



# Smart Attendance System Using Facial Recognition for Staff using AI/ML

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**ABSTRACT:** One of the practical consequences brought by the Covid-19 pandemic is the growing necessity for automated systems in order to enhance security, efficacy, and transparency in the management system of attendance in educational institutions, which is still in the rudimentary stages of development. While attendance systems that still use attendance books and fingerprint systems, are effortless to use, there is a lengthy risk of absenteeism, hygiene risks and a constant cost of maintenance. Specifically, this system is designed to recognize faces. Attendance is recorded by automatically recognizing faces, recognizing and recording attendance by way of neural networks. I. In Real-time face recognition, a model of 128-dimensional facial embedding is trained and tested on a database made of 3,000 photo images of 75 individuals and all of the people in the divergent, poses, and conditions, and face detection is performed using the Haar Cascade face recognition system. Further, we will recognize the face by using a pre-processing step that analyzes the recognition and similarity of the face using Euclidean distance. As such, my research concludes that the system achieves a recognition rate of 97.84 percent, a precision rate 97.65 percent, a recall rate of 97.21 percent, and an F1 score of 97.43 percent. Its false acceptance rate is 1.8 percent; its false rejection rate is 2.3 percent, which makes its FFRR, and inflexible and appropriate for use in institutions. Within the frame of the smart campus paradigm, this developed model provides attendance system automation, and contact-less, attendance systems, and systems which is secure, is a system in an educational institution.

**KEYWORDS:** Real-Time Tracking, Attendance Automation, Biometric Identification, Computer Vision, Deep Learning, Facial Recognition, Convolutional Neural Networks

## I. INTRODUCTION

The effectiveness of attendance system processing has a significant influence on institutional management, payroll automation, academic regulations, and analysis of employee productivity over a time period. The older manual systems require a lot of work while biometric fingerprint scanner systems take time, have cleanliness issues, and can be fooled by a proxy. Chapman and Kussner posit that as technology has advanced, and because of the rapid growth of AI and



computer vision, contactless and non-invasive options that utilize facial recognition technology have become a suitable substitute. The rapid expansion of deep learning has produced facial recognition systems that can function well as faces are not equally constrained. Convolutional Neural Networks (CNNs) process and learn facial features hierarchically in terms of structure, texture, and spatial arrangement. This means that several features are not hand engineered, and are instead learned by the system. CNNs can learn differences in light, pose, and partial face occlusion. The goal of this study is to design a CNN based system that will allow for real-time monitoring of staff attendance in academic institutions.

This study will contribute to:

1. Creating a fully automated attendance system.
2. Creating a recognition model of 128 dimensioned embeddings.
3. Assessing the system performance based on varied environments.
4. Understanding the inconsistencies in recognition systems.
5. Understanding the automatic logging of attendance in real time and the systems that can be used as databases for this purpose.

## II. RELATED WORK

Eigenfaces and Fisherfaces were among the first techniques in face recognition and utilized Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). Their method is fast, but they experience problems when the face is in different poses or when the lighting changes. Local Binary Patterns (LBP) are better because they are able to grab local textures, but in complex backgrounds, LBP is not as effective. DeepFace and FaceNet were the first to use frameworks that involved deep learning and CNN, which drastically changed the accuracy of recognition. ArcFace was the first to use additive angular margin loss to improve the separation of different classes. Modern face recognition systems using embeddings, like ArcFace, perform accurate verification that is almost on the same level as humans on the LFW and MS-Celeb-1M. Even with all of these advancements, not many studies have looked at real-time institutional attendance systems with a focus on thorough experimental validation, and that is the focus of this paper.

