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Attendance System Using Face Recognition Enhancing Accuracy and Efficiency in Employee or Student Attendance Tracking

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ABSTRACT: The Attendance System Project uses Facial Recognition technology to make the attendance process easier and accurate. The system automatically marks the attendance of students or employee by detecting and recognizing faces through a webcam. The key components of the system include loading known faces, capturing student detail and marking attendance using real-time video processing. The system is designed to be user-friendly with a GUI interface built using Tkinter and it integrates with OpenCV and face_recognition libraries for handling Image Processing.

KEYWORDS: Face Recognition, GUI-based Interface, Real-time video feed, Multi subject support, Face Detection, Attendance log

I. INTRODUCTION

Manual attendance system is widely used in educational institution and workplaces but often suffer from inefficiency, inaccuracies and susceptibility to manipulation. The traditional methods such as Roll calls or physical sign-in sheets are time consuming, prone to human error, and can be manipulated by dishonest practices like proxy attendance. These challenges make it difficult to maintain accurate attendance records, specially in large organizations where monitoring hundreds or thousands of individuals is necessary on a daily basis.

To address these issues the face recognition attendance system has been developed as an automated solution that uses advance face recognition technology to mark attendance in real-time. This project uses OpenCV, face_recognition and Tkinter libraries to create a system capable of detecting faces from live video feed, identifying individuals by comparing facial features against the pre-existing database, and marking their attendance automatically. This system eliminates the need for manual intervention, significantly reducing time consumption and improving accuracy.

II. KEY CONCEPTS

1. Facial Landmark Detection:
This is the process of identifying prominent features of the face (for example, eyes, nose, mouth, etc) which are used to align and normalize the face.

2. Embeddings:
These are high-dimensional numerical vectors that represent a face uniquely in the feature space.

3. Face Alignment:
Before comparison, the face is aligned based on detected landmarks to ensure consistency in the features extraction process.

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4. Comparison Metrics:
The comparison between embedding is often done using the Euclidean distance to determine similarity. The lower the distance, the higher the similarity between the faces.

Diagram:

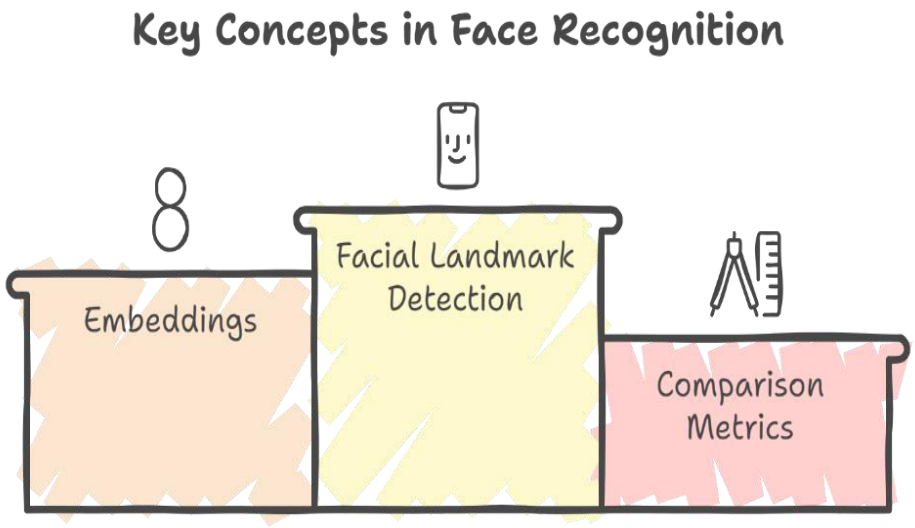

Fig 2.1 Key concepts in face detection

III. METHODOLOGY

1. Experimental Setup:
1.1 Webcam: Captures video frame for processing.
1.2 Haar Cascade Classifier: Used for real-time face detection. Haar-like features are simple rectangular features used to detect patterns in images. They calculate the difference in intensity between adjacent rectangular regions in a detection window.
1.3 Database: Contains known Face Embeddings for comparison and recognition.

