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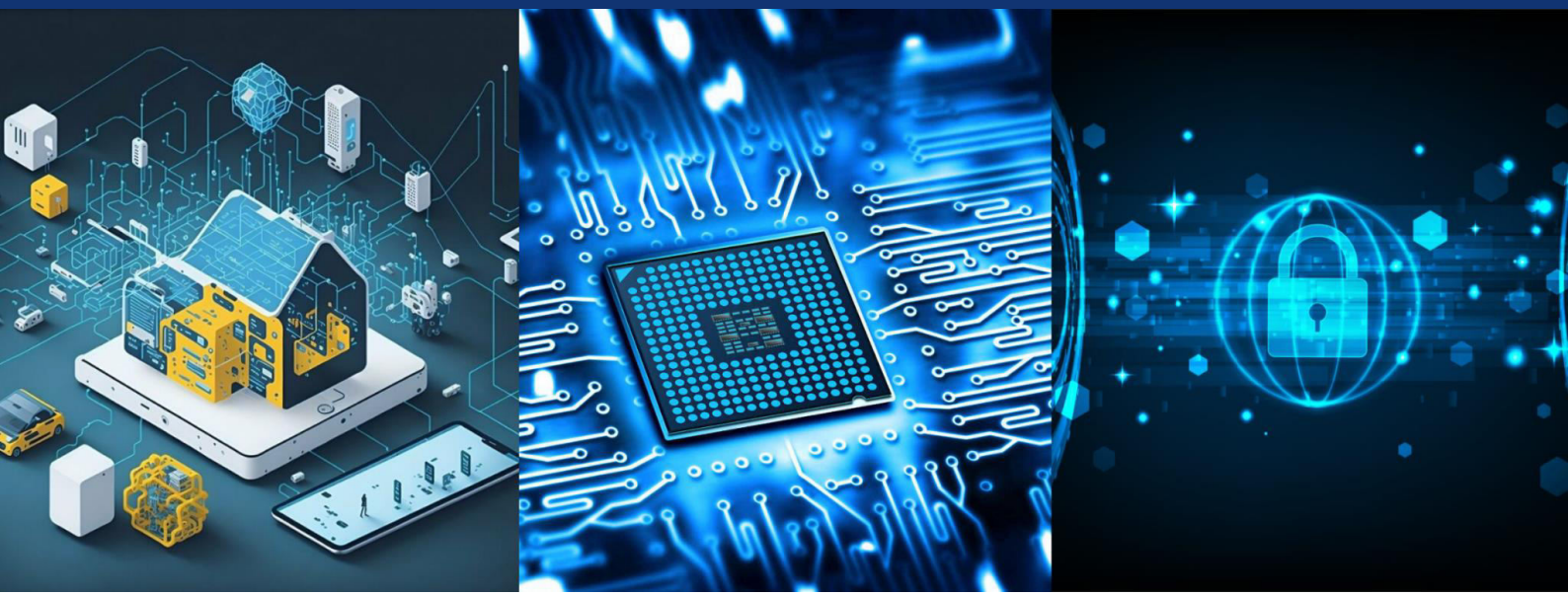

