

## Facial Biometrics for Attendance System

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### Abstract

*This paper discusses the necessity for effective student attendance management systems by proposing a smart attendance management system utilizing biometric technology. It is well recognized that manually recording attendance is time-consuming and error prone. In this study, we propose a facial biometrics attendance system that automates attendance process without requiring human intervention. The system consists of a camera placed in the classroom to take pictures of the pupils. Subsequently, the captured images are analyzed for facial features through the implementation of the histogram of oriented gradients (HOG) algorithm for precise face detection. After identification, the K-nearest neighbor (KNN) classifier is used to identify the faces. Then marked as present or absent upon the recognition results, and these detected facial records are securely stored within a database for future reference and analysis. The technology allows users to have access to real-time attendance data and can generate monthly attendance reports effortlessly. By employing this methodology, the system achieves efficiency and stability, resulting in a significant reduction in classroom attendance management costs.*

**Keywords:** Facial biometrics, images, histogram of oriented gradients (HOG) algorithm, K-nearest neighbor

### INTRODUCTION

Artificial intelligence (AI) represents a dynamic and continually evolving field within computer science that aims to develop computers capable of performing activities that usually need human intelligence. These activities encompass learning, thinking, problem-solving, perception, comprehension of natural language, and creativity. AI systems are created to analyze extensive data, identify patterns, and make judgments with different levels of independence.

As a branch of AI (Figure 1), machine learning aims to enable computers to acquire knowledge from data on their own without the need for explicit programming instructions. Machine learning algorithms utilize statistical methods to enhance computer performance by being exposed to larger volumes of data.

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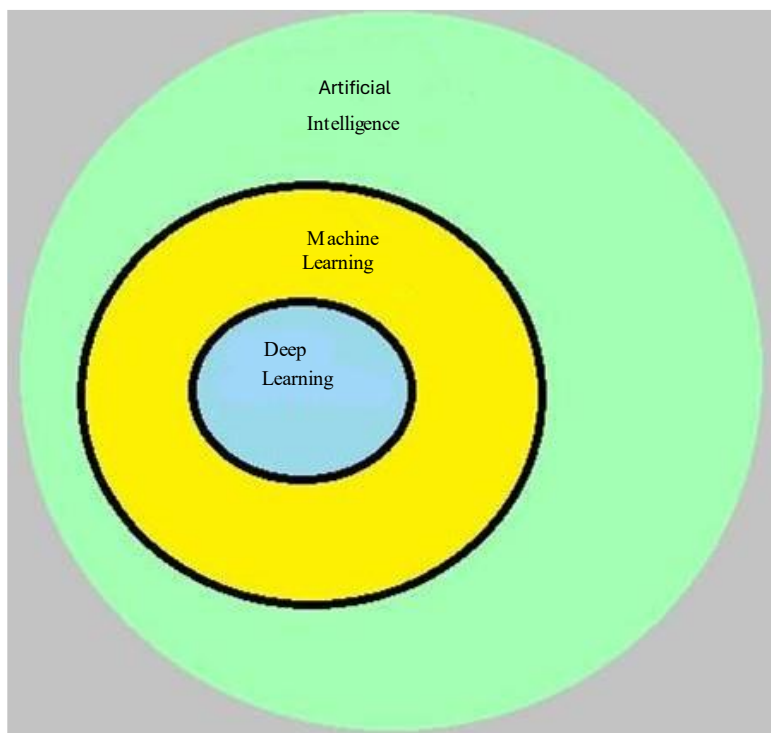
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Numerous facets of daily life currently incorporate AI technologies. has uses in a number of fields, such as cybersecurity, medical treatment, banking, higher learning, and transportation.

In educational institutions worldwide, efficient attendance management is essential for monitoring student engagement, ensuring compliance with academic requirements, and facilitating administrative processes. However, exhausting, prone to error, and demanding on resources, old manual methods of attendance systems frequently

prove to be. Using state-of-the-art biometric technologies, this article offers a revolutionary approach to attendance leadership, recognizing the need for a modern, automated solution.



**Figure 1.** Components of artificial intelligence.

Face recognition systems are essential across sectors in the digital era, served as a prominent biometric tool.

Despite lower accuracy than iris or fingerprint recognition, it is widely utilized for security, authentication, and identification due to the non-invasive nature. In an increasingly digital world, face recognition technology continues to be instrumental in enhancing efficiency and security [1].