2. Procedures Adopted:
The following steps outline the procedure followed in the project:
2.1 Face Detection: The Haar Cascade Classifier detects face in the video stream. This classifier was chosen due to speed and accuracy in real-time recognition.
2.2 Face Alignment: Detected Face are aligned using Facial Landmarks to standardize the position and orientation.
2.3 Embedding Generation: Once aligned, faces are processed through a pre-trained CNN to generate 128- dimensional face Embeddings.
2.4 Database Comparison: The generated embedding is compared to a database of known face embeddings using Euclidean distance. If a match is found (i.e. the distances below a certain threshold), the system identifies the individual.
2.5 Attendance Logging: If a face is recognized, the system logs the individual's name and timestamp in a attendance sheet.

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Diagram:

$$d(A, B) = \sqrt{\sum_{i=1}^{128}(A_i - B_i)^2}$$

Fig 3.1 Euclidean Distance Formula

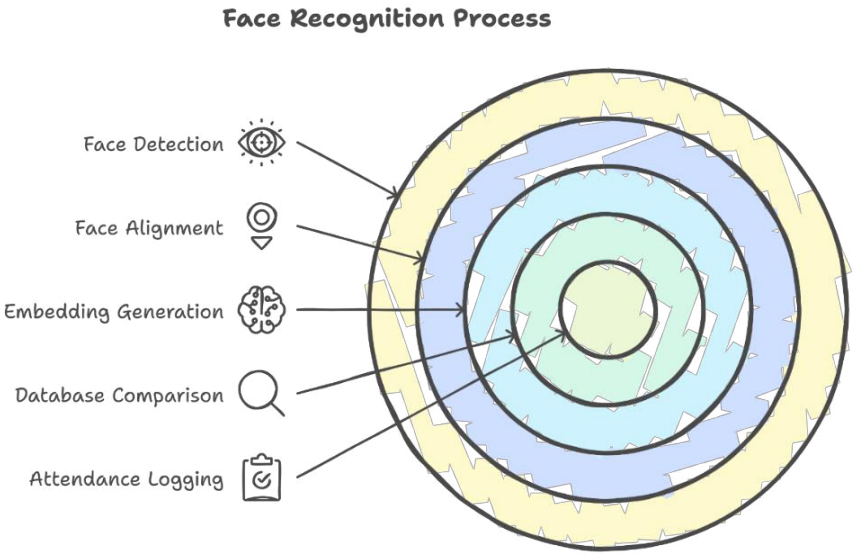

Fig 3.2 Procedure Adopted

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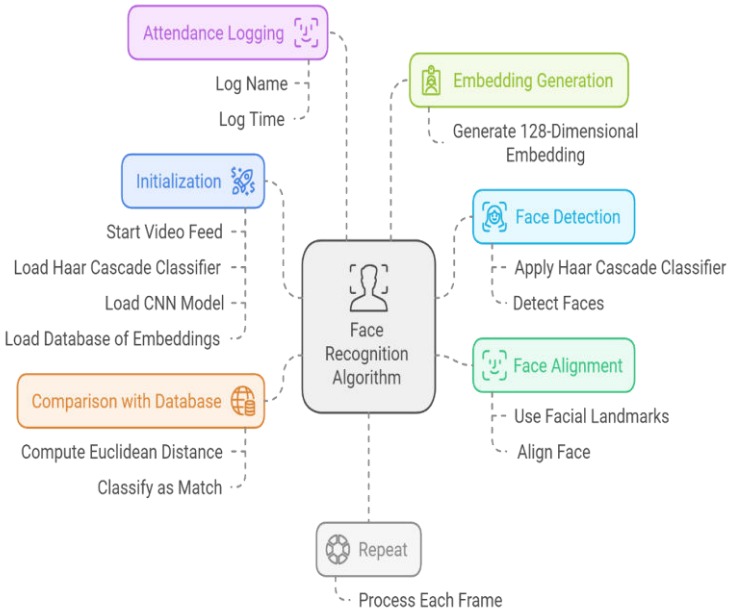

Fig 3.3 Face Recognition Algorithm

IV. RESULTS

The face recognition-based attendance system provided satisfactory performance, achieving high levels of accuracy and efficiency under controlled conditions. This section breaks down the result in terms of recognition accuracy, processing time, and user feedback. The system's process invloves several stages, starting from input data to face detection to mark attendance.