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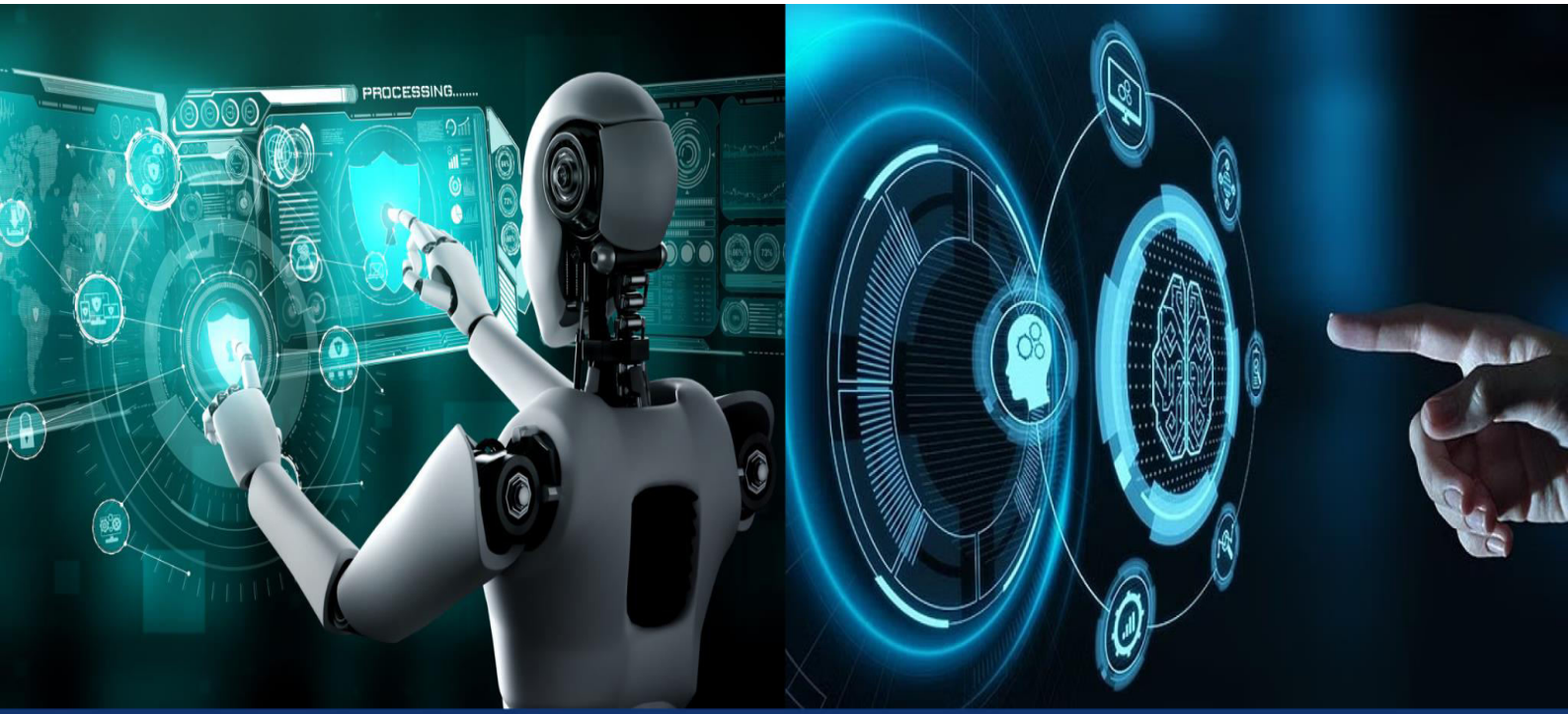

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Real-Time Facial Recognition-Based Attendance System with Face Liveness Detection and Multi-Role Portal Architecture

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ABSTRACT: Traditional attendance management process in educational institutions is time-consuming and prone to errors, proxy attendance, and inefficiencies. This paper proposes a smart AI-driven attendance system that automates attendance using facial recognition technology. The system utilizes YOLOv8 for real-time face detection and FaceNet for accurate identity recognition through deep feature embeddings. A FastAPI-based backend handles API requests, authentication, and data processing, while a Next.js frontend provides interactive dashboards for students, faculty, and parents. The system captures images, verifies identity, and records attendance automatically without manual intervention. This contactless solution improves accuracy, enhances efficiency, and ensures secure, scalable attendance management with real-time monitoring and analytics.

KEYWORDS: Facial Recognition , Attendance System , YOLOv8 , FaceNet , Artificial Intelligence, Computer Vision.

I. INTRODUCTION

In educational institutions, maintaining accurate attendance records is a routine yet critical administrative task. Attendance data is essential for monitoring student engagement, enforcing discipline, and ensuring academic accountability. It also serves as a key parameter for performance evaluation and determining eligibility for examinations.[1]

Traditionally, most colleges and universities rely on manual attendance systems, where instructors call out student names and record attendance during lectures. Although this approach is simple to implement, it consumes valuable instructional time. It is also highly dependent on human intervention, which can result in inconsistencies such as missing entries or incorrect recordings.[1]

A significant limitation of manual attendance is the occurrence of proxy attendance. In such cases, students may respond on behalf of others, leading to inaccurate and unreliable data. This compromises the integrity of attendance records and affects effective academic monitoring. As class sizes increase, manual attendance management becomes increasingly inefficient.[3]

To mitigate these issues, biometric systems such as fingerprint-based authentication were introduced. These systems utilize unique physiological characteristics for identity verification, thereby improving accuracy compared to manual methods. However, biometric systems require physical interaction, which can introduce delays when processing large numbers of users.[4]

