Smart Attendance Tracking System Using Face Recognition

Ayush Jangid[1], Ms. Ashima Tiwari[2], Ankit Kumar[3], Deepak Mehra[4]

[1] *Student, Computer Science and Engineering, Poornima Institute of Engineering and Technology Jaipur, India, 2020pietcsayush47@poornima.org*
[2] *Assistant Professor, Computer Science and Engineering, Poornima Institute of Engineering and Technology Jaipur, India, ashima.tiwari@poornima.org*
[3] *Student, Computer Science and Engineering, Poornima Institute of Engineering and Technology Jaipur, India, 2020pietcsankit30@poornima.org*
[4] *Student, Computer Science and Engineering, Poornima Institute of Engineering and Technology Jaipur, India, 2020pietcsdeepak56@poornima.org*

ABSTRACT

The "Smart Attendance Tracking System" is an innovative project that automates attendance management in educational institutions or anywhere where attendances are getting marked on a daily basis. This project uses facial recognition powered by Machine Learning and integrates with React for the frontend and Node.js with express.js library for the backend. Cameras installed in classrooms capture the real time video in which every student can be tracked and mark their attendance in a database after recognising the student's face at the server using ML. For exceptional cases, teachers can manually update attendance. Students can monitor their attendance through the frontend. This project improves accuracy, efficiency, and accessibility in attendance tracking, revolutionizing traditional methods. Key Features of the Smart Attendance Tracking System:
Facial Recognition for Automated Attendance: *The system employs advanced facial recognition technology to automatically track and record student's attendance as they enter the classroom, eliminating the need for manual attendance taking.*
Exception Handling: *In cases where facial recognition may not work, such as when a student is on sick leave or if the camera fails to recognize a student, teachers have the ability to manually mark attendance, ensuring accuracy and completeness in attendance records..*

Keywords : *Smart Attendance, Face Recognition, Facial Recognition System, Web-based, Automated Attendance, Real-time Tracking, Facial Features Detection*

1. INTRODUCTION

In the dynamic landscape of education, the management of student attendance remains a fundamental aspect of ensuring academic success and institutional accountability. Manual attendance tracking methods have long been the standard, but they are prone to errors, time-consuming, and often lack the efficiency and transparency needed for modern educational institutions. To address these challenges, we introduce the "Smart Attendance Tracking System," a technologically advanced and innovative solution designed to revolutionize how attendance is managed in educational environments.

The "Smart Attendance Tracking System" is a comprehensive project that integrates cutting-edge technologies and software solutions to automate and enhance the attendance tracking process. This project combines the power of Machine Learning, React for the frontend, and Node.js for the backend to create a cohesive and user-friendly system for students and teachers.

With the deployment of strategically positioned cameras in each classroom, this system harnesses the capabilities of Machine Learning, particularly facial recognition, to accurately identify and record the attendance of students. The

Machine Learning model, developed using Python, plays a central role in the system, enabling precise recognition of students as they enter the classroom.

The database management system, hosted on a Node.js server, seamlessly stores and organizes attendance records, ensuring data integrity and accessibility. Simultaneously, the React-based frontend application empowers students to monitor their attendance records in real-time, while providing teachers with a user-friendly platform to mark attendance manually in exceptional situations. This includes scenarios where a student may be on sick leave or when the camera system encounters recognition challenges.

The "Smart Attendance Tracking System" promises to deliver numerous advantages to educational institutions. It enhances efficiency by automating attendance marking, significantly reduces the risk of errors, and promotes transparency by granting access to attendance records for both students and teachers. Exception handling mechanisms ensure flexibility in attendance management, allowing teachers to address unique situations as they arise. Additionally, the system offers the potential for valuable data analysis, enabling educational institutions to gain insights into attendance patterns and make data-driven decisions.

In conclusion, the "Smart Attendance Tracking System" represents a significant leap forward in the realm of attendance management in educational institutions. By fusing state-of-the-art technology with user-friendly interfaces, this project offers a promising solution to the age-old challenges of attendance tracking. As it modernizes and optimizes attendance management, it aims to empower educational institutions to focus more on the core mission of education and less on administrative burdens.

