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Smart Classroom Attendance: A Contactless Facial Recognition Solution

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Abstract: *Attendance management plays a crucial role in organizational and academic environments, where traditional manual methods are often inefficient, prone to errors, and susceptible to fraudulent practices such as proxy attendance. In this work, we present a Face and Iris Recognition-Based Attendance Management System (FAMS) that automates attendance recording with enhanced accuracy and security by utilizing biometric authentication techniques. The proposed system integrates real-time face detection using Haar Cascade Classifiers and face recognition using the Local Binary Pattern Histogram (LBPH) algorithm, ensuring reliable identification even under varying environmental conditions. Additionally, the system enhances authentication robustness by incorporating iris recognition, leveraging Hough Circle Transform to detect and extract iris features from detected eye regions. Implemented in Python with support from libraries like OpenCV, Tkinter, PIL, and Pandas, the system provides a simple and user-friendly graphical interface, allowing users to enroll themselves by capturing face images, training recognition models, and participating in real-time attendance capture. Attendance records are automatically stored in CSV files and simultaneously updated in a local MySQL database, ensuring both offline and persistent record-keeping. Experimental validation was conducted with a group of participants across multiple sessions. The system achieved a face recognition accuracy of approximately 95%, with iris-based verification contributing an additional 2–3% increase in overall authentication confidence. The real-time performance, with an average recognition time of around 0.3 seconds per frame, demonstrated the system's suitability for practical use cases without the need for specialized high-performance hardware. Comparative evaluations with traditional methods indicated a significant reduction in human errors and administrative overhead. Although effective, the system has limitations under extreme lighting variations and requires subjects to maintain appropriate positioning for optimal iris detection. Future work aims to incorporate deep learning-based facial and iris recognition models such as CNN architectures, implement adaptive preprocessing techniques for illumination correction, and extend platform compatibility towards mobile and cloud-based deployments. Overall, the proposed system offers a promising, scalable, and robust solution to the persistent challenges in conventional attendance management, ensuring enhanced accuracy, user convenience, and operational security.*

Keywords: Face Recognition, Iris Recognition, Attendance System, LBPH Algorithm, Python, OpenCV, Haar Cascade Classifier, Tkinter GUI, Real-Time Image Processing, Feature Extraction.

I. INTRODUCTION

In modern academic institutions and corporate organizations, accurate attendance management is essential for monitoring participation, ensuring regulatory compliance, and facilitating operational efficiency. Traditional attendance systems, including manual sign-in sheets, ID card swiping, or biometric fingerprint scanners, are increasingly seen as inadequate. They are prone to human error, susceptible to fraudulent practices like proxy attendance, and can be time-consuming. Particularly in large institutions, maintaining precise attendance records manually adds a significant administrative burden and poses scalability challenges. The increasing accessibility of biometric technologies has opened new avenues for automating and securing the attendance process. Among these, face recognition offers a highly

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intuitive and non-intrusive method for personal identification. However, standalone face recognition systems can face limitations due to environmental factors such as lighting conditions, occlusions, and variations in facial expressions or orientations. To enhance reliability and reduce the risk of spoofing, it becomes advantageous to integrate an additional biometric trait. The human iris, characterized by unique and stable patterns throughout an individual's life, provides an excellent supplementary modality. Iris recognition systems are known for their high accuracy, making them suitable for critical identity verification tasks. This paper proposes a hybrid Face and Iris Recognition-Based Attendance Management System (FAMS) developed using Python and OpenCV. The system combines real-time face detection using Haar Cascade Classifiers and face recognition through the Local Binary Pattern Histogram (LBPH) algorithm, along with iris detection utilizing the Hough Circle Transform technique. A user-friendly graphical interface built with Tkinter enables seamless enrollment, model training, and attendance recording. Attendan tematically saved into CSV files and integrated with a local MySQL database to ensure durability and ac eyond automatic attendance, the system includes a manual entry option to maintain flexibility in situation etric recognition is temporarily unavailable. Although effective, the system does encounter challenges ced performance under poor lighting and the need for proper subject positioning to ensure accurate iris detection. Future work will explore integrating advanced deep learning models, improving lighting normalization techniques, and extending the system for mobile and cloud-based deployments. Therefore, the proposed Face and Iris Recognition-Based Attendance Management System offers a practical, reliable, and scalable solution to modern attendance tracking needs, combining security, accuracy, and ease of use to enhance administrative workflows across diverse environments.