Biometric solutions also depend on dedicated hardware devices, increasing installation and maintenance costs. Challenges such as device failure, hygiene concerns, and queuing delays reduce their practicality in large-scale classroom environments. These drawbacks emphasize the need for a more efficient and scalable solution.[5]

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With advancements in artificial intelligence and computer vision, facial recognition has emerged as an effective alternative. This technology identifies individuals based on distinctive facial features, enabling non-intrusive and contactless recognition. It also supports simultaneous detection and identification of multiple individuals using a camera-based system.[5]

The proposed Smart AI-Driven Attendance System utilizes YOLOv8 for high-speed and accurate face detection and FaceNet for robust face recognition through deep feature embeddings. The system captures images, detects facial regions, and transforms them into embeddings for similarity comparison. Upon successful matching, attendance is automatically recorded in the database without manual intervention.[6]

In addition to recognition capabilities, the system includes a multi-role web portal designed for faculty, students, and parents. Faculty members can initiate attendance sessions and monitor records, students can access their attendance data, and parents can review performance reports. Real-time analytics further assist institutions in identifying students with low attendance.[6]

Overall, the proposed system aims to minimize manual intervention, enhance accuracy, and provide an efficient and scalable solution for attendance management. It offers a modern, automated approach that supports transparent and reliable attendance tracking in educational institutions.

II. LITERATURE REVIEW

Over the years, several methods have been developed to enhance attendance tracking in educational institutions. Traditional manual attendance systems are still widely adopted; however, they are time-intensive and prone to inaccuracies and misuse, such as proxy attendance.

To improve efficiency, RFID-based systems were introduced, where students utilize identification cards for attendance logging. Although this approach reduces manual intervention, it remains susceptible to issues like card sharing and requires additional hardware infrastructure. Subsequently, biometric systems, particularly fingerprint-based authentication, were implemented to enhance accuracy.

While biometric systems reduce impersonation, they require physical interaction, which can introduce delays in high-density classroom environments and increase maintenance overhead. With advancements in artificial intelligence, facial recognition has emerged as a more efficient and contactless alternative. It enables identity verification based on distinctive facial features and supports simultaneous recognition of multiple individuals.[1]

Deep learning models such as FaceNet generate feature embeddings from facial images, facilitating accurate identity matching, while techniques like ArcFace improve discriminative performance. For face detection, modern architectures such as YOLOv8 provide real-time, high-precision detection of multiple faces within a single frame.[2]

In addition to recognition, recent systems integrate cloud-based storage and web-based applications to enhance accessibility and scalability. These solutions enable secure data storage and remote access, making attendance management more flexible and efficient for institutions.[2]

Research efforts also focus on improving recognition accuracy under challenging conditions, including low illumination, facial variations, and occlusions. Advanced deep learning models are continuously optimized to handle such variations, improving robustness in real-world scenarios.[3]

Furthermore, modern systems incorporate data analytics to extract meaningful insights from attendance records. These analytics support trend analysis, performance prediction, and early identification of students with low attendance, enabling timely intervention.[4]

The proposed system addresses existing limitations by integrating face detection, recognition, database management, and a multi-role interface into a unified architecture. It also incorporates real-time analytics and notification mechanisms, enhancing overall system efficiency and usability.[5]

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Another significant advancement is the integration of mobile and web-based platforms, which improves user accessibility and interaction. These interfaces allow students, faculty, and parents to access attendance data, receive updates, and manage academic activities seamlessly across devices.[6]

Moreover, data security and privacy have become critical considerations in modern attendance systems. Current approaches implement secure authentication protocols, encryption mechanisms, and role-based access control to protect sensitive information. Ensuring data privacy enhances system reliability and supports large-scale deployment in educational environments.

III. SYSTEM ARCHITECTURE

The proposed system is structured into four primary components: the client interface, backend server, AI recognition module, and database. These components are integrated to enable an automated and efficient attendance management workflow.

