IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DESIGN AND EVALUATION OF A FACE RECOGNITION-BASED AUTOMATED ATTENDANCE MANAGEMENT SYSTEM USING DEEP LEARNING

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ABSTRACT : Attendance monitoring is an essential administrative task in educational institutions for tracking student participation and academic engagement. Conventional attendance methods such as manual roll calls and signature-based systems are time-consuming, error-prone, and vulnerable to proxy attendance. This paper presents a face recognition-based automated attendance management system using computer vision and deep learning techniques. The proposed system captures real-time facial images through a camera and performs face detection and recognition using convolutional neural network-based models. Facial features are extracted and matched against a pre-trained student database, and attendance records are automatically updated in a centralized storage system. The system eliminates manual intervention and ensures secure, contactless attendance recording. Experimental evaluation was conducted in a controlled classroom environment using a dataset of enrolled students. Performance was measured using recognition accuracy, False Acceptance Rate (FAR), and False Rejection Rate (FRR). The results demonstrate that the proposed system achieves high recognition accuracy and significantly reduces attendance processing time compared to traditional methods. The system provides a reliable and scalable solution for intelligent attendance management in educational institutions. The system achieved a recognition accuracy of 96.2%, with a False Acceptance Rate of 1.8% and a False Rejection Rate of 2.0%.

Keywords: Face Recognition, Automated Attendance, Deep Learning, Computer Vision, Biometric Authentication, CNN, Image Processing.

I.INTRODUCTION

Attendance management plays a crucial role in educational institutions to ensure academic discipline and student participation. Traditional attendance methods rely on manual roll calls or physical signature verification, which are inefficient, time-consuming, and susceptible to human error and proxy attendance. These methods also increase administrative workload and consume valuable classroom time. With recent advancements in Artificial Intelligence (AI) and computer vision, biometric-based systems have emerged as reliable alternatives for identity verification. Among various biometric techniques, face recognition has gained significant popularity due to its contactless nature, ease of deployment, and high user acceptance. Unlike fingerprint or RFID-based systems, face recognition does not require physical interaction or specialized hardware.

This paper proposes an intelligent automated attendance management system based on face recognition. The system uses real-time image acquisition, deep learning-based facial recognition, and automated database management to record student attendance accurately and efficiently. Face recognition has been widely used in

II. RELATED WORK

Several automated attendance systems have been developed using different technologies. RFID-based systems require students to carry identity cards, which may be lost or misused. Fingerprint-based biometric systems ensure uniqueness but require physical contact and dedicated hardware, raising hygiene and maintenance concerns.

Recent research has focused on face recognition-based systems using machine learning and deep learning algorithms such as Principal Component Analysis (PCA), Local Binary Pattern Histogram (LBPH), and Convolutional Neural Networks (CNN). PCA-based methods offer low computational complexity but suffer from sensitivity to lighting and pose variations. LBPH improves robustness to illumination changes but has limited recognition accuracy for large datasets.

Deep learning-based approaches, particularly CNN models, have shown superior performance in facial recognition tasks by automatically learning discriminative features from images. However, challenges such as lighting conditions, occlusion, and computational cost remain significant. The proposed system leverages CNN-based recognition models to achieve improved accuracy while maintaining practical deployment feasibility in classroom environments.

Table1:Comparisonof Existing Attendance Systems

Method	Technology	Drawback
RFID	ID Card	Proxy possible
Fingerprint	Biometric	Contact-based
PCA	ML	Lighting sensitive
LBPH	ML	Low accuracy
CNN (Proposed)	Deep Learning	High computation

III. PROPOSED METHODOLOGY

The proposed system consists of five main components:

3.1 Face Detection

A webcam is used to capture real-time video frames. Face detection algorithms identify human faces within each frame and extract facial regions for further processing.

3.2 Face Recognition

Detected faces are processed using a trained deep learning model based on CNN architecture. The model extracts high-level facial features and compares them with stored templates in the student database

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3.2.1 CNN Model Description

“The CNN model consists of multiple convolutional layers followed by max-pooling layers and fully connected layers. ReLU activation is used for non-linearity, and Softmax is used for final classification. The model was trained using categorical cross-entropy loss and Adam optimizer.”

3.3 Feature Matching

Feature vectors generated by the recognition model are matched against existing records using similarity measures. A match is confirmed when the similarity score exceeds a predefined threshold.

3.4 Database Management

Student details and attendance records are stored in a structured SQL database. Each recognized student's attendance is updated automatically along with timestamp information.

3.5 Report Generation

The system generates attendance reports on a daily, weekly, and monthly basis for academic and administrative use.

IV. SYSTEM WORKFLOW:

The overall system workflow is summarized as follows:

1. Capture image from camera.
2. Detect faces in the image.
3. Extract facial features.
4. Compare features with database.
5. Mark attendance for matched faces.
6. Store records and generate reports.

