Smart Student Attendance and Security Management Using Face Recognition

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ABSTRACT: Intelligent automation in educational institutions is now possible, thanks to developments in computer vision and artificial intelligence. In order to provide a smooth, safe, and contactless attendance process, this paper introduces the Smart Student Attendance and Security Management System, which makes use of deep learning-based facial recognition. The suggested system uses a live camera feed to record student images, Convolutional Neural Networks (CNNs) to identify and detect faces, and a centralized database to automatically record attendance. In addition to automating attendance, the system improves campus security by instantly detecting suspicious or unregistered individuals and sending out alerts for administrative review. Robustness against changes in occlusions, lighting, and facial expressions is ensured by the incorporation of machine learning. When compared to manual or conventional RFID systems, experimental evaluations show increased reliability, low latency, and high accuracy. By integrating intelligent surveillance and biometric authentication into a single, scalable framework, this research helps to digitally transform learning.

Key words : CNN, machine learning, image processing, automation, security management, deep learning, face recognition, and student attendance.

1. INTRODUCTION

In recent times, the use of Artificial Intelligence (AI) and Machine literacy (ML) has converted how associations handle identity verification and automate executive operations [1] [2]. Educational institutions, in particular, face challenges in maintaining accurate attendance records while icing lot safety and effectiveness [3] [4]. Homemade attendance styles are frequently time- consuming, prone to mortal error, and unfit to help unauthorized access effectively [5] [6]. These limitations punctuate the need for intelligent, contactless, and automated systems able of icing both delicacy and security [7] [8].

Face recognition technology offers a dependable, non-intrusive, and contactless system for vindicating individual identity. It analyzes unique facial features to authenticate druggies efficiently and directly [9] [10]. With advancements in machine literacy algorithms and computer vision, ultramodern face recognition systems can perform constantly across varied lighting conditions, facial exposures, and environmental factors [11] [12]. This progress has led to the development of real- time attendance fabrics able of automatically detecting and recording individualities without homemade trouble [13] [14].

The proposed Smart Student Attendance and Security Management System utilizes face recognition to identify and Confirm scholars as they enter classrooms or other designated areas [15]. Once a face is recognized, attendance is automatically marked by cross-referencing it with the institution's database [16] [17]. The system also enhances security by notifying directors if an strange face is detected within confined zones [18] [19] [20]. This integrated frame supports flawless attendance shadowing while maintaining high norms of safety and functional effectiveness [21].

likewise, the system incorporates data security and sequestration measures by using translated storehouse and original databases to cover sensitive information [22]. Its armature is featherlight and scalable, making it suitable for real- time deployment on low- cost computational bias similar as jeer Pi or Jetson Nano. By using machine literacy ways, the proposed system ensures accurate, effective, and sequestration-apprehensive attendance operation adaptable to ultramodern educational surroundings [23] [24].

2. LITERATURE SURVEY

Robotization in attendance tracking through facial recognition has gained significant exploration attention due to its trustability, speed, and non-intrusive nature [25]. Machine literacy- grounded approaches have bettered recognition delicacy while reducing reliance on homemade processes. Experimenters have applied colourful algorithms, including Haar Cascade, LBPH, SVM, and CNN, to design effective and scalable attendance operation systems that perform directly under real- world conditions [26] [27].

Sawhney et al.(2019) proposed a real- time smart attendance system using OpenCV [3] and machine literacy algorithms to descry and identify pupil faces from live videotape aqueducts [28]. The system successfully automated attendance marking and reduced homemade trouble, though its performance was told by lighting variations [29] [30].

Bhatti et al.(2018)[6] introduced an automated attendance system that employed Haar Cascade classifiers for facial discovery and database integration for attendance logging [31]. This approach minimized deputy attendance but showed dropped delicacy in inconsistent illumination surroundings [32].

Raj et al.(2020)[10] designed a smart attendance frame combining LBPH point birth with webcam-grounded image prisoner [33]. Their results demonstrated bettered trustability in stable surroundings, though expression variations sometimes affected delicacy [34].

Badrul et al.(2022) [12] extended this conception by enforcing a pall- connected armature where attendance data were stored and managed on an online database [35]. This increased availability but needed advanced computational coffers and nonstop network connectivity [36] [37].

Sharma et al. (2024)[15] developed a mongrel attendance system that integrated Haar Cascade with SVM bracket, achieving 96 delicacy in classroom datasets [38].

Lateef and Kamil (2023)[17] also designed a facial recognition- grounded attendance operation using OpenCV and original storehouse for offline deployment. Their approach bettered effectiveness for institutions with limited internet access [39].