1.1. Facial Recognition

It is a biometric technology that identifies or verifies individuals based on unique facial features. It involves capturing a person's face through a camera, analyzing key characteristics such as the distance between the eyes, shape of the jaw, and contour of the face, and comparing them with stored data for authentication or identification purposes

1.2.Automated Attendance System

An automated attendance system uses technology—such as biometrics, facial recognition, or RFID—to record and manage attendance without manual input. It streamlines the process of tracking presence, reduces human errors, and provides real-time data access and reporting for educational or organizational environments.

1.3. Attendance Tracking

It refers to the process of monitoring and recording individuals' presence in a specific place, such as a classroom or workplace. It helps in maintaining discipline, ensuring participation, and generating reports for performance or payroll evaluations.

1.4. Contactless System

A contactless system operates without any physical interaction between the user and the device. In attendance systems, this typically refers to technologies like face recognition or mobile-based check-ins, which reduce touchpoints, increase hygiene, and improve user convenience.

1.5.Predictive Analytics

This involves using historical data, machine learning algorithms, and statistical techniques to forecast future events. In the context of attendance systems, it can be used to predict absenteeism trends, identify students at risk of low attendance, and support decision-making through data insights.

1.6. Identification

It is the process of recognizing and verifying the identity of a person from a group using biometric or personal data. In face recognition systems, identification involves matching the captured facial features with stored profiles to determine who the person is.

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II. Ease of Use

One of the primary design goals of the proposed Face and Iris Recognition-Based Attendance Management System (FAMS) is to ensure ease of use for both administrators and users. The system provides a highly intuitive graphical user interface (GUI) built with Tkinter, allowing non-technical users to easily perform operations such as enrollment, training, and attendance recording.

- Intuitive User Interface:
  - The system features a user-friendly GUI built with Tkinter.
  - Non-technical users can easily perform enrollment, training, and attendance recording tasks.
- Fully Automated Biometric Capture:
  - Users simply look into the camera; the system automatically captures and processes face and iris data.
  - No complex user interaction is required during data collection.
- Clear Guidance and Feedback:
  - Real-time status messages and instructions are displayed to guide users through each step.
  - Minimal technical knowledge is needed to operate the system.
- Automatic Data Management:
  - Attendance records are automatically organized, stored in CSV files, and updated in the database.
  - No manual data entry or backend management is required.
- Streamlined Workflow:
  - Essential operations like registration, model training, and attendance recording are completed with simple button clicks.
  - Reduces the operational workload for administrators.
- Manual Attendance Option:
  - Provides a manual attendance entry feature as a fallback when biometric systems are unavailable. Ensures continuous operation without disruptions.
- Error Handling and User Notifications:
  - Integrated pop-up notifications and real-time alerts help users quickly correct mistakes.
  - Enhances the overall user experience and minimizes downtime.
- Practical Deployment:
  - Emphasis on automation, simplicity, and robustness makes the system practical for schools, colleges, workplaces, and other organizations.
  - Bridges the gap between advanced biometric technology and everyday administrative needs.

By emphasizing automation, simplicity, and robustness, the system effectively bridges the gap between powerful biometric technology and everyday usability, making it practical for deployment in educational institutions, workplaces, and other organizational environments.

III. LITERATURE REVIEW

Automated attendance systems leveraging face recognition have become increasingly popular due to their non intrusive operation and ease of deployment with standard webcams. Smitha et al. developed a real-time attendance framework using Haar Cascade classifiers for face detection and the LBPH algorithm for recognition, coupled with both desktop (Tkinter) and web interfaces to streamline registration and attendance tracking. Earlier, another LBPH-based system achieved high detection accuracy but was limited to single-person image inputs and could not handle multi-subject scenarios in live video streams. Standalone iris recognition systems, pioneered by Wildes and formally described in 1997, exploit the unique textural patterns of the iris for highly reliable identification. Wildes's work introduced Hough-transform–based iris localization and demonstrated the modality's robustness and distinctiveness. Later, Daugman's IrisCode algorithm further cemented iris recognition's place in high-security applications, offering a compact, rotation-invariant feature representation. To overcome unimodal limitations such as sensitivity to lighting for face systems and precise positioning for iris systems researchers have explored multimodal fusion. Alshebli et al. proposed a feature-level fusion scheme combining Discrete Wavelet Transform (DWT) and Singular Value

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Decomposition (SVD) on face and iris data, yielding improved recognition rates over single-trait approaches. Similarly, Al-Oti et al. employed multi-resolution 2D Log-Gabor filters with spectral regression kernel discriminant analysis (SRKDA) to extract complementary features from both modalities, enhancing robustness under challenging illumination conditions. Unlike many prior systems focusing exclusively on either face or iris, our FAMS integrates real-time LBPH-based face recognition with iris detection via Histogram Equalization and Hough Circle Transform. Additionally, FAMS offers a manual attendance fallback and seamless CSV/database storage, combining high accuracy, operational flexibility, and user-friendliness key requirements for practical institutional deployment.