Diagram:

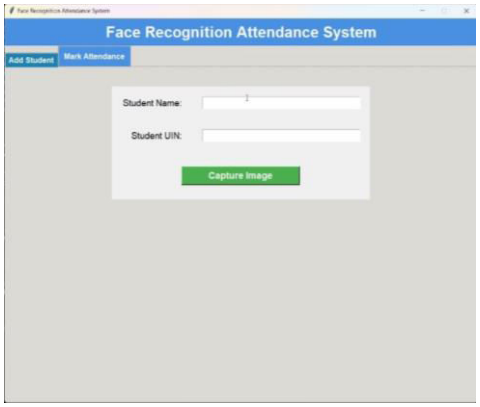

Fig 4.1 Data Input Interface

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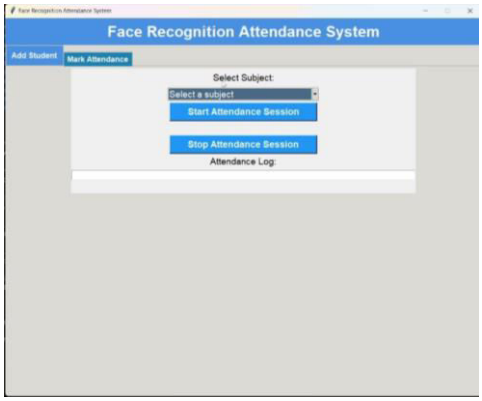


Fig 4.2 Mark Attendance Interface

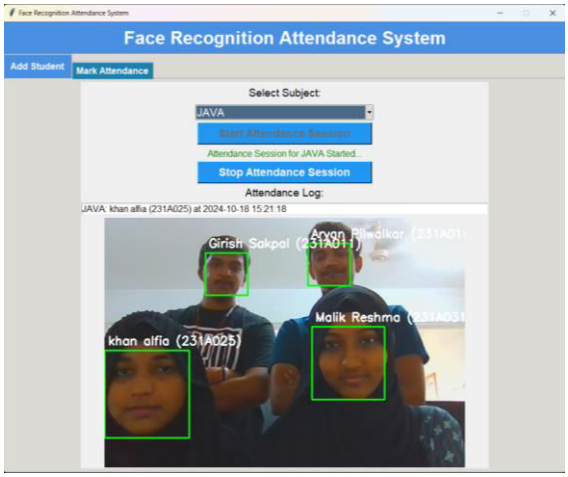
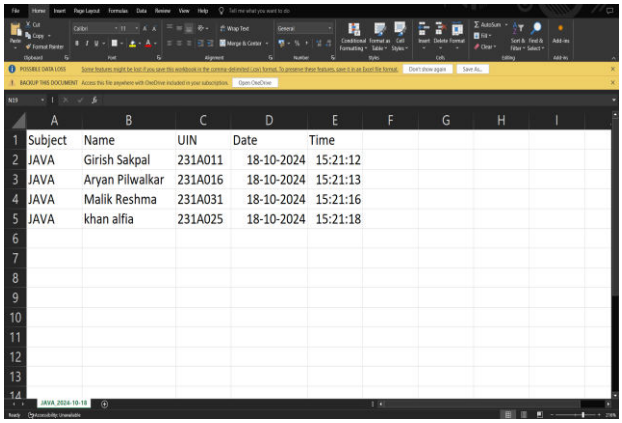


