International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

SMART GROUPED ATTENDANCE MANAGEMENT SYSTEM

E. Siva Krushna[1] , Chittiboina Charan Sai[2] , Rongali Karthik[3] , Saragadam Yamini Priya[4] , Shaik Noorjahan[5]

[1]Dept of CSE, Nadimpalli Satyanarayana Raju Institute of Technology, Visakhapatnam – 530026

[2,3,4,5] Department of CSE(AIML), Nadimpalli Satyanarayana Raju Institute of Technology Visakhapatnam, Andhra Pradesh -530026

A B S T R A C T :

The Smart Grouped Attendance Management System is an innovative solution designed to streamline and enhance the traditional process of tracking attendance in educational institutions and corporate environments. Unlike conventional systems that record attendance on an individual basis, this system introduces a smart grouping mechanism, allowing users to manage attendance based on predefined groups such as classes, departments, teams, or projects. The system leverages modern technologies like RFID, QR codes, biometric authentication, or facial recognition to automate the check-in/check-out process, reducing manual errors and saving time. Additionally, it provides real-time data analytics, attendance summaries, and customizable reports to improve decision-making and operational efficiency. By integrating cloud storage and mobile access, the system ensures accessibility, security, and scalability, making it a comprehensive tool for smart attendance management in dynamic organizational settings.

Keywords:

Smart Attendance, Grouped Attendance, Face Recognition, Biometric Authentication, Real-time Tracking, Cloud Integration, Student Management, Mobile Application, Classroom Automation, Natural Language Processing (NLP), Data Visualization, Attendance Analytics, Academic Monitoring, Secure Access, AI-powered System, Role-based Access, Smart Campus, Automated Scheduling.

1. Introduction

The Smart Grouped Attendance Management System is an advanced mobile application designed to revolutionize the process of attendance tracking in group settings. Developed using React Native, this application incorporates cutting-edge Machine Learning technologies to automate and streamline the attendance-taking process. The system leverages two powersful machine learning algorithms_dlib_face_recognition_resnet_model_v1.dat and shape_predictor_68_face_landmarks.dat to detect and recognize faces with high accuracy. A key feature of this system is its ability to recognize and register up to 6 faces simultaneously, making it ideal for classrooms, meetings, or events where multiple individuals need to be identified at once. This capability significantly reduces the time spent on attendance and eliminates the need for manual input, ensuring a more efficient and accurate process. The app's user-friendly interface provides real-time updates, while the facial recognition technology guarantees precise and reliable attendance logging. By incorporating these innovations, the Smart Grouped Attendance Management System enhances both convenience and security, making it a valuable tool for any group-based environment.

1.1. Research Objectives and Methodology

The primary objective of this research is to enhance the efficiency, accuracy, and user experience of attendance management through smart grouping and automation techniques. This project aims to modernize traditional attendance systems by integrating intelligent technologies. The following objectives outline the scope of this investigation:

1. To design and implement a smart attendance system that enables grouped attendance marking for students using digital technologies.
2. To incorporate biometric or face recognition and/or QR-based verification methods to automate and authenticate attendance with minimal manual effort.
3. To develop a centralized dashboard for real-time tracking, monitoring, and visualization of attendance records and patterns.
5. To improve academic monitoring by analyzing attendance data and generating actionable insights for faculty and administration.
5. To ensure data security, integrity, and role-based access control within the system for students, faculty, and administrators.

2. Literature Survey

Attendance management has long been a crucial aspect of academic institutions, directly impacting student performance, discipline tracking, and administrative operations. Traditional attendance systems—whether paper-based or manual digital entry—often suffer from inefficiencies, errors, and

the inability to scale effectively in large classrooms or institutions. Early digital solutions typically relied on simple database management and manual user input, lacking automation, real-time insights, and integration with smart technologies. With advancements in biometric technologies, IoT, and automation, modern systems now leverage tools such as face recognition, QR scanning, and cloud platforms to enable faster, more accurate, and tamper-proof attendance tracking. These systems reduce the burden on faculty, enhance monitoring capabilities, and ensure better data accuracy. However, challenges remain in managing grouped attendance (such as for clubs, batches, or event-based participation), ensuring user authentication, and generating actionable insights from attendance data.