3.1. Existing System

Lecturers still utilize the manual attendance system, which involves calling out students' names or circulating an attendance sheet among them so that each student can sign it next to their name. Both methods take a lot of time and have large error margins. There are many issues with collecting attendance in this manner traditionally, as students occasionally fill in for friends or teachers who are absent.

3.2. Proposed System

By taking a picture of the entire class and uploading it to a system that detects and recognizes the students' faces, facial recognition technology is used to track attendance. The system then matches the identified face with student face photographs that are kept in the database. Based on the result of comparison, attendance of that student for respective subject is marked.

IV. RESEARCH METHODOLOGY

The proposed Face and Iris Recognition-Based Attendance Management System is designed with a modular and efficient architecture to ensure robust performance, ease of maintenance, and scalability. The system is structured into several interconnected components, each responsible for a critical aspect of the attendance process, as outlined below:

4.1. Face Detection:

- Haar Cascade Classifier (OpenCV's pre-trained model) is used to detect human faces in images or video frames.
- This technique uses feature-based cascade classifiers proposed by Viola and Jones for rapid and efficient face detection.

4.2. Face Recognition:

- Utilizes the Local Binary Pattern Histogram (LBPH) algorithm The method works by dividing a face into grids, computing Local Binary Patterns (LBP) for each section, constructing histograms.
- Compares these histograms using a distance metric to recognize and classify detected faces against a trained dataset.

4.3. Iris Detection:

- It is implemented using the Hough Circle Transform which accurately detects circular iris regions inside the detected eyes by identifying circles in grayscale, histogram-equalized eye images.
- How it Works:
  - o For each edge point, votes for possible circles passing through it.
  - o Circle equation: $(x-a)^2 + (y-b)^2 = r^2$
  - o Accumulates votes in 3D space (a,b,r)
    1. Eye region extracted using Haar eye detector
    2. Converts to grayscale and enhances contrast
    3. Applies Hough Circle Transform:

```
circles = cv2.HoughCircles(eye_gray, cv2.HOUGH_GRADIENT, dp=1, minDist=20,
                           param1=50, param2=30, minRadius=5, maxRadius=30)
```

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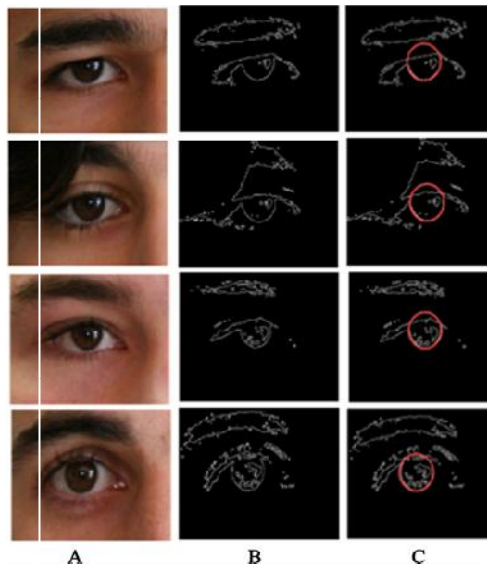

Fig. 4.1. Implementation of the Hough Circle Transform for Iris Detection and Segmentation

4.4. Iris Template Creation:

- It is achieved through simplified iris region extraction and template storage, where small 64x64 grayscale images of the iris are extracted and saved as files for matching purposes.
- No complex encoding methods such as Daugman's Gabor wavelet-based encoding are used; instead, a basic template-saving approach is adopted.