Fig 4.3 Detecting Face



	A	B	C	D	E
1	Subject	Name	UIN	Date	Time
2	JAVA	Girish Sakpal	231A011	18-10-2024	15:21:12
3	JAVA	Aryan Pilwalkar	231A016	18-10-2024	15:21:13
4	JAVA	Malik Reshma	231A031	18-10-2024	15:21:16
5	JAVA	khan alfia	231A025	18-10-2024	15:21:18

Fig 4.4 Attendance saved in excel sheet

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V. CONCLUSION

5.1 Effectiveness of Face Recognition Technology:
Face recognition algorithm proved highly effective under optimal lighting and normal conditions, achieving high recognition accuracy. This validates the suitability of face recognition for attendance systems.

5.2 Real-time Processing Performance:
The system processed attendance in approximately 450 milliseconds per person, confirming its ability. To operation in near real-time. The quick processing time was primarily achieved by optimizing the detection and recognition stages, making it a practical tool for managing attendance efficiently in large classrooms.

5.3 Impact of Environmental Factors:
The analysis revealed that external conditions, such as lightning and face occlusions (e.g., masks), significantly affected the systems performance.
In low lightning, recognition accuracy drops, indicating the need for improve illumination or infrared- based techniques for reliable detection. Face occlusions, particularly the use of face mask, caused a sharp decline in accuracy, which is major limitation in scenarios where masks are mandatory. Implementing more robust algorithm like mask-aware face recognition would address this.

5.4 Multiple Faces and Group Scenarios:
The system demonstrated very high detection accuracy when handling multiple faces simultaneously, confirming that it can process group-based scenarios, which is critical in large classrooms or settings where students are seated closed together.

5.5 Positional Constraints:
The system struggled with non-frontal face angles and distant faces beyond 2 meters, where recognition accuracy dropped by a considerable margin. The limitations suggest that the system is more effective for front facing camera setups requiring students to face the camera directly.

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Authors Profile

Mr. Girish Dayaghan Sakpal is a Second Year Student at Mumbai University, completing his Bachelor of Engineering in Artificial Intelligence and Data Science from Rizvi College of Engineering. His research interests include application of programming and Artificial Intelligence. He has completed courses in various programming languages, which has fueled his passion for applying his knowledge for meaningful projects in the field. With a keen interest in AI and a commitment to using technology for social good, he is currently leading a project on Attendance System using Facial Recognition which aims at improving efficiency in attendance tracking.

Mr. Aryan Prakash Pilwalkar is an enthusiastic Second Year Student specializing in AI and Data Science from Rizvi College of Engineering at Mumbai University. He has a special interest in machine learning and computer vision. He is focused on developing facial recognition attendance system that would aid attendance-capture in various fields. His dedication to the making of technology that works seamlessly and ensuring responsible and ethical use of it, he wants to be a part of the technology innovating that bring's easiness to the routine that includes the social and ethical aspects in their application.

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Ms. Malik Reshma Shafaat is a Second Year Engineering Student pursuing a Bachelor's Degree in Artificial Intelligence and Data Science at Rizvi College of Engineering, Mumbai University. Her area of research includes programming and applications of AI, with a focus on Machine Learning and Computer Vision. Passionate about the moral implications of AI, she seeks to create technology that addresses real-life settings. Currently, she is part of a group developing a facial recognition attendance system to enhance attendance tracking in educational settings. In this project, she played a key role in troubleshooting face recognition errors and took the lead in creating the PowerPoint presentation to showcase their work. She also enhanced her skills in Python and Visual Studio Code and gained valuable insights into the Haar cascade algorithm.

Ms. Alfia Shamsul Khan is an enthusiastic second-year student at Rizvi college or engineering afflicted with mumbai University where she is working towards a bachelor's degree in Artificial Intelligence Data Science. she is interested In computational intelligence and database system,her course work in a python and c programming language is finished.She wants to improve her research in AI tools and AI technology for improving Indian educational system.Her ability to write reports made sure that complicated technical information was communicated clearly which helped the project Face Recognition Attendance system explanation with the successful presentation and evaluation.

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