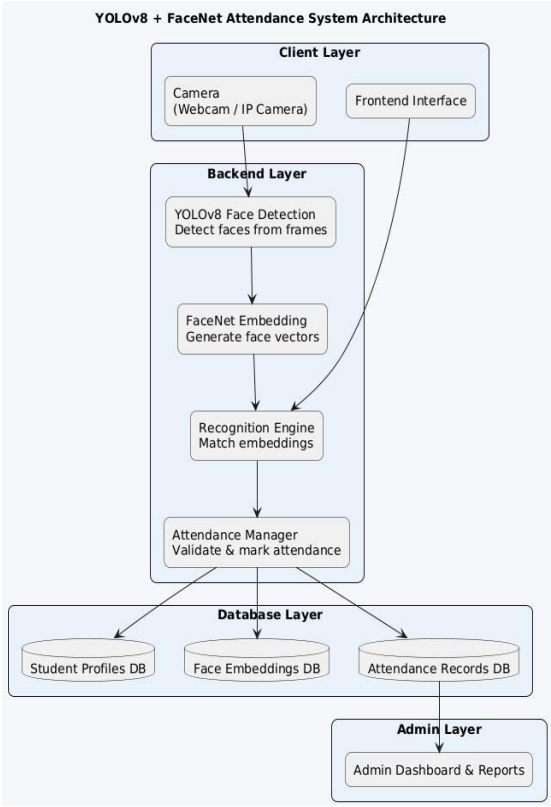

Fig1: System Architecture

The client interface is implemented as a web-based application that facilitates user interaction. Faculty members can initiate attendance sessions, while students can capture or upload images for attendance marking through an intuitive interface.

The backend server is developed using FastAPI and functions as the core processing unit of the system. It handles API requests, executes business logic, and coordinates communication between the frontend, AI module, and database for data processing and retrieval.

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The AI recognition module performs face detection and identification tasks. YOLOv8 is utilized for real-time face detection, while FaceNet generates feature embeddings for identity recognition. The system compares embeddings using a similarity metric, such as Euclidean distance, to verify matches.

The database stores critical information, including student profiles, facial embeddings, attendance sessions, and records, ensuring efficient data storage and management. Overall, the architecture is designed to be modular and scalable, enabling the system to handle multiple users while maintaining high performance and reliability.

IV. IMPLEMENTATION DETAILS

The proposed attendance system is implemented using advanced AI models and modern web technologies to ensure high performance, scalability, and reliability. The system integrates real-time computer vision techniques with efficient backend processing for seamless operation.

For face detection, the system employs the YOLOv8 model, which performs real-time object detection on images and video streams. It accurately localizes facial regions by generating bounding boxes around detected faces, making it suitable for high-speed and multi-face detection scenarios.

For face recognition, the system utilizes the FaceNet model with the Inception ResnetV1 architecture. This deep learning model extracts discriminative feature representations by converting each detected face into a fixed-length embedding vector. These embeddings enable efficient and accurate identity comparison.

To perform identity verification, the generated embedding is compared with pre-stored embeddings using a similarity metric, specifically the Euclidean distance. If the computed distance falls below a predefined threshold, the system classifies the input as a valid match corresponding to a registered user.

During the enrollment phase, multiple facial samples of each student are collected under varying conditions such as pose, illumination, and expressions. This enhances the robustness and generalization capability of the recognition model.

The system incorporates session management to regulate attendance marking. Faculty members initiate time-bound attendance sessions, typically active for a limited duration, within which students must submit their facial data for verification.

Additionally, the system provides a multi-role web portal with role-based access control. Faculty members can manage sessions and analyze attendance reports, students can submit images and monitor their attendance status, and parents can access reports and receive notifications for low attendance.

V. FEATURES OF THE PROPOSED SYSTEM

The proposed Smart AI-Driven Attendance System provides an intelligent and automated framework for attendance management in educational institutions. It leverages advanced facial recognition algorithms to detect and identify students, eliminating the need for manual attendance marking. This significantly optimizes classroom time and reduces administrative overhead.

A key feature of the system is real-time face detection and recognition. Utilizing deep learning models, the system can simultaneously detect and identify multiple individuals from live video streams or uploaded images. This enables instantaneous attendance recording with minimal latency, even in large classroom environments.

The system operates in a completely contactless manner, unlike traditional biometric solutions such as fingerprint-based systems. It eliminates the need for physical interaction, thereby improving operational speed, user convenience, and hygiene, particularly in high-density environments.

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The system incorporates a multi-role web portal with role-based access control, supporting faculty, students, and parents. Faculty members can initiate attendance sessions, monitor participation, and generate analytical reports. Students can access their attendance metrics, while parents can monitor performance and receive notifications, enhancing transparency and communication.

Another important feature is session-based attendance management, where attendance marking is restricted to a predefined time window. This ensures that only physically present students are recorded, effectively mitigating proxy attendance and unauthorized access.