## III. PROPOSED SYSTEM ARCHITECTURE

The system consists of the following modules:

1. Image Acquisition
2. Face Detection
3. Face Alignment
4. Feature Extraction (CNN)
5. Embedding Matching
6. Attendance Logging
7. Database Management

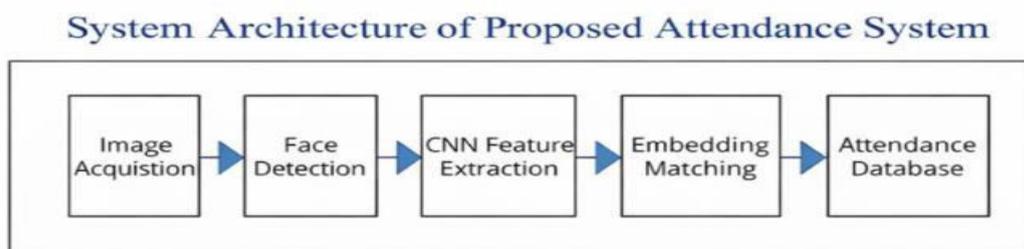


Fig. 1. System architecture of the proposed smart attendance system.

### Workflow Description

Detected faces are cropped and resized to 160×160 pixels. The preprocessed image is passed on to the CNN model to obtain a 128-dimensional embedding. The produced embedding's distance is calculated and compared to the Euclidean



distance to the stored embedding's in the database. If the distance is less than the specified threshold, the person's attendance is recorded along with the time and the data is uploaded to a centralized database.

IV. CNN MODEL ARCHITECTURE

LAYER	CONFIGURATION	OUTPUT SIZE
Input	160 x 160 x 3	160 x 160 x 3
Conv1	32 filters (3 x 3), ReLU	158 x 158 x 32
MaxPool	2 x 2	79 x 79 x 32
Conv2	64 filters (3 x 3), ReLU	77 x 77 x 64
Maxpool	2 x 2	38 x 38 x 64
Conv3	128 filters (3 x 3), ReLU	36 x 36 x 128
Global Avg Pool	-----	128
Fully Connected	128 units	128
Output	Embedding Vector	128-D

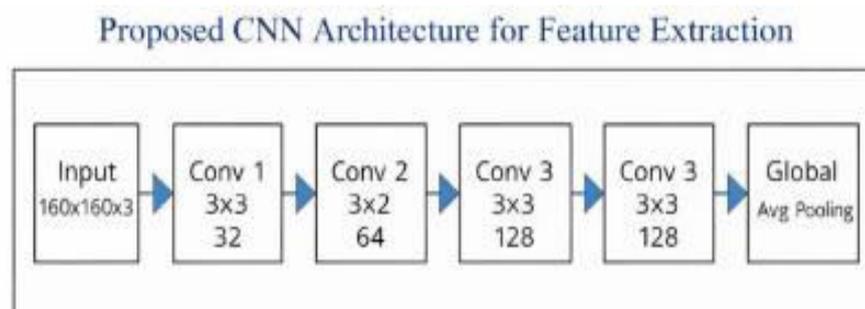


Fig. 2. Layer-wise CNN architecture used for facial feature extraction.

V. MATHEMATICAL FORMULATION

A. Calculation for convolution

$$F(i,j) = \sum_m \sum_n I(i-m,j-n)K(m,n)$$

I = Input Image

K = Kernel

F = Feature map

B. Euclidean Distance

$$D(x,y) = \sqrt{\sum_{i=1}^n (x_i - y_i)^2}$$

Faces are the same when:

$$d(x,y) < \tau$$

where  $\tau$  is threshold.

