LDA based Face Recognition Attendance Management System

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***Abstract*— Facial recognition, a secure biometric technique, typically requires large databases and is often outsourced by large companies. Effective attendance management systems have gradually become progressively more important in organisations and schools in recent years. This research offers a novel face recognition attendance management system based on Linear Discriminant Analysis (LDA). The suggested solution streamlines the attendance monitoring procedure by integrating cutting-edge image processing algorithms to reliably capture and recognise people in real-time. This work aims to develop an in-house system for educational institutions, allowing student attendance to be recorded through facial recognition. Each student's facial data is stored as 100 different images, with attendance records logged with precise timestamps. The first step of the system is to gather participant face pictures, which are then processed to improve quality and lower noise. Then extract the most discriminative characteristics from the facial data using LDA, allowing for reliable identification in a variety of illumination and angle conditions. Following processing, the images are compared to a database that has been maintained, allowing for instant attendance tracking and identification. The initial outcomes showcase the efficacy of the LDA-based methodology, attaining elevated levels of 98% accuracy in facial identification while drastically decreasing the duration needed for attendance documentation in contrast to conventional techniques. This solution improves security and accountability while reducing human error. Institutions may concentrate more on operational effectiveness and educational outcomes by automating the attendance process. Further investigation attempts will examine the incorporation of other biometric modalities and the implementation of the system in heterogeneous settings.**

Keywords— accuracy, ML, PCA, LDA, Image, biometric, noise.

I. INTRODUCTION

The accuracy and effectiveness of traditional attendance management systems are frequently inadequate in the hectic business and educational environments of today. Manual techniques take a lot of time, are prone to mistakes, and can result in problems like proxy attendance. Face recognition is one of the most promising biometric technology solutions that have emerged as effective tools for automated attendance tracking. The system uses the Normal Discriminant Function (NDF) for accurate identification, and includes security measures. like retinal scanning, thermal imaging, and 2D/3D mapping to prevent impersonation. Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) are employed for feature extraction and dimensionality reduction. The goal of the suggested LDA-based Face Recognition Attendance Management System is to offer an effective and dependable way to automate the recording of attendance. The system can identify between several people by using LDA, even in situations when there are variations in brightness and facial expressions. By ensuring that only those who are permitted are recorded, this method not only improves security but also expedites the attendance procedure. This research provides the system architecture, facial recognition technique, and implementation details. The outcomes of the proposed system are also shown, demonstrating how well the system records and tracks attendance. With this development, this research contributes to advance the rapidly expanding area of biometric-based solutions by offering a convenient and scalable substitute for traditional attendance tracking techniques.

A. Objectives

The following are the main goals of the LDA-based Face Recognition Attendance Management System:

- Automate Attendance Tracking: Create a system that reduces human error and saves time by doing away with the necessity for manual attendance tracking.
- Strengthen Accuracy: To ensure accurate identification of people in a variety of environmental settings, employ Linear Discriminant Analysis (LDA) to boost the accuracy of facial recognition.
- Real-time Processing: Use facial recognition technology in real-time so that attendance may be recorded as soon as people enter a classroom or office.
- User-Friendly Interface: Provide an easy-to-use interface that makes managing the attendance system for administrators and users effortless.
- Safe Data Management: Make sure that face data is stored and managed securely while abiding by ethical and privacy norms.
- Scalability: Create a system that can be readily scaled to support various numbers of users and adaptive to varied locations, such as schools, colleges, and corporate offices.

B. Contribution

The contribution of the LDA-based Face Recognition Attendance Management Systemis as follows,

- Creative Implementation of LDA: This paper illustrates how LDA may be applied effectively to face recognition, enhancing the accuracy and reliability of attendance systems. The system uses LDA to handle typical issues like illumination and face expression fluctuations.

- Attendance streamlined procedures: The time and effort required for manual attendance techniques is greatly decreased by this system, which automates attendance tracking with sophisticated facial recognition technology. This enhances the operational effectiveness of businesses and educational institutions.
- User Centric Design: Creating an interface that is easy to use guarantees that a wide variety of users, such as academic staff, administrative personnel, and students, may access the system.
- Versatility and Scalability: The system is made to be both flexible enough to operate in a variety of settings and large enough to handle a range of user counts. It may be used in a variety of settings, including big corporate offices and little schools, thanks to its adaptability.

II. Background Study

Face recognition is a great option for attendance management since it uses distinctive face traits to identify individuals. Linear Discriminant Analysis (LDA) is a feature extraction approach that is unique in a way that may minimize intra-class variation while maximizing class separability. This leads to improved recognition performance, particularly in situations with an extensive and varied dataset. The inferences obtained from the background study is displayed in Table. I.