The system also provides real-time analytics and reporting capabilities. Attendance data is dynamically updated and visualized through dashboards, enabling institutions to analyze trends, identify at-risk students, and make data-driven decisions.

Additionally, the system is designed for scalability and high performance. It can efficiently handle concurrent users and large datasets without degradation in system responsiveness, making it suitable for both small-scale and large-scale deployments.

Security and data integrity are integral aspects of the system. Sensitive facial data is protected through secure storage mechanisms, encryption, and role-based access control, ensuring that only authorized users can access or modify records.

Finally, the system offers a user-friendly interface with intuitive navigation, allowing users to interact with the platform without requiring technical expertise. Overall, the proposed system delivers a robust, accurate, and scalable solution for modern attendance management.

A. Frontend Design

The frontend of the Smart AI-Driven Attendance System is designed to deliver an intuitive, responsive, and user-centric interface for seamless interaction. It serves as the primary layer through which users access system functionalities. The frontend is developed using modern web technologies such as Next.js, enabling high performance, fast rendering, and cross-device compatibility across desktops and mobile platforms.

The system supports three user roles—faculty, students, and parents—each provided with a dedicated interface based on role-based access control. Faculty members can initiate attendance sessions, monitor participation, and generate analytical reports. Students can upload facial images for attendance marking and track their attendance metrics, while parents can access attendance records to monitor academic engagement. The frontend incorporates essential features such as secure authentication, interactive dashboards, session management forms, and report visualization modules.

The dashboard interface presents attendance data in a structured and visually organized format, enhancing readability and interpretability. The design prioritizes simplicity and usability, ensuring that users with minimal technical expertise can efficiently navigate and operate the system.

A key functionality of the frontend is real-time data synchronization. Attendance updates are instantly reflected on the dashboard upon successful processing, enabling users to access the latest information without latency and supporting timely decision-making.

The interface design emphasizes clarity and accessibility through clean layouts, consistent navigation patterns, and responsive design principles. This ensures smooth transitions between different modules and an overall enhanced user experience.

Overall, the frontend acts as a critical component in bridging user interaction with system operations, providing efficient access to features while maintaining usability, responsiveness, and performance.

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B. Backend Design

The backend of the Smart AI-Driven Attendance System serves as the core computational layer, responsible for handling request processing, data management, and system operations. It operates as the central controller that ensures all client requests are processed efficiently and appropriate responses are returned. The backend is implemented using FastAPI, a high-performance web framework optimized for building scalable and efficient APIs.

The backend manages critical functionalities including user authentication, session management, facial recognition processing, and database interactions. When a user submits a request, such as uploading an image for attendance, the backend validates the request, processes the input, and forwards the data to the AI recognition module for further analysis.

The system integrates advanced deep learning models within the backend pipeline. YOLOv8 is utilized for real-time face detection, while FaceNet is employed for identity recognition through feature embedding generation. The extracted embeddings are compared with stored embeddings in the database using a similarity metric, typically Euclidean distance, to accurately identify individuals.

The backend also handles database operations, storing essential data such as student profiles, facial embeddings, attendance sessions, and attendance records. A lightweight database such as SQLite is used to ensure efficient data storage and rapid retrieval. Security mechanisms are implemented to protect sensitive data and maintain data integrity.

Communication between the frontend and backend is facilitated through RESTful API endpoints. These endpoints enable functionalities such as student registration, attendance marking, session creation, and report generation. This modular API architecture ensures maintainability and clear separation of concerns.

The backend is designed with scalability and concurrency in mind, allowing it to handle multiple simultaneous requests without performance degradation. This is particularly important in real-time classroom scenarios with high user activity.

Overall, the backend ensures efficient system execution, low-latency processing, and accurate results, thereby maintaining the reliability, scalability, and performance of the attendance system.

C. Database Design and Management

The database is a critical component of the Smart AI-Driven Attendance System, responsible for efficient data storage, retrieval, and management. It maintains essential information such as student profiles, facial embeddings, attendance sessions, and attendance records. A lightweight relational database like SQLite is utilized due to its simplicity, low overhead, and suitability for real-time applications.

The database follows a relational schema design, where data is organized into multiple tables with well-defined relationships. Core entities include Users, Students, Faculty, Attendance Sessions, and Attendance Records. These tables are interconnected through primary and foreign keys such as student ID and session ID, ensuring data integrity and consistency.