Face recognizing in images or videos are prominent topics in biometric research, especially in real-time applications. The principal component analysis (PCA) facial recognition system is suggested as a framework for authentication, aiming to reduce data storage needs while maintaining representation accuracy. PCA, a statistical method akin to factor analysis, transforms a large 2D face image into a compact 1D pixel vector, enabling efficient facial recognition. This method, known as self-space projection, is crucial for real-time face recognition applications [2].

Smitha et al. [1] studied the optimal facial recognition algorithms, Eigenface and Fisher face, provided in OpenCV. They evaluated the algorithms using receiver operating characteristics (ROC) curves and included the Eigenface algorithm into an attendance system [3–8], reaching an accuracy between 70% and 90% through testing.

A student attendance system utilizing facial recognition and a combination of discrete wavelet transforms (DWT) and discrete cosine transforms (DCT) for feature extraction was provided by the authors [1]. An accuracy of 82% was achieved by applying radial basis function (RBF) to categorize face objects.

Managing student attendance system is the challenging responsibility in different educational institutions. Every university adopts its own approach of recording attendance, which may involve

attendance sheets or biometric technology. However, these approaches are time-consuming. Student attendance is mostly recorded via an attendance form distributed to teaching members [9]. It takes a lot of time and work to accomplish this. It is uncertain if the student in question is providing a response. Consolidating attendance is a significant undertaking that might lead to human mistakes. Occasionally, the attendance sheet may be misplaced or taken by pupils. An automated attendance management system is required to address these issues.

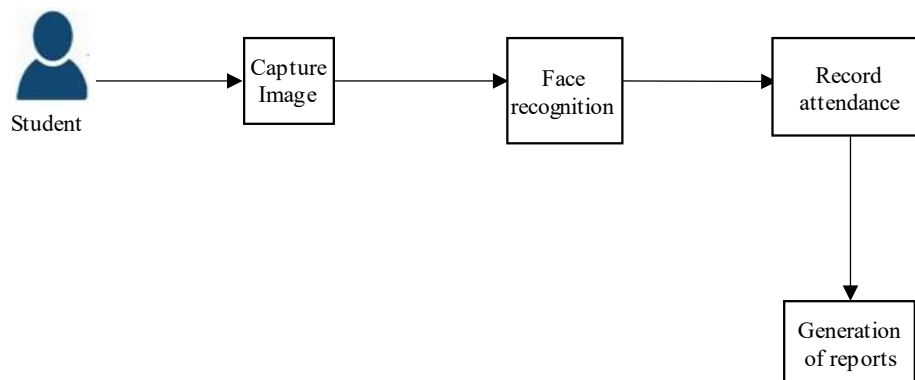
## EXISTING SYSTEM

There is comparison done between existing system and proposed system as shown in Table 1.

## Proposed System

The proposed system introduces a cutting-edge attendance management solution that leverages facial biometrics, revolutionizing the traditional approach to recording and managing classroom attendance. This system utilizes face recognition technology to automate the attendance process, alleviating the workload of educators and administrators while improving precision and productivity. Proxy attendance, data entry errors, and logistical difficulties are just a few of the drawbacks associated with traditional attendance management techniques like human roll calls or barcode scanning. On the other hand, facial biometrics provide a strong and dependable method of recognizing people based on distinctive facial characteristics, doing away with the necessity for tangible tokens or human input.

The core components of this system include a camera installed in the classroom to capture student images, sophisticated face detection algorithms to isolate facial features, and advanced recognition techniques like the K-nearest neighbor (KNN) classifier to match detected faces with pre-existing templates as shown in Figure 2. By seamlessly integrating these components, this can accurately track student attendance without human involvement in real time.



**Figure 2.** Proposed system architecture.

## RESEARCH METHODS

Our proposal combines histogram of oriented gradients (HOG) for face detection with KNN for face recognition.

### Histogram of Oriented Gradients Algorithm

The mostly used method for detecting faces and objects is through the HOG classifiers. The term histogram of oriented gradients is abbreviated as HOG. The key is to identify suitable feature descriptors for a picture, whether it be faces or other things. The HOG is object detection in image processing. A function descriptor simplifies a picture by extracting important information from it, representing either the image itself or an image patch [10].

