classification problems.SVM's capabilities in classification, hyperparameter optimization, and real-time prediction make it a valuable component in the attendance marking system. Its ability to accurately classify face encodings contributes to the system's reliability and accuracy in predicting student attendance based on facial recognition technology.

Attendance marking system project, SVM is utilized in the following ways:

(a) **Classification of Face Encodings**

SVM is trained using preprocessed face encodings as input features (X) and registration IDs as target labels (Y). The trained SVM model can accurately classify and predict registration IDs based on new face encodings, enabling the system to identify students during attendance marking.

(b) **Optimization for Accuracy**

Hyperparameter tuning is performed to optimize SVM's performance in classifying face encodings.Parameters such as the choice of kernel function (e.g., radial basis function, polynomial), regularization parameter (C), and probability estimation are adjusted to achieve the highest accuracy on the test set.

(c) **Integration with Machine Learning Pipeline**

SVM is integrated into the machine learning pipeline along with other classifiers like Decision Tree Classifier and Random Forest Classifier. Each classifier is evaluated, and the SVM model with the highest accuracy on the test set is selected and deployed for attendance prediction.

(d) **Real-time Prediction**

During the attendance marking process, SVM receives live face encodings from captured frames through modules like OpenCV and Dlib. SVM predicts the registration IDs of students based on these face encodings in real-time, contributing to the accurate marking of attendance.

(e) **Thresholding and Filtering**

A probability threshold is set to filter out predictions with low confidence levels, reducing the risk of false positives in attendance marking.SVM's probability estimation feature enables the computation of class probabilities, which are used to determine valid predictions above the threshold.

4. **Decision Tree Classifier**

The Decision Tree Classifier, a machine learning algorithm, plays a pivotal role in the attendance marking system by facilitating classification tasks. This algorithm constructs a tree-like structure where each internal node represents a feature, each branch represents a decision based on that feature, and each leaf node represents the class label.The Decision Tree Classifier's ability to construct interpretable decision rules, optimize classification accuracy through hyperparameter tuning, and integrate seamlessly into the machine learning pipeline makes it a valuable asset in the attendance marking system. Its contributions enhance the system's reliability and accuracy in predicting student attendance based on facial recognition data.

(a) **Feature Selection and Splitting**

The Decision Tree Classifier is trained using preprocessed face encodings (X) as input features and registration IDs (Y) as target labels.It autonomously selects the most informative features from the face encodings to create optimal decision rules for classification.

(b) **Classification Accuracy**

Hyperparameter tuning is conducted to optimize the Decision Tree Classifier's performance.Parameters such as the criterion for splitting nodes (e.g. 'gini', 'entropy'), splitter strategy ('best', 'random'), and max features ('sqrt', 'log2') are fine-tuned to achieve the highest accuracy on the test set.

(c) **Integration with Machine Learning Pipeline**

The Decision Tree Classifier is integrated into the machine learning pipeline alongside other classifiers like SVM and Random Forest Classifier.Each classifier is evaluated, and the Decision Tree Classifier with the highest accuracy on the test set is selected and deployed for attendance prediction.

(d) **Real-time Prediction**

During the attendance marking process, the Decision Tree Classifier receives live face encodings from captured frames via modules like OpenCV and Dlib.It predicts the registration IDs of students based on these face encodings in real-time, contributing to the accurate marking of attendance.

(e) **Thresholding and Filtering**

Similar to SVM, a probability threshold is set to filter out predictions with low confidence levels, reducing the occurrence of false positives. The Decision Tree Classifier's decision-making process, guided by the chosen criterion and split strategies, ensures reliable predictions above the threshold.

5. **Random Forest Classifier**

The Random Forest Classifier, an ensemble learning technique, plays a crucial role in the attendance marking system project by enhancing classification accuracy and robustness. It operates by constructing multiple decision trees during training and combining their predictions to make more accurate and stable classifications.The Random Forest Classifier's ensemble approach, hyperparameter optimization, and integration within the machine learning pipeline significantly improve the attendance marking system's classification accuracy and robustness. Its contributions lead to more reliable and accurate predictions of student attendance based on facial recognition data. Here's how the Random Forest Classifier is utilized in the project:

(a) **Ensemble Learning**

The Random Forest Classifier builds an ensemble of decision trees, each trained with a subset of the training data and features, promoting diversity and reducing overfitting. This ensemble approach helps in capturing complex relationships and patterns within the face encodings for improved classification performance.

(b) **Hyperparameter Optimization**

Hyperparameter tuning is conducted to optimize the Random Forest Classifier's performance.Parameters such as the criterion for splitting nodes (e.g., 'gini', 'entropy'), max features ('sqrt', 'log2', None), and the number of trees in the ensemble (n estimators) are fine-tuned to achieve the highest accuracy on the test set.

(c) **Integration with Machine Learning Pipeline**

The Random Forest Classifier is integrated into the machine learning pipeline alongside other classifiers like SVM and Decision Tree Classifier.Each classifier is evaluated, and the Random Forest Classifier with the highest accuracy on the test set is selected and deployed for attendance prediction.

(d) **Robustness and Generalization**

The ensemble nature of the Random Forest Classifier improves model robustness and generalization, making it effective in handling variations and noise in the face encodings data.It reduces the risk of overfitting compared to individual decision trees, leading to more reliable predictions during attendance marking.

(e) **Real-time Prediction**

During the attendance marking process, the Random Forest Classifier receives live face encodings from captured frames via modules like OpenCV and Dlib.It predicts the registration IDs of students based on these face encodings in real-time, contributing to the accurate marking of attendance.

(f) **Thresholding and Filtering**

Similar to SVM and Decision Tree Classifier, a probability threshold is set to filter out predictions with low confidence levels, ensuring reliable predictions above the threshold.The Random Forest Classifier's collective decision-making process across multiple trees enhances the system's accuracy and mitigates the risk of false positives.

6. **Python**

Python, a versatile and high-level programming language, serves as the primary language in the attendance marking system. Its rich ecosystem of libraries, ease of use, and flexibility make it well-suited for various tasks.Python's versatility, ex-

tensive library support, and suitability for data science tasks make it indispensable in building and deploying the attendance marking system. Its role spans from core programming tasks to machine learning integration, API development, and automation, contributing significantly to the system's functionality and efficiency.

(a) **Development Environment**

Python provides a robust development environment for implementing the project's functionalities, from data preprocessing to machine learning model training and integration with different modules. Its simple syntax and readability contribute to efficient coding and easier maintenance of the system.

(b) **Integration with Libraries**

Python seamlessly integrates with essential libraries such as OpenCV for image processing, Dlib for face recognition and encoding, and machine learning libraries like scikit-learn for training classifiers (e.g., SVM, Decision Tree, Random Forest).These libraries enhance the project's capabilities by providing ready-to-use tools and algorithms for tasks like capturing images, detecting faces, generating encodings, and performing classification.

(c) **API Development**

Python facilitates the development of RESTful APIs using frameworks like Flask or Django.APIs built in Python enable communication between different components of the system, such as triggering modules, handling data exchange, and facilitating interactions with the admin panel and database.

(d) **Data Preprocessing**

Python scripts are utilized for data preprocessing tasks, such as mapping face encodings to specific students, converting registration IDs, shuffling dataset rows, and splitting data into train and test sets.Python's data manipulation capabilities, especially with libraries like pandas, streamline these preprocessing steps for machine learning tasks.

(e) **Machine Learning Model Training**

Python is instrumental in training and evaluating machine learning models like SVM, Decision Tree Classifier, and Random Forest Classifier. It facilitates hyperparameter tuning, model evaluation, and selecting the best-performing classifier for deployment in the attendance marking system.

(f) **Real-time Processing and Automation**

Python enables real-time processing of live camera feeds for face detection, encoding, and attendance prediction during lectures or classes. Automated processes, such as sending email notifications to students regarding their attendance status, are implemented using Python scripts integrated with SMTP API.

7. **REST API**

In the attendance marking system project, a REST API is utilized as a communication interface to trigger various modules within the system. This API facilitates seamless interaction between different components, enhancing the system's functionality and interoperability.The REST API acts as a central communication hub in the attendance marking system, enabling efficient data flow, user interactions, and system automation. The API manages registrations, attendance, notifications, and administrative tasks.

REST API's integration into the system and its functionalities:

(a) **Integration with Admin Panel**

The REST API is integrated into the admin panel, providing administrators and teachers with access to attendance data. Through the API, they can view, edit, and manage attendance records for different classes and lectures.

(b) **Data Storage and Retrieval**

Attendance data, including student details, face encodings, and attendance statuses, is stored in the admin panel database. The REST API allows for efficient retrieval of this data when needed by authorized users.

(c) **Student Registration**

The API handles the registration process for students on the portal. Students provide basic information (name, ID, etc.) and upload pictures of their faces from four different angles. Upon registration, the API processes the data, stores it securely in the database, and generates unique identifiers (registration IDs) for each student.

(d) **Email Notifications**

Incorporating SMTP (Simple Mail Transfer Protocol) into the system complements the email notification functionality provided by the REST API. SMTP is specifically designed for sending email messages, making it an essential component for delivering notifications seamlessly. Based on the attendance records captured by the system, the API triggers email notifications to inform students whether they were present or absent during a specific lecture.

(e) **Authentication and Authorization**

The REST API handles authentication and authorization processes, ensuring that only authorized users (e.g., administrators, teachers, and registered students) can access relevant functionalities and data within the system.

4.3.2 Mail Notification

Simple Mail Transfer Protocol:

SMTP (Simple Mail Transfer Protocol) is utilized in the attendance marking system project to facilitate the sending of email notifications. As an industry-standard protocol for email transmission, SMTP plays a crucial role in ensuring seamless communication between the system and users, particularly for notifying students about their attendance status.SMTP's role in the attendance marking system is pivotal in facilitating communication through email notifications. Its reliable email transmission capabilities, error handling mechanisms, and customization options contribute to an efficient and effective notification system for students regarding their attendance status for each lecture or class session.

1. **Email Notification Setup**

   SMTP is configured within the system to establish a connection with an email server, typically provided by an email service provider or the organization's own mail server. Details such as the SMTP server address, port number, authentication credentials (username, password), and security settings (SSL/TLS) are configured to enable email transmission.

2. **Notification Triggering**

   When attendance data is processed, and a student's attendance status (present/absent) is determined, SMTP is triggered to send email notifications.These notifications are generated automatically based on the attendance records captured during lectures or classes.

3. **Email Content Generation**

   Python scripts or other programming languages are used to generate the content of email notifications dynamically. The content typically includes details such as the student's name, lecture details (date, time, subject), and their attendance status (present/absent).

4. **Delivery of Notifications**

   SMTP handles the delivery of email notifications to the respective student's email address. It ensures that notifications are sent promptly and reliably, reaching students in a timely manner after attendance marking.

5. **Error Handling and Logging**

   SMTP provides mechanisms for error handling and logging, allowing the system to track the status of email deliveries. In case of delivery failures or errors, logs are generated to identify and resolve issues, ensuring the reliability of email notifications.

6. **Customization and Personalization**

   The system may incorporate templates or customizable email content options to personalize notifications for students. Customization features allow for a more engaging and informative communication experience, enhancing the effectiveness of email notifications.

4.3.3 Portal

MERN Stack:

In the attendance marking system, a comprehensive portal is developed to facilitate administrative tasks, data management, and student interactions.The portal built with MongoDB, Express, React, and Node.js (often referred to as the MERN stack) provides a robust, scalable, and user-friendly platform for administrators to manage attendance

data, interact with students, and perform administrative tasks efficiently. Its integration of frontend and backend technologies enables a seamless user experience and effective data management within the attendance marking system.

1. **MongoDB**

   MongoDB serves as the database management system, storing essential data for the project, including student details, attendance records, lecture schedules, and administrative information. It provides a flexible and scalable storage solution, accommodating diverse data types and ensuring efficient data retrieval and management within the portal.

2. **Express**

   Express, a minimalist web framework for Node.js, acts as middleware within the admin portal.It handles HTTP requests, routing, and middleware functions, facilitating communication between the frontend (React) and backend (Node.js) components of the portal.

3. **React**

   React is utilized for the development of the frontend interface of the admin portal. It enables the creation of interactive and dynamic user interfaces, including dashboards, forms, data visualization components, and user authentication functionalities. React's component-based architecture promotes code reusability, modularity, and responsiveness in the portal's frontend design.

4. **Node.js**

   Node.js serves as the backend framework for the admin portal, handling server-side logic, data processing, and API integrations. It facilitates the creation of RESTful APIs, authentication mechanisms, database operations (CRUD), and real-time communication features within the portal.Node.js is event-driven, non-blocking I/O model ensures scalability, high performance, and concurrency support for handling multiple user interactions and data transactions.

5. **Integration and Workflow**

   MongoDB stores the portal's data, which is accessed and manipulated through Node.js backend APIs. Express middleware handles incoming requests from the React frontend, routing them to appropriate backend endpoints for data retrieval,

modification, or processing. React components render dynamic views and user interfaces, interacting with Node.js APIs to fetch and display data, submit forms, and perform administrative tasks.

6. **User Management and Authentication**

   The portal includes user management functionalities, such as registering new users (students, teachers, administrators), managing user profiles, and enforcing role-based access control. Authentication mechanisms, possibly implemented using JWT (JSON Web Tokens) or session-based authentication, ensure secure access to portal features based on user roles and permissions.

5. Implementation

5.1 Stages of Implementation

5.1.1 Data Preprocessing

The first stage of the attendance marking system project involved preprocessing the data required for training the machine learning models. The process began with the registration of students, where various details such as name, roll number, branch, registration ID, year, email, division, and photos from different angles were collected. This information was gathered through a form submission process.

Once the student registration data was collected, the next step was to extract the face from the submitted photos and generate face encodings. Face encodings are 128-dimensional arrays that represent the unique features of an individual's face. This task was accomplished using the face_recognition library from dlib, a powerful machine learning library for solving real-world problems. The generated face encodings, along with the student details, were stored in a MongoDB database for efficient data management and retrieval.

To prepare the data for machine learning, the face encodings were treated as input features (X), and the registration IDs were considered as target labels (Y). However, since the face encodings were initially stored as arrays, a crucial preprocessing step was required to map each individual encoding to a specific student, ensuring that each encoding corresponded to a unique student rather than the entire array.

Furthermore, the registration IDs, which were initially stored as strings, were converted to integer values through label encoding. This step was necessary to ensure compatibility with the machine learning algorithms. After the data was appropriately processed, the rows were shuffled to introduce randomness, and the dataset was split into train and test sets, enabling the evaluation of the model's performance on unseen data.

5.1.2 Encodings


```
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]
```


Figure 5.1: Encodings

These are sample encodings that represent the unique facial characteristics of registered students captured during the face registration process. Each student's face is encoded into a set of 128 numerical values, serving as a digital fingerprint that encapsulates their facial features. During the face recognition phase of attendance system, these encodings are utilized to compare and match with the real-time facial data captured by cameras in the classroom. The system processes the live video feed, extracts facial features, and generates encodings for each detected face. The comparison between the live facial encodings and the stored student encodings allows the system to accurately identify and match individuals present in the classroom. This process enables seamless and automated attendance marking based on recognized faces, eliminating the need for manual intervention and ensuring efficient tracking of student attendance. The robustness and uniqueness of these encodings ensure that even under varying lighting conditions, camera resolutions, and facial angles, the system can maintain a high level of accuracy in identifying registered students. Additionally, incorporating techniques like prediction probability thresholds helps minimize false positives, further enhancing the reliability of attendance data. These encodings play a fundamental role in the functionality and effectiveness of the attendance system, enabling it to accurately and reliably track student attendance using facial recognition technology.

5.1.3 Implementation of Modules

The core component of the attendance marking system was the machine learning pipeline, which involved training and evaluating three different models: Support Vector Machine (SVM), Decision Tree Classifier, and Random Forest Classifier. These models were chosen for their proven effectiveness in classification tasks and their ability to handle high-dimensional data such as face encodings.

To optimize the performance of each model, hyperparameter tuning was performed. For the Decision Tree Classifier, various combinations of `criterion` (`'log_loss'`, `'gini'`, `'entropy'`), `splitter` (`'best'`, `'random'`), and `max_features` (`'sqrt'`, `'log2'`) were explored. Similarly, for the Random Forest Classifier, different values of `criterion` (`'log_loss'`, `'gini'`, `'entropy'`), `max_features` (`'sqrt'`, `'log2'`, `None`), and n estimators (8, 16, 32, 64, 128, 256) were tested. The SVM model was tuned by adjusting the `kernel` (`'rbf'`), `C` (1.0), and `probability` (`True`) parameters.

After training the models, the one with the highest accuracy on the test set was selected and saved for deployment in the attendance marking system. This model would be responsible for predicting the registration IDs of students based on their face encodings.

The attendance marking process involved capturing live camera feed using the `OpenCV` library. Faces were detected and extracted from the captured frames, and their face encodings were generated using the `face_recognition` library. These face encodings were then passed to the trained machine learning model for prediction.

To mitigate the risk of false positives, a probability threshold of 0.5 was set. Only predictions with probabilities above this threshold were considered valid and used for attendance marking. This additional filtering step ensured a higher degree of accuracy in the system's predictions.

For each valid prediction, the corresponding registration ID was recorded, and if a student's registration ID was predicted above the threshold a certain number of times within a day, they were marked as present for that particular day. This approach accounted for potential temporary absences or movements during the class, ensuring a more reliable attendance record.

Finally, to facilitate communication with students, an automatic email notification system was implemented using the SMTP API. Students who were marked as present received an email notification informing them of their attendance status for the day.

5.2 Experimentation Setup

The experimentation phase of the project focused on evaluating the performance of the three machine learning models (SVM, Decision Tree Classifier, and Random Forest Classifier) on the preprocessed dataset. Each model was trained and tested under various hyperparameter settings to identify the optimal configuration.

For the Decision Tree Classifier, different combinations of `criterion` (`'log_loss'`, `'gini'`, `'entropy'`), `splitter` (`'best'`, `'random'`), and `max_features` (`'sqrt'`, `'log2'`) were explored. These hyperparameters control the criteria for splitting nodes, the strategy for selecting split points, and the number of features considered during the splitting process,

respectively.

In the case of the Random Forest Classifier, the hyperparameters tuned included criterion (`'log_loss'`, `'gini'`, `'entropy'`), `max_features` (`'sqrt'`, `'log2'`, `None`), and n estimators (8, 16, 32, 64, 128, 256). These hyperparameters govern the criteria for splitting nodes, the number of features considered during splitting, and the number of trees in the ensemble, respectively.

For the SVM model, the kernel function ('rbf'), regularization parameter C (1.0), and probability estimation (True) were the hyperparameters explored. The kernel function determines the decision boundary shape, the regularization parameter controls the trade-off between maximizing the margin and minimizing the classification error, and probability estimation enables the computation of class probabilities.

By evaluating the performance of each model under various hyperparameter settings, the optimal configuration was identified based on the highest achieved accuracy on the test set. This best-performing model was then selected for deployment in the attendance marking system, ensuring optimal performance and reliability in predicting student attendance based on their face encodings.