The Students table stores attributes such as student ID, name, course, academic year, and facial embeddings. These embeddings, generated using the FaceNet model, are used for identity verification during the recognition process. The Faculty table maintains information about instructors responsible for managing attendance sessions.[6]

The Attendance Sessions table captures session-specific metadata, including session ID, date, start time, and duration. This enables controlled attendance marking within predefined time intervals. The Attendance Records table logs transactional data, mapping student IDs to session IDs along with timestamps, and serves as the basis for report generation and analytics.

The system employs SQLAlchemy ORM for database interaction, enabling efficient abstraction of CRUD operations without direct SQL query handling. This enhances code maintainability and development efficiency.

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To ensure data integrity and security, the system implements role-based access control and secure storage mechanisms. Sensitive data such as facial embeddings is protected using appropriate safeguards. Additionally, the database is optimized through indexing and efficient query design to support concurrent access and low-latency data retrieval.

Overall, the database architecture ensures reliability, scalability, and high performance, enabling seamless operation of the attendance system in real-world deployment scenarios.

VI. RESULTS

The Smart AI-Driven Attendance System was successfully developed and tested, showing efficient performance in real-time attendance tracking and academic monitoring. It combines AI-based facial recognition with a simple and user-friendly interface, ensuring accurate and smart attendance management.

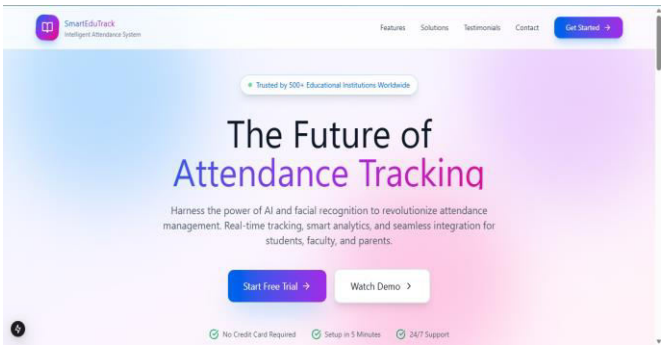

Fig2: Home page

The system provides a modern landing page and role-based dashboards for students, faculty, and parents. Students can easily track their attendance, view performance statistics, and analyze predicted academic outcomes such as CGPA. This helps them understand their progress and improve accordingly.

The system was evaluated using the **LFW (Labeled Faces in the Wild) dataset** to measure recognition performance and latency.

Performance Metrics

Metric	Value
Accuracy	97.52%
Precision	100%
Recall	97.52%
F1 Score	98.74%
False Acceptance Rate	0%
False Rejection Rate	2.48%
Average Confidence	79.1%

Table1: Performance Metrics

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Latency Performance

Stage	Latency
Face Detection (YOLOv8)	~120 ms
Face Embedding (FaceNet)	~55 ms
Matching + Database	~89 ms
Total Pipeline Latency	**~264 ms**

Table2: Latency Performance

The proposed Smart AI-Driven Attendance System demonstrates high classification performance in facial recognition tasks. The model achieved an overall accuracy of 97.52%, with a precision of 100% and a recall of 97.52%, resulting in an F1-score of 98.74%, indicating a strong balance between precision and recall.

The system exhibits robust security performance with a false acceptance rate (FAR) of 0%, ensuring that no unauthorized identities are falsely recognized. The false rejection rate (FRR) is 2.48%, reflecting minimal instances where genuine users are incorrectly rejected.

The average confidence score of 79.1% indicates stable prediction confidence across varying environmental conditions such as lighting and pose variations, demonstrating the model's generalization capability.

In terms of computational efficiency, the system achieves low inference latency. The face detection module based on YOLOv8 operates at approximately 120 ms, while the feature extraction (embedding generation) using FaceNet requires around 55 ms.

The similarity matching and database retrieval operations take approximately 89 ms, contributing to efficient backend processing.

Overall, the end-to-end pipeline latency is approximately 264 ms, enabling real-time inference and making the system suitable for deployment in practical, large-scale classroom environments.