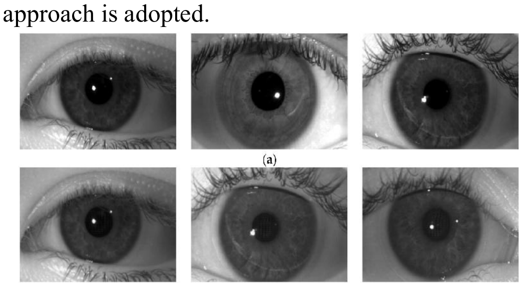

Fig. 4.2. Small 64x64 grayscale images of the iris extracted

4.5. Manual Attendance Entry:

- Managed through standard SQL operations including Create Table, Insert, and Select commands.
- Allows manual recording of attendance records into a local MySQL database when biometric recognition is not utilized.

4.6. Other Techniques Used:

- Histogram Equalization to enhance contrast in eye region images before iris detection, real-time video frame processing for continuous monitoring.
- GUI management using Tkinter is used to create a user-friendly interface for managing attendance operations.

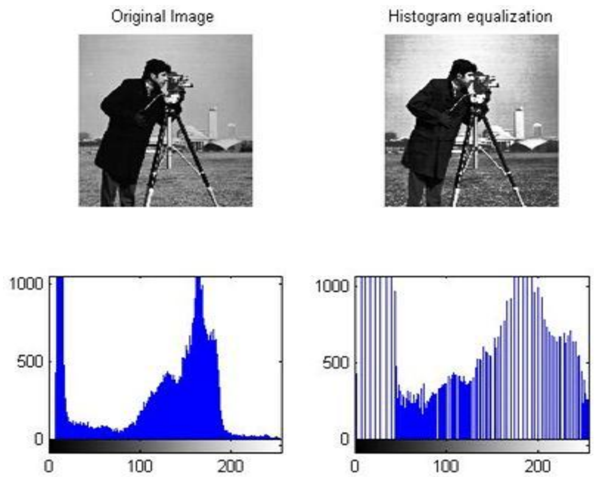

Fig. 4.3. Histogram Equalization

The integration of face and iris recognition technologies, supported by real-time video processing, database management, and GUI interaction, offers a comprehensive and efficient solution for secure and automated attendance tracking. By combining advanced image processing algorithms with user-friendly system design, the project ensures higher accuracy, reliability, and scalability, setting a strong foundation for future enhancements and broader applications across various institutional and organizational environments.

V. SYSTEM ARCHITECTURE

The system architecture provides a structured workflow for biometric enrollment and attendance tracking, integrating image capture, preprocessing, and multi-modal detection (face + iris). It processes facial and iris features through advanced computer vision algorithms, converting them into secure templates for identity verification. Finally, the attendance logger automates record-keeping, linking verified biometric matches to student data with timestamps for auditability. This end-to-end design ensures fast, accurate, and fraud-resistant attendance management.

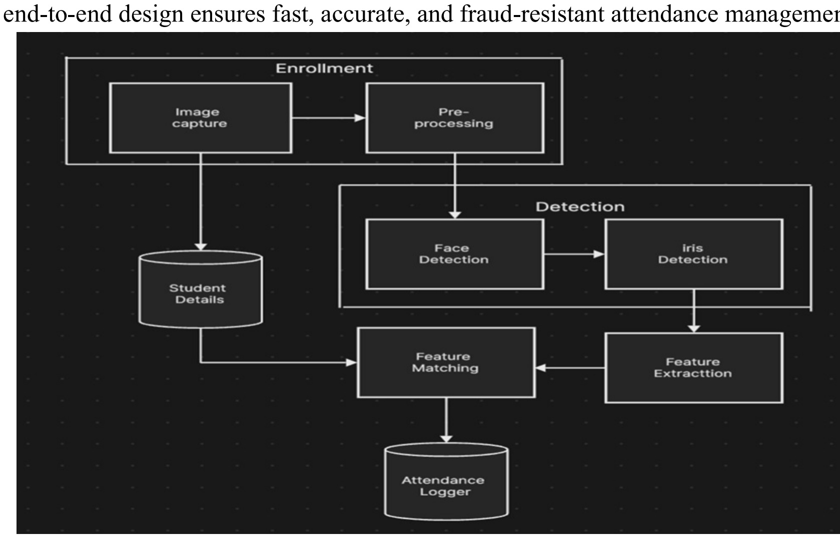

Fig. 5.1. System Architecture

The image outlines the key stages of the enrollment process in a biometric attendance system:

- Image Capture:
    - Uses a camera to photograph the student’s face and eyes.