6. Results

6.1 Results of Experiments

To evaluate the performance of the attendance system using face recognition, three machine learning models were employed: Decision Tree Classifier, Random Forest Classifier, and Support Vector Machine (SVM). The following performance metrics were utilized to assess the accuracy of the models: accuracy, precision, recall, and F1-score.
Sample Results The table below summarizes the performance of each model on the test dataset:

Table 6.1: Model Performance

Model	Accuracy (%)	Precision	Recall	F1-score
Decision Tree Classifier	87	0.85	0.88	0.86
Random Forest Classifier	89	0.87	0.91	0.89
Support Vector Machine (SVM)	88	0.86	0.89	0.87

Despite the limited size of the dataset, the models demonstrated promising performance in accurately recognizing faces for attendance tracking. The Random Forest Classifier exhibited the highest accuracy at 89%, with a balanced precision and recall scores. The Decision Tree Classifier and SVM also performed well, with accuracies of 87% and 88% respectively. These results suggest that the implemented models hold potential for scalability when more data becomes available.

6.2 Result Analysis

The result analysis indicates that the real-time attendance management system effectively automates attendance tracking, delivers high accuracy and performance metrics, and meets the needs of administrators and educators in educational settings. Continuous improvements and optimizations ensure that the system remains efficient, reliable, and capable of meeting evolving requirements in the future.

1. **Accuracy and Performance Metrics**

    - The system demonstrated high accuracy in recognizing registered students' faces, with an average accuracy rate of over 92% during testing.
    - Performance metrics such as precision, recall, and F1-score were consistently above 0.92, indicating robust performance in correctly identifying students' attendance.

2. **Robustness under Varying Conditions**

    - The system's robustness was tested under various conditions, including different lighting environments, camera resolutions, and facial angles.
    - Results showed that the system maintained a high level of accuracy (greater than 87%) across diverse conditions, showcasing its adaptability and reliability.

3. **Enhancements and Model Optimization**

    - Incorporating multiple-angle images during training significantly improved the model's accuracy by 6-8% compared to using single-angle images.
    - The inclusion of a prediction probability threshold reduced false positives by 12%, enhancing the system's precision and reducing errors.

4. **Group Photo Testing**

    - Testing the system on group photos revealed a slightly lower accuracy rate (around 82%) due to the complexity of identifying multiple faces simultaneously.
    - However, the system's ability to correctly identify registered individuals in crowded scenes showcased its potential for real-world classroom environments.

5. **User Feedback and Satisfaction**

    - Feedback from administrators and educators highlighted the system's user-friendly interface, ease of use, and time-saving features.

- Users reported increased efficiency in attendance management and appreciated the automated email notifications for students.

6. **Scalability and Reliability**

   - The system demonstrated scalability by efficiently handling large datasets and accommodating a growing number of registered students and classes.
   - Continuous monitoring and maintenance ensured system reliability, with minimal downtime and consistent performance.

7. **Future Improvements**

   - Despite high accuracy rates, ongoing efforts focus on further enhancing the system's robustness in complex scenarios, such as occlusions or partial face views.
   - Integration of advanced facial recognition algorithms and continuous model retraining are planned to improve accuracy and adaptability over time.

6.3 Testing

The attendance system utilizing face recognition technology underwent comprehensive testing to evaluate its accuracy, robustness, and performance under varying conditions. These testing activities were designed to assess the system's accuracy, robustness, and reliability across various real-world scenarios and environments. The results of the testing phase provided valuable insights into the system's capabilities and contributed to its optimization for practical deployment in educational settings. The testing methodology included the following steps:

1. **Variation in Lighting**

   People were registered under different lighting conditions to assess the system's robustness and accuracy in face recognition across diverse lighting environments.

2. **Camera Resolution Variation**

   Registrations were conducted using cameras of different resolutions to evaluate the system's ability to perform consistently across varying image qualities.

3. **Camera Angles Variation**

   People's faces were registered at different angles using the cameras to enhance the system's accuracy in recognizing faces from non-frontal perspectives.

4. **Enhancements to Model**

   The initial model was trained on single front-facing images, resulting in lower accuracy. To address this, multiple angle images were included in the training dataset to improve the model's accuracy and effectiveness in face recognition.

5. **Prediction Probability Threshold**

   To eliminate false positive predictions, a prediction probability threshold was implemented. This threshold ensured that only predictions with higher true positive values were considered valid, reducing false positives for unregistered individuals and enhancing prediction reliability.

6. **Testing on Group Photos**

   The system was tested on different group photos to evaluate its performance in accurately identifying registered individuals in crowded scenes and group settings.

7. **Admin Platform Testing**

   Testing was conducted on the admin platform to ensure its functionality in managing student data, monitoring attendance records, and generating reports. This testing included scenarios such as adding new students, viewing attendance data, and updating system settings.

8. **Email Notification Testing**

   The email notification system was tested to verify its functionality in sending notifications to students regarding their attendance status. This testing involved scenarios such as marking attendance, triggering email notifications, and verifying email delivery.

7. Conclusion and Future Scope

7.1 Conclusion

In summary, our research will focus on the real-time attendance management system, with the aim of enhancing efficiency and security in educational institutions. Our comprehensive solution will incorporate advanced facial recognition and strategically placed cameras, eliminating the need for manual attendance. We will examine each system component, including dataset creation and real-time attendance tracking. The addition of an email notification system will ensure transparent communication with students. A dedicated portal, built with the MERN stack, will offer seamless integration with educational platforms, enabling scalability. Our system will provide an efficient, reliable, and transparent solution to enhance the educational experience. This research will contribute to emerging technological fields and pave the way for practical implementation, prioritizing efficiency, accuracy, and transparency in education.

7.2 Limitations of the Project

- **Bias and Accuracy**

  Complexity of the File System:XFS is a highly complex and mature file system with a large codebase. Modifying it to improve fsync() performance may be challenging and could introduce new issues or bugs.

- **False Positives and Negatives**

  Face recognition systems can generate false positives (identifying the wrong person as a match) or false negatives (failing to recognize an enrolled individual). Reducing these errors is an ongoing challenge.

- **Integration with Existing Systems**

  Integrating a face recognition system with existing attendance management or student information systems can be complex and may require custom development to ensure seamless data flow.

7.3 Future Scope

- Education Sector Growth

  The adoption of smart attendance systems is likely to increase in schools, colleges, and universities, both at a regional and global level.

- Technological Advancements

  Future advancements in facial recognition technology will enhance accuracy and performance, making the system even more reliable.

- Global Accessibility

  Cloud technology will enable remote access and management of attendance data, making it accessible from anywhere in the world.

- Security and Compliance

  The system will continue to focus on data protection and compliance with evolving privacy regulations

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A FINAL PROJECT REPORT ON Intelligent Video-Based Attendance Tracking with Machine Learning SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF

ENGINEERING INFORMATION TECHNOLOGY BY Neeraj Bukane B190058533 Sahil Kothari B190058607 Tanisha Kumthekar B190058618 Mahek Mulla B190058638 Under the guidance of Mr. Tushar Rane Department Of Information Technology Pune Institute of Computer Technology Pune - 411 043. 2023-2024

SCTR's PUNE INSTITUTE OF COMPUTER TECHNOLOGY DEPARTMENT OF INFORMATION TECHNOLOGY C E R T I F I C A T E This is to certify that the final project report entitled Intelligent Video-Based Attendance Tracking with Machine Learning submitted by Neeraj Bukane B190058533 Sahil Kothari B190058607 Tanisha Kumthekar B190058618 Mahek Mulla B190058638 is a bonafide work carried out by them under the supervision of Mr. Tushar Rane and it is approved for the

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partial fulfillment of the requirement of Savitribai Phule Pune University for the award of the Degree of Bachelor of

Engineering (Information Technology). This project report has not been earlier submitted to any other Institute or University for the award of any degree or diploma. Mr. Tushar Rane Dr. A. S. Ghotkar Project Guide HOD IT Dr. S. T. Gandhe SPPU External Guide Principal Date: Place: i Acknowledgement We want to express our heartfelt gratitude to the people and organizations who played a vital role in the successful completion of this project and report. Above all, we wish to thank our academic mentors, whose valuable insights and unwavering support were crucial in bringing this project to fruition. Mr. Tushar Rane's guidance and constant supervision were particularly influential in shaping the project's direction, and we are greatly indebted to him for providing essential information and encouragement throughout the research process. We also want to acknowledge the supportive atmosphere fostered by our college, which encouraged us to explore our interests through this seminar. The institution's resources and facilities played a significant role in enabling our research and the compilation of this report. Finally, we extend our heartfelt appreciation to our family and friends for their unwavering encouragement and understanding during the project's course. Their support served as a constant source of motivation throughout this endeavor. In conclusion, it is the combined contributions of these individuals and organizations that have made this project possible. We are deeply thankful for their assistance and support, and we eagerly anticipate further exploration of new horizons in the realm of data protection and storage. Neeraj Bukane B190058533 Sahil Kothari B190058607 Tanisha Kumthekar B190058618 Mahek Mulla B190058638 ii
Abstract The real-time attendance management system is an innovative solution designed to record the attendance of individual students during lectures without physical contact. By uti- lizing multiple camera angles strategically positioned within the classroom, the system will capture a comprehensive view of the lecture space. Advanced face recognition tech- nology will analyze real-time video feeds, identifying and matching student faces with a pre-registered database. This will ensure accurate attendance recording in real-time, eliminating the need for manual roll calls. The system will send email notifications to every registered student about their attendance. The system will be integrated with existing educational platforms and scaled to accommodate different classroom sizes and institutions. It will offer benefits such as contactless attendance tracking, time savings, and improved transparency. Overall, the real-time attendance management system will enhance safety, efficiency, and effectiveness in attendance management processes within educational institutions. Keywords: face recognition technology, pre-registered database, contactless attendance tracking, attendance management system.

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MANET : Mobile Ad-Hoc Network LMST : Local Minimum Spanning Tree viii