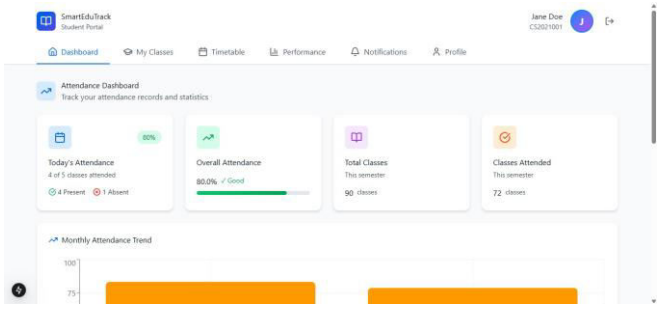

Fig3: Student Portal

The student dashboard interface presents a clear and organized view of attendance information. It displays details such as today's attendance, overall attendance percentage, total classes, and classes attended. The use of cards and visual elements like progress bars and charts makes it easy for students to quickly understand their attendance status and monitor their performance.

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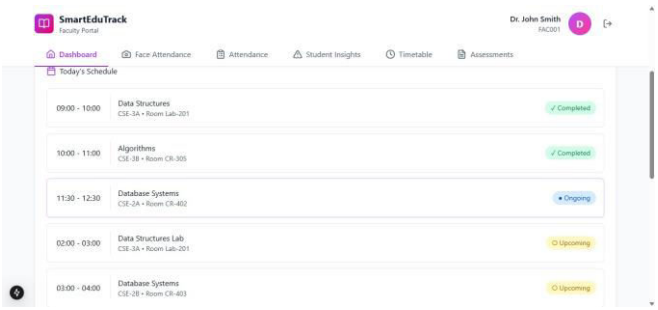

Fig4: Faculty Portal

The faculty portal interface focuses on managing classes and attendance sessions efficiently. It shows the daily schedule with subject names, timings, and status indicators such as completed, ongoing, or upcoming sessions. This helps faculty members keep track of their teaching activities and conduct attendance in a smooth and structured manner. The integration of YOLOv8 for face detection and FaceNet for recognition ensures high accuracy while reducing manual errors and proxy attendance. Additionally, analytics such as attendance trends and performance graphs provide meaningful insights.

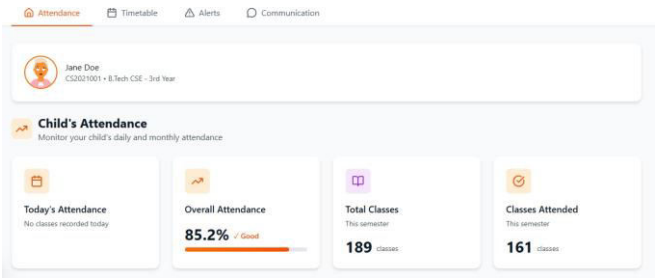

Fig5: Parent Portal

The parent portal interface allows parents to stay updated on their child's attendance. It provides information such as overall attendance percentage, total classes, and attendance records in a simple and readable format. This feature enhances transparency and helps parents monitor academic participation more effectively.

Overall, the system proves to be accurate, efficient, user-friendly, scalable, and reliable. It successfully achieves the goal of automating attendance management while enhancing academic monitoring and decision-making.

VII. FUTURE WORK

Future enhancements can further improve the performance and functionality of the system. One possible improvement is the integration of face liveness detection to prevent spoofing attacks using photographs. The system can also be optimized for deployment on edge devices such as Raspberry Pi for classroom-level processing. Additional features such as multi-camera support and emotion analysis may help institutions monitor student engagement during lectures.

VIII. CONCLUSION

Overall, the Smart AI-Driven Attendance System is a practical and efficient solution for managing attendance in educational institutions. It simplifies the attendance process by using facial recognition technology, ensuring fast and accurate recording. The system reduces manual effort and eliminates proxy attendance, improving data reliability. It is user-friendly and allows faculty, students, and parents to access attendance information anytime. With its quick processing and real-time functionality, the system is highly suitable for modern classroom environments.

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REFERENCES

1. Ms. Nivetha Renjuies.R, Mrs. Gayathri.R ,"Automated Student Monitoring and Attendance System with Faster R-CNN", 2023.
2. Dr. S. Balaji, Mrs. S. Sugashini, J. Ruchitha, A. Tejaswini and A. Vaishnavi3,"Automated Student Monitoring and Attendance System with Faster RCNN",2025.
3. Garv Kamra,"AI-Based Classroom Monitoring and Attendance System",2025.
4. Prof. Shital.D Jadhav," A Modern Web-Based Student Attendance Management System",2025.
5. Kotramma T S and Team,"Automatic Attendance System Using Machine Learning",2023.
6. Divy Shukla ,"AI-Based Attendance Monitoring System", 2023.

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