2. LITERATURE REVIEW

A literature survey on “Smart Attendance Tracking System” that provides the current implementations and researches about it. To track student’s attendance using face detection using live footage in a classroom is also a way but there are many other researches and proposed projects based on IoT, RFID, GPS tracking that can be used according to the scenario. Here are some previous related work:

2.1 Smart Attendance Automation System

The Smart Attendance Marking System leverages facial recognition technology to automate attendance tracking in educational institutions and businesses. By creating a face database and training deep learning algorithms, it offers advantages such as time savings, increased accuracy, and real-time updates. This versatile system can integrate with existing attendance management solutions or stand alone, aiming to optimize attendance monitoring and reduce manual efforts and errors for improved management. The objective is to design, develop, and implement an efficient system that ensures precise attendance records through facial recognition technology, ultimately delivering benefits like time efficiency, accuracy, real-time updates, and enhanced security.

2.2 Smart Attendance Management System Based on Face Recognition Using CNN

Introduces CNN's role in Face Recognition and its adaptation for attendance tracking within the Smart Attendance Management System (SAMS). It details the workflow of SAMS and discusses data collection and augmentation for CNN model development. The paper proposes an efficient CNN model for face recognition and provides experimental results demonstrating its effectiveness in SAMS. SAMS is user-friendly, easy to deploy, and maintain. Future work aims to expand this system for real-time attendance management of larger student populations.

2.3 Smart Attendance Management System Based on RFID

The proposed IoT-based smart attendance system using RFID aims to replace manual attendance management with an efficient, error-free solution. It streamlines attendance tracking, benefiting schools, colleges, and organizations. While various methods exist for attendance management, this system is user-friendly, time-saving, and highly reliable, offering a seamless solution for diverse organizations.

3. PROBLEM IDENTIFICATION

As we are making our project to automate a handy and time taking attendance tracking tasks for an institution, we though to make it fully automated using student’s mobile current location and according to that we could mark their attendances at database but GPS doesn’t work for indoor and cannot provide accurate position of a student within the institute. We also thought of a wifi strength based positioning system but there were also many problems, same with

RFID because of its physical presence with a student. After all we decided to move forward with face detection within a classroom using a camera and update the attendances, there are also some problems as shown below :

- **Face Recognition Accuracy:** One of the most critical challenges is ensuring that the face recognition system accurately identifies students, even in different lighting conditions, angles, or if students change their appearance (e.g., wearing glasses, growing facial hair).
- **Privacy Concerns:** Implementing a camera-based system raises privacy concerns. we'll need to address how we plan to handle and secure the data collected, especially since we're working with sensitive biometric information. Hardware Costs and Infrastructure: Installing cameras in every classroom can be expensive and technically challenging. We'll need to consider the hardware and infrastructure requirements, including power supply, network connectivity, and maintenance.
- **Scalability:** If our system is deployed in a large educational institution, it should be able to scale effectively to handle a large number of students and classrooms.
- **Exception Handling:** Our system needs to handle exceptional cases effectively, such as when the camera can't recognize a student. There may be N number of reasons that a student cannot attend class so the system should contain additional service for faculty to mark attendance.

4. DESIGN METHODOLOGY AND IMPLEMENTATION

The three primary user roles in the system are Faculty, Student, and Admin. Every position has unique functions designed to meet their requirements.

4.1 Admin Functionality:

The Admin is in charge of overseeing user accounts for both teachers and students and has the greatest level of access. The Administrator gathers necessary data, including name, email address, date of birth, and cellphone number, during user registration. To grant users access to the system, the administrator establishes user accounts and assigns them special passwords. The administrator also has the power to remove people from the system if needed and to view all registered users, including instructors and students.