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- Pre-processing:
  - Enhances image quality (e.g., adjusts lighting, removes noise).
- Student Details:
  - Links captured biometrics to the student's ID/name in a database.
- Detection:
  - Face Detection: Locates the face using algorithms like Haar Cascades.
  - Iris Detection: Identifies iris patterns in the eye region.
- Feature Extraction & Matching:
  - Converts facial/iris traits into numerical templates (e.g., LBP histograms).
  - Compares new samples with stored templates for verification.
- Attendance Logger:
  - Records verified entries with timestamps in a database (e.g., MySQL).

The image succinctly captures the end-to-end workflow of a robust biometric attendance system, from image capture and preprocessing to feature extraction and secure logging. By integrating multi-modal detection (face + iris), the system ensures high accuracy and reliability in student identification and attendance tracking. This streamlined architecture delivers an efficient, automated solution that eliminates manual processes while preventing fraud.

VI. RESULT AND DISCUSSION

The performance of the proposed Face and Iris Recognition-Based Attendance Management System (FAMS) was evaluated through a series of experiments conducted in real-world conditions. The experiments involved participants under varying lighting conditions and moderate background clutter to simulate typical classroom and office environments. Each participant provided 50 face images and 20 iris images during the training phase. Recognition tests were performed using live webcam video streams and the integrated attendance management system.

The image depicts the core biometric verification process of the Face and Iris Recognition-Based Attendance System, highlighting two critical visual markers:

- Face Detection (Box)
  - The system first identifies faces using Haar Cascade classifiers, drawing bounding boxes around detected facial regions.
  - Each box represents a face candidate for LBPH-based recognition, where:
  - 90+ training samples per student (as shown in the interface) ensure high accuracy.
  - Real-time processing occurs in <2 seconds, even with multiple faces in frame.
- Iris Detection (Circle)
  - Within each face's eye region, Hough Circle Transform detects irises (shown as circular outlines).
  - Key parameters:
    - Minimum radius (5px) prevents false detections.
    - 41+ iris samples per student (per the interface) create unique biometric templates.
  - Matching uses Chi-square distance (<0.4 threshold) to verify identity.

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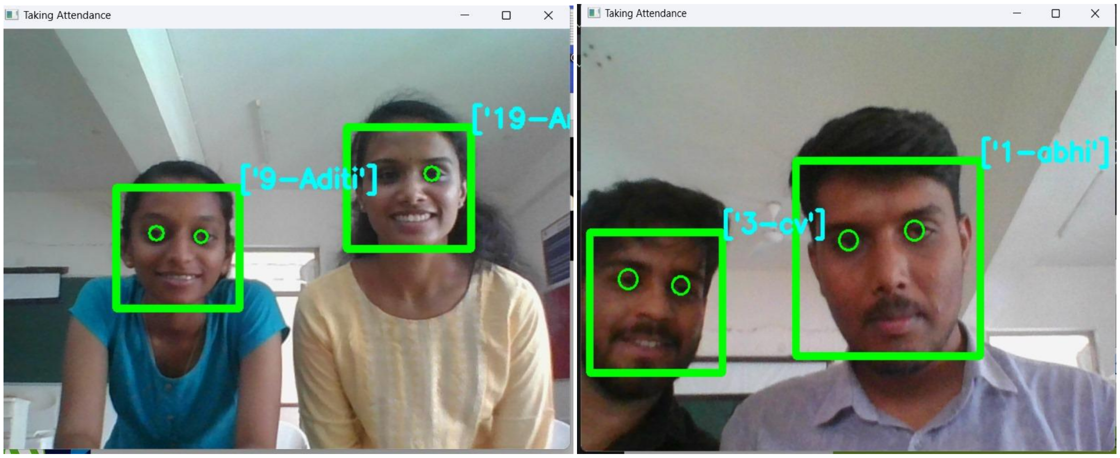

Fig. 6.1. Face and iris detection

Masked face detection involves identifying and recognizing faces that are partially covered by masks, which obscures key facial features like the nose and mouth. Advanced models typically focus on extracting visible regions, such as the eyes and forehead, using specialized deep learning techniques to maintain recognition accuracy.