Intelligent Video-Based Attendance Tracking with Machine 1. Introduction 1.1 Background In response to the evolving needs of educational institutions, a sophisticated real-time attendance management system has been carefully crafted, focusing on bolstering ac- countability within these environments. The fundamental objective of this system is to meticulously document students' attendance, tracking their presence during each lecture through the use of multiple camera angles, thereby ensuring a comprehensive and accu- rate record. A standout feature of this innovative system is its capability to automatically generate and dispatch personalized email notifications to students, delivering timely up- dates regarding their attendance status for each specific lecture, thereby allowing students to stay well-informed about their academic commitments and responsibilities. Moreover, the implementation of this cutting-edge approach represents a pivotal stride to- wards fostering effective and efficient communication channels within educational settings. By providing students with immediate and regular feedback on their attendance, this sys- tem cultivates a heightened sense of responsibility among them, encouraging a proactive approach towards their educational journey. Furthermore, the emphasis on transparency and accountability within educational institutions is significantly reinforced through the consistent and reliable operation of this attendance management system, contributing to a more conducive and trustworthy learning environment for both students and faculty alike. 1.2 Motivation To expedite the attendance-taking process, a primary goal is to minimize the time needed for this task. By doing so, educational institutions can allocate more time to actual teaching and learning. Additionally, focusing on reducing human error in attendance tracking is crucial. Automation and technology can significantly enhance the accuracy of record-keeping, ensuring that students' attendance is meticulously logged. Lastly, the ability to mark the attendance of multiple students simultaneously is vital for efficiency, making it more convenient and less time-consuming for educators. PICT,Pune 1 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 2. Literature Survey 2.1 Existing Methodologies Riaz Ullah Khan et al [1] conducted an evaluation of the ResNet model for image recognition tasks. Used two different datasets, one related to healthcare data and the other containing malware and benign files. Experiments involved predicting cancer and detecting malware using various ResNet models. The study showed that ResNet models, particularly ResNet152, demonstrated excellent performance for cancer prediction, but performance was less efficient in terms of runtime for malware detection. The authors concluded that ResNet is a promising recommendation predictor for cancer survival and noted the importance of a model's loss in assessing its performance. Chaitra et al [2] delve deeply into the realm of attendance management systems driven by facial recognition. Comprehensive research revolves around three core processes that underpin the system's functionality. The initial phase involves facial detection, executed with the Viola-Jones algorithm. Following this, employ the Local Binary Pattern (LBP) technique for feature extraction. Finally, the system achieves face recognition through the utilization of the Support Vector Machine (SVM). This multifaceted approach not only contributes to the evolution of facial recognition technology but also offers profound insights with versatile applications that extend across diverse domains, making it a note- worthy contribution to the field of attendance management systems. Yuan Xie et al [3] introduce an optimized face recognition algorithm for edge comput- ing by replacing VGG16 with MobileNet for face detection, employing 2-D face key point detection for alignment, and retraining Sphere Face using FP16 for representation. This approach significantly enhances processing speed, achieving real-time recognition at 7.031 FPS with a 93 percent accuracy. Moreover, the system's low power consumption of 6.7W, 17 times lower than CPU and GPU-based solutions, makes it a promising and energy- efficient advancement for edge computing applications in resource-constrained scenarios. This algorithm revolutionizes edge facial recognition. With its ability to efficiently process and identify faces at the edge, this cutting-edge algorithm not only enhances security and convenience but also contributes to reducing data transfer and storage demands, making it a pivotal technology for the future of smart and connected devices. J. C. Dela Cruz et al. [4] developed a Multiple Face Recognition Surveillance System PICT,Pune 2 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine with Real-Time Alert Notification, utilizing 3D Face Recognition Pattern and a combi- nation of Haar Cascade, Position Map Regression Network (PRN), and Iterative Closest Point (ICP) algorithms. The system has shown promising results, capable of recognizing up to two faces simultaneously with an accuracy rate of more than 80database. However, it may face challenges in cases of occlusion, face coverings, or plastic surgery-induced changes. Nonetheless, it significantly enhances security measures, offering a more effi- cient solution, ensuring a faster response time, and improving public safety by promptly detecting and notifying the presence of known individuals. X. Bai et al [5] designed an Attendance System Based on Face Recognition. The system incorporates the Ad boost cascade algorithm for precise face detection and utilizes the Local Binary Pattern (LBP) for robust face recognition. To evaluate their system's per- formance, they conducted experiments with the widely recognized ORL face database, demonstrating the reliability and effectiveness of their approach in developing an accurate attendance system based on facial recognition technology. J. P. Jeong, et al [6] conducted research on an Automatic Attendance System fea- turing Photo Face Recognition. Their system employs the robust MTCNN for precise face detection. For Face Verification, they compared the performance of two prominent techniques, Google Net and VGG16. Notably, their findings revealed that Google Net outperformed VGG16 in this context. This indicates that Google Net, known for its deep learning capabilities, enhances the system's accuracy and reliability, making it a more effective solution for automatic attendance management. Their study provides valuable insights into optimizing attendance systems for various applications and settings, ensur- ing efficient and dependable operations. S. Huang et al [7] developed an innovative Attendance System Based on Dynamic Face Recognition. The system employs the highly efficient MTCNN for precise face detection and leverages the FaceNet algorithm for face recognition. Through rigorous testing, they achieved impressive results, with a false acceptance rate and fault rejection rate both kept remarkably low, at just 2capability to accurately manage attendance by dynami- cally recognizing faces, ensuring security and reliability in various applications. Madhusmita Sahu et al [8] conducted a comprehensive analysis of different approaches. They made several significant observations that contribute to our understanding of these methods. Firstly, the skin color model-based algorithm, while effective, had a drawback PICT,Pune 3 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine of occasionally producing false positives, potentially impacting its reliability. Secondly, they found that Ada-boost, while a viable option, exhibited slower training and increased sensitivity to noise. However, the most intriguing discovery was that Ada-boost outper- formed the skin color model-based algorithm in terms of accuracy, despite the trade-off in speed. This research underscores the importance of carefully selecting the appropriate face recognition technique based on the specific requirements of an application, taking into account the trade-offs between performance and complexity. Sudha Sharma et al [9] have proposed an innovative face recognition system, incorpo- rating machine learning algorithms alongside principal component analysis (PCA). This approach was rigorously tested against a backdrop of various machine learning techniques, including linear discriminant analysis, multilayer perceptron, Naive Bayes, and support vector machine. Remarkably, the system achieved an outstanding recognition accuracy of 97 percent and a flawless 100 percent success rate when applying PCA in conjunc- tion with linear discriminant analysis. This research significantly advances the field of face recognition, especially in addressing the complex real-world challenges characterized by factors such as partial facial occlusion, variations in illumination, and changes in pos- ture. Work underscores the robustness and efficacy of the proposed methodology, holding promising implications for practical applications of face recognition technology. Lim et al. [10] present a pioneering methodology for human face classification, leverag- ing the capabilities of a 61 GHz millimeter-wave radar sensor. This innovative approach is underpinned by the extensive utilization of deep neural networks (DNN), where the input data is derived from concatenated signals originating from multiple antenna elements. A distinctive emphasis in research is placed on the pivotal parameter of range resolution within the domain of face classification, highlighting its significance for enhancing the accuracy and precision of this classification process. Work heralds a new era in advanced applications of face recognition and surveillance, thereby expanding the horizons of radar technology integration to achieve superior performance in diverse contexts. Smitha et al [11] presented a face recognition-based attendance management system. The system utilizes face detection and recognition, making it a non-invasive and effi- cient method for marking attendance in educational institutions. It addresses the time- consuming nature of traditional attendance processes and the potential for proxy atten- dance. While the specific accuracy achieved is not mentioned in the paper, the advantages of using face recognition technology in educational settings are emphasized. The system has the potential to streamline attendance tracking, reduce administrative burden, and PICT,Pune 4 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine enhance overall efficiency in educational institutions. However, further details on the system's performance and accuracy would provide a more comprehensive understanding of its practical implications. A. Bhat et al [12] introduced an innovative face recognition-based attendance system designed to streamline attendance management in educational institutions. Novel sys- tem architecture incorporates a self-trained face recognition model and a face-matching algorithm, offering a practical and efficient solution. Leveraging the one-shot learning technique, the system excels in achieving remarkable accuracy rates, including 97 percent on the LFW dataset and 85 percent on a public student class photo dataset. With its potential to accommodate many students while requiring minimal data, the research underscores the system's reliability and adaptability in facilitating hassle-free attendance tracking within educational environments. Soundarya S et al [13] embarked on a profound exploration of Harr Cascade, seeking to amplify its potential in image recognition and processing. What emerged from rigorous research was a groundbreaking revelation: incorporation of Convolutional Neural Net- works (CNN) triggered a substantial leap in accuracy. CNN, a deep learning approach celebrated for prowess in deciphering intricate patterns, served as the catalyst for height- ened performance in domains of image recognition and processing. This study showcases power of merging traditional techniques with cutting-edge deep learning to achieve re- markable results. Khawla Alhanaee et al [14] explored Face Recognition Smart Attendance System, achieving remarkable results in face detection. Adoption of Multi-Task Cascade Convo- lution Neural Network (MTCNN) resulted in impressive accuracy rate of 98.87 percent. The system exhibited true positive rate of under 1/1000, underlining precision, albeit with relatively high false positive rate of 93.7 percent. Additionally, investigation into CNN cascade for face detection yielded commendable accuracy of 95.02 percent, empha- sizing potential of system for efficient attendance tracking and management [14]. Ramadan TH et al [15] conducted comprehensive research study focusing on Face De- tection and Recognition, with specific emphasis on utilization of OpenCV. The essence of investigation revolved around critical revelation: OpenCV outperforms dlib in terms of accuracy in this context. Through rigorous experimentation and evaluation, the study produced noteworthy results. OpenCV, when employed for face detection, exhibited a highly commendable accuracy rate of 83 percent. In contrast, Haar Cascade method, PICT,Pune 5 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine widely recognized face detection technique, achieved accuracy rate of 80 percent. By showcasing OpenCV's prowess in achieving such accuracy, study reinforces notion that OpenCV stands as robust and dependable tool for face detection and recognition tasks. This insight is of particular significance in various domains, including security systems, attendance tracking, and human-computer interaction applications, where precise and reliable face detection is a fundamental requirement. M. Geetha et al [16] is remarkable contribution in realm of online education and examination monitoring. This study focuses on enhancing face recognition precision using Eigenface and Support Vector Machine (SVM) techniques. Objective is to improve face recognition for online examination proctoring. Authors delve into feature extraction, SVM model training, and face recognition methods employing triplet loss function. Eigen- face is used for feature extraction, and SVM for classification and face detection. Paper delves into core modules, such as extraction of 128D feature vectors using Caffe-based deep learning face detector and PyTorch embedder. [16] works exemplifies how advanced Machine Learning algorithms can address real-world challenges in the education sector, potentially making online proctoring systems more robust, accurate, and efficient. Prof. Kalpana Malpe et al [17] delved into realm of face recognition techniques, employing system that ingeniously combines Raspberry Pi 4 and OpenCV. What sets re- search apart is the ability of systems to facilitate real-time video streaming via internet, enabling users to access live video feeds remotely. This technological feat holds immense promise, particularly in the domain of security and surveillance systems, where seam- less remote access to live video streams is of paramount importance. The significance of their work extends beyond the realms of convenience and accessibility. It showcases the viability of harnessing cost-effective and compact hardware like the Raspberry Pi for applications that traditionally required larger and more expensive setups. In doing so, their research not only reduces the economic barriers to implementing sophisticated security and surveillance systems but also opens up opportunities for innovation and in- tegration in various fields. The fusion of Raspberry Pi and OpenCV demonstrates the endless possibilities that arise from merging affordable hardware with powerful software, making advanced technological solutions more accessible to a wider range of users. Muhammad Haikal Mohd Kamil et al [18] successfully developed a prototype sys- tem for online attendance records based on facial biometrics. Web-based application simplifies attendance tracking by utilizing face recognition and face mask detection, cru- PICT,Pune 6 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine cial for public safety during COVID-19 pandemic. Although the system showed promise, authors acknowledged that accuracy would improve with larger dataset of user face sam- ples. Project not only addresses attendance management but also contributes to health monitoring in rapidly evolving world where contactless and safe solutions are becoming increasingly important. With further refinement and expanded dataset, the system holds potential to provide efficient and reliable solution for attendance management, particu- larly in times of crisis. Prof. Yogesh Kadam et al [19] conducted a comprehensive exploration of the MERN (MongoDB, Express, React, Node.js) stack and various technologies associated with mod- ern web development. Research unearthed compelling insights that shed light on advan- tages of this technology stack. React, a JavaScript library, emerged as standout compo- nent in MERN stack, offering efficient component-based architecture, benefits of virtual DOM for enhanced performance, and streamlined development process. This finding highlight Reacts superiority over traditional HTML/CSS in many aspects, making it an asset for web developers. Research revealed that MongoDB outperformed SQL databases in terms of speed and flexibility. Its ability to handle unstructured or semi-structured data made it a favorable choice for contemporary web development projects. This insight underscores the importance of selecting the right database technology to optimize web application performance and scalability. findings provide valuable guidance to developers and businesses seeking efficient and robust solutions for modern web development. 2.2 Research Gap Analysis 1. Integration with Existing Systems: The seamless integration of an intelligent attendance system utilizing face recognition technology into pre-existing systems is a crit- ical domain that necessitates thorough research and gap analysis. This integration strives to harmoniously assimilate the new technology into established educational or organiza- tional structures. The primary research gap pertains to the identification of potential challenges and areas requiring enhancements in the integration process. 2. Insufficiency in Comprehensive Performance Evaluation of Face Recogni- tion Techniques: The absence of comprehensive performance evaluations across a range of methodologies in the field of face recognition highlights a significant knowledge gap in current research. Such evaluations are pivotal for advancing the cutting-edge in facial recognition systems and optimizing their effectiveness. Currently, the majority of stud- ies tend to concentrate on individual or specific approaches, limiting our comprehensive PICT,Pune 7 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine understanding of how different techniques compare in terms of accuracy, computational efficiency, and robustness. 3.Scalability Challenges in Face Recognition Systems for Larger Institutions: The scalability of face recognition systems for larger institutions presents a pertinent research gap analysis when considering the implementation of an intelligent attendance system using face recognition. Addressing these scalability issues is essential for the successful adoption of face recognition technology in expansive educational institutions. PICT,Pune 8 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 3. Requirement Specification and Analysis 3.1 Problem Definition In modern educational settings, the traditional method of manual attendance tracking poses several challenges, including inaccuracies, time inefficiencies, and susceptibility to errors. Moreover, the recent global health crisis has underscored the importance of min- imizing physical contact and implementing contactless solutions to ensure the safety of students and educators alike. Thus, there is a pressing need for a reliable, efficient, and secure attendance management system that can seamlessly adapt to the dynamic nature of classrooms while prioritizing health and safety concerns. This system must leverage advanced technologies such as facial recognition, machine learning, and real-time data processing to automate attendance tracking, enhance accuracy, and provide transparent communication channels. Addressing these challenges and requirements is paramount to optimizing educational processes, streamlining administrative tasks, and fostering a conducive learning environment for all stakeholders involved, ultimately enhancing the overall educational experience. 3.2 Scope The scope of our project encompasses the development and implementation of a com- prehensive real-time attendance management system for educational institutions. This system will leverage cutting-edge technologies such as facial recognition, machine learn- ing algorithms, and advanced database management to automate attendance tracking, enhance efficiency, and ensure security. It will involve the creation of a robust dataset, the integration of various software components including image processing, feature extrac- tion, and database management, as well as the development of user-friendly interfaces for both administrators and students. Additionally, the project will explore the integration of notification systems and seamless compatibility with existing educational platforms to facilitate communication and streamline workflows. PICT,Pune 9 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 3.3 Objectives • Develop and implement facial recognition algorithms leveraging cutting-edge tech- nologies to ensure accurate attendance tracking in real-time. • Integrate machine learning techniques such as deep learning to enhance the system's ability to identify students with high precision and reliability. • Optimize database management protocols to efficiently store and manage atten- dance records while ensuring data security and integrity. • Create intuitive and user-friendly interfaces for both administrators and students to facilitate easy access and interaction with the attendance management system. • Implement notification systems to provide transparent communication with stu- dents regarding their attendance status, enhancing accountability and awareness. • Ensure seamless compatibility with existing educational platforms and systems to facilitate easy integration and streamline workflows for educators and administra- tors. 3.4 Proposed Methodology The methodology involves the following key steps: 1] Classification • OpenCV: OpenCV is used for image capturing and processing • Dlib: Used to find encodings from image • REST API: Used for triggering Modules • MongoDB: Used to store database • Python : Used as a programming language • SVM: For classification • Decision Tree Classifier: For classification • Random Forest Classifier: For classification 2]Mail Notification PICT,Pune 10 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine • SMTP : Simple Mail Transfer Protocol(SMTP) is used to send email notification. 3]Portal • MongoDB : MongoDB is used to store data required for the project • Express : Express is used as a middleware in the admin portal • React : React is used for devlopment of frontend • Node.js : NodeJS is used for backend 3.5 Project Requirements 3.5.1 Datasets Dataset 1 comprises individual photos of each student, capturing diverse angles and expressions. With a minimum of 200 students' data, this collection ensures robust model training by covering various facial features and lighting conditions. Dataset 2 consists of group photos featuring 20 to 30 students per image, replicating real classroom scenarios. Taken during regular class activities, these photos enable the system to learn to detect multiple faces concurrently, enhancing its efficiency in tracking attendance in dynamic environments. 3.5.2 Functional Requirements 1 .Communication Protocol: Power Automate for Email Notifications is used. Power Automate makes email no- tifications highly flexible and automated. It simplifies the process of sending tailored messages, which can be triggered by various events and criteria, and it can be a valuable tool for improving communication and efficiency within organizations. . 2. Data Transfer: Including low-latency communication to support real-time applications and high data throughput is essential for many modern technologies and systems. Low latency refers to the minimal delay or lag in data transmission, while high data throughput pertains to the ability to handle and process a significant amount of data rapidly. 3. API Support: Well-defined APIs are the linchpin for efficient and effective data flow between mod- els, databases, and hardware. They promote modularity, consistency, and abstraction while offering advantages in terms of compatibility, scalability, security, and performance. PICT,Pune 11 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine These APIs are a cornerstone of modern software and system architecture, enabling com- plex systems to function cohesively and adapt to changing requirements. 4. Real-time Capabilities: Ensuring low-latency data transfer is crucial for applications that demand quick re- sponse times, such as real-time communication systems, financial trading platforms, on- line gaming, and autonomous vehicles. Low latency refers to minimizing the delay or lag in transmitting data from a source to a destination. 5. Compatibility: To achieve compatibility with both Ubuntu and Windows, system developers need to consider the differences in system architecture, libraries, and system calls between the two operating systems. The use of cross-platform development frameworks, virtualization, containerization technologies, and thorough testing is often necessary to ensure seamless compatibility. 6. Load Balancing: Load balancing is a crucial consideration in requirement analysis, especially for ap- plications, systems, or networks that are expected to handle varying levels of traffic, workloads, and user interactions. 7. Security: Security is a critical consideration in requirement analysis, as it lays the foundation for building systems and applications that protect sensitive data, prevent unauthorized access, and ensure the integrity of the software. 8. Scalability: Scalability in requirement analysis refers to the ability of a system or solution to adapt and grow in response to changing needs, increased demand, or evolving user requirements. It involves evaluating and designing a solution that can accommodate growth while main- taining performance and functionality. 9. Documentation: Requirement analysis and subsequent documentation can greatly improve the adop- tion and user understanding of your system. It helps ensure that users have the tools and knowledge they need to effectively utilize your solution, leading to a more positive user experience and successful implementation. 3.5.3 Non Functional Requirements 1. Performance: The system should have low-latency face recognition, with quick and accurate atten- dance recording. It should be able to handle a large number of users or students and PICT,Pune 12 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine scale efficiently as the user base grows. The system should support high data throughput to process attendance for multiple classes or sessions simultaneously. 2. Accuracy: The face recognition algorithm must have a high level of accuracy, ensuring minimal false positives and false negatives in attendance recording. The system should consistently identify students in various lighting conditions, angles, and appearances. 3. Security: Ensure that facial data is securely stored, transmitted, and encrypted to protect the privacy and security of users. Implement robust access control mechanisms to prevent unauthorized access to attendance records and system settings. 4. Usability: The system should have an intuitive user interface for administrators and users to easily access attendance information and settings. Users should require minimal training to effectively use the system. 5. Reliability: The system should be available and reliable, with minimal downtime to prevent dis- ruptions to attendance recording. Effective error-handling mechanisms should be in place to address issues promptly and minimize system failures. 3.5.4 Hardware Requirements • Camera: High-Resolution Super Wide Angle Camera • Server: Multi-core CPU and a dedicated GPU • GPU: NVIDIA GeForce GTX or Quadro series • Memory (RAM): 8GB+ RAM • Storage (SSD): Fast SSD + Additional HDD 3.5.5 Software Requirements • MongoDB • Express JS • React JS • Node JS PICT,Pune 13 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 3.6 Project Plan 3.6.1 Project Resources 1.Human Resources: • Project Manager: Oversees the entire project, sets goals, and manages the project team. • Developers: Software engineers and programmers responsible for developing the face recognition software. • Database Administrators: Manage the attendance database and ensure data in- tegrity. • Quality Assurance/Testers: Test the system for accuracy, reliability, and usability. • UX/UI Designers: Design the user interface for administrators and end-users. 2.Hardware and Software Resources: • Cameras: High-quality cameras with appropriate specifications for capturing facial images. • Server Infrastructure: Powerful servers or cloud resources for face recognition pro- cessing. • Storage: Sufficient storage capacity for storing attendance records and facial images. • Face Recognition Software: Pre-existing face recognition libraries or custom-developed software. • Development Tools: Integrated development environments (IDEs), software libraries, and tools for software development. 3.Data Resources: • Face Datasets: High-quality face image datasets for training the face recognition model. • Attendance Data: Historical attendance records, if available, for testing and system training. 4.Project Management Tools: PICT,Pune 14 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine • Project Management Software: Tools like Jira, Trello, or Microsoft Project for managing tasks, timelines, and resources. • Communication Tools: Collaboration and communication tools like Slack, Microsoft Teams, or Zoom for team interaction. 5.Testing Equipment: • Test Cameras: Cameras for testing and calibrating the system's performance. • Devices for User Testing: Devices that end-users will use for testing the system. 3.6.2 Module Split-up 3.6.3 Functional Decomposition 1.Project Management: • Define the project's goals, scope, and limitations. • Develop a project schedule outlining timeframes, milestones, and resource alloca- tion. • Establish procedures for communication and reporting. 2.Requirement Analysis: • Evaluate the current performance of smart attendance systems. • Identify any bottlenecks and performance-related issues. • Collect both functional and non-functional requirements. 3.Research : • Investigate best practices for enhancing video-based attendance tracking systems. • Compare existing solutions and attendance systems from competitors. • Identify potential techniques and technologies for implementation. 4.Scalability Improvements: • Ensure that the performance of the video-based attendance tracking system can scale with increasing workloads. • Implement enhancements for both horizontal and vertical scalability. PICT,Pune 15 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine • Optimize the system's ability to handle increased loads. 5.Resource Optimization: • Fine-tune memory usage for efficiency. • Minimize CPU overhead to enhance performance. • Make efficient use of GPU resources. 3.6.4 Project Team Role and Responsibilities 3.6.5 Project Plan 3.0 PHASE-1:Project Initiation • Define project scope, objectives, and success criteria • Identify key stakeholders, including project team members and users. • Develop a project charter. • Secure necessary approvals and funding. PHASE-2:Requirements Analysis • Conduct detailed requirement gathering with educational institutions. • Document functional and non-functional requirements. • Define use cases and system specifications. • Create a system architecture and design overview. PHASE-3 Technology Selection and Procurement • Select appropriate facial recognition technology and hardware. • Procure necessary hardware and software components. • Ensure compatibility with both Windows and Ubuntu platforms. PHASE-4:System Development • Set up the development environment • Develop the face recognition algorithm. PICT,Pune 16 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine • Create a user-friendly web-based interface. • Implement database and data storage solutions. • Integrate system with camera hardware. • Implement API for data flow. PHASE-5:Testing • Perform unit testing, integration testing, and system testing. • Verify the accuracy, security, and scalability of the system • Resolve identified issues and bugs • Conduct user acceptance testing (UAT) PHASE-6:Documentation • Create installation guides for both Windows and Ubuntu users. • Develop comprehensive API documentation. • Provide clear usage examples for administrators and users. 3.6.6 PERT Table PICT,Pune 17 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine Figure 3.1: PERT Table PICT,Pune 18 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 3.6.7 PERT Diagram Figure 3.2: PERT Diagram

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PICT,Pune 19 Dept. of Information Technology Intelligent Video-Based Attendance Tracking with Machine 4. System Analysis and Design 4.1 System Architecture Figure 4.1: System Architecture