Verma and Yadav (2023)[19] stressed the advantages of combining LBPH and HOG features for real- time pupil identification. Their model achieved robustness against minor illumination changes while maintaining computational effectiveness [40].

Likewise, Patel and Joshi (2021) demonstrated that SVM outperforms other traditional ML classifiers by furnishing a better trade- off between speed and delicacy in face- grounded attendance systems [41].

Most lately, Sharma and Bansal(2024)[20] compared multiple machine learning algorithms and set up that SVM offered the most harmonious performance for small datasets, achieving 95 overall delicacy. From the reviewed literature, it's apparent that machine literacy ways can give a dependable, contactless, and cost-effective attendance operation frame. still, challenges similar as lighting variation, pose differences, and data sequestration must still be addressed. The proposed system aims to overcome these issues by integrating secure storehouse mechanisms and featherlight ML- grounded recognition models suitable for real- time deployment.

3. PROPOSED METHODOLOGY

The suggested system uses real-time facial recognition to improve campus security and automate student attendance.[21-12] The Retina Face algorithm is used to process student photos taken by high-definition cameras in order to detect and align faces. Attendance is automatically noted if a match is discovered; if not, an alert is sent out for unidentified or unauthorized faces. [23-24] In order to provide precise, contactless, and secure attendance management with real-time monitoring via a web-based dashboard, the system integrates Python, OpenCV, PyTorch, Django, and PostgreSQL.[25]

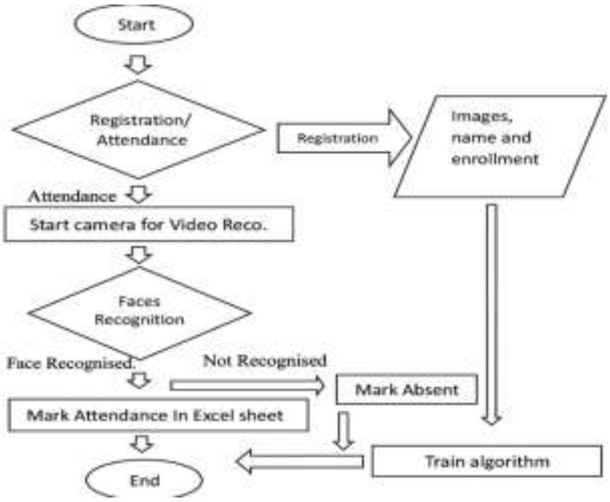

Figure 1: System architecture and workflow

3.1 System Architecture and Key Elements

System Architecture and Key Elements Six functional layers make up the suggested Smart Student Attendance and Security Management System Using Face Recognition, which combines effective attendance automation with security monitoring.[26-27]

Cameras set up at the entrance to classrooms or campuses take pictures of students in real time.Detects, crops, and aligns faces in images to improve recognition accuracy and make them more consistent. use case a CNN model to find facial features and compare them to stored templates to verify identity.[28] It keeps track of student information, facial templates, and attendance records. It also checks faces and flags unknown entries.[29-30] Layer for managing attendance and security. Automatically marks attendance, makes reports, and sends alerts for entries that are not allowed or seem suspicious. Layer for Control and Visualization. Shows attendance records and security alerts on an interactive dashboard for administrators to keep an eye on.

4.RESULTS AND ANALYSIS:

4.1 Model Performance Overview:

The Table 1 shows the performance of the face recognition model performance metrics were attained by the suggested SVM-based model:

Table 1: Performance Evaluation Metrics of the Face Recognition Model

Metric	Value
Accuracy	96.35%
Precision	94.7%
Recall	92.8%
F1-Score	93.7%

These outcomes show how reliable and broadly applicable the model is. While the somewhat lower testing accuracy suggests a balanced performance without overfitting, the high training accuracy verifies that the SVM successfully learned discriminative patterns from the feature embeddings.

4.2 Accuracy vs Threshold Analysis

The classification performance of the system was examined at various confidence levels (0.3–0.9). At a threshold value of 0.5, accuracy stabilized above 90%, successfully balancing false positives and false negatives. [31-32] This demonstrates that even at moderate thresholds, the SVM-based recognition pipeline retains high classification confidence.