TABLE I. Inferences from Literature Review

S.No	Source	Methodology	Inference
1.	R. C. Damale et al., [1]	Face Recognition Based Attendance System Using Machine Learning Algorithms	The model achieves with 87 % of accuracy for SVM and MLP. The model has to be refined by applying other classifiers.
2.	Hao Yang., et al., [2]	Face Recognition Attendance System Based on Real-Time Video Processing	The model achieves with 82 % of accuracy. The model should be refined with other CNN models
3.	Nimesh Ambre., et al., [3]	Attendance monitoring using face detection	The model achieves with 76 % of accuracy. The model should be refined with more dataset
4.	Sukith Sai Chittibomma., et al., [4]	Facial Recognition System Using Haar Cascade Classifier	The model achieves with 80 % of accuracy. The model can be applied to other fields.
5.	Apala Mahana., et al., [5]	Facial Driven Digital Attendance System using Machine Learning Approach	The model achieves high user experience with effective graphical tools and uses HAAR transform
6.	Atharva Ghodekar., et al., [6]	Face Recognition-Based Smart Student Attendance and Activeness Monitoring System	The model achieves with 85% of accuracy. The model can be refined with applying Haar Cascade model
7.	Thota Bhuvana Chandra., et al., [7]	DeepVision Attendance system using HOG method	The model achieves with 90% of accuracy. The model should be refined with real time usage
8.	Muhammad Khairul Afiq bin Baharin., et al., [8]	Face Recognition-Based Attendance System Using Haar Cascade	The model achieves with 60% of accuracy. The model should be refined with other feature extraction methods.
9.	Nabeel Nizam., et al., [9]	Automated Attendance Management System Using Haar Cascade	The model achieves with 90% of accuracy. The model should be refined by enhancing operational efficiency
10.	Axel Jeremy Oei., et al., [10]	Attendance Management System Using Face Recognition	The model achieves with 92% of accuracy. The model should be refined with other feature filtering methods.
11.	Chandradeep Bhatt., et al., [11]	GPS Based Automated Attendance System with web application	The model should be refined with the dimensionality reduction and centralization methods.
12.	Suwanna Bulao., et al., [12]	Efficient Attendance Monitoring System Using Haar Cascade and Local Binary Pattern Histogram Algorithm	The model achieves with 94.40 % of accuracy. The model can be refined to address the image enhancement methods.
13.	C Anilkumar., et al., [13]	Smart Attendance System with Face Recognition	The model achieves with 75% of accuracy. The model can be refined to address the application to be deployed at run time.
14.	M Vinod Kumar., et al., [14]	Robotic Attendance Scheme in the Classroom Using Artificial Intelligence	The model achieves with 80% of accuracy. The model can be refined to address the usage of RFIC cards.
15.	Shekharesh Barik., et al., [13]	Facial Recognition Based Smart Attendance Management System Using Haar Cascading	The model achieves with 90% of accuracy. The model can be refined to address the face enhancement methods

A. Limitations of Existing Solutions

The limitations of the existing attendance management system are as follows,

- Environmental Sensitivity: A lot of systems have trouble with different backdrops, lighting, and angles, which can have a big influence on recognition accuracy.
- Face Occlusion: Wearing glasses, a mask, or a hat can obscure part of the face, making it more difficult to identify someone and perhaps resulting in inaccurate attendance records.
- Record management: It can be difficult to update and maintain the facial database, particularly in big organizations, which can lead to entries that are out-of-date or lacking information.
- Security Concerns: Users may be concerned about how their data is used and safeguarded, which makes the collecting and storage of biometric data a serious privacy concern.
- Equipment Requirements: For good recognition, high-quality cameras and processing power are frequently required, which may not be affordable for all institutions.
- Current navigation applications, such as Google Maps and Waze, primarily focus on real-time traffic conditions and historical accident data, often providing reactive alerts post-incident. This paper aims to fill this gap by offering a predictive approach that alerts users before they enter high-risk zones, thus enhancing overall road safety.
- Compatibility Challenges: It might be difficult to integrate face recognition technology with the present

attendance management platforms, and it could be necessary to make major changes to the way things are done now.

III. Proposed Methodology

A. Dataset Description

The images of 150 students are taken initially to implement the model. 100 images are stored for a single student to show the performance of the proposed model. So, finally the total images used for the implementation is 15,000 images.