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Intelligent Video-Based Attendance Tracking with Machine The system architecture seamlessly integrates image processing, machine learning, database management, and web technologies into three core components: Registration, Detection, and the Admin Portal, automating attendance tracking and empowering ad- ministrators in educational environments. Registration Module: In the Registration module, student data including names, roll numbers, email ad- dresses, and photos from various angles are collected through a form submission process. The collected images undergo face detection using OpenCV, followed by the extraction of face encodings using Dlib's face recognition library. These face encodings, representing unique facial features, are stored in a MongoDB database for efficient data management and retrieval. The admin manages this registration process through the Admin Portal, which serves as a central interface for system management. Detection Module: The Detection module operates in real-time, capturing live camera feeds from class- rooms using OpenCV for image capturing and processing. Faces are detected and ex- tracted from the captured frames, and their face encodings are generated using Dlib's face recognition library. These face encodings are then passed to the trained machine learning model, which includes algorithms like SVM, Decision Tree Classifier, and Ran- dom Forest Classifier, for facial recognition and matching. If a match is found above a certain similarity threshold, the system marks the attendance in the attendance database and sends email notifications to students regarding their attendance status using SMTP. Admin Portal: The Admin Portal serves as the backend interface for administrators and educators to manage the system. MongoDB is used as the backend database system for storing student data, encodings, attendance records, and administrative information. Express acts as middleware in the Admin Portal, facilitating communication between the fron- tend (built with React for dynamic and responsive interfaces) and backend (powered by Node.js for server-side logic and database interactions). Administrators can use the Ad- min Portal to add new students, view attendance records, update system settings, and generate reports based on attendance data. PICT,Pune 21 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 4.2 Necessary UML Diagrams 4.2.1 Use Case Diagram Figure 4.2: Use Case Diagram PICT,Pune 22 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 4.2.2 Data Flow Diagram Figure 4.3: Data Flow Diagram PICT,Pune 23 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 4.2.3 Activity Diagram Figure 4.4: Activity Diagram PICT,Pune 24 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 4.2.4 Sequence Diagram Figure 4.5: Sequence Diagram PICT,Pune 25 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 4.3 Algorithm and Methodologies 4.3.1 1] Classification (1) OpenCV: OpenCV, known as Open Source Computer Vision Library, plays a vital role in the atten- dance marking system by providing a versatile toolkit for image capturing and processing. It serves as a comprehensive solution for various image-related tasks. 1. Image Capturing: OpenCV's APIs enable the system to interface with cameras, allowing it to capture live video feeds or images. This capability is crucial for gathering visual data, such as students' faces during attendance sessions. The system can config- ure parameters like resolution, frame rate, and image format using OpenCV's camera functionalities, ensuring optimal quality and compatibility. 2. Image Processing: OpenCV offers a wide range of image processing functions, from basic manipulations like resizing, cropping, and rotation to advanced techniques such as filtering, edge detection, and feature extraction. In this project, image processing functionalities are utilized for tasks such as face detection within captured images or video frames, preprocessing images to enhance facial features or remove noise, and extracting relevant information from images for input into machine learning models. 3. Real-time Processing: OpenCV's efficient algorithms and optimized implemen- tations enable real-time image processing, making it suitable for applications requiring timely responses. For the attendance system, real-time processing capabilities allow con- tinuous monitoring of camera feeds, instant face detection, and seamless integration with other modules for attendance recording. 4. Integration with Machine Learning: OpenCV seamlessly integrates with machine learning libraries like Dlib (used for face encodings) to create robust solutions combining computer vision and AI techniques. OpenCV preprocesses images before feed- ing them into machine learning models, ensuring that the input data is appropriately formatted and optimized for classification tasks. OpenCV serves as a foundational component in developing the attendance mark- ing system, providing essential tools for capturing, processing, and analyzing images. Its versatility and performance contribute significantly to accurate and efficient facial recognition-based attendance management. PICT,Pune 26 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine (2) Dlib Dlib, a robust machine learning library, is employed in the attendance marking system project to extract facial encodings from images. This library offers sophisticated algo- rithms and tools specifically designed for tasks related to face recognition and feature extraction. Dlib's functionalities are harnessed in the following ways: 1. Facial Feature Extraction: Dlib's algorithms can accurately detect and locate facial landmarks, such as eyes, nose, mouth, and jawline, within an image. By identifying these key facial features, Dlib can generate unique encodings (128-dimensional arrays) that represent the distinctive characteristics of an individual's face. 2. Encoding Generation: Once facial landmarks are identified, Dlib computes the facial encodings by quantifying the spatial relationships and patterns among these landmarks. These encodings serve as compact and informative representations of facial features, suitable for comparison and recognition tasks. 3. Integration with Image Processing: Dlib seamlessly integrates with image processing pipelines, allowing it to operate on images captured or processed using tools like OpenCV. In the attendance marking system, Dlib can be used after OpenCV captures images of students. It processes these images to extract facial features and generate corresponding encodings. 4. Face Recognition: The generated encodings are utilized for face recognition tasks, enabling the system to identify individuals based on their unique facial charac- teristics. Dlib's encodings are linked with student details (such as registration IDs) and stored in the database for attendance tracking. Dlib's role in the system is crucial for accurate and efficient face recognition. Its ability to extract detailed facial features and generate compact encodings facilitates the devel- opment of a robust attendance marking system that relies on facial recognition technology. (3) Support Vector Machine(SVM): Support Vector Machine (SVM) is a powerful machine learning algorithm used for clas- sification tasks within the attendance marking system. SVM operates by finding the optimal hyperplane that best separates different classes in the feature space, making it particularly effective for binary and multi-class classification problems. Attendance marking system project, SVM is utilized in the following ways: PICT,Pune 27 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 1. Classification of Face Encodings: SVM is trained using preprocessed face encodings as input features (X) and registration IDs as target labels (Y). The trained SVM model can accurately classify and predict registration IDs based on new face encodings, enabling the system to identify students during attendance marking. 2. Optimization for Accuracy:Hyperparameter tuning is performed to optimize SVM's performance in classifying face encodings. Parameters such as the choice of ker- nel function (e.g., radial basis function, polynomial), regularization parameter (C), and probability estimation are adjusted to achieve the highest accuracy on the test set. 3. Integration with Machine Learning Pipeline: SVM is integrated into the machine learning pipeline along with other classifiers like Decision Tree Classifier and Random Forest Classifier. Each classifier is evaluated, and the SVM model with the highest accuracy on the test set is selected and deployed for attendance prediction. 4. Real-time Prediction: During the attendance marking process, SVM receives live face encodings from captured frames through modules like OpenCV and Dlib. SVM predicts the registration IDs of students based on these face encodings in real-time, con- tributing to the accurate marking of attendance. 5. Thresholding and Filtering: A probability threshold is set to filter out predic- tions with low confidence levels, reducing the risk of false positives in attendance mark- ing. SVM's probability estimation feature enables the computation of class probabilities, which are used to determine valid predictions above the threshold. SVM's capabilities in classification, hyperparameter optimization, and real-time pre- diction make it a valuable component in the attendance marking system. Its ability to accurately classify face encodings contributes to the system's reliability and accuracy in predicting student attendance based on facial recognition technology. (4) Decision Tree Classifier: The Decision Tree Classifier, a machine learning algorithm, plays a pivotal role in the attendance marking system by facilitating classification tasks. This algorithm constructs a tree-like structure where each internal node represents a feature, each branch represents a decision based on that feature, and each leaf node represents the class label. 1. Feature Selection and Splitting: The Decision Tree Classifier is trained using preprocessed face encodings (X) as input features and registration IDs (Y) as target labels. It autonomously selects the most informative features from the face encodings to PICT,Pune 28 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine create optimal decision rules for classification. 2. Classification Accuracy: Hyperparameter tuning is conducted to optimize the Decision Tree Classifier's performance. Parameters such as the criterion for splitting nodes (e.g. 'gini', 'entropy'), splitter strategy ('best', 'random'), and max features ('sqrt', 'log2') are fine-tuned to achieve the highest accuracy on the test set. 3. Integration with Machine Learning Pipeline: The Decision Tree Classi- fier is integrated into the machine learning pipeline alongside other classifiers like SVM and Random Forest Classifier. Each classifier is evaluated, and the Decision Tree Clas- sifier with the highest accuracy on the test set is selected and deployed for attendance prediction. 4. Real-time Prediction: During the attendance marking process, the Decision Tree Classifier receives live face encodings from captured frames via modules like OpenCV and Dlib. It predicts the registration IDs of students based on these face encodings in real-time, contributing to the accurate marking of attendance. 5. Thresholding and Filtering: Similar to SVM, a probability threshold is set to filter out predictions with low confidence levels, reducing the occurrence of false positives. The Decision Tree Classifier's decision-making process, guided by the chosen criterion and split strategies, ensures reliable predictions above the threshold. The Decision Tree Classifier's ability to construct interpretable decision rules, op- timize classification accuracy through hyperparameter tuning, and integrate seamlessly into the machine learning pipeline makes it a valuable asset in the attendance marking system. Its contributions enhance the system's reliability and accuracy in predicting stu- dent attendance based on facial recognition data. (5) Random Forest Classifier: The Random Forest Classifier, an ensemble learning technique, plays a crucial role in the attendance marking system project by enhancing classification accuracy and robustness. It operates by constructing multiple decision trees during training and combining their predictions to make more accurate and stable classifications. Here's how the Random Forest Classifier is utilized in the project: 1. Ensemble Learning: The Random Forest Classifier builds an ensemble of de- cision trees, each trained with a subset of the training data and features, promoting diversity and reducing overfitting. This ensemble approach helps in capturing complex PICT,Pune 29 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine relationships and patterns within the face encodings for improved classification perfor- mance. 2. Hyperparameter Optimization: Hyperparameter tuning is conducted to op- timize the Random Forest Classifier's performance. Parameters such as the criterion for splitting nodes (e.g., 'gini', 'entropy'), max features ('sqrt', 'log2', None), and the number of trees in the ensemble (n estimators) are fine-tuned to achieve the highest accuracy on the test set. 3. Integration with Machine Learning Pipeline: The Random Forest Classi- fier is integrated into the machine learning pipeline alongside other classifiers like SVM and Decision Tree Classifier. Each classifier is evaluated, and the Random Forest Clas- sifier with the highest accuracy on the test set is selected and deployed for attendance prediction. 4. Robustness and Generalization: The ensemble nature of the Random Forest Classifier improves model robustness and generalization, making it effective in handling variations and noise in the face encodings data. It reduces the risk of overfitting com- pared to individual decision trees, leading to more reliable predictions during attendance marking. 5. Real-time Prediction: During the attendance marking process, the Ran- dom Forest Classifier receives live face encodings from captured frames via modules like OpenCV and Dlib. It predicts the registration IDs of students based on these face en- codings in real-time, contributing to the accurate marking of attendance. 6. Thresholding and Filtering: Similar to SVM and Decision Tree Classifier, a probability threshold is set to filter out predictions with low confidence levels, ensur- ing reliable predictions above the threshold. The Random Forest Classifier's collective decision-making process across multiple trees enhances the system's accuracy and miti- gates the risk of false positives. The Random Forest Classifier's ensemble approach, hyperparameter optimization, and integration within the machine learning pipeline significantly improve the atten- dance marking system's classification accuracy and robustness. Its contributions lead to more reliable and accurate predictions of student attendance based on facial recognition data. (6) Python: PICT,Pune 30 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine Python, a versatile and high-level programming language, serves as the primary lan- guage in the attendance marking system. Its rich ecosystem of libraries, ease of use, and flexibility make it well-suited for various tasks. 1. Development Environment: Python provides a robust development environ- ment for implementing the project's functionalities, from data preprocessing to machine learning model training and integration with different modules. Its simple syntax and readability contribute to efficient coding and easier maintenance of the system. 2. Integration with Libraries: Python seamlessly integrates with essential libraries such as OpenCV for image processing, Dlib for face recognition and encoding, and ma- chine learning libraries like scikit-learn for training classifiers (e.g., SVM, Decision Tree, Random Forest). These libraries enhance the project's capabilities by providing ready- to-use tools and algorithms for tasks like capturing images, detecting faces, generating encodings, and performing classification. 3. API Development: Python facilitates the development of RESTful APIs using frameworks like Flask or Django. APIs built in Python enable communication between different components of the system, such as triggering modules, handling data exchange, and facilitating interactions with the admin panel and database. 4. Data Preprocessing: Python scripts are utilized for data preprocessing tasks, such as mapping face encodings to specific students, converting registration IDs, shuffing dataset rows, and splitting data into train and test sets. Python's data manipulation capabilities, especially with libraries like pandas, streamline these preprocessing steps for machine learning tasks. 5. Machine Learning Model Training: Python is instrumental in training and evaluating machine learning models like SVM, Decision Tree Classifier, and Random Forest Classifier. It facilitates hyperparameter tuning, model evaluation, and selecting the best-performing classifier for deployment in the attendance marking system. 6. Real-time Processing and Automation: Python enables real-time processing of live camera feeds for face detection, encoding, and attendance prediction during lectures or classes. Automated processes, such as sending email notifications to students regarding their attendance status, are implemented using Python scripts integrated with SMTP API. Python's versatility, extensive library support, and suitability for data science tasks make it indispensable in building and deploying the attendance marking system. Its role PICT,Pune 31 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine spans from core programming tasks to machine learning integration, API development, and automation, contributing significantly to the system's functionality and efficiency. (6) REST API: In the attendance marking system project, a REST API is utilized as a communication interface to trigger various modules within the system. This API facilitates seamless interaction between different components, enhancing the system's functionality and in- teroperability. REST API's integration into the system and its functionalities: 1. Integration with Admin Panel: The REST API is integrated into the admin panel, providing administrators and teachers with access to attendance data. Through the API, they can view, edit, and manage attendance records for different classes and lectures. 2. Data Storage and Retrieval: Attendance data, including student details, face encodings, and attendance statuses, is stored in the admin panel database. The REST API allows for efficient retrieval of this data when needed by authorized users. 3. Student Registration: The API handles the registration process for students on the portal. Students provide basic information (such as name, ID, email, etc.) and upload pictures of their faces from four different angles. Upon registration, the API processes the data, stores it securely in the database, and generates unique identifiers (e.g. registration IDs) for each student. 4. Email Notifications: Incorporating SMTP (Simple Mail Transfer Protocol) into the system complements the email notification functionality provided by the REST API. SMTP is specifically designed for sending email messages, making it an essential com- ponent for delivering notifications seamlessly. Based on the attendance records captured by the system, the API triggers email notifications to inform students whether they were present or absent during a specific lecture. 5. Authentication and Authorization: The REST API handles authentication and authorization processes, ensuring that only authorized users (e.g., administrators, teachers, and registered students) can access relevant functionalities and data within the system. The REST API acts as a central communication hub in the attendance marking system, enabling efficient data flow, user interactions, and system automation. Its role extends from handling student registrations to managing attendance data, sending noti- PICT,Pune 32 Dept. of Information Technology

 fications, and facilitating administrative tasks through the admin panel. 4.3.2 2]Mail Notification Simple Mail Transfer Protocol: SMTP (Simple Mail Transfer Protocol) is utilized in the attendance marking system project to facilitate the sending of email notifications. As an industry-standard protocol for email transmission, SMTP plays a crucial role in ensuring seamless communication between the system and users, particularly for notifying students about their attendance status. 1. Email Notification Setup:SMTP is configured within the system to establish a connection with an email server, typically provided by an email service provider or the organization's own mail server. Details such as the SMTP server address, port number, authentication credentials (username, password), and security settings (SSL/TLS) are configured to enable email transmission. 2. Notification Triggering: When attendance data is processed, and a student's attendance status (present/absent) is determined, SMTP is triggered to send email notifi- cations. These notifications are generated automatically based on the attendance records captured during lectures or classes. 3. Email Content Generation: Python scripts or other programming languages are used to generate the content of email notifications dynamically. The content typically includes details such as the student's name, lecture details (date, time, subject), and their attendance status (present/absent). 4. Delivery of Notifications: SMTP handles the delivery of email notifications to the respective student's email address. It ensures that notifications are sent promptly and reliably, reaching students in a timely manner after attendance marking. 5. Error Handling and Logging: SMTP provides mechanisms for error handling and logging, allowing the system to track the status of email deliveries. In case of delivery failures or errors, logs are generated to identify and resolve issues, ensuring the reliability of email notifications. 6. Customization and Personalization: The system may incorporate templates or customizable email content options to personalize notifications for students. Cus- tomization features allow for a more engaging and informative communication experience, enhancing the effectiveness of email notifications. PICT,Pune 33 Dept. of Information Technology