To address these gaps, our project implements a Smart Grouped Attendance Management System using a combination of biometric or QR code-based verification methods, centralized cloud storage, and a real-time web-based dashboard. The system is designed to allow faculty to mark attendance for specific groups or entire batches efficiently, while providing role-based access for students, faculty, and administrators. Data visualization tools are integrated to present trends, defaulters, and overall attendance statistics for informed academic decisions. Our implementation adopts a resource-conscious yet scalable approach, combining intuitive UI/UX design with backend automation to deliver a seamless user experience.

3. Methodology and Proposed Method

The proposed system is designed to perform automated attendance management by leveraging face recognition for accurate and efficient tracking of student attendance. The method interconnects multiple modules, each responsible for data acquisition, model training, recognition, and user interaction via a mobile application. The goal is to streamline the attendance process, eliminate manual errors, and ensure secure, real time attendance logging across institutional settings.

Step 1: Face Data Acquisition and Preprocessing

The first step involves collecting face data of students with prior informed consent, ensuring diversity in facial expressions, angles, and lighting conditions. The Dlib library's 68-point facial landmark predictor is used for facial alignment and feature extraction. All collected images are resized and normalized for consistent input into the model. To improve generalization and robustness, data augmentation techniques such as rotation, flipping, and scaling are applied to expand the dataset artificially.

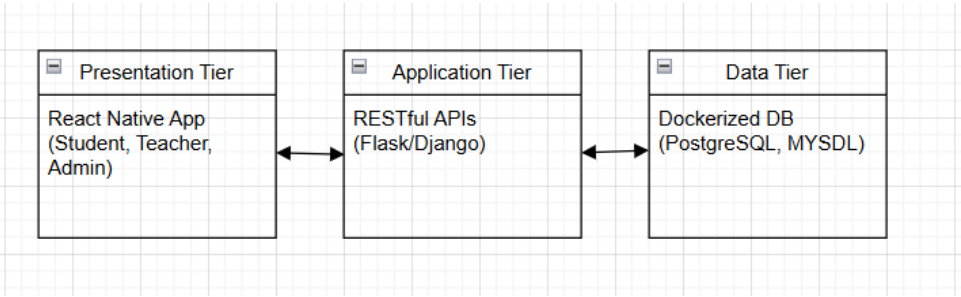

Fig1: Architecture

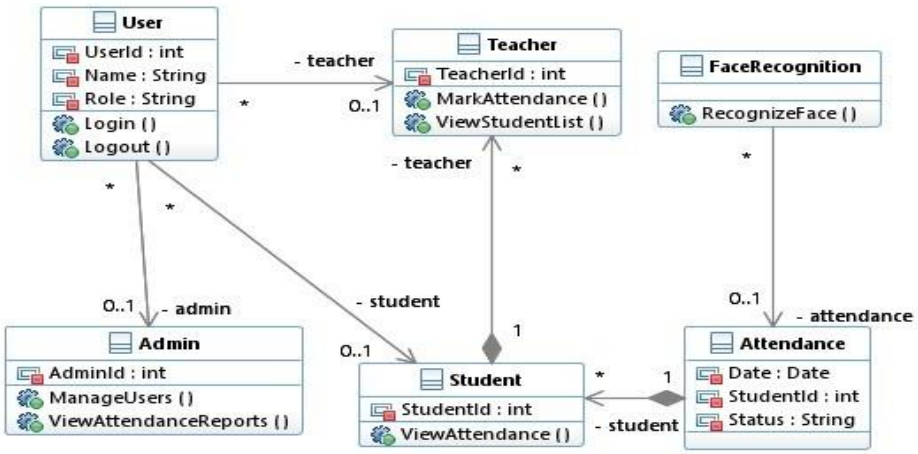

Fig2: Class Diagram

Step 2: Face Recognition Model Training and Optimization

Next, a pre-trained deep learning model, such as ResNet-50, is used as the base for facial recognition due to its powerful feature extraction capabilities. Transfer learning is applied to fine-tune the model on the prepared dataset of student faces. The model is evaluated using accuracy, precision, and recall on a held-out validation set to ensure its reliability. Based on the performance metrics, the model is iteratively improved through hyperparameter tuning and architectural adjustments.