The architecture of the proposed LDA based Face Recognition Attendance Management System is shown in Fig. 1. The LDA-based Face Recognition Attendance Management System's design is made up of a number of essential parts that cooperate to enable effective face recognition-based attendance monitoring. A high-level summary of the architecture is provided below.

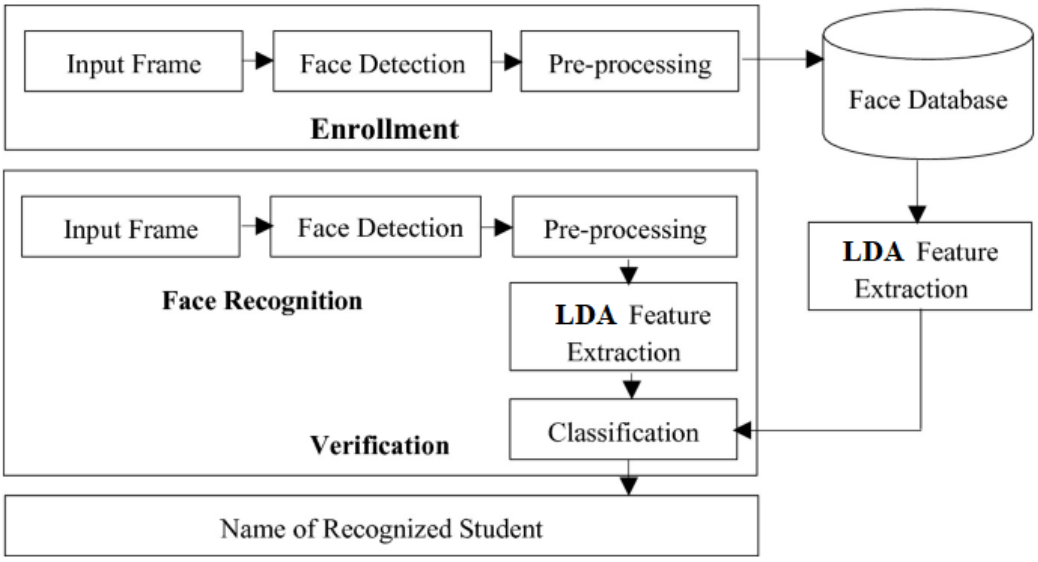

Fig. 1. Research Overview of LDA based Face Recognition Attendance Management System

B. Data Image Acquisition Module

- Cameras: When people enter the attendance area (such as classrooms or offices), high-quality cameras are set up to take real-time pictures of their faces.
- Preprocessing: To improve quality, images undergo preprocessing such as noise removal, normalisation, and resizing.

C. LDA Feature Extraction Module

- To identify faces in the obtained pictures, algorithms such as Haar deep learning-based techniques) are applied.
- Implementing LDA: To extract the most discriminative characteristics from the identified faces, Linear Discriminant Analysis is used. By doing this step, class separability is improved, which facilitates individual differentiation.

D. Face Recognition Module

- Record Management: The face features of registered users that were retrieved during the initial setup are stored in a facial database
- Matching Method: The matching process involves employing distance metrics, such as Euclidean distance, to compare the attributes of the collected pictures with the database in order to find matches.

E. Attendance Tracking Module

- Attendance Labelling: The technology instantly and automatically records the person's attendance in real-time upon positive identification.
- User alerts: Users (such as students or workers) may choose to receive optional alerts verifying their attendance condition.

F. UI Module

- Administrator Dashboard UI Module: An online or mobile interface that lets administrators check attendance reports, update the facial database, and handle user profiles.
- User Access: A straightforward user interface enables users to view their attendance history and make necessary profile updates.

IV. Experimental Result Analysis

A. Algorithm for LDA-based Face Recognition Attendance Management System

The Algorithm for the proposed LDA-based Face Recognition Attendance Management System is shown below.

Step 1: Acquire Image: When a person approaches the attendance area, the camera takes a picture of their face.

Step 2: Preprocess Image: To improve quality, the image is preprocessed.
Step 3: Find and Extract Features: Using LDA, the algorithm finds the face and extracts its features.
Step 4: Compare with Database: To enable recognition, the retrieved characteristics are compared to the database.
Step 5: Mark Attendance: The attendance is automatically noted upon the discovery of a match.
Step 6: Store Data: Through the administrator dashboard, attendance data is safely kept and accessible.