The descriptor histogram of directed gradients theory posits that the arrangement of intensity gradients or edge orientations will determine the visual characteristics and contours of local elements

in an image [11–14]. The x and y derivatives of a picture, known as gradients, are valuable due to their ability to large magnitudes near edges and corners with significant variations in amplitude. Edges and corners include more object form details compared to flat regions [13–17]. Thus, gradient route histograms serve as characteristics of this descriptor as shown in Figures 3 and 4.

**Table 1.** Comparison between existing system and proposed system.

Aspect	Existing System	Proposed System
Methodology	Relies on manual methods such as attendance sheets or biometric technology.	Utilizes facial biometrics technology for automated attendance tracking.
Accuracy	Prone to errors due to manual data entry and recording.	Provides high accuracy in attendance tracking through facial recognition algorithms.
Time consumption	Time-consuming process for both students and faculty members.	Process that is rapid and effective and does not require manual data entry.
Cost	Requires resources for printing attendance sheets or maintaining biometric devices.	Initial investment in camera installation, but significant reduction in long-term attendance management costs.
Administrative effort	Requires significant administrative effort to consolidate and manage attendance records.	Reduces administrative burden by automating attendance tracking and record-keeping processes.



**Figure 3.** Histogram of oriented gradients.



**Figure 4.** Original versus histogram of oriented gradients (HOG) representation.

***K-Nearest Neighbor Algorithm***

K-nearest neighbor (KNN) is a basic machine learning method that depends on the supervised learning approach. The KNN algorithm categorizes new data by comparing its resemblance to existing examples and assigning it to the category that is most similar. The KNN algorithm retains all the data and categorizes a new data point by comparing its resemblance to the stored data. When fresh data emerges, it may be efficiently categorized into an appropriate group by employing the KNN method. The KNN method is beneficial for addressing classification difficulties as shown in Figure 5.

## IMPLEMENTATION MODULES: ADMIN AND FACULTY

The admin module is responsible for adding students' details to the database.

Secondly, the faculty module captures images and submits them.

After capturing the image, face detection and face recognition technologies are employed using the HOG and algorithm for face detection. The faces are detected and passed to the KNN classifier for recognition.

For determining people, the KNN classifier matches facial traits to an already-existing database. Upon successful face recognition, the attendance of individuals is marked as "Present" or "Absent" in the database. The admin and faculty can view the attendance reports.

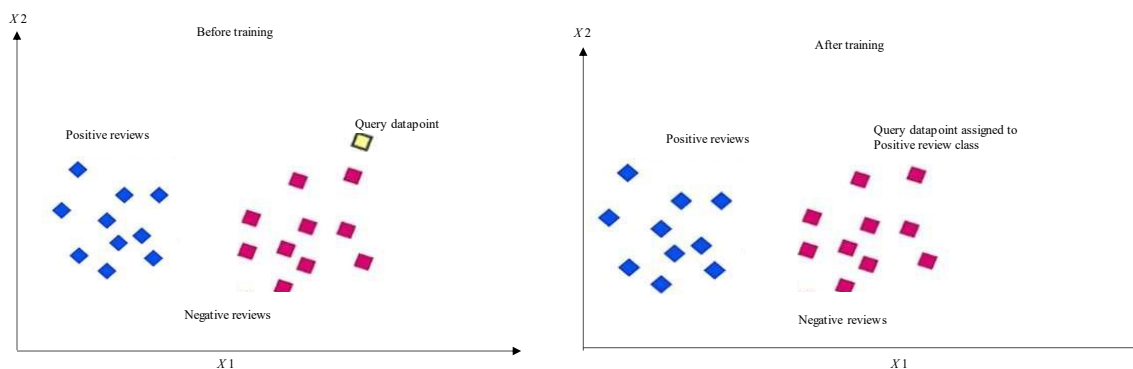


Figure 5. K-nearest neighbor (KNN) algorithm.

## Dataset

We are not using any pre-trained dataset. We are preparing the customized dataset. Here the admin will upload the student details with profile pictures into a dataset. So, as the admin adds the student pictures, the dataset will be increased as shown in Figure 6.