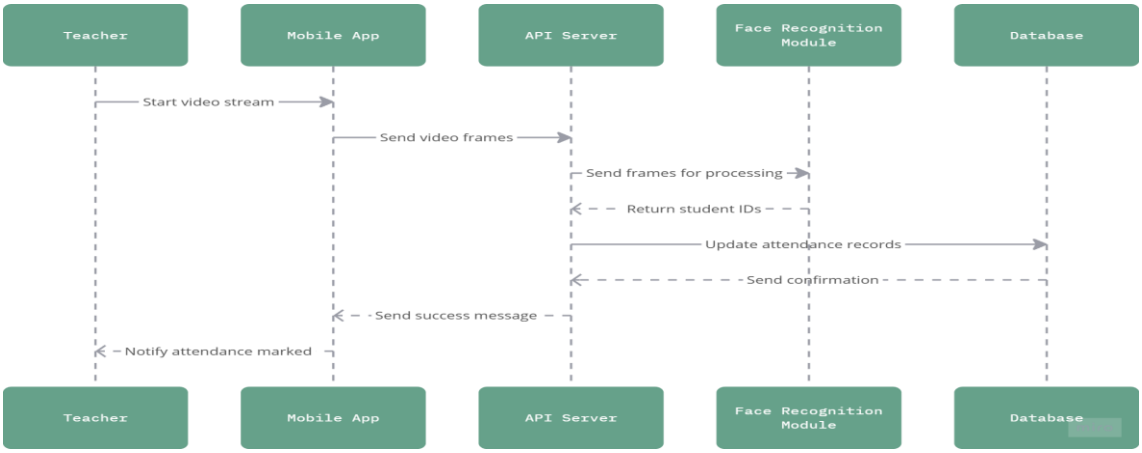

Fig3: Sequence Diagram

Step 3: System Integration and API Communication

After successful model training, a RESTful API is developed using Python frameworks like Flask or FastAPI. This API facilitates seamless communication between the mobile application, facial recognition engine, and the backend database. It handles face recognition requests, user authentication, and attendance logging in real time, ensuring smooth data flow across modules.

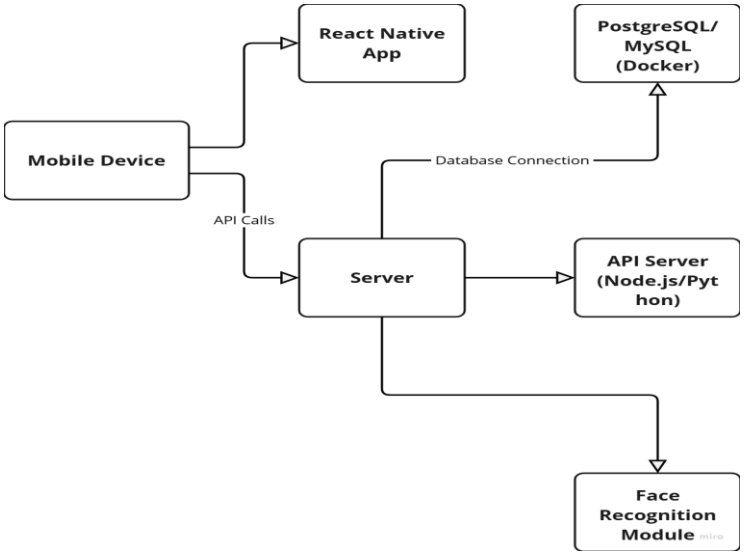

Fig4: Deployement Diagram

Step 4: Mobile Application for User Interaction

To provide users with direct access to the system, a React Native mobile application is developed. It supports multiple user roles—students, faculty, and administrators—allowing role-based access and attendance functionality. Students can authenticate using face recognition, while teachers can take group attendance, view statistics, and track attendance records conveniently from their devices.

Step 5: Secure Data Management and Privacy Protection

User data, including facial embeddings and attendance logs, are stored securely in a containerized database setup (e.g., Dockerized PostgreSQL or MySQL). Sensitive data is encrypted, and the system adheres to strict data protection practices, such as anonymizing facial features and restricting data access by user role. Real time attendance logs are stored only when necessary, and users are informed about data usage in compliance with privacy norms.