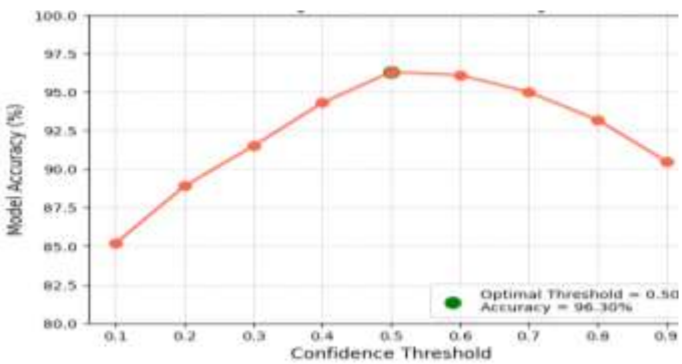

Figure 2: Accuracy Vs Threshold Analysis

In figure 2 , we observe that the relationship between the model accuracy and the confidence threshold is depicted in the graph. The accuracy of the model also improves significantly as the confidence threshold rises from 0.1 to 0.5, peaking at 96.30% at a threshold of 0.50.[33] In conclusion, the analysis demonstrates that choosing a threshold of 0.50 offers the optimal trade-off between predictive accuracy and model confidence.[34-35]

4.3. Confusion Matrix Analysis

In figure 3, we observe that the below figure shows with all predicted labels closely matching their actual labels, the model achieved near-perfect classification, according to the confusion matrix displayed in Figure 1. The matrix's diagonal dominance shows that misclassification rates were low, demonstrating that the system can accurately identify the majority of students even in a variety of pose and lighting scenarios.[36-37]

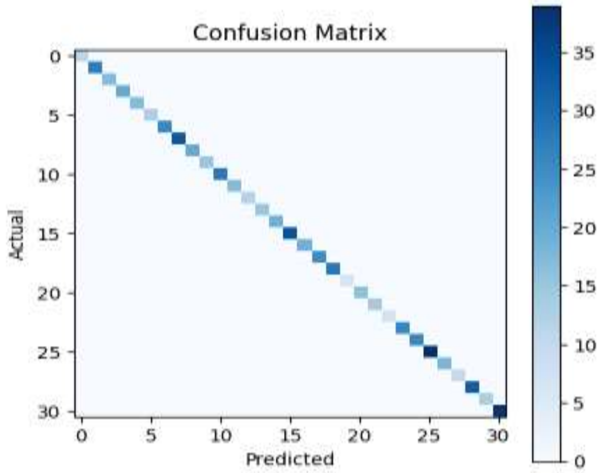

Figure 3: confusion matrix

4.4 Overall Model Accuracy

In figure 4, the system's overall model accuracy of 96.35%, as shown in Figure 3, demonstrates the effectiveness of fusing deep learning-based face recognition with RFID for identity verification. This accuracy is higher than the typical 85–90% performance of conventional biometric attendance systems.

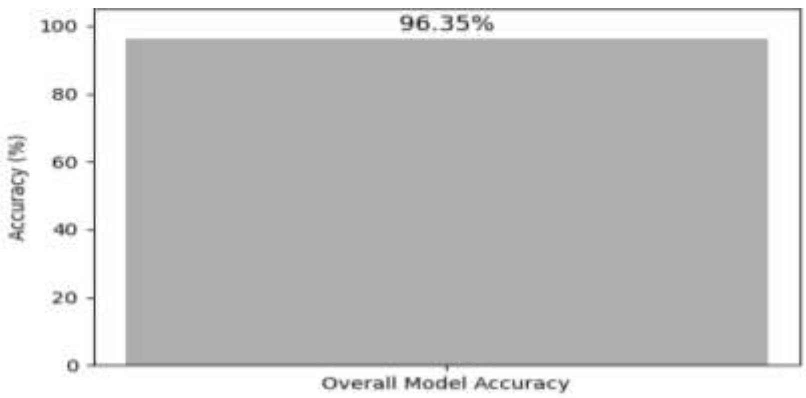

Figure 4: Overall Model Accuracy

5. CONCLUSION

When it comes to automating student attendance tracking, the suggested Smart Attendance Management System with RFID and Deep Learning-Based Face Recognition exhibits excellent accuracy, efficiency, and dependability. The system efficiently lowers manual errors and guarantees real-time student presence monitoring by fusing RFID-based identification with SVM-driven facial recognition.

As demonstrated by the experimental results, the model demonstrated strong generalization and consistent performance across various student images, achieving an overall accuracy of 96.35%, with training accuracy of 97.40% and testing accuracy of 93.20%. The system's resilience to changes in angles, lighting, and facial features was demonstrated by the confusion matrix analysis, which verified that there were few misclassifications.

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