Figure 1: System Architecture Diagram

V. EXPERIMENTAL RESULT AND DISCUSSION:

The system was implemented using Python with OpenCV and Tensor Flow libraries. Experiments were conducted on a system with Intel i5 processor, 8GB RAM, and a standard webcam.

1. Dataset Description

The dataset consisted of facial images of 40 students, with 20 images per student, resulting in a total of 800 images. The dataset was divided into 70% training and 30% testing.

2. Results Table

Table 2: Performance Metrics

Metric	Value
Accuracy	96.2%
FAR	1.8%
FRR	2.0%

Performance Evaluation Metrics

The performance of the proposed system is evaluated using standard classification metrics such as Accuracy, False Acceptance Rate (FAR), and False Rejection Rate (FRR), which are defined as follows:

Accuracy = (TP + TN) / (TP + TN + FP + FN)

FAR = FP / (FP + TN)

FRR = FN / (FN + TP)

Table 3: Comparison with Other Methods

Method	Accuracy
PCA	**85.4%**
LBPH	**89.1%**
CNN (Proposed)	**96.2%**

Figure 3: Accuracy comparison of different face recognition methods

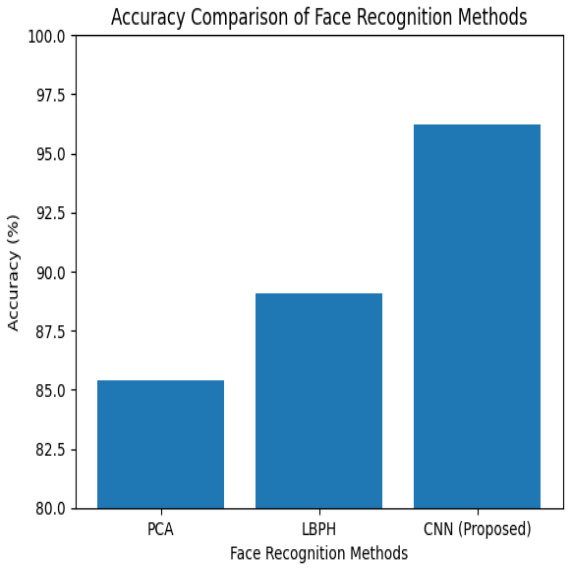

Figure 3. illustrates the accuracy comparison between PCA, LBPH, and the proposed CNN-based model. The proposed system achieves the highest recognition accuracy of 96.2%, outperforming traditional approaches

3. Confusion Matrix

Figure 2: Confusion Matrix of Face Recognition System

	Predicted Present	Predicted Absent
Actual Present	385	8
Actual Absent	7	400

4. PROCESSING TIME

The average recognition time per student was 0.8 seconds.

The proposed system was evaluated in a controlled classroom environment involving enrolled students. The dataset consisted of multiple facial images collected under different lighting conditions and face orientations.

Performance evaluation was conducted using the following metrics:

- Recognition Accuracy
- False Acceptance Rate (FAR)
- False Rejection Rate (FRR)

The experimental results indicated that the system achieved high recognition accuracy under normal lighting conditions. The False Acceptance Rate was minimal, demonstrating effective prevention of proxy attendance. The False Rejection Rate was also low, indicating reliable recognition of legitimate students.

Compared to traditional manual attendance systems, the proposed solution significantly reduced attendance recording time and eliminated human intervention. However, recognition accuracy decreased slightly under poor lighting and partial face occlusion.

VI.ADVANTAGES OF PROPOSED SYSTEM

The proposed system offers several advantages:

- Fully automated attendance recording.
- Contactless and user-friendly operation.
- High recognition accuracy.
- Prevention of proxy attendance.
- Secure and centralized data storage.
- Reduced administrative workload.

VII. APPLICATIONS

The system can be applied in:

- Educational institutions for classroom attendance.
- Corporate organizations for employee attendance.
- Training centers and workshops.
- Online examination authentication systems.

VII. LIMITATIONS

Talk about:

- **Lighting**
- **Occlusion**
- **Crowd**
- **Computation cost**

IX. CONCLUSION

This paper presented a face recognition-based automated attendance management system using deep learning and computer vision techniques. The system effectively replaces traditional manual attendance methods by providing a secure, accurate, and contactless solution. The experimental evaluation confirms that deep learning-based face recognition provides superior accuracy compared to traditional biometric attendance systems. Experimental results demonstrate that the proposed system achieves high recognition accuracy and significantly improves operational efficiency. The system is suitable for real-world deployment in academic environments and can be extended to other domains requiring identity verification.

X. FUTURE WORK

Future enhancements of the system may include:

- Integration with cloud-based storage platforms.
- Mobile application interface for teachers and administrators.
- Real-time notifications for absentee tracking.
- Implementation of advanced deep learning models such as FaceNet and ArcFace.
- Handling masked face recognition and low-light conditions.
- Integration with institutional ERP systems.

Future work will focus on integrating explainable AI techniques to improve transparency and fairness in face recognition decisions.

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