Step 6: Deployment and Real-Time Attendance Processing

The complete system is deployed on a suitable platform—either a cloud service or local institution server— ensuring reliability and scalability. The deployment includes hosting the REST API, distributing the mobile app, and enabling real-time video stream processing for face recognition. The platform is designed to be device agnostic, responsive, and user-friendly, ensuring broad accessibility and a seamless experience.

4. Implementation

The proposed system implements a smart, automated attendance tracking framework using facial recognition, transfer learning, and mobile integration. The goal is to eliminate manual attendance tracking, reduce time consumption, and ensure accuracy and security using AI-powered face recognition models.

Step 1: Visualization of Mobile Interface

The first step begins with the visualization and design of the Smart Attendance mobile application interface using React Native. The home screen features a welcoming dashboard for users—students, teachers, and admins—with role-based login options. The interface is clean and intuitive, offering actions like “Mark Attendance,” “View Attendance Reports,” and “Manage Classes.” The app emphasizes ease of access and functionality, with minimal steps to complete tasks. A simple camera access feature allows students to scan their face and mark attendance in real time.

Step 2:Student Face Data Collection and Alignment

Once students log in, their facial data is collected through the mobile app or web portal with explicit informed consent. Using the Dlib’s 68-point facial landmark detector, the system aligns and extracts key face features, ensuring accurate recognition regardless of lighting or pose. The images are resized and normalized for model training. Data augmentation methods such as flipping, rotating, and scaling are used to artificially increase dataset variability, improving model generalization .

Step 3: Training the Recognition Model (ResNet)

The core facial recognition functionality is powered by a fine-tuned ResNet-50 model, initially pre-trained on standard datasets like Labeled Faces in the Wild (LFW). Through transfer learning, the model is adapted specifically to the collected student face dataset. Performance is continuously evaluated using accuracy, precision, and recall metrics, and the model is optimized accordingly. The result is a lightweight yet accurate model that can recognize individual faces with high precision.

Step 4: Real-Time Attendance Marking and Processing

After model deployment, the user simply opens the app and scans their face. The app communicates with a Flask/FastAPI-based backend API, which matches the scanned face to the database and records the timestamped attendance. The process is fast, secure, and prevents proxy attendance. For group attendance, teachers can initiate a camera scan, and the system recognizes multiple faces simultaneously using real-time video processing.

Step 5: Attendance Records & Role-Based Dashboard

Once attendance is marked, the information is stored in a Dockerized PostgreSQL/MySQL database. Admins and faculty can view attendance logs and generate reports through a clean dashboard interface. Data is encrypted and protected to maintain user privacy. The app also includes role-specific dashboards:

- Students see their personal attendance history.
- Teachers can manage class attendance and export reports.
- Admin can monitor system-wide performance and usage.

Step 6: Deployment and Future Enhancements

The entire system is deployed on a cloud server or local institution server for maximum availability. The backend API, database, and app interface are containerized for easier scaling. The system is built with extensibility in mind—future updates may include deep learning enhancements using YOLO, integration with IoT-based biometric devices, cloud sync for multi-location access, and AI-powered analytics for student behavior insights. Web portal support will also be added for remote administration.

5. Conclusion

This project presents a Smart Grouped Automated Attendance Management System that utilizes facial recognition technology and machine learning to modernize and simplify the attendance process. By leveraging a pre-trained ResNet model fine-tuned with student facial data, the system accurately identifies individuals and marks attendance in real time, reducing manual effort and eliminating common issues like proxy attendance and data entry errors. The integration of facial landmark detection ensures robustness against variations in lighting, angle, and expressions, making the system reliable and consistent across diverse environments. Designed to be fast, secure, and scalable, this AI-powered solution provides a seamless experience for students, teachers, and administrators through a mobile-first interface. By automating attendance tracking, generating detailed reports, and enhancing data privacy, the system serves as a powerful tool for educational institutions aiming to improve operational efficiency. With promising accuracy and performance in real-time testing, this system lays the groundwork for future enhancements like YOLO-based detection, IoT integration, biometric authentication, and cloud synchronization—making it a forward-thinking solution adaptable to diverse organizational needs.

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