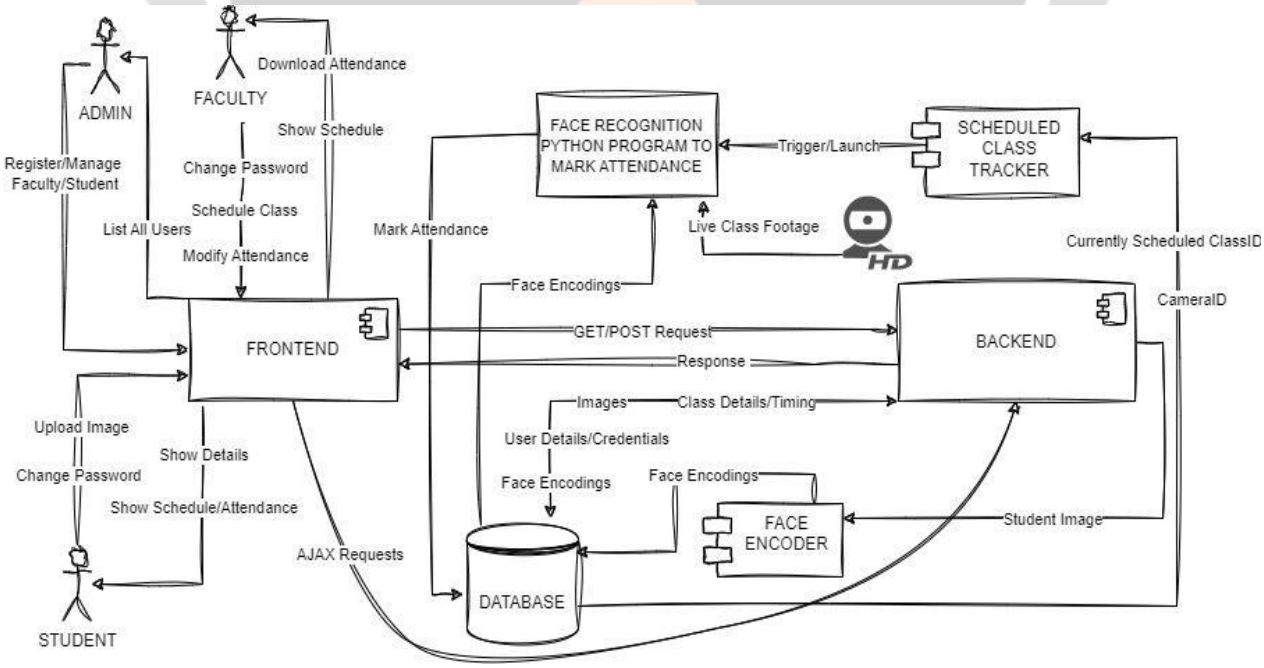

Chart -1: System design for the project

4.2 Student Functionality:
Students may examine their timetables and mark their attendance using the system. Students can choose to upload their photographs upon registration, and such images are kept in the database of the system. The system extracts face traits from these pictures and stores them safely using the Dlib and OpenCV libraries. Using the encoded facial traits, the system uses the students' presence in the classroom to automatically record their attendance during class. Additionally, students have access to their attendance records and daily agendas.

4.3 Faculty Functionality:
Teachers can set up classes, see their own timetables, and get attendance data. They are able to make class schedules that include the date, time, and other pertinent information. Teachers can check attendance data throughout class to keep an eye on student engagement. In addition, for record-keeping and analytical purposes, faculty members can obtain attendance data from previous sessions.

4.4 The technological stack:
The set of databases, frameworks, libraries, and programming languages that go into creating an intelligent attendance monitoring system is known as the technological stack. Here's a more thorough breakdown of every element:

- **Developing Frontends using React.js :** One well-liked JavaScript library for creating user interfaces is called React.js. Because of its component-based architecture, developers are able to produce UI elements that are reusable. React.js is utilized to construct the frontend of the smart attendance system, giving users an interactive and dynamic interface.
- **Using Express.js and Node.js for Backend Development :** A runtime environment called Node.js makes it possible to execute JavaScript server-side. Because it offers an event-driven, non-blocking I/O mechanism, developing scalable web applications may be done effectively with it. A straightforward web framework for Node.js, Express.js makes it easier to create reliable online APIs. The server-side functionality and API endpoints for the smart attendance system are defined using Node.js and Express.js in tandem.
- **Managing Databases with MySQL :** Renowned for its dependability, scalability, and performance, MySQL is a widely used relational database management system (RDBMS). It is used to hold a variety of data in the smart attendance system, such as class schedules, user information, and attendance records. MySQL offers an organized method of storing data, making it possible to retrieve and manipulate data effectively.
- **Using Dlib and OpenCV for Facial Recognition Technology :** These two open-source libraries are frequently used for computer vision applications, such as facial recognition. Pre-trained models for face identification, facial landmark detection, and face recognition are available in Dlib's machine learning toolbox. For image processing and computer vision applications, OpenCV offers a large selection of functions and methods. Dlib and OpenCV are used in the smart attendance system to encode and decode face characteristics for attendance monitoring, guaranteeing precise and trustworthy student identification.