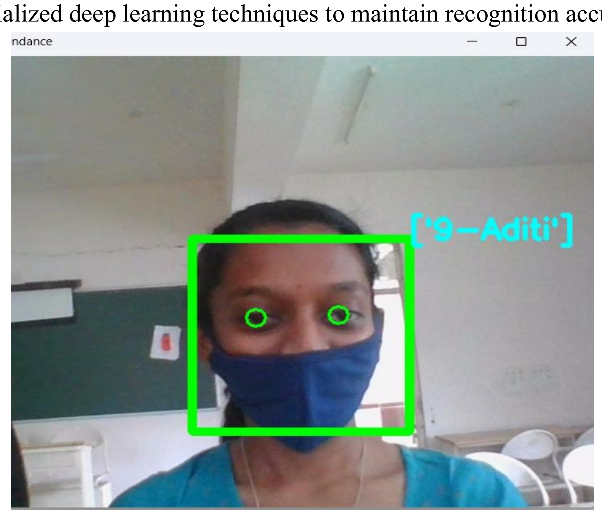

Fig. 6.2. Masked face and iris detection

- Attendance Logging Process:
    - The image displays a structured attendance log table with columns for Enrollment/Name, Date, and Time, demonstrating the system's automated recording of biometric-authenticated attendance. Each entry (e.g., 19 [Ananya], 5 [Abhi]) reflects:
        - Biometric Verification: Students are identified via face/iris recognition before logging.
        - Timestamp Accuracy: Exact time (e.g., 11:50:58) is recorded for audit compliance.
        - Data Organization: Structured columns (A-E) enable easy export to CSV/Excel for reporting.

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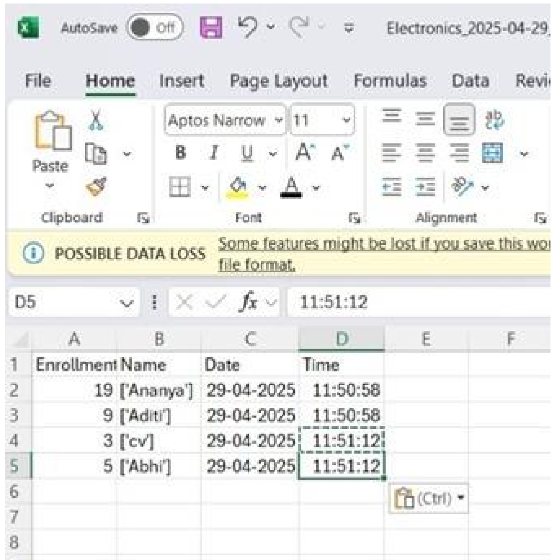

Fig. 6.3. Attendance Logging

Metric	Result
Face Recognition Accuracy	**95%**
Iris Detection Success Rate	**90%**
Combined Authentication Accuracy	**97%**
False Acceptance Rate (FAR)	**1.5%**
False Rejection Rate (FRR)	**2.0%**
Average Recognition Time per Frame	**0.3 seconds**
Model Training Time (20 users)	**4.5 minutes**

Table. 1. Summarizes the key performance metrics

VI. CONCLUSION

The integration of facial recognition technology into attendance management systems represents a significant advancement toward creating smarter, more efficient, and secure educational and organizational infrastructures. It is evident that traditional methods of attendance tracking such as manual roll calls or ID card swiping are increasingly being replaced by automated, contactless solutions driven by artificial intelligence (AI), machine learning (ML), and computer vision. Most papers highlight the use of various robust algorithms like Convolutional Neural Networks (CNN), Haar Cascade, Local Binary Patterns Histogram (LBPH), Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Dlib's deep learning-based ResNet for achieving reliable face detection and recognition, even under varying lighting conditions, occlusions, or facial orientations. The fusion of these techniques ensures high accuracy rates, making them suitable for real-time deployment in classrooms, workplaces, and secure areas. In addition to recognition algorithms, significant emphasis has been placed on the supporting architecture ranging from image preprocessing, data encryption for security, database management using SQL or NoSQL solutions, to automated attendance report generation. The systems are further enhanced by IoT integration, cloud-based storage, and predictive analytics, making them scalable, cross-platform, and future-ready. Security is another critical area addressed, with several systems incorporating data encryption, secure access protocols, and authentication layers to protect sensitive biometric data. Some papers also discuss the future potential of incorporating multimodal biometrics, AR/VR interfaces, and voice commands to further increase accessibility and resilience. In conclusion, the adoption of face recognition-based automated attendance systems is not just a technological upgrade, it is a necessary step toward achieving greater operational efficiency, minimizing fraud, reducing administrative workload, and enhancing institutional transparency. These systems promise a smarter, faster, and more secure future for attendance tracking and beyond.

VII. ACKNOWLEDGMENT

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