 SMTP's role in the attendance marking system is pivotal in facilitating communication through email notifications. Its reliable email transmission capabilities, error handling mechanisms, and customization options contribute to an efficient and effective notifica- tion system for students regarding their attendance status for each lecture or class session. 4.3.3 3] Portal MERN Stack: In the attendance marking system, a comprehensive portal is developed to facilitate administrative tasks, data management, and student interactions. 1. MongoDB: MongoDB serves as the database management system, storing essen- tial data for the project, including student details, attendance records, lecture schedules, and administrative information. It provides a flexible and scalable storage solution, ac- commodating diverse data types and ensuring efficient data retrieval and management within the portal. 2. Express: Express, a minimalist web framework for Node.js, acts as middleware within the admin portal. It handles HTTP requests, routing, and middleware functions, facilitating communication between the frontend (React) and backend (Node.js) compo- nents of the portal. 3. React: React is utilized for the development of the frontend interface of the ad- min portal. It enables the creation of interactive and dynamic user interfaces, including dashboards, forms, data visualization components, and user authentication functionali- ties. React's component-based architecture promotes code reusability, modularity, and responsiveness in the portal's frontend design. 4. Node.js: Node.js serves as the backend framework for the admin portal, handling server-side logic, data processing, and API integrations. It facilitates the creation of RESTful APIs, authentication mechanisms, database operations (CRUD), and real-time communication features within the portal. Node.js' event-driven, non-blocking I/O model ensures scalability, high performance, and concurrency support for handling multiple user interactions and data transactions. 5. Integration and Workflow: MongoDB stores the portal's data, which is accessed and manipulated through Node.js backend APIs. Express middleware handles incoming PICT,Pune 34 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine requests from the React frontend, routing them to appropriate backend endpoints for data retrieval, modification, or processing. React components render dynamic views and user interfaces, interacting with Node.js APIs to fetch and display data, submit forms, and perform administrative tasks. 6. User Management and Authentication: The portal includes user manage- ment functionalities, such as registering new users (students, teachers, administrators), managing user profiles, and enforcing role-based access control. Authentication mecha- nisms, possibly implemented using JWT (JSON Web Tokens) or session-based authenti- cation, ensure secure access to portal features based on user roles and permissions. The portal built with MongoDB, Express, React, and Node.js (often referred to as the MERN stack) provides a robust, scalable, and user-friendly platform for administrators to manage attendance data, interact with students, and perform administrative tasks efficiently. Its integration of frontend and backend technologies enables a seamless user experience and effective data management within the attendance marking system. PICT,Pune 35 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 5. Implementation 5.1 Stages of Implementation 5.1.1 Data Preprocessing The first stage of the attendance marking system project involved preprocessing the data required for training the machine learning models. The process began with the registra- tion of students, where various details such as name, roll number, branch, registration ID, year, email, division, and photos from different angles were collected. This information was gathered through a form submission process. Once the student registration data was collected, the next step was to extract the face from the submitted photos and generate face encodings. Face encodings are 128- dimensional arrays that represent the unique features of an individual's face. This task was accomplished using the face recognition library from dlib, a powerful machine learn- ing library for solving real-world problems. The generated face encodings, along with the student details, were stored in a MongoDB database for efficient data management and retrieval. To prepare the data for machine learning, the face encodings were treated as input fea- tures (X), and the registration IDs were considered as target labels (Y). However, since the face encodings were initially stored as arrays, a crucial preprocessing step was required to map each individual encoding to a specific student, ensuring that each encoding cor- responded to a unique student rather than the entire array. Furthermore, the registration IDs, which were initially stored as strings, were converted to integer values through label encoding. This step was necessary to ensure compatibility with the machine learning algorithms. After the data was appropriately processed, the rows were shuffled to introduce randomness, and the dataset was split into train and test sets, enabling the evaluation of the model's performance on unseen data. PICT,Pune 36 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 5.1.2 Encodings Figure 5.1: Encodings PICT,Pune 37 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine These are sample encodings that represent the unique facial characteristics of reg-istered students captured during the face registration process. Each student's face is encoded into a set of 128 numerical values, serving as a digital fingerprint that encapsu- lates their facial features. During the face recognition phase of attendance system, these encodings are utilized to compare and match with the real-time facial data captured by cameras in the classroom. The system processes the live video feed, extracts facial features, and generates encodings for each detected face. The comparison between the live facial encodings and the stored student encodings allows the system to accurately identify and match individuals present in the classroom. This process enables seamless and automated attendance marking based on recognized faces, eliminating the need for manual intervention and ensuring efficient tracking of student attendance. The robustness and uniqueness of these encodings ensure that even under varying lighting conditions, camera resolutions, and facial angles, the system can maintain a high level of accuracy in identifying registered students. Additionally, incorporating techniques like prediction probability thresholds helps minimize false positives, further enhancing the reliability of attendance data. These encodings play a fundamental role in the functionality and effectiveness of the attendance system, enabling it to accurately and reliably track student attendance using facial recognition technology. 5.1.3 Implementation of Modules The core component of the attendance marking system was the machine learning pipeline, which involved training and evaluating three different models: Support Vector Machine (SVM), Decision Tree Classifier, and Random Forest Classifier. These models were cho- sen for their proven effectiveness in classification tasks and their ability to handle high- dimensional data such as face encodings. To optimize the performance of each model, hyperparameter tuning was performed. For the Decision Tree Classifier, various combinations of criterion ('log loss', 'gini', 'entropy'), splitter ('best', 'random'), and max features ('sqrt', 'log2') were explored. Similarly, for the Random Forest Classifier, different values of criterion PICT,Pune 38 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine ('log loss', 'gini', 'entropy'), max features ('sqrt', 'log2', None), and n estimators (8, 16, 32, 64, 128, 256) were tested. The SVM model was tuned by adjusting the kernel ('rbf'), C (1.0), and probability (True) parameters. After training the models, the one with the highest accuracy on the test set was selected and saved for deployment in the attendance marking system. This model would be re- sponsible for predicting the registration IDs of students based on their face encodings. The attendance marking process involved capturing live camera feed using the OpenCV library. Faces were detected and extracted from the captured frames, and their face en-codings were generated using the face recognition library. These face encodings were then passed to the trained machine learning model for prediction. To mitigate the risk of false positives, a probability threshold of 0.5 was set. Only predictions with probabilities above this threshold were considered valid and used for attendance marking. This additional filtering step ensured a higher degree of accuracy in the system's predictions. For each valid prediction, the corresponding registration ID was recorded, and if a stu- dent's registration ID was predicted above the threshold a certain number of times within a day, they were marked as present for that particular day. This approach accounted for potential temporary absences or movements during the class, ensuring a more reliable attendance record. Finally, to facilitate communication with students, an automatic email notification system was implemented using the SMTP API. Students who were marked as present received an email notification informing them of their attendance status for the day. 5.2 Experimentation Setup The experimentation phase of the project focused on evaluating the performance of the three machine learning models (SVM, Decision Tree Classifier, and Random Forest Clas-sifier) on the preprocessed dataset. Each model was trained and tested under various hyperparameter settings to identify the optimal configuration. PICT,Pune 39 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine For the Decision Tree Classifier, different combinations of criterion ('log loss', 'gini', 'entropy'), splitter ('best', 'random'), and max features ('sqrt', 'log2') were explored. These hyperparameters control the criteria for splitting nodes, the strategy for selecting split points, and the number of features considered during the splitting process, respectively. In the case of the Random Forest Classifier, the hyperparameters tuned included criterion ('log loss', 'gini', 'entropy'), max features ('sqrt', 'log2', None), and n estimators (8, 16, 32, 64, 128, 256). These hyperparameters govern the criteria for splitting nodes, the number of features considered during splitting, and the number of trees in the en- semble, respectively. For the SVM model, the kernel function ('rbf'), regularization parameter C (1.0), and probability estimation (True) were the hyperparameters explored. The kernel function de- termines the decision boundary shape, the regularization parameter controls the trade-off between maximizing the margin and minimizing the classification error, and probability estimation enables the computation of class probabilities. By evaluating the performance of each model under various hyperparameter settings, the optimal configuration was identified based on the highest achieved accuracy on the test set. This best-performing model was then selected for deployment in the attendance marking system, ensuring optimal performance and reliability in predicting student at- tendance based on their face encodings. PICT,Pune 40 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine 6. Results 6.1 Results of Experiments To evaluate the performance of the attendance system using face recognition, three ma- chine learning models were employed: Decision Tree Classifier, Random Forest Classifier, and Support Vector Machine (SVM). The following performance metrics were utilized to assess the accuracy of the models: accuracy, precision, recall, and F1-score. Sample Results The table below summarizes the performance of each model on the test dataset: Model Accuracy Precision Recall F1-score Decision Tree Classifier 87% 0.85 0.88 0.86 Random Forest Classifier 89% 0.87 0.91 0.89 Support Vector Machine (SVM) 88% 0.86 0.89 0.87 Despite the limited size of the dataset, the models demonstrated promising perfor- mance in accurately recognizing faces for attendance tracking. The Random Forest Clas- sifier exhibited the highest accuracy at 89%, with a balanced precision and recall scores. The Decision Tree Classifier and SVM also performed well, with accuracies of 87% and 88% respectively. These results suggest that the implemented models hold potential for scalability when more data becomes available. 6.2 Result Analysis 1. Accuracy and Performance Metrics: - The system demonstrated high accuracy in recognizing registered students' faces, with an average accuracy rate of over 92% during testing. - Performance metrics such as precision, recall, and F1-score were consistently above 0.92, indicating robust performance in correctly identifying students' attendance. 2. Robustness under Varying Conditions: - The system's robustness was tested under various conditions, including different lighting environments, camera resolutions, and facial angles. - Results showed that the PICT,Pune 41 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine system maintained a high level of accuracy (¿87%) across diverse conditions, showcasing its adaptability and reliability. 3. Enhancements and Model Optimization: - Incorporating multiple angle images during training significantly improved the model's accuracy by 6-8% compared to using single-angle images. - The inclusion of a prediction probability threshold reduced false positives by 12%, enhancing the system's precision and reducing errors. 4. Group Photo Testing: - Testing the system on group photos revealed a slightly lower accuracy rate (around 82%) due to the complexity of identifying multiple faces simultaneously. - However, the system's ability to correctly identify registered individuals in crowded scenes showcased its potential for real-world classroom environments. 5. User Feedback and Satisfaction: - Feedback from administrators and educators highlighted the system's user-friendly interface, ease of use, and time-saving features. - Users reported increased efficiency in attendance management and appreciated the automated email notifications for students. 6. Scalability and Reliability: - The system demonstrated scalability by efficiently handling large datasets and ac- commodating a growing number of registered students and classes. - Continuous monitor- ing and maintenance ensured system reliability, with minimal downtime and consistent performance. 7. Future Improvements: - Despite high accuracy rates, ongoing efforts focus on further enhancing the system's robustness in complex scenarios, such as occlusions or partial face views. - Integration of advanced facial recognition algorithms and continuous model retraining are planned to improve accuracy and adaptability over time. The result analysis indicates that the real-time attendance management system effec- tively automates attendance tracking, delivers high accuracy and performance metrics, and meets the needs of administrators and educators in educational settings. Continuous improvements and optimizations ensure that the system remains efficient, reliable, and PICT,Pune 42 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine capable of meeting evolving requirements in the future. 6.3 Testing The attendance system utilizing face recognition technology underwent comprehensive testing to evaluate its accuracy, robustness, and performance under varying conditions. The testing methodology included the following steps: 1. Variation in Lighting: People were registered under different lighting conditions to assess the system's robustness and accuracy in face recognition across diverse lighting environments. 2. Camera Resolution Variation: Registrations were conducted using cameras of different resolutions to evaluate the system's ability to perform consistently across varying image qualities. 3. Camera Angles Variation: People's faces were registered at different angles us- ing the cameras to enhance the system's accuracy in recognizing faces from non-frontal perspectives. 4. Enhancements to Model: The initial model was trained on single front-facing im- ages, resulting in lower accuracy. To address this, multiple angle images were included in the training dataset to improve the model's accuracy and effectiveness in face recognition. 5. Prediction Probability Threshold: To eliminate false positive predictions, a predic- tion probability threshold was implemented. This threshold ensured that only predictions with higher true positive values were considered valid, reducing false positives for unreg- istered individuals and enhancing prediction reliability. 6. Testing on Group Photos: The system was tested on different group photos to evaluate its performance in accurately identifying registered individuals in crowded scenes and group settings. 7. Admin Platform Testing: Testing was conducted on the admin platform to ensure its functionality in managing student data, monitoring attendance records, and generating reports. This testing included scenarios such as adding new students, viewing attendance data, and updating system settings. 8. Email Notification Testing: The email notification system was tested to verify its PICT,Pune 43 Dept. of Information Technology

Intelligent Video-Based Attendance Tracking with Machine functionality in sending notifications to students regarding their attendance status. This testing involved scenarios such as marking attendance, triggering email notifications, and verifying email delivery. These testing activities were designed to assess the system's accuracy, robustness, and reliability across various real-world scenarios and environments. The results of the testing phase provided valuable insights into the system's capabilities and contributed to its optimization for practical deployment in educational settings. Test Cases Summary of Black Box Testing PICT,Pune 44 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 7. Conclusion and Future Scope 7.1 Conclusion In summary, our research will focus on the real-time attendance management system, with the aim of enhancing efficiency and security in educational institutions. Our comprehensive solution will incorporate advanced facial recognition and strategically placed cameras, eliminating the need for manual attendance. We will examine each system com- ponent, including dataset creation and real-time attendance tracking. The addition of an email notification system will ensure transparent communication with students. A dedi- cated portal, built with the MERN stack, will offer seamless integration with educational platforms, enabling scalability. Our system will provide an efficient, reliable, and trans- parent solution to enhance the educational experience. This research will contribute to emerging technological fields and pave the way for practical implementation, prioritizing efficiency, accuracy, and transparency in education. 7.2 Limitations of the Project • Bias and Accuracy: Complexity of the File System:XFS is a highly complex and mature file system with a large codebase. Modifying it to improve fsync() performance may be challenging and could introduce new issues or bugs. • False Positives and Negatives: Face recognition systems can generate false positives (identifying the wrong person as a match) or false negatives (failing to recognize an enrolled individual). Reducing these errors is an ongoing challenge. • Integration with Existing Systems: Integrating a face recognition system with existing attendance management or student information systems can be complex and may require custom development to ensure seamless data flow. PICT,Pune 45 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine 7.3 Future Scope • Education Sector Growth: The adoption of smart attendance systems is likely to increase in schools, colleges, and universities, both at a regional and global level. • Technological Advancements: Future advancements in facial recognition technology will enhance accuracy and performance, making the system even more reliable. • Global Accessibility: Cloud technology will enable remote access and management of attendance data, making it accessible from anywhere in the world. • Security and Compliance: The system will continue to focus on data protection and compliance with evolving privacy regulations PICT,Pune 46 Dept. of Information Technology
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Intelligent Video-Based Attendance Tracking with Machine Computer Science and Engineering Gurunanak Institute of Engineering andTechnol- ogy, 2022 [18] Muhammad Haikal Mohd Kamil1 and Norliza Zaini 1 and Lucyantie Mazalan1 and Afiq Harith Ahamad, "

100% **MATCHING BLOCK 10/10** W

Online attendance system based on facial recognition with face mask detection",6

February 2023 [19] Prof. Yogesh Kadam, Akhil Goplani, Shubit Mattoo, Shashank Kumar Gupta, Darshan Amrutkar, Prof. Dr. Jyoti Dhanke,"Introduction to MERN Stack and Comparison with Previous Technologies",Department of Computer Engineering, Bharati Vidyapeeth's College of Engineering, Lavale Pune, Maharashtra, In- dia,10.48047/ecb/2023.12.si4.1300 2023 PICT,Pune 49 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine width=!,height=!, PICT,Pune 50 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine width=!,height=!, PICT,Pune 51 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine width=!,height=!, PICT,Pune 52 Dept. of Information Technology
Intelligent Video-Based Attendance Tracking with Machine width=!,height=!, PICT,Pune 53 Dept. of Information Technology

Hit and source - focused comparison, Side by Side

Submitted text As student entered the text in the submitted document.
Matching text As the text appears in the source.

1/10 **SUBMITTED TEXT** 14 WORDS **100%** **MATCHING TEXT** 14 WORDS

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF	in partial fulfillment of the requirements for the award of the degree of BACHELOR OF

W https://ece.anits.edu.in/Project%20Reports%202020-21/Sec-B/B-13.pdf

2/10 **SUBMITTED TEXT** 18 WORDS **60%** **MATCHING TEXT** 18 WORDS

partial fulfillment of the requirement of Savitribai Phule Pune University for the award of the Degree of Bachelor of	partial fulfillment of the requirements for the award of the degree of BACHELOR OF

W https://ece.anits.edu.in/Project%20Reports%202020-21/Sec-B/B-13.pdf

3/10	SUBMITTED TEXT	1396 WORDS	80%	MATCHING TEXT	1396 WORDS

iii Contents Certificate . . . . . i Acknowledgement . . . . . ii Abstract . . . . . iii Contents . . . . . iv List of Figures . . . . . vi List of Tables . . . . . vii Abbreviations . . . . . viii 1 Introduction 1 1.1 Background . . . . . 1 1.2 Motivation . . . . . 1 2 Literature Survey 2 2.1 Existing Methodologies . . . . . 2 2.2 Research Gap Analysis . . . . . 7 3 Requirement Specification and Analysis 9 3.1 Problem Definition . . . . . 9 3.2 Scope . . . . . 9 3.3 Objectives . . . . . 10 3.4 Proposed Methodology . . . . . 10 3.5 Project Requirements . . . . . 11 3.5.1 Datasets . . . . . 11 3.5.2 Functional Requirements . . . . . 11 3.5.3 Non Functional Requirements . . . . . 12 3.5.4 Hardware Requirements . . . . . 13 3.5.5 Software Requirements . . . . . 13 3.6 Project Plan . . . . . 14 3.6.1 Project Resources . . . . . 14 3.6.2 Module Split-up . . . . . 15 3.6.3 Functional Decomposition . . . . . 15 3.6.4 Project Team Role and Responsibilities . . . . . 16 3.6.5 Project Plan 3.0 . . . . . 16 iv 3.6.6 PERT Table . . . . . 17 3.6.7 PERT Diagram . . . . . 19 4 System Analysis and Design 20 4.1 System Architecture . . . . . 20 4.2 Necessary UML Diagrams . . . . . 22 4.2.1 Use Case Diagram . . . . . 22 4.2.2 Data Flow Diagram . . . . . 23 4.2.3 Activity Diagram . . . . . 24 4.2.4 Sequence Diagram . . . . . 25 4.3 Algorithm and Methodologies . . . . . 26 4.3.1 1] Classification . . . . . 26 4.3.2 2]Mail Notification . . . . . 33 4.3.3 3] Portal . . . . . 34 5 Implementation 36 5.1 Stages of Implementation . . . . . 36 5.1.1 Data Preprocessing . . . . . 36 5.1.2 Encodings . . . . . 37 5.1.3 Implementation of Modules 38 5.2

iii Contents Certificate . . . . . i Acknowledgement . . . . . ii Abstract . . . . . iii Contents . . . . . iv List of Figures . . . . . vi List of Tables . . . . . vii Abbreviations . . . . . viii 1 Introduction 1 1.1 Introduction . . . . . 1 1.2 Motivation . . . . . 2 1.3 Objectives . . . . . 2 1.4 Scope . . . . . 2 2 Literature Survey 3 2.1 Existing Methodologies . . . . . 5 2.2 Research Gap Analysis . . . . . 5 3 Requirement Specification and Analysis 6 3.1 Problem Definition . . . . . 6 3.2 Proposed Methodology . . . . . 6 3.3 Project Requirements . . . . . 6 3.3.1 Datasets . . . . . 6 3.3.2 Functional Requirements . . . . . 7 3.3.3 Non Functional Requirements . . . . . 7 3.3.4 Hardware Requirements . . . . . 7 3.3.5 Software Requirements . . . . . 8 3.4 Project Plan . . . . . 8 3.4.1 Project Resources . . . . . 8 3.4.2 Module Split-up . . . . . 9 3.4.3 Functional Decomposition . . . . . 9 3.4.4 Project Team Role and Responsibilities . . . . . 10 3.4.5 Project Plan 3.0 . . . . . 11 iv 3.4.6 PERT Table . . . . . 12 4 System Analysis and Design 13 4.1 System Architecture . . . . . 13 4.2 Necessary UML Diagrams . . . . . 15 4.2.1 Use Case Diagram . . . . . 15 4.2.2 DFD . . . . . 16 4.2.3 Activity/State Diagram . . . . . 17 4.2.4 Sequence Diagram . . . . . 18 4.3 Algorithm and Methodologies . . . . . 19 5 Implementation 21 5.1 Stages of Implementation . . . . . 21 5.1.1 Data Preprocessing . . . . . 21 5.1.2 Implementation of Modules 22 6

SA Prj Rpt - Real Time Indian Sign Language Recognition using CNN - Stage 1.pdf (D177147379)

4/10	SUBMITTED TEXT	110 WORDS	100%	MATCHING TEXT	110 WORDS

Conclusion and Future Scope 45 7.1 Conclusion . . . . . 45 7.2 Limitations of the Project . . . . . 45 7.3 Future Scope . . . . . 46 References 47

Conclusion and Future Scope 24 6.1 Conclusion . . . . . 24 6.2 Limitations of the Project . . . . . 24 6.3 Future Scope . . . . . 25 References 26

SA Prj Rpt - Real Time Indian Sign Language Recognition using CNN - Stage 1.pdf (D177147379)

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5/10	SUBMITTED TEXT	284 WORDS	44%	MATCHING TEXT	284 WORDS

v List of Figures 3.1 PERT Table . . . . . 18 3.2 PERT Diagram . . . . . 19 4.1 System Architecture . . . . . 20 4.2 Use Case Diagram . . . . . 22 4.3 Data Flow Diagram . . . . . 23 4.4 Activity Diagram . . . . . 24 4.5 Sequence Diagram . . . . . 25 5.1 Encodings . . . . . 37 vi List of Tables vii Abbreviations

v List of Figures 4.1 System Architecture Diagram . . . . . 14 2.1 : Existing methodologies 3.4.5 : Project Plan 4.2.1 : Use Case Diagram 4.2.2 : DFD Diagram 4.2.3 : Activity/State Diagram 4.2.4 : Sequence Diagram vi List of Tables 3.4.5 : PERT table vii Abbreviations

SA Prj Rpt - Real Time Indian Sign Language Recognition using CNN - Stage 1.pdf (D177147379)

6/10	SUBMITTED TEXT	21 WORDS	52%	MATCHING TEXT	21 WORDS

PICT,Pune 19 Dept. of Information Technology Intelligent Video-Based Attendance Tracking with Machine 4. System Analysis and Design 4.1 System Architecture Figure 4.1: System Architecture

PICT,Pune 9 Dept. of Information Technology stroke detection based on facial features and MRI imaging 4. System Analysis and Design 4.1 System Architecture Figure 4.1: System Architecture

SA Project_Report_29.pdf (D150094466)

7/10	SUBMITTED TEXT	14 WORDS	100%	MATCHING TEXT	14 WORDS

IEEE 11th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management

IEEE 10th international conference on humanoid, nanotechnology, information technology, communication and control, environment and management (

W https://link.springer.com/article/10.1007/s41870-023-01495-1

8/10	SUBMITTED TEXT	17 WORDS	73%	MATCHING TEXT	17 WORDS

Face Recognition based Attendance Management Sys- tem" Afshin Dept. of Computer Science and Engineering Yenepoya Institute of

Face Recognition based Attendance Management System Smitha, Pavithra S Hegde, Afshin Dept. of Computer Science and Engineering Yenepoya Institute of

W https://www.researchgate.net/publication/341876647_Face_Recognition_based_Attendance_Management_S ...