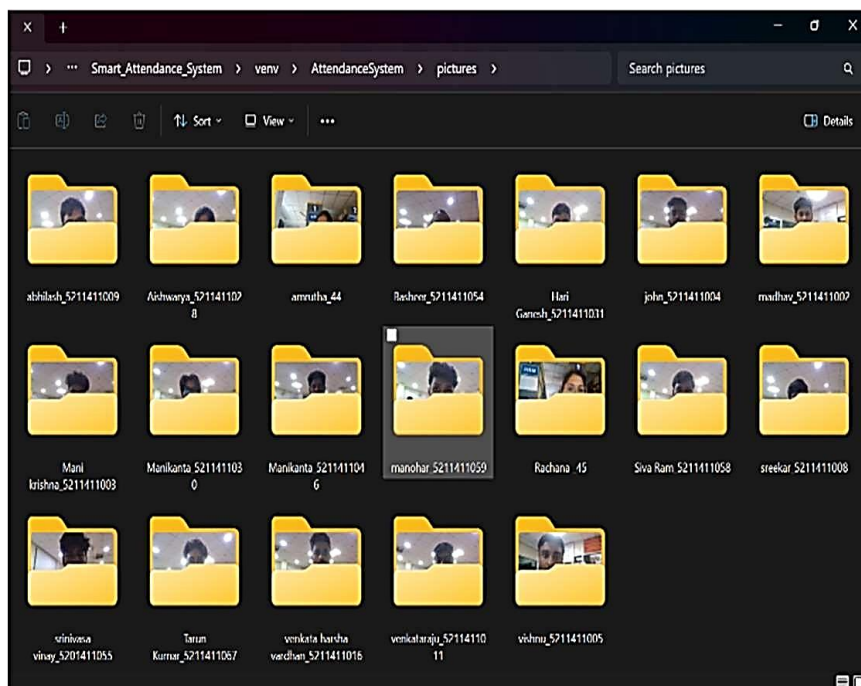


Figure 6. Student data

**RESULTS**

The home page for the proposed system is shown in Figure 7: Main home in first part, faculty home page in (b) part and biometrics for attendance system is shown in Figure 7(c). The results tested under different scenarios are shown in Figure 8. The generated Excel sheet is shown in Figure 9. The output of face recognition of individuals is shown in Figure 10. Student data in the database is presented in Figure 11. Face recognition of multiple persons is shown in Figure 12. Result after performing HOG algorithm is shown in Figure 13. To check the accuracy, we take a student who is not in the database and then test the system on that student, then the system shows output as in Figures 14 and 15.



**Figure 7.** (a) Homepage, (b) faculty homepage, and (c) admin homepage.

S.NO	TESTCASE	INPUT	EXPECTED RESULT	ACTUAL RESULT	PASS/FAIL
1	Attendance Checking		Attendance captured... 5201411055		PASS
2	Attendance Checking		Attendance Captured... 5201411055, 5201411031, 5201411044		PASS
3	Attendance Checking		Student does not exist		PASS

**Figure 8.** These are the results tested under different scenarios.

	A	B	C	D	E	F	G	H	I	J
69	2024-02-23	5211411005	vishnu	A						
70	2024-02-23	5211411002	madhav	A						
71	2024-02-23	5211411046	Manikanta	A						
72	2024-02-23	5211411011	venkataraju	A						
73	2024-02-23	5211411004	john	A						
74	2024-02-23	5211411031	Harj Ganesh	A						
75	2024-02-23	5211411058	Siva Ram	A						
76	2024-02-23	5211411030	Manikanta	A						
77	2024-02-23	5211411016	venkata harsha var	A						
78	2024-02-23	5211411028	Aishwarya	A						
79	2024-02-23	5211411059	manohar	A						
80	2024-02-23	5211411003	Mani krishna	A						
81	2024-02-23	5211411067	Tarun Kumar	A						
82	2024-02-23	5211411009	abhilash	A						
83	2024-02-23	5211411008	sreekar	A						
84	2024-02-23	5211411054	Basheer	A						
85	2024-02-23	5201411055	srinivasa vinay	P						
86	2024-02-23	5201411069	Teja	P						
87	2024-02-23	5201411019	Roopesh	P						