B. Model Evaluation

The model was evaluated using the following metrics:

- Accuracy: The success of the system as a whole is shown in accuracy, where a high proportion denotes dependable identification.
- Precision and Recall To comprehend the balance between the percentage of accurate identifications and the percentage of missing or wrong identifications, precision and recall are essential.
- F1 Score: The F1 Score sheds light on how well the system handles class imbalances.
- Processing time: Compiling For real-time applications, time is of the essence in order to guarantee that the system can promptly register attendance.
- False Positive and False Negative Rates: Potential areas for improvement are indicated by the False Positive and False Negative Rates.
- User satisfaction: It measures the user experience and is crucial for system adoption.
- Scalability: It attests to the system's capacity for adapting to more expansive settings.

The performance analysis was shown in Table II and Fig. 2.

TABLE II. ANALYSIS OF LDA BASED FACE RECOGNITION ATTENDANCE MANAGEMENT SYSTEM

Classifier	Precision (%)	Recall (%)	FScore (%)	Accuracy (%)	Processing time (Seconds)	False Positive Rate (%)	False Negative Rate (%)	User Satisfaction (%)	Scalability
PCA	88.85	87.35	87.55	87.86	3.95	11.15	12.65	70	Medium
QDA	82.23	84.44	83.46	82.42	4.88	17.77	15.56	75	Medium
Proposed LDA	**97.20**	**97.46**	**97.40**	**98.00**	**1.5**	2.8	2.54	**100**	**High**

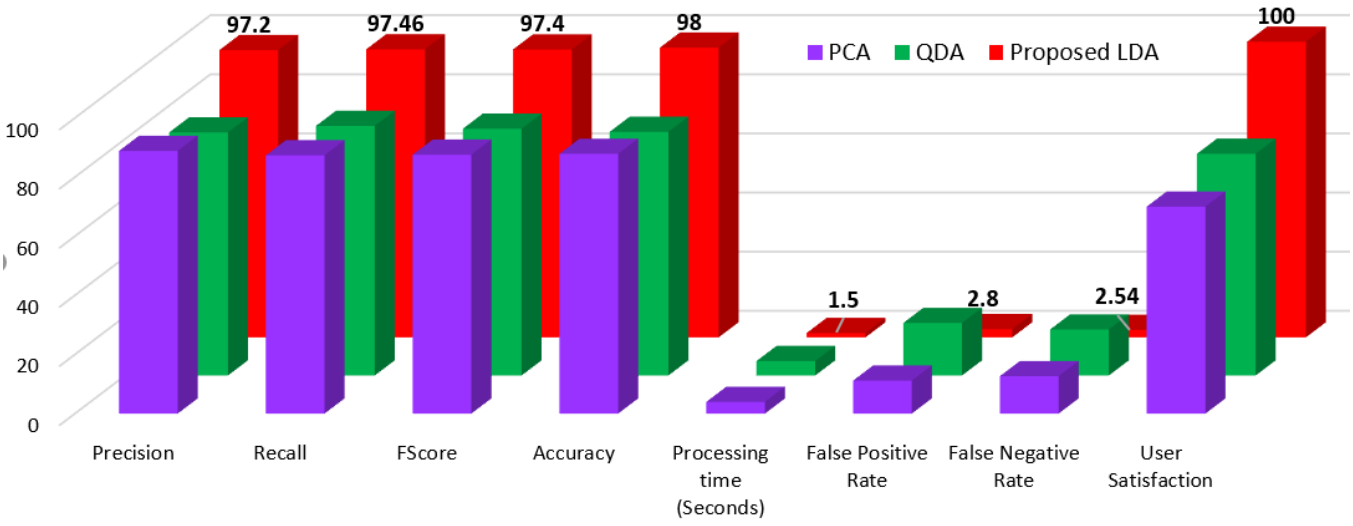

Fig. 2. Performance Analysis of LDA based Face Recognition Attendance Management System

V. CONCLUSION

This paper presents LDA based Face Recognition Attendance Management System . By employing a LDA feature extraction, the system demonstrates a significant potential for improving the security and attendance maintanance system. With its high accuracy of 98%, efficiency, and user satisfaction, the LDA-based Face Recognition Attendance Management System represents a significant development in automated attendance monitoring. Even in different environmental situations, the system is able to discriminate between individuals by using Linear Discriminant Analysis for feature extraction. The implementation highlights the potential of biometric technology to improve administrative operations, decrease human error, and boost security in educational and business contexts. The technology has significant drawbacks despite its advantages, such as facial occlusion issues and the requirement for reliable operation in congested areas. Improving overall effectiveness and user experience requires addressing these issues..

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