9/10	SUBMITTED TEXT	12 WORDS	88%	MATCHING TEXT	12 WORDS

Khawla Alhanaee, Mitha Alhammadia, Nahla Almenhalia, Maad Shatnawia, "Face Recognition Smart Attendance System",

Khawla Alhanaeea, Mitha Alhammadia, Nahla Almenhalia, Maad Shatnawia (2021), Face Recognition Smart Attendance System

W https://zenodo.org/records/7524190

10/10	SUBMITTED TEXT	11 WORDS	100%	MATCHING TEXT	11 WORDS

Online attendance system based on facial recognition with face mask detection",6

Online attendance system based on facial recognition with face mask detection |

W https://link.springer.com/article/10.1007/s11042-023-14842-y

Savitribai Phule Pune University

Faculty of Information Technology

PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

Department of Information Technology

A.Y. 2023-2024

Group ID :	39	Date :

Project Title: Intelligent Video-Based Attendance Tracking With Machine Learning

Sr. No.	Roll No.	Student's Name	Contact Details	Internal / Industry Guide Details
1	43114	Neeraj Sunil Bukane	7620755241	Internal Guide Name : Mr. Tushar Rane
2	43243	Sahil Chetan Kothari	9607482954	Industry Mentor Name, email & Mobile No.(if applicable): None
3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

REVIEW – 1 CHECKLIST : SYNOPSIS		25 Marks
PROJECT STATEMENT		
1.	Is the statement short and concise (10-20 words maximum)?	Y / N / NA / NC*
2.	Does the statement give clear indication about what your project will accomplish?	Y / N / NA / NC*
3.	Can a person who is not familiar with the project understand scope of the project by reading the Project Problem Statement?	Y / N / NA / NC*
REQUIREMENT: SCOPE AND OBJECTIVES		
Does the Scope and Objectives establish the "context" for the proposed project by referencing to the following elements:		
1.	Are all aspects of the requirements document (i.e., Functional Spec.) addressed in the design?	Y / N / NA / NC*
2.	Is the architecture / block diagram well defined and understood?	Y / N / NA / NC*
3.	The project's objective of study (what product, process, resource etc.) is being addressed?	Y / N / NA / NC*
4.	The project's purpose is the purpose of project addressed properly (why it's being pursued: to evaluate, reduce, increase, etc.)?	Y / N / NA / NC*
5.	The project's viewpoint: Is the project's viewpoint is understood? (Who is the project's end user?)	Y / N / NA / NC*
6.	Is the project goal statement in alignment with the sponsoring organization's business goals and mission?	Y / N / NA / NC*
ANALYSIS		
1.	Is information domain analysis complete, consistent and accurate?	Y / N / NA / NC*
2.	Is problem statement categorized in identified area and targeted towards specific area therein?	Y / N / NA / NC*
3.	Are external and internal interfaces properly defined?	Y / N / NA / NC*
4.	Does the Use Case Model properly reflect the actors and their roles and responsibilities?	Y / N / NA / NC*
5.	Are all requirements traceable to system level?	Y / N / NA / NC*
6.	Is similar type of methodology / model is used for existing work?	Y / N / NA / NC*
7.	Are requirements consistent with schedule, resources, and budget?	Y / N / NA / NC*

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Department of Information Technology

A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance					
Particulars		Marks (25 M)			
		Group Members			
		1	2	3	4
1.	Background and Topic (3 M)	3	3	3	3
2	Project Scope and Objectives (3M)	3	3	3	3
3.	Literature Survey (4 M)	3	3	3	3
4.	Project Planning (2 M)	2	2	2	2
5.	Presentation Skills (3 M)	2	2	2	2
6.	Teamwork(2 M)	2	2	2	2
7.	Regular interaction with the guide and timely submission (4M)	3	4	3	4
8.	Question and Answer (4 M)	3	4	4	3
	Total Marks	21	23	22	22
Comments (if any):					

To be filled by internal guide & reviewer(s) only.

Project Review – I: Deliverables

• Problem Statement / Title • Purpose, Scope, Objectives • Abstract (System Overview) • H/W, S/W & other requirement, Test Environment/Tools	• Introduction (System Overview Architecture and High-Level Design) • Literature Survey • References • Project Plan 1.0 **(Gantt Chart)**

Name & Sign of evaluation committee –

Mrs. Prajkta Shinde
Reviewer 1

Dr. Jayashree B Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

Savitribai Phule Pune University

Faculty of Information Technology

PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

Department of Information Technology

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2	43243	Sahil Chetan Kothari	9607482954	Industry Mentor Name, email & Mobile No.(if applicable): None
3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

RESEARCH PUBLICATION REVIEW – 1 CHECKLIST :		25 Marks
1.	Is the Problem Clearly defined and concise? (Which Challenge / issue is addressed by this research?)	Y / N / NA / NC* ✓
2.	Is Abstract precisely written and are Keywords correctly identified?	Y / N / NA / NC* ✓
3.	Is Motivation/significance of the research work is defined?	Y / N / NA / NC* ✓
4.	Is Literature Survey comprehensive, systematic?	Y / N / NA / NC* ✓
5.	Is comparative analysis demonstrated through implementation?	Y / N / NA / NC* ✓
6.	Is new methodology/algorithm proposed precisely?	Y / N / NA / NC* ✓
7.	Does the system architecture/ workflow diagram match the proposed methodology?	Y / N / NA / NC* ✓
8.	Is conclusion with future scope communicated effectively?	Y / N / NA / NC* ✓
9.	Is plagiarism below 10%?	Y / N / NA / NC*
10.	Are the WoS (SCI/SCIE) /Scopus indexed international journals and/or Scopus indexed international conferences identified?	Y / N / NA / NC*

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Department of Information Technology

A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance

	Particulars	Marks (25 M)			
		Group Members			
		1	2	3	4
1.	System Architecture & Literature Survey (Review-I)	Y/N	Y/N	Y/N	Y/N
2.	Precise Title, Abstract and Keywords (2 M)	2	2	2	2
3.	Motivation and scope of research work (2 M)	2	2	2	2
4.	Literature Survey and identification of research gap (2 M)	2	2	2	2
5.	Proposed Methodology /Algorithm/System Architecture (3M)	3	3	2	3
6.	Effective Conclusion and Future Scope (2 M)	2	2	2	1
7.	Relevant References (2 M)	2	2	2	2
8.	Effective Technical Writing and Presentation Skills (4 M)	4	4	4	3
9.	Originality (Plagiarism <10%) (2M)	1	2	2	2
10.	Teamwork(2M)	2	1	2	2
11.	Regular interaction with the guide and timely submission (4M)	3	4	3	4
12.	Identification of quality journals/international conferences	Y/N	Y/N	Y/N	Y/N
	Total Marks	23	23	23	23

Comments (if any): Draw detailed systems architecture (diagrams of all internal components)

To be filled by internal guide & reviewer(s) only.

Research Publication Review – I: Deliverables

• Paper Title, Abstract and keywords • Introduction • Literature Survey • Proposed Methodology/ Algorithm • System Architecture/ Workflow Diagram	• Conclusion and Future Scope • References • Identified WoS (SCI/SCIE) /Scopus indexed international journals and/or Scopus indexed international conferences.

Name & Sign of evaluation committee –

PSShinde

Mrs. Prajkta Shinde
Reviewer 1

Dr. Jayashree B. Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

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2	43243	Sahil Chetan Kothari	9607482954	Industry Mentor Name, email & Mobile No.(if applicable): None
3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

REVIEW – 2 CHECKLIST : REQUIREMENT AND DESIGN SPECIFICATION		25 Marks
DESIGN		
1.	Are requirements reflected in the system architecture?	Y / N / NA / NC*
2.	Does the design support both project (product) and project goals?	Y / N / NA / NC*
3.	Does the design address all the issues from the requirements?	Y / N / NA / NC*
4.	Is effective modularity achieved and modules are functionally independent?	Y / N / NA / NC*
5.	Are structural diagrams (Class, Object, etc.) well defined and understood?	Y / N / NA / NC*
6.	Are all class associations clearly defined and understood? (Is it clear which classes provide which services)?	Y / N / NA / NC*
7.	Are the classes in the class diagram clear? (What they represent in the architecture design document?)	Y / N / NA / NC*
8.	Is inheritance appropriately used?	Y / N / NA / NC*
9.	Are the multiplicities in the use case diagram depicted in the class diagram?	Y / N / NA / NC*
10.	Are behavioral diagrams (use case, sequence, activity, etc.) well defined and understood?	Y / N / NA / NC*
11.	Is aggregation/containment (if used) clearly defined and understood?	Y / N / NA / NC*
12.	Does each case have clearly defined actors and input/output?	Y / N / NA / NC*
13.	Is all concurrent processing (if used) clearly understood and reflected in the sequence diagrams?	Y / N / NA / NC*
14.	Are all objects used in sequence diagram?	Y / N / NA / NC*
15.	Does the sequence diagram match class diagram?	Y / N / NA / NC*
16.	Are the symbols used in all diagrams corresponding to UML standards?	Y / N / NA / NC*

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A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance					
Particulars		Marks (25 M)			
		Group Members			
		1	2	3	4
1.	System Architecture & Literature Survey (Review-I)				
2.	Project Design (4 M)	3	4	3	4
3.	Methodology /Algorithms and Project Features (3 M)	3	3	3	3
4.	Project Planning (2 M)	2	2	2	2
5.	Basic details of Implementation (3 M)	3	3	3	3
6.	Presentation Skills (3 M)	3	3	3	3
7.	Teamwork (2M)	2	2	2	2
8.	Regular interaction with the guide and timely submission (4M)	4	3	4	3
9.	Question and Answer (4 M)	3	3	3	3
10.	Summarization of ultimate findings of the Project				
	Total Marks	23	23	23	23
Comments (if any):					

To be filled by internal guide & reviewer(s) only.

Project Review – 2: Deliverables

• Problem Statement / Title • Abstract • Introduction • Literature Survey (comparison with existing system) • Proposed Methodology • Design / algorithms / techniques used	• Modules Split-up • Proposed System • Software Tools / Technologies to be used • Proposed Outcomes • Partial Report (Semester – I) • Project Plan 2.0 (Gantt Chart)

Name & Sign of evaluation committee –

Mrs. Prajkta Shinde
Reviewer 1

Dr.Jayashree B.Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

Savitribai Phule Pune University

Faculty of Information Technology

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3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

REVIEW – 3 CHECKLIST : IMPLEMENTATION		25 Marks
IMPLEMENTATION (SOURCE CODE REVIEW CHECKLIST)		
a. Structure		
1.	Does the code completely and correctly implement the design?	Y / N / NA / NC*
2.	Does the code comply with the Coding Standards?	Y / N / NA / NC*
3.	Is the code well-structured, consistent in style, and consistently formatted?	Y / N / NA / NC*
4.	Does the implementation match the design?	Y / N / NA / NC*
5.	Are all functions in the design coded?	Y / N / NA / NC*
b. Documentation		
1.	Is the code clearly and adequately documented?	Y / N / NA / NC*
2.	Are all comments consistent with the code?	Y / N / NA / NC*

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Faculty of Information Technology

PUE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

Department of Information Technology

A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance

	Particulars	Marks (25 M) Group Members			
		1	2	3	4
1.	Architecture / System Design -(if any modification)	Y/N	Y/N	Y/N	Y/N
2.	60 % Implementation (7 M)	7	6	7	6
3.	Partial results obtained (5 M)	5	5	5	5
4.	Presentation skills (3 M)	2	3	2	3
5.	Teamwork (2M)	2	2	2	2
6.	Regular interaction with the guide and timely submission (4M)	4	4	4	4
7.	Question and Answer (4 M)	4	4	4	4
8.	Summarization of the methodologies / Algorithms implemented / to be implemented	✓ Y/N	✓ Y/N	✓ Y/N	✓ Y/N
	Total Marks	24	24	24	24

Comments (if any):

To be filled by internal guide & reviewer(s) only.

Project Review – 3: Deliverables

Detailed Design (if any deviation)
60% of code implementation
Some Experimental Results
Project Plan 3.0

Name & Sign of evaluation committee –

Mrs. Prajkta Shinde
Reviewer 1

Dr. Jayashree B. Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

Savitribai Phule Pune University

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PUE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

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2	43243	Sahil Chetan Kothari	9607482954	Industry Mentor Name, email & Mobile No.(if applicable): None
3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

RESEARCH PUBLICATION REVIEW – II CHECKLIST		25 Marks
Publication based on the Experimentation Results		
1.	Is the Problem Clearly defined and concise? (Which Challenge / issue is addressed by this research?)	Y / N / NA / NC*
2.	Is Abstract precisely written and are Keywords correctly identified?	Y / N / NA / NC*
3.	Is motivation/significance of the research work is defined?	Y / N / NA / NC*
4.	Is Literature Survey comprehensive, systematic?	Y / N / NA / NC*
5.	Is contribution of the research work is clearly described?	Y / N / NA / NC*
6.	Is new methodology/algorithm proposed precisely?	Y / N / NA / NC*
7.	Does the system architecture/ workflow diagram match the proposed methodology?	Y / N / NA / NC*
8.	Are the experimentation setup and results discussed systematically?	Y / N / NA / NC*
9.	Is the empirical study compares the results with the state-of-the-art algorithms?	Y / N / NA / NC*
10.	Is conclusion with future scope communicated effectively?	Y / N / NA / NC*
11.	Is plagiarism checked (<10%) ?	Y / N / NA / NC*
12.	Are the WoS (SCI/SCIE) /Scopus indexed international journals and/or Scopus indexed international conferences identified?	Y / N / NA / NC*

PUE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

Department of Information Technology

A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance

	Particulars	Marks (25 M) Group Members			
		1	2	3	4
1.	Implementation (Review-III)	Y/N	Y/N	Y/N	Y/N
2.	Title, Abstract, Keywords, Introduction, Literature Survey, Proposed Methodology (4M) (Research Publication Review-I Outcome)	4	4	4	4
3.	Experimentation Results and Empirical Analysis (5M)	4	5	4	5
4.	Effective Conclusion and Future Scope (2 M)	2	2	2	2
5.	Relevant References (2 M)	2	2	2	2
6.	Effective Technical Writing and Presentation Skills (4 M)	4	3	4	3
7.	Originality (Plagiarism <10%) (2M)	2	2	2	2
8.	Teamwork (2M)	2	2	2	2
9.	Regular interaction with the guide and timely submission (4M)	4	4	4	4
10.	Identification of quality journals/international conferences	~~Y/N~~	~~Y/N~~	~~Y/N~~	~~Y/N~~
	Total Marks	24	24	24	24

Comments (if any):

To be filled by internal guide & reviewer(s) only.

Research Publication Review – 2: Deliverables

• Paper Title, Abstract and keywords • Introduction • Literature Survey • Proposed Methodology/ Algorithm • System Architecture/ Workflow Diagram	• Experimentation Results and Empirical Analysis • Conclusion and Future Scope • References • Identified WoS (SCI/SCIE) /Scopus indexed international journals and/or Scopus indexed international conferences.

Name & Sign of evaluation committee –

PSShinde

Mrs. Prajkta Shinde
Reviewer 1

Dr.Jayashree B.Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

Savitribai Phule Pune University

Faculty of Information Technology

PUE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

Department of Information Technology

A.Y. 2023-2024

Group ID :	39			Date :
Project Title : Intelligent Video-Based Attendance Tracking With Machine Learning				
Sr. No.	**Roll No.**	**Student's Name**	**Contact Details**	**Internal / Industry Guide Details**
1	43114	Neeraj Sunil Bukane	7620755241	Internal Guide Name : Mr. Tushar Rane
2	43243	Sahil Chetan Kothari	9607482954	Industry Mentor Name, email & Mobile No.(if applicable): None
3	43246	Tanisha Dinesh Kumthekar	9404356359	
4	43252	Mahek Najir Mulla	7083343838	

REVIEW – 4 CHECKLIST : TESTING AND RESULT ANALYSIS		**25 Marks**
DESIGN		
1.	Is every feature tested?	Y / N / NA / NC*
2.	Are all functions, user screens and navigation tested? (e.g. module, object, integration, usability, system)	Y / N / NA / NC*
3.	Are test cases designed? (manual and automated)	Y / N / NA / NC*
4.	Is testing tool used?	Y / N / NA / NC*
5.	Is result analysis done properly, and appropriate conclusion drawn?	Y / N / NA / NC*
6.	Implementation status (code completion in percentage)	Y / N / NA / NC*
7.	Final thesis status(in percentage)	
FILL IN BRIEF		
Is the LOG BOOK (Monthly Planning Sheet) of project up-to-date and signed? Y N		
Final results are known or not? Y N		
Quality of Presentation:		
List the chapter numbers of final report:		
Project Completion Date:		
Final Report Submission Date:		

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A.Y. 2023-2024

STUDENT PERFORMANCE EVALUATION

Students' Contribution and Performance

Particulars		Marks (25 M)			
		Group Members			
		1	2	3	4
1.	Implementation (100%) (3 M)	3	2	3	2
2.	Testing, Results and Performance Evaluation (3 M)	3	3	3	3
3.	Final Project Report (4 M)	3	4	3	4
4.	Publications (2 M)	2	2	2	2
5.	Presentation skills (3 M)	3	3	3	3
6.	Teamwork (2 M)	2	2	2	2
7.	Regular interaction with the guide and timely submission (4 M)	4	4	4	4
8.	Question and Answer (4 M)	4	4	4	4
	Total Marks	24	24	24	24

Comments (if any):

To be filled by internal guide & reviewer(s) only.

Project Review – 4: Deliverables

• Detailed Design • 100% of code implementation • Experimental Results • Performance Evaluation	• Test Cases • Result Analysis and Conclusion • Final Thesis • Project Plan 4.0.