**Figure 9.** Generated Microsoft Excel sheet.



Figure 10. Face recognition of individuals

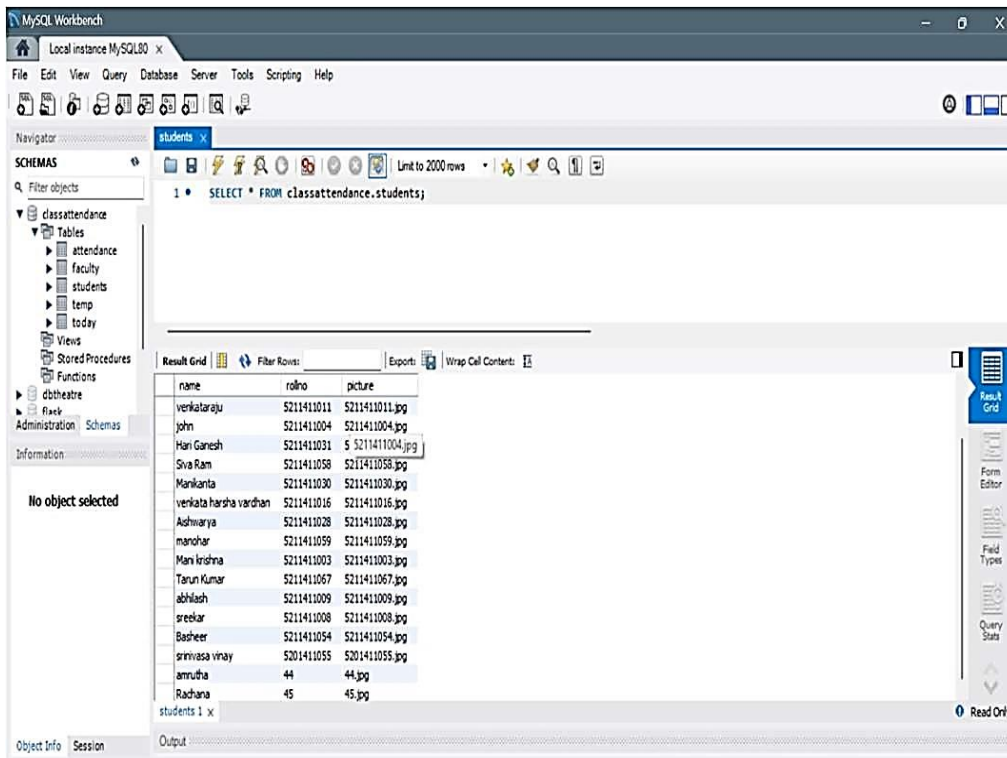


Figure 11. Student data in the database

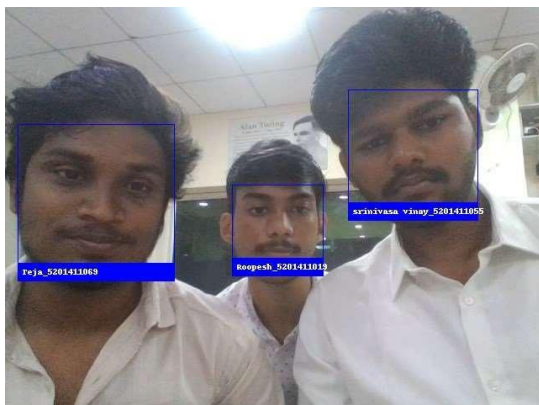


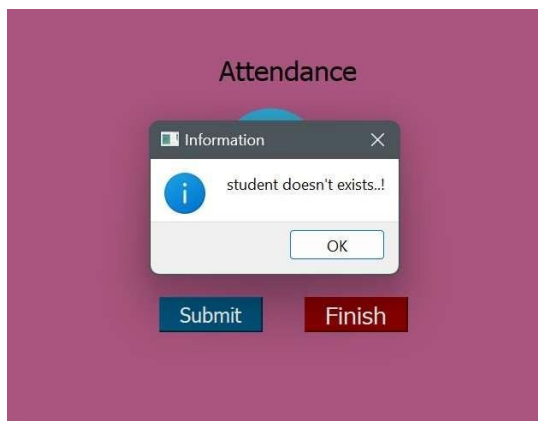
Figure 12. Face recognition of multiple persons.



**Figure 13.** Result after performing histogram of oriented gradients (HOG) algorithm.



**Figure 14.** Student not in the database.



**Figure 15.** Face recognition of student not in the database.

## CONCLUSION

In summary, the outcome of our study is a facial biometrics attendance scheme, which utilizes machine learning algorithms. That way, it overcomes the disadvantages that are inherent in conventional attendance systems, such as slowness, errors, and high spending to maintain them. While advanced face recognition capabilities are provided by algorithms such as convolutional neural networks, they come with huge computational expenses and time. Unlike those systems, ours offers a modest but effective way to follow up on attendance that can be adapted to different situations. In doing this project, we help streamline processes involved in checking students in and out and improve accuracy and reduce workload with little or no use of heavy computation.

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