4.5 Specifics of Implementation:
The smart attendance monitoring system's architecture and the ways in which its many parts function together are explained in the implementation details. Here's a more thorough breakdown of the elements of implementation:

- **Modular Architecture:** To improve organization, scalability, and maintainability, the system is divided into frontend and backend components. This promotes code reuse and lets developers work on various system components separately.
- **RESTful APIs:** Representational State Transfer, or RESTful APIs, facilitate communication between the system's front end and back end. API endpoints are guaranteed to be stateless, scalable, and compliant with common HTTP methods (GET, POST, PUT, DELETE) by adhering to RESTful principles. This allows the client-side (frontend) and server-side (backend) parts of the system to integrate and exchange data with ease.
- **User Authorization and Authentication:** To provide safe access to system features, user authorization and authentication procedures are put in place. This entails utilizing login credentials, such as a username and password, to confirm users' identities. Furthermore, rights and privileges are assigned to users according to their responsibilities (Admin, Faculty, Student) using role-based access control (RBAC).
- **Automation of Scheduled Tasks:** Python scripts run as child processes in the Node.js environment are used to automate scheduled tasks for attendance monitoring. These scripts do facial recognition and record attendance in

class using the Dlib and OpenCV libraries. Without human interference, automation guarantees precise and effective attendance tracking.

5. HARDWARE REQUIREMENTS

- Intel Core i7 or AMD Ryzen 7 series
- 16 GB RAM
- 50 GB SSD
- Dedicated GPU with CUDA support

6. SOFTWARE FRAMEWORKS AND TOOLS

- Ubuntu OS
- Programming Language: JavaScript, Python
- Python Libraries :
  - pip install python-mysql-connector
  - pip install opencv-python
  - pip install dlib
  - pip install numpy
- Node,js Packages:
  - npm install express
  - npm install react
  - npm install mysql
  - npm install body-parser
  - npm install multer
- Front-end Technologies: Reach.js
- Back-end Technologies: Node.js with Express server

7. CONCLUSIONS

The "Smart Attendance Tracking System Using Python" is a noteworthy development in educational institution attendance management. The solution uses machine learning techniques, face recognition technology, and a strong technical stack that includes React and Node.js to automate attendance monitoring and do away with manual procedures. The project's design focuses on security, dependability, and user-friendliness despite obstacles like guaranteeing face recognition accuracy and resolving privacy issues. This provides a scalable and effective solution for a variety of educational situations. The system promises to revolutionize traditional attendance management practices and free up educational institutions to concentrate more on their primary mission by streamlining attendance tracking, increasing transparency, and giving faculty and students real-time access to attendance data through its user-friendly interfaces, modular architecture, and RESTful APIs.

In the long run, the initiative has the potential to completely transform attendance management procedures, promoting increased effectiveness, precision, and openness in educational settings. The system establishes a new benchmark for attendance monitoring by utilizing state-of-the-art technology and creative design approaches, opening the door for a more efficient and productive manner of handling administrative duties. The project is a game-changing tool that helps educational institutions embrace digital change. It helps them maximize resources, increase accountability, and improve the entire educational experience for both professors and students.

7. FUTURE SCOPE

7.1 Students Safety : School student’s safety is the top priority for their parents because of their immature age. The installed camera in school can be integrated with this project so that student’s parents don’t worry about them. For

example, the school's main door camera can recognize a student if he/she tries to exit the school before time then this project can message to his/her parents.

7.2 IoT and Sensor Integration : Integrate IoT (Internet of Things) devices can be integrated with this project like a screen in class which will verify the attendance of total students.

This project also can be used to rate a class's environment according to the facial expressions of students and many insights can be harnessed in the future.

7. REFERENCES

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