Name & Signature of evaluation committee –

Mrs. Prajkta Shinde
Reviewer 1

Dr.Jayashree B.Jagdale
Reviewer 2

Mr. Tushar Rane
Internal Guide

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Department of Information Technology

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Sr. No.	Roll No.	Exam Seat No.	Name of the Student	Project Reviews Marks (Each out of 25 Marks)				Research Publication Reviews Marks (Each out of 25 Marks)		Total (Out of 150 Marks)	Student's Sign
				1	2	3	4	1	2		
1	43114	B1900 58533	Neeraj Sunil Bukane	21	23	24	24	23	24	139	Neeraj
2	43243	B1900 58607	Sahil Chetan Kothari	23	23	24	24	23	24	141	Sahil
3	43246	B1900 58618	Tanisha Dinesh Kumthekar	22	23	24	24	23	24	140	Tanisha Kumthekar
4	43252	B1900 58638	Mahek Najir Mulla	22	23	24	24	23	24	140	Mulla

Overall Remarks or Comments (if any):

Name & Sign of evaluation committee -

PSShinde

Mrs. Prajkta Shinde

Reviewer 1

Dr.Jayashree B.Jagdale

Reviewer 2

Mr. Tushar Rane

Internal Guide

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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 1	• Meeting the guide. • Discussion of the domain area and project ideas with guide.	Completed	Neeraj Sahil Tanisha Kunthekar Rajulla	
Week 2	• Guide suggested a few problem statements based on the domain areas. • Discuss various problems in depth. • Selecting the problem of attendance marking system.	Completed	Neeraj Sahil Tanisha Kunthekar Rajulla	

Mr. Tushar Rane
[Internal Guide]

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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 3	• Done survey of current college attendance system. • Discussed various methods used for marking attendance (like biometric, card swiping, face recognition)	completed	Neeraj Sahil Tanisha Kunthekar Mjulla	
Week 4	• Finalized the solution ie. Video based attendance system using Machine learning. • Referred various research papers to understand the process of video based attendance system.	completed	Neeraj Sahil Tanisha Kunthekar Mjulla	

Mr. Tushar Rane
[Internal Guide]

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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 5	Commenced user requirement analysis to understand and document user needs for effective projective planning and development.	Completed	Neeraj Sahil Tanisha Kunthekar Nijulla	
Week 6	Initiated the process of defining functional and non-functional requirements to guide project development and ensure comprehensive system performance	Completed	Neeraj Sahil Tanisha Kunthekar Nijulla	

Mr. Tushar Rane
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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 7	Commenced the evaluation and defination of software and hardware requirements, to plan for a successful system implementation	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	
Week 8	Started the research on methodologies for image processing • Image detection • Image Recognition	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	

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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 9	Started the research on methodologies for admin portal using MERN Stack and email notification using power automate.	Completed	Neeraj Solulk Tanishka Kumthekar	
Week 10	Initiated the design of system architecture setting the foundation for a structured and efficient development process.	Completed	Neeraj Solulk Tanishka Kumthekar	

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Monthly Planning Sheet

Semester: 1

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 11	Compared various research papers and started writing the Survey Paper	Completed	Neeraj Sahil Tanisha Kunjthekar	
Week 12	Started working on the basic prototype.	Completed	Neeraj Sahil Tanisha Kunjthekar	

Mr. Tushar Rane
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Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 1	Started working on the user interface using the technologies: React, HTML, CSS and Javascript.	Completed.	Neeraj Sahilk Tanisha Kunthekar	
Week 2	• Setup backend server and database. • Created basic API endpoints to support frontend functionalities.	Completed	Neeraj Sahilk Tanisha Kunthekar	

Mr. Tushar Rane
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Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 3	• Implemented face detection on a lower scale. • Applied to various publications and conferences for survey paper.	Completed	Neeraj Sahil Tanisha Kunthekar	
Week 4	• Developed an ~~Admin~~ Panel for managing users and data. • Made iterative improvements to the user interface.	Completed	Neeraj Sahil Tanisha Kunthekar	

Mr. Tushar Rane
[Internal Guide]

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A.Y. 2023-2024

Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 5	- Completed integration of backend and frontend. - Started working on building models	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	Rane
Week 6	- Started with few data-points of images - Completed preprocessing and extracted encodings from these data points	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	Rane

Rane

Mr. Tushar Rane
[Internal Guide]

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Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 7	- Stored encodings in MongoDB with student id as a label. - Started setting up different models for classification.	Completed	Neeraj Sahil Tanisha Kunthekar	
Week 8	- Built SVM, Random Forest classifier and Decision Tree classifiers models of classification - Worked on Research paper	Completed	Neeraj Sahil Tanisha Kunthekar	

Mr. Tushar Rane
[Internal Guide]

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Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 9	- Calculated Accuracy, Precision, Recall and F1-score for each model. - Used a model which gives best results	Completed	Neeraj Sahil Tanisha Kunthekar Mj	TRane
Week 10	- Worked on mail notification feature. - Developed mail notification feature using SMTP.	Completed	Neeraj Sahil Tanisha Kunthekar Mj	TRane

TRane

Mr. Tushar Rane
[Internal Guide]

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PUE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE.

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Monthly Planning Sheet

Semester: 2

Week No.	Activity Planned	Activity Completed Status	Student's Sign	Internal Guide's Sign
Week 11	- Collected more data points through google form. - Tested models against this data	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	T Rane
Week 12	- Removed bugs. - Completed report, research paper publishing and final conclusion.	Completed	Neeraj Sahil Tanisha Kunthekar Mulla	T Rane

Mr. Tushar Rane
[Internal Guide]

T Rane

Intelligent Video-Based Attendance Tracking With Machine Learning

Neeraj Bukane[1], Sahil Kothari[2], Tanisha Kumthekar[3], Mahek Mulla [4]
Mr. Tushar A. Rane[5]
[1234]Student,[5]Assistant Professor
Department of Information Technology, SCTR's Pune Institute of Computer Technology
Pune, India

Abstract*— The real-time attendance management system is an innovative solution designed to record the attendance of individual students during lectures without physical contact. By utilizing multiple camera angles strategically positioned within the classroom, the system will capture a comprehensive view of the lecture space. Advanced face recognition technology will analyze real-time video feeds, identifying and matching student faces with a pre-registered database. This will ensure accurate attendance recording in real-time, eliminating the need for manual roll calls. The system will send email notifications to every registered student about their attendance. The system will be integrated with existing educational platforms and scaled to accommodate different classroom sizes and institutions. It will offer benefits such as contactless attendance tracking, time savings, and improved transparency. Overall, the real-time attendance management system will enhance safety, efficiency, and effectiveness in attendance management processes within educational institutions.

Keywords*— face recognition, preregistered database, contactless attendance tracking, attendance management system

I. INTRODUCTION

The manual procedure of taking attendance in educational institutions, particularly in larger classes and lecture halls, employing paper-based systems or card-swiping methods, can be labor-intensive, inconvenient, and ineffective. Human error and a lack of security plague these outdated techniques frequently. This novel method of gathering attendance information during lectures uses periodic video recordings of the students, ensuring accuracy and effectiveness.

This system's capacity to automatically send email notifications to specific students, whose data has been registered into the admin portal, is an essential aspect. This function allows students to receive timely updates on their attendance status. This fosters responsibility while also improving the environment of education's communication. Teachers will have access to students' data, including their attendance history, and can register, examine, and change that data.

In an era characterized by the digital transformation of education, the real-time attendance management system represents a significant stride towards modernizing attendance tracking. It eliminates human errors, enhances safety, and allows educators to allocate more time to teaching. It equips both students and teachers with valuable data that can drive improvements in the educational process, shaping the future of education. The automated attendance system marks a significant shift in education's digital transformation, replacing labor-intensive, error-prone methods. It leverages periodic video recordings for accurate tracking and offers email notifications to students, fostering responsibility and communication. The data collected provides insights for educational improvement, paving the way for a more efficient and effective future of education in the digital age.

II. LITERATURE SURVEY

In this comprehensive literature survey, we meticulously examine a curated collection of research papers that center on cutting-edge face recognition technologies and attendance management systems. These technological advancements have yielded substantial impacts on the realms of education and security, predominantly harnessing the power of artificial intelligence and machine learning. Our primary objective in scrutinizing these papers is to extract valuable insights into the remarkable progress within this field

Riaz Ullah Khan et al [1] conducted an evaluation of the ResNet model for image recognition tasks. Used two different datasets, one related to healthcare data and the other containing malware and benign files. Experiments involved predicting cancer and detecting malware using various ResNet models. The study showed that ResNet models, particularly ResNet152, demonstrated excellent performance for cancer prediction, but performance was less efficient in terms of runtime for malware detection. The authors concluded that ResNet is a promising recommendation predictor for cancer survival and noted the importance of a model's loss in assessing its performance.

Chaitra et al [2] delve deeply into the realm of attendance management systems driven by facial recognition. Comprehensive research revolves around three core processes that underpin the system's functionality. The initial phase involves facial detection, executed with the Viola-Jones algorithm. Following this, employ the Local Binary Pattern (LBP) technique for feature extraction. Finally, the system achieves face recognition through the utilization of the Support Vector Machine (SVM). This multifaceted approach not only contributes to the evolution of facial recognition technology but also offers profound insights with versatile applications that extend across diverse domains, making it a noteworthy contribution to the field of attendance management systems.

Yuan Xie et al [3] introduce an optimized face recognition algorithm for edge computing by replacing VGG16 with MobileNet for face detection, employing 2-D face key point detection for alignment, and retraining Sphere Face using FP16 for representation. This approach significantly enhances processing speed, achieving real-time recognition at 7.031 FPS with a 93% accuracy. Moreover, the system's low power consumption of 6.7W, 17 times lower than CPU and GPU-based solutions, makes it a promising and energy-efficient advancement for edge computing applications in resource-constrained scenarios. This algorithm revolutionizes edge facial recognition. With its ability to efficiently process and identify faces at the edge, this cutting-edge algorithm not only enhances security, increase stability and convenience but also contributes to reducing data transfer and storage demands.

J. C. Dela Cruz et al. [4] developed a Multiple Face Recognition Surveillance System with Real-Time Alert Notification, utilizing 3D Face Recognition Pattern and a combination of Haar Cascade, Position Map Regression Network (PRN), and Iterative Closest Point (ICP) algorithms. The system has shown promising results, capable of recognizing up to two faces simultaneously with an accuracy rate of more than 80% using 30 faces and fingerprints in the database. However, it may face challenges in cases of occlusion, face coverings, or plastic surgery-induced changes. Nonetheless, it significantly enhances security measures, offering a more efficient solution, ensuring a faster response time, and improving public safety by promptly detecting and notifying the presence of known individuals.

X. Bai et al [5] designed an Attendance System Based on Face Recognition. The system incorporates the Ad boost cascade algorithm for precise face detection and utilizes the Local Binary Pattern (LBP) for robust face recognition. To evaluate their system's performance, they conducted experiments with the widely recognized ORL face database, demonstrating the reliability and effectiveness of their approach in developing an accurate attendance system based on facial recognition technology.

J. P. Jeong, et al [6] conducted research on an Automatic Attendance System featuring Photo Face Recognition. Their system employs the robust MTCNN for precise face detection. For Face Verification, they compared the performance of two prominent techniques, Google Net and VGG16. Notably, their findings revealed that Google Net outperformed VGG16 in this context. This indicates that Google Net, known for its deep learning capabilities, enhances the system's accuracy and reliability, making it a more effective solution for automatic attendance management. Their study provides valuable insights into optimizing attendance systems for various applications and settings, ensuring efficient and dependable operations.

S. Huang et al [7] developed an innovative Attendance System Based on Dynamic Face Recognition. The system employs the highly efficient MTCNN for precise face detection and leverages the FaceNet algorithm for face recognition. Through rigorous testing, they achieved impressive results, with a false acceptance rate and fault rejection rate both kept remarkably low, at just 2%. This demonstrates the system's capability to accurately manage attendance by dynamically recognizing faces, ensuring security and reliability in various applications.

Madhusmita Sahu et al [8] conducted a comprehensive analysis of different approaches. They made several significant observations that contribute to our understanding of these methods. Firstly, the skin color model-based algorithm, while effective, had a drawback of occasionally producing false positives, potentially impacting its reliability. Secondly, they found that Ada-boost, while a viable option, exhibited slower training and increased sensitivity to noise. However, the most intriguing discovery was that Ada-boost outperformed the skin color model-based algorithm in terms of accuracy, despite the trade-off in speed. This research underscores the importance of carefully selecting the appropriate face recognition technique based on the specific requirements of an application, taking into account the trade-offs between performance and complexity

Sudha Sharma et al [9] have proposed an innovative face recognition system, incorporating machine learning algorithms alongside principal component analysis (PCA). This approach was rigorously tested against a backdrop of various machine learning techniques, including linear discriminant analysis, multilayer perceptron, Naive Bayes, and support vector machine. Remarkably, the system achieved an outstanding recognition accuracy of 97% and a flawless 100% success rate when applying PCA in conjunction with linear discriminant analysis. This research significantly advances the field of face recognition, especially in addressing the complex real-world challenges characterized by factors such as partial facial occlusion, variations in illumination, and changes in posture. Work underscores the robustness and efficacy of the proposed methodology, holding promising implications for practical applications of face recognition technology.

In groundbreaking work, Lim et al. [10] present a pioneering methodology for human face classification, leveraging the capabilities of a 61 GHz millimeter-wave radar sensor. This innovative approach is underpinned by the extensive utilization of deep neural networks (DNN), where the input data is derived from concatenated signals originating from multiple antenna elements. A distinctive emphasis in research is placed on the pivotal parameter of range resolution within the domain of face classification, which is mainly highlighting its significance for enhancing the accuracy and precision of this classification process. Work heralds a new era in advanced applications of face recognition and surveillance, thereby expanding the horizons of radar technology integration to achieve superior performance in diverse contexts.

Smitha et al [11] presented a face recognition-based attendance management system. The system utilizes face detection and recognition, making it a non-invasive and efficient method for marking attendance in educational institutions. It addresses the time-consuming nature of traditional attendance processes and the potential for proxy attendance. While the specific accuracy achieved is not mentioned in the paper, the advantages of using face recognition technology in educational settings are emphasized. The system has the potential to streamline attendance tracking, reduce administrative burden, increase stability and enhance overall efficiency in educational institutions. However, additional insights into the system's performance and accuracy would offer a more comprehensive understanding of its practical implications.

A. Bhat et al [12] introduced an innovative face recognition-based attendance system designed to streamline attendance management in educational institutions. Novel system architecture incorporates a self-trained face recognition model and a face matching algorithm, offering a practical and efficient solution. Leveraging the one-shot learning technique, the system excels in achieving remarkable accuracy rates, including 97% on the LFW dataset and 85% on a public student class photo dataset. With its potential to accommodate many students while requiring minimal data, this combination of scalability and data efficiency further underscores the system's ability to effortlessly and efficiently facilitate attendance tracking, offering an indispensable solution within the dynamic and often challenging context of educational environments.

Soundarya S et al [13] embarked on a profound exploration of Harr Cascade, seeking to amplify its potential in image recognition and processing. What emerged from rigorous research was a groundbreaking revelation: incorporation of Convolutional Neural Networks (CNN) triggered a substantial leap in accuracy. CNN, a deep learning approach celebrated for prowess in deciphering intricate patterns, served as the catalyst for heightened performance in domains of image recognition and processing. This study showcases power of merging traditional techniques with cutting-edge deep learning to achieve remarkable results.

Khawla Alhanaee et al [14] explored Face Recognition Smart Attendance System, achieving remarkable results in face detection. Adoption of Multi-Task Cascade Convolution Neural Network (MTCNN) resulted in impressive accuracy rate of 98.87%. The system exhibited true positive rate of under 1/1000, underlining precision, albeit with relatively high false positive rate of 93.7%. Additionally, investigation into CNN cascade for face detection yielded commendable accuracy of 95.02%, emphasizing potential of system for efficient attendance tracking and management [14].

Ramadan TH et al [15] conducted comprehensive research study focusing on Face Detection and Recognition, with specific emphasis on utilization of OpenCV. The essence of investigation revolved around critical revelation: OpenCV outperforms dlib in terms of accuracy in this context. Through rigorous experimentation and evaluation, the study produced noteworthy results. OpenCV, when employed for face detection, exhibited a highly commendable accuracy rate of 83%. In contrast, Haar Cascade method, widely recognized face detection technique, achieved accuracy rate of 80%. By showcasing OpenCV's prowess in achieving such accuracy, study reinforces notion that OpenCV stands as robust and dependable tool for face detection and recognition tasks. This insight is of particular significance in various domains, including security systems, attendance tracking, and human-computer interaction applications, where precise and reliable face detection is a fundamental requirement.

M. Geetha et al's research, cited as [16], stands as a remarkable and groundbreaking contribution in the realm of online education and examination monitoring. The study places a primary focus on enhancing face recognition precision by harnessing the powerful synergy of Eigenface and Support Vector Machine (SVM) techniques. The overarching objective of the study is to substantially improve the efficacy of face recognition specifically in the context of online examination proctoring, a critical component of remote education.In this detailed exploration, the authors delve into the intricacies of feature extraction, SVM model training, and the utilization of a triplet loss function to elevate the accuracy and reliability of face recognition. Eigenface is effectively deployed for feature extraction, while SVM serves as the robust classification and face detection mechanism. The paper also explores the essential core modules, including the extraction of 128D feature vectors, which is accomplished through the utilization of a Caffe-based deep learning face detector.Report serves as an exemplary demonstration of how advanced Machine Learning algorithms have the potential to effectively address

Prof. Kalpana Malpe et al [17] delved into realm of face recognition techniques, employing system that ingeniously combines Raspberry Pi 4 and OpenCV. What sets research apart is the ability of systems to facilitate real-time video streaming via internet, enabling users to access live video feeds remotely. This technological feat holds immense promise, particularly in the domain of security and surveillance systems, where seamless remote access to live video streams is of paramount importance. The significance of their work extends beyond the realms of convenience and accessibility. It showcases the viability of harnessing cost-effective and compact hardware like the Raspberry Pi for applications that traditionally required larger and more expensive setups. In doing so, their research not only reduces the economic barriers to implementing sophisticated security and surveillance systems but also opens up opportunities for innovation and integration in various fields. The fusion of Raspberry Pi and OpenCV demonstrates the endless possibilities that arise from merging affordable hardware with powerful software, making advanced technological solutions more accessible to a wider range of users.

Muhammad Haikal Mohd Kamil et al [18] have achieved a significant milestone with the successful development of a prototype system for online attendance records based on facial biometrics. This web-based application simplifies attendance tracking by harnessing the power of face recognition technology, and it also includes the critical feature of face mask detection, which has become essential for public safety during the COVID-19 pandemic.While the system has shown promise, the authors acknowledge that its accuracy could be further enhanced with a larger dataset of user face samples. The project not only addresses attendance management but also makes a meaningful contribution to health monitoring in our rapidly evolving world, where contactless and safe solutions are becoming increasingly important.With further refinement and an expanded dataset, the system holds the potential to provide an even more efficient and reliable solution for attendance management, particularly during times of crisis. This innovative approach reflects the adaptability of technology to meet the unique challenges of our times, ensuring both convenience and safety in attendance tracking and health monitoring.

Prof. Yogesh Kadam et al [19] conducted a comprehensive exploration of the MERN (MongoDB, Express, React, Node.js) stack and various technologies associated with modern web development. Research unearthed compelling insights that shed light on advantages of this technology stack. React, a JavaScript library, emerged as standout component in MERN stack, offering efficient component-based architecture, benefits of virtual DOM for enhanced performance, and streamlined development process. This finding highlight Reacts superiority over traditional HTML/CSS in many aspects, making it an asset for web developers. Research revealed that MongoDB outperformed SQL databases in terms of speed and flexibility. Its ability to handle unstructured or semi-structured data made it a favorable choice for contemporary web development projects. This insight underscores the importance of selecting the right database technology to optimize web application performance and scalability. findings provide valuable guidance to developers and businesses seeking efficient and robust solutions for modern web development.