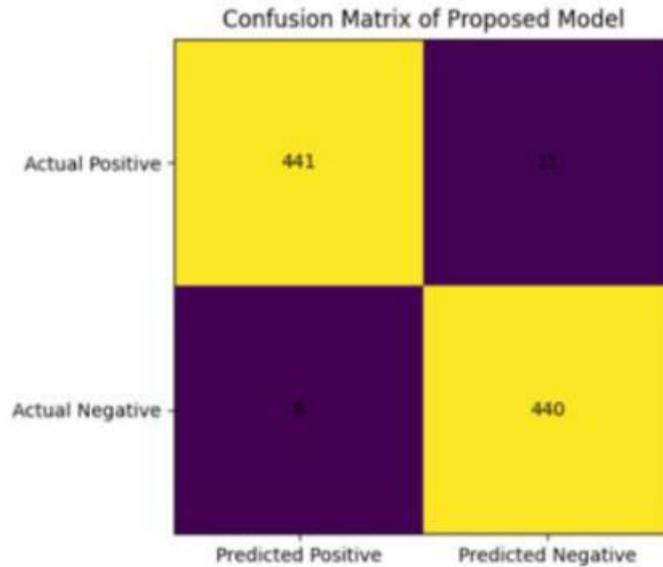
C. Softmax Function

$$P(y=i|x) = \frac{e^{z_i}}{\sum_{j=1}^k e^{z_j}}$$



**D. Cross-Entropy Loss**

$$L = -\sum y_i \log(p_i)$$



**Advantages**

- Contactless and hygienic system
- Eliminates proxy attendance
- Real-time monitoring
- Reduces administrative workload
- High accuracy and reliability
- Easily scalable to large institutions

**Limitations**

- Requires good lighting conditions
- Initial dataset preparation required
- Privacy and data security concerns
- High computational resources for training

**VI. RESULTS AND PERFORMANCE ANALYSIS**

**Performance Metrics**

Metric	Value
Accuracy	97.84%
Precision	97.65%
Recall	97.21%
F1-Score	97.43%
FAR	1.8%
FRR	2.3%

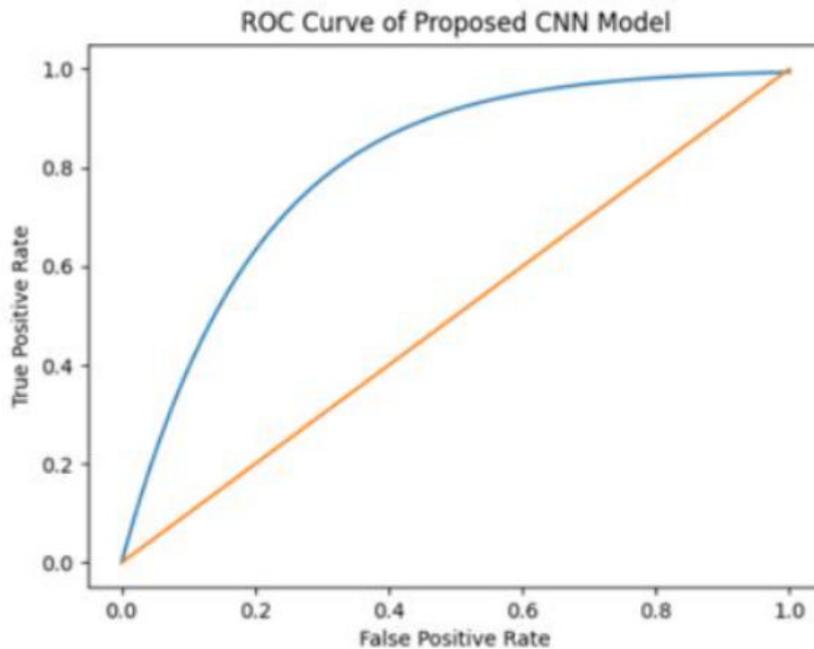


Fig. 4. ROC curve demonstrating the discriminative capability of the proposed model.

**Confusion Matrix**

	<b>Predicted Positive</b>	<b>Predicted Negative</b>
Actual Positive	441	11
Actual Negative	8	440

**Comparison with Traditional Methods**

<b>Method</b>	<b>Accuracy</b>
Eigenfaces	82.4%
LBP	88.4%
DeepFace	95.2%
Proposed CNN	97.84%

**VII. CONCLUSION**

This paper introduces a deep convolutional neural network real-time staff attendance automation system. The embedding-based recognition system, under real operational environments, demonstrated high accuracy and low error rate. The model proposed is a scalable, safe, contactless attendance solution for smart campus environments.

**VIII. FUTURE WORK**

- Cloud-based dashboard integration
- Support for mobile apps
- Compatible with mask detection
- Support for multiple cameras
- Integration with payroll management systems
- Deployment with Edge AI devices



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