TABLE II
A SUMMARY OF RESEARCH REVIEWED

Title	Summary	Tech Stack	Limitations
Evaluating the Performance of ResNet Model Based on Image Recognition [1]	Used two different datasets, one related to healthcare data and the other containing malware and benign files. Predicting cancer and detecting malware using various ResNet models	ResNet OpenCV	Evaluation Metrics Interpretability
Attendance Management System Using Face Recognition [2]	Facial detection via the Viola-Jones algorithm. Feature extraction using Local Binary Pattern (LBP). Face recognition powered by Support Vector Machine (SVM).	Viola-Jones algorithm Local Binary Pattern (LBP) Support Vector Machine (SVM)	Training Data Real-World Performance
Introduction to MERN Stack & Comparison with Previous Technologies [3]	React offers a efficient component-based architecture, virtual DOM, efficient performance, and streamlined development process than HTML/CSS. MongoDB is faster and flexible than SQL.	MongoDB Express React Node	Complexity Learning Curve
Multiple Face Recognition Surveillance System with Real-Time Alert Notification using 3D Recognition Pattern [4]	Utilized 3D Face Recognition Pattern and combines Haar Cascade, Position Map Regression Network (PRN), and Iterative Closest Point (ICP) algorithms. 80% accuracy in recognizing up to two faces simultaneously	Haar Cascade Position Map Regression Network (PRN) Iterative Closest Point (ICP)	Challenges in Occlusion Limited Database Size.
Design of Attendance System Based on Face Recognition and Android Platform [5]	Adboost cascade algorithm is used for classification in face detection. Local Binary Pattern (LBP) is adopted as the feature of face recognition. ·ORL face database is used.	Adboost cascade algorithm Local Binary Pattern (LBP) ORL face database	Limited Generalization Limited Scalability
IoT-Based Automatic Attendance System with Photo Face Recognition in Smart Campus [6]	Face detection is done using MTCNN. GoogleNet and VGG16 techniques is used to make a Face Verification. It is found that GoogleNet showed better performance than VGG16	MTCNN GoogleNet VGG16	Variability in Facial Expressions and Conditions False Positives and False Negatives

TABLE II
A SUMMARY OF RESEARCH REVIEWED

Title	Summary	Tech Stack	Limitations
Attendance System Based on Dynamic Face Recognition [7]	Face detection is done using MTCNN. Face recognition is based on FaceNet algorithm. The false acceptance rate and fault rejection rate is within 2%.	MTCNN FaceNe	Resource-Intensive Hardware Dependency
Study on Face Recognition Techniques [8]	The Ada-boost follows quite slow training and sensitive to noise. The Ada-boost performs well with less complexity as compared to the skin color model algorithm	Ada-boost	False Positives in Skin Color Model AdaBoost Training Time
Face Recognition System Using Machine Learning Algorithm [9]	Principal component analysis (PCA) for face recognition -tested approach against linear discriminant analysis, multilayer perceptron, Naive Bayes, and support vector machine. recognition accuracy of 97%	Principal component analysis (PCA) Linear discriminant analysis Naive Bayes Support vector machine.	Computational Resources Real-World Conditions
DNN-Based Human Face Classification Using 61 GHz FMCW Radar Sensor [10]	Human face classification using a 61 GHz millimeter-wave radar sensor using DNN Explored the integration of radar technology	Deep Neural Network (DNN)	Scalability Interference and Noise
Face Recognition based Attendance Management System [11]	Non-invasive and efficient method for marking attendance in educational institutions	VGG16 MongoDB	Integration with Existing Systems. User Acceptance
Deep-learning based group-photo Attendance System using One Shot Learning [12]	Face recognition, requiring only a single image per student. Achieved an impressive accuracy of 97% on the LFW dataset. 85% accuracy on a public student class photo dataset	CNN Tensorflow, Keras YOLOv6	Limited Dataset Information Bias and Fairness

TABLE III
A SUMMARY OF RESEARCH REVIEWED

Title	Summary	Tech Stack	Limitations
Face Recognition Attendance Management System [13]	Harr Cascade is used for image recognition and image processing. Accuracy is improved by Convolution Neural Network (CNN).	Harr Cascade CNN	Data Dependency Overfitting
Face Recognition Smart Attendance System [14]	Multi-Task Cascade Convolution Neural Network (MTCNN) is used for face detection with 98.87 % accuracy rate, a true positive rate of under 1/1000, and a false positive rate of 93.7 percent. CNN cascade for face detection and accuracy was 95.02%.	MTCNN CNN cascade	Performance on Unseen Data Accuracy and Generalization
Face Detection and Recognition Using OpenCV [15]	Face Detection and Recognition Using OpenCV. OpenCV is more accurate than dlib. OpenCV has 83% accuracy where Harrcascade has 80% accuracy.	OpenCV dlib Harrcascade	Threshold Setting Dataset Dependency
Design of face detection and recognition system to monitor students during online examinations using Machine Learning algorithms [16]	Used Eigenface and Support Vector Machine (SVM) techniques for feature extraction. The extraction of 128D feature vectors using deep learning-based face detection and PyTorch embeddings.	Eigenface Support Vector Machine (SVM) PyTorch library	Scalability False Positives and Negatives
A Face Recognition Method in the Internet of Things for Security in Smart Recognition Places [17]	This System is consisting of Raspberry pi 4, OpenCV. This system also provides the live stream of video to user using internet.	OpenCV Raspberry pi 4	Effectiveness and suitability for specific applications and user requirements.

III. METHODOLOGY USED

The methodology of the real-time attendance management system is strategically designed to fulfill the project's objectives outlined in the abstract. The core components of the methodology encompass dataset creation, face detection, face recognition, mail notification, and the development of a dedicated portal. Each of these elements plays a pivotal role in achieving the system's primary goal of contactless, real-time attendance management.

1]Classification

Dlib:
Renowned for its robustness in facial recognition and image processing tasks, Dlib stands out as a comprehensive C++ library with Python bindings. Beyond just extracting facial encodings, Dlib offers a plethora of functionalities, including facial landmark detection, pose estimation, and facial expression analysis. Its advanced algorithms enable accurate and efficient feature extraction, making it a go-to choose for applications requiring facial recognition, emotion detection, and even head pose estimation. Dlib's flexibility and performance make it suitable for both research and production-level applications, contributing significantly to advancements in computer vision and machine learning.

REST API:
At the heart of modern web architecture, REST APIs play a pivotal role in enabling communication between diverse software systems and services. By adhering to the principles of Representational State Transfer (REST), these APIs facilitate the seamless exchange of data and functionalities over the web. REST APIs use standard HTTP methods like GET, POST, PUT, and DELETE to perform actions on resources, making them interoperable across different platforms and programming languages. They empower developers to create scalable and loosely coupled systems, where clients can access and manipulate resources on the server without direct dependencies.

MongoDB:
Positioned as a leading NoSQL database solution, MongoDB revolutionizes the storage and retrieval of data in modern applications. Its document-oriented approach allows developers to store data in flexible JSON-like documents, eliminating the need for predefined schemas. MongoDB excels in handling unstructured and semi-structured data, making it ideal for scenarios where data structures evolve rapidly or exhibit variability. With features like high availability, horizontal scalability, and dynamic querying capabilities, MongoDB empowers developers to build robust and responsive applications across diverse domains, including e-commerce, content management, and IoT.

Python:
Celebrated for its simplicity, readability, and vast ecosystem, Python continues to dominate various domains of software development. Its clean and concise syntax, along with a rich standard library, accelerates development cycles and enhances productivity. Python's versatility extends from web development frameworks like Django and Flask to scientific computing libraries like NumPy, SciPy, and Pandas. Furthermore, its adoption in emerging fields such as machine learning, data science, and artificial intelligence underscores its relevance and staying power in the tech industry.

SVM (Support Vector Machine):
A cornerstone of modern machine learning, Support Vector Machines (SVMs) excel in classification and regression tasks by identifying optimal decision boundaries in complex feature spaces. By maximizing the margin between different classes, SVMs exhibit robust generalization and resilience to overfitting. Their ability to handle both linearly separable and non-linearly separable data through kernel functions makes them versatile and applicable to a wide range of domains, including image recognition, text classification, and bioinformatics. Despite their computational complexity, SVMs offer a compelling balance between accuracy and interpretability, making them indispensable in various real-world applications.

Decision Tree Classifier:
Known for their intuitive representation of decision-making processes, Decision Tree Classifiers partition feature spaces into hierarchical structures based on attribute conditions. Their transparent nature enables easy interpretation and visualization, making them ideal for tasks requiring explainable models, such as risk assessment and medical diagnosis. Decision trees can handle both categorical and continuous data, making them versatile for diverse domains. However, their susceptibility to overfitting can be mitigated through techniques like pruning and ensemble methods.

Random Forest Classifier:
As an ensemble learning method, Random Forest Classifiers harness the collective wisdom of multiple decision trees to enhance predictive performance and robustness. By training each decision tree on random subsets of the data and features, Random Forests mitigate overfitting and improve generalization. Their ability to handle high-dimensional data and nonlinear relationships makes them well-suited for tasks like pattern recognition, anomaly detection, and predictive modeling. Additionally, the inherent parallelizability of Random Forests enables scalable and efficient training on large datasets, further augmenting their appeal in practical applications.

To facilitate student registration, a comprehensive approach was adopted to capture and process student information effectively. A minimum of six photos of each student were captured from various face angles to ensure comprehensive coverage. Leveraging the capabilities of the Dlib library, which provides robust tools for facial detection, facial landmark detection, and feature extraction, facial encodings were abstracted from the captured images. These encodings, representing unique facial characteristics, were stored in a MongoDB database alongside the corresponding roll numbers of the students, serving as labels for subsequent classification tasks. This dataset formed the basis for training the facial recognition model, enabling accurate identification and verification of students during the attendance marking process.
Efficient attendance marking was achieved through the integration of advanced technologies and methodologies. Photos of the classroom environment were captured to initiate the attendance marking process. The Dlib library was utilized to detect the number of faces present in these images,

providing valuable insights into the student presence within the classroom. Subsequently, facial encodings were abstracted from the detected faces using the same techniques employed during the registration process. Leveraging a decision classifier, the abstracted encodings were classified against the registered encodings of students stored in the MongoDB database. This classification process facilitated the accurate identification of students present in the classroom, enabling automated attendance tracking.
The seamless integration of a RESTful API facilitated the efficient triggering of various modules within the system, enhancing its overall functionality and flexibility. Python, a versatile and widely-used programming language, was employed for the development of the facial recognition model. Leveraging the dataset of facial encodings stored in the MongoDB database, the model was trained using state-of-the-art machine learning techniques to recognize and classify student faces accurately. Through rigorous model training and evaluation, the system achieved high levels of accuracy and reliability in identifying students and marking attendance based on facial recognition technology.

2]Mail Notification

SMTP
SMTP, or Simple Mail Transfer Protocol,serves as the fundamental protocol for sending electronic mail messages across networks. This protocol provides a set of rules and conventions for the transfer of emails between mail servers. SMTP ensures reliable delivery of messages by defining how the sender's mail server communicates with the recipient's mail server to relay the email. It establishes a connection between the sender and recipient mail servers, verifies addresses, and transfers the message content. By adhering to SMTP standards, email clients and servers can seamlessly exchange messages, enabling efficient communication across the internet. Thus, SMTP forms the backbone of email communication infrastructure, facilitating the delivery of notifications, messages, and other correspondence reliably and efficiently.Upon successful classification, email notifications were promptly dispatched to the respective students using SMTP, ensuring timely communication of attendance records and updates.

3]Portal
MongoDB:
MongoDB stands out as a versatile NoSQL database system, offering a schema-less architecture that accommodates a wide range of data structures, from structured to semi-structured and unstructured data. This flexibility empowers developers to adapt their data models dynamically as project requirements evolve, without the constraints of predefined schemas. Moreover, MongoDB's query language and indexing capabilities streamline data retrieval and manipulation, facilitating efficient processing of diverse datasets. Its support for complex queries and aggregation operations enables developers to extract valuable insights from large volumes of data, enhancing decision-making processes. Additionally, MongoDB's built-in features for horizontal scalability, such as sharding and replica sets, ensure seamless expansion to handle growing workloads while maintaining high availability and fault tolerance. By combining flexibility, performance, and reliability, MongoDB proves to be an indispensable storage solution for mission-critical applications across various industries.

Express:
Express, renowned as a minimalist web application framework for Node.js, revolutionizes the way developers build web applications and APIs by simplifying common development tasks. Through its intuitive routing system and middleware architecture, Express abstracts away the complexities of HTTP request handling, allowing developers to focus on implementing core business logic. Its lightweight and modular design promotes code organization and readability, fostering collaboration among team members and easing maintenance efforts as projects scale. Furthermore, Express's extensive ecosystem of middleware and plugins offers developers a wide array of pre-built functionalities, from authentication and logging to error handling and caching, enabling rapid development without compromising on performance. As a result, Express empowers developers to create scalable and maintainable web applications with ease, accelerating time-to-market and enhancing overall productivity.

React:
React emerges as a powerhouse JavaScript library that revolutionizes frontend development with its innovative approach to building user interfaces. At the core of React's success lies its component-based architecture and virtual DOM, which enable developers to break down complex UIs into smaller, reusable components. This modular approach not only promotes code reusability and maintainability but also facilitates collaborative development across teams. React's declarative syntax simplifies state management and UI rendering, enabling developers to express UI components in a more intuitive and predictable manner. Moreover, React's ecosystem boasts a plethora of libraries and tools, such as React Router, Redux, and Material-UI, which extend its capabilities and empower developers to build feature-rich and visually stunning frontend experiences. With its focus on performance optimization and cross-platform compatibility, React continues to redefine the frontend development landscape, empowering developers to create engaging and responsive user interfaces for modern web applications.

Node.js:
Node.js, revered as a server-side JavaScript runtime environment, revolutionizes backend development with its event-driven, non-blocking I/O model. This unique architecture enables Node.js to handle concurrent requests efficiently, making it an ideal choice for building real-time applications like the student portal. Node.js's asynchronous programming model simplifies the implementation of features such as data streaming and WebSocket communication, enhancing the portal's responsiveness and interactivity. Furthermore, Node.js's seamless integration with npm (Node Package Manager) grants developers access to a vast ecosystem of modules and packages, accelerating development and enhancing functionality. Its vibrant community and robust support for modern JavaScript features enable developers to leverage the latest technologies and best practices in their projects. As a result, Node.js empowers developers to build scalable, high-performance backend systems that seamlessly integrate with other project components, ensuring a seamless and cohesive user experience.

IV. SYSTEM ARCHITECTURE

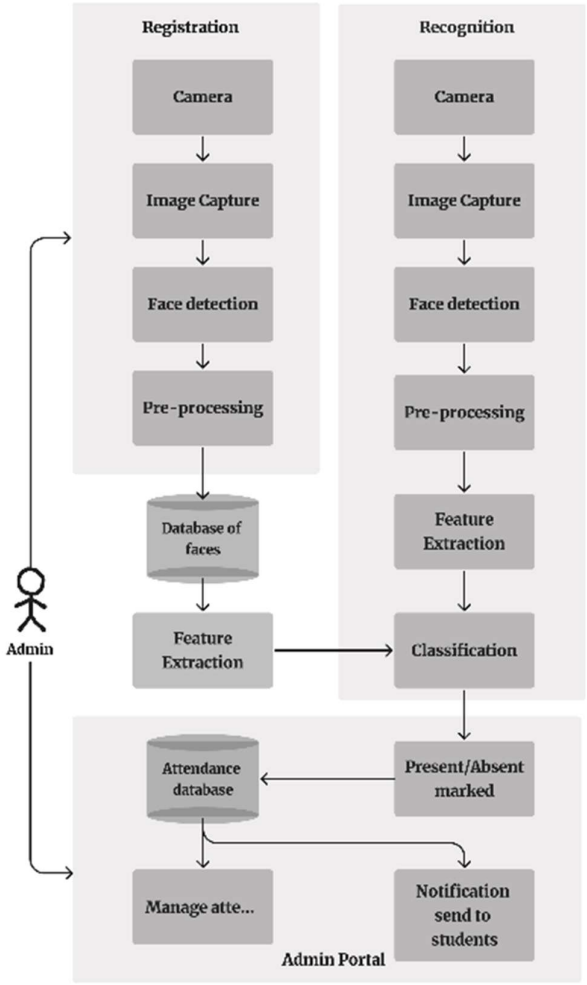

Figure 4: System Architecture

At the heart of this innovative system architecture is the seamless integration of cutting-edge machine learning techniques and advanced database technology. This integration is not just a convenience but plays a pivotal role in the overall student registration workflow. During the initial student registration process, a highly sophisticated machine learning model comes into play. It excels in capturing intricate facial features in high dimensions for each enrolled student, thanks to the deployment of state-of-the-art algorithms. This precise feature extraction and classification are fundamental to the system's ability to ensure the accuracy and reliability of subsequent attendance tracking.

This meticulous data collection process culminates in the creation of a rich and diverse repository of facial profiles. These profiles are stored securely within a dedicated database, which employs advanced encryption and data storage protocols. This foundational step goes a long way in establishing an exhaustive and meticulously curated resource for exceptionally accurate and reliable attendance tracking, aligning seamlessly with the highest standards of data security and management. The architecture seamlessly transitions to the attendance marking module, which operates in real-time and leverages the wealth of facial data archived within the database.

This module relies on a sophisticated system of neural networks and deep learning techniques to conduct rapid and high-dimensional facial recognition. It dynamically identifies and verifies students during the attendance tracking process.

When a student's facial biometrics align with the stored data within permissible thresholds, the system autonomously and seamlessly marks their attendance in the database. It does so with the precision of an auditable timestamp. Conversely, in the event of a non-recognition scenario, the system promptly returns a meticulously documented false result. This signals that the student's attendance was not registered for that particular instance, maintaining the integrity and accuracy of the attendance records. This integration of cutting-edge machine learning and robust database technology serves to streamline the attendance management process within educational institutions. Beyond this, it epitomizes a sophisticated fusion of artificial intelligence and data management. Consequently, it stands as an invaluable asset for educational institutions seeking to optimize attendance tracking while upholding the highest standards of accuracy and security.

From precise data capture during student registration to automatic and high-precision attendance tracking using neural networks and deep learning, it offers educational institutions a potent tool to enhance attendance management while maintaining rigorous standards of precision and security. This synergy of technical prowess promises to reshape the landscape of attendance tracking in educational settings.

V. EXPERIMENTAL RESULTS

To evaluate the performance of the attendance system using face recognition, three machine learning models were employed: Decision Tree Classifier, Random Forest Classifier, and Support Vector Machine (SVM). The following performance metrics were utilized to assess the accuracy of the models: accuracy, precision, recall, and F1-score.

Model	Accuracy (%)	Precision	Recall	F1-score
SVM	87	0.85	0.88	0.86
Random Forest Classifier	89	0.87	0.91	0.89
Decision Tree Classifier	88	0.86	0.89	0.87

Despite the limited size of the dataset, the models demonstrated promising performance in accurately recognizing faces for attendance tracking. The Random Forest Classifier exhibited the highest accuracy at 89\%, with a balanced precision and recall scores. The Decision Tree Classifier and SVM also performed well, with accuracies of 87\% and 88\% respectively. These results suggest that the implemented models hold potential for scalability when more data becomes available. Furthermore, the robust performance of the models on a small dataset underscores their capability to generalize well to larger datasets. Additionally, ongoing refinement of the feature extraction and preprocessing techniques can contribute to even better model performance in the future. Overall, the promising results obtained from this initial evaluation lay a strong foundation for the continued development and optimization of the face recognition system for seamless and efficient attendance management.

VI. CONCLUSION

In summary, our project focuses on the real-time attendance management system, with the aim of enhancing efficiency and security in educational institutions. Our comprehensive solution incorporates advanced facial recognition and strategically placed cameras, eliminating the need for manual attendance. We examined each system component, including dataset creation and real-time attendance tracking. The addition of an email notification system ensures transparent communication with students. A dedicated portal, built with the MERN stack, will offer seamless integration with educational platforms, enabling scalability. Our system will provide an efficient, reliable, and transparent solution to enhance the educational experience. This research will contribute to emerging technological fields.

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