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AI Automated Attendance Management System

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Abstract: *The smart classroom utilizes automation to streamline tasks such as attendance registration, which traditionally demands considerable time and effort. While methods like identification cards, radio frequency systems, and biometric authentication have been employed, they often encounter challenges related to safety, accuracy, and cost.*
Recent advancements in digital image processing, particularly face recognition technology, offer a promising alternative. This study presents an automated attendance system based on the YOLOv7 algorithm, designed to efficiently detect and recognize multiple student faces simultaneously. Tested on a database of 31 students from Mustansiriyah University, the system achieved up to 100% accuracy, demonstrating its reliability and efficiency in automating classroom attendance.
The proposed system focuses on automatically marking attendance and generating analytical reports. Facial recognition plays a crucial role in uniquely identifying individuals, making it an effective approach for student attendance tracking in classrooms. This method integrates face detection technology to enhance accuracy and efficiency in educational environments.

Keywords: Attendance, Face recognition, HOG, LBPH, MySQL, YOLOv7, CNN

I. INTRODUCTION

Organizations have adopted various methods for Attendance Management Systems (AMS). While some still use traditional manual methods, others have transitioned to biometric techniques. [1] The manual approach can be cumbersome, especially in large classrooms, and calculating attendance percentages manually is time-consuming. Radio Frequency Identification (RFID) offers high efficiency and hands-free access control but is prone to misuse. Biometric systems, such as fingerprint, retina, and voice recognition, provide solutions but have their own limitations.

To address these challenges, the proposed system uses a camera to capture images of students in the classroom [2]. Face detection is then applied to identify and extract faces from the images. These faces are clustered using a clustering algorithm, creating a training database. The system compares the clustered faces with the database, recording attendance for the recognized faces.. If no match is found, new faces are added to the database, improving accuracy over time. This automated system, combining image processing and machine learning techniques, ensures efficient and accurate attendance management, saving time and resolving the issues match with ongoing methods [3].

A comparable problem arises with traditional attendance systems, where administrative staffs supply lecturers with a list of student names for manual attendance marking. This method not only consumes valuable lecture time but also causes inconvenience for both students and lecturers. Errors can occur when students do not hear their names being called, leading to frustration for everyone involved. Furthermore, relying on paper-based attendance systems introduces security risks, as records can easily be lost or stolen.

To overcome the limitations of traditional methods and the challenges posed by RFID and biometric techniques, an automated Attendance Management System (AMS) using face recognition technology is proposed. This system utilizes computer vision and machine learning to streamline and enhance the accuracy of attendance management.

The primary function of the proposed system is to capture images of students in the classroom using a camera. Once the images are captured, the system applies face detection algorithms to identify and extract faces from the scene. Face detection is an essential step in this process, as it isolates individual faces from the background and other non-relevant elements of the image.

After detection, the faces are processed using a clustering algorithm, which groups similar faces together to create a training database. This database is dynamically updated as new faces are detected and added to the system. By clustering faces, the system minimizes errors in face recognition, ensuring that similar-looking faces are correctly classified.

The system then matches the clustered faces with those in the existing database, automatically marking attendance for recognized faces. If a face does not match any in the current database, the system prompts the addition of the new face, further improving the accuracy of the system over time as it learns to recognize more individuals.

This automated face recognition-based attendance system offers several advantages over traditional and biometric methods. First, it significantly reduces the time and effort required to take attendance, as the process is automated and requires minimal manual intervention. Second, it eliminates the possibility of misuse or fraud, as face recognition cannot be easily bypassed.

Overall, the proposed face recognition-based AMS provides a more efficient, reliable, and scalable solution to attendance management. By combining image processing and machine learning techniques, this system addresses the shortcomings of traditional and biometric methods, offering an innovative approach the system continuously improves its accuracy over time through machine learning, adapting to new faces and learning from previous interactions. Lastly, the use of cameras and image processing makes the system more scalable and adaptable to various environments, including large classrooms, conferences, or office spaces that improves both accuracy and user experience.

II. BACKGROUND

Additionally, determining the attendance status of a specific student on a particular date is a labor-intensive process, requiring extensive searches through multiple documents and archives. These challenges have led to the need for an alternative method that ensures safe and efficient attendance tracking without human intervention. Biometric systems have emerged as a solution, using individuals' fingerprints to record attendance.

Title: A Unimodal Face Recognition System for Automated Class Attendance in IoT-Enabled Educational Environments
Author: Paniti Netinant; Nongnapus Akkharasup-Anan
Year: 2023

This study outlines the design and implementation of an IoT-based attendance system utilizing face recognition, specifically tailored for high school environments. The system integrates the OpenCV library, Python programming, and a Raspberry Pi as the core processing unit. The system leverages haar file object detection and classical machine learning algorithms including eigenfaces fisherfaces and local binary pattern histograms. A comprehensive methodology is detailed, including flowcharts depicting each phase of the system's operation. Experimental results are analyzed and presented through plots and screenshots. Challenges encountered during the development process are discussed, as well as the system's potential applications and future enhancements. The system aims to automate attendance tracking, enhance the accuracy and security of attendance records, and support student performance monitoring by recording attendance data directly into Google Sheets.

Additionally, the system is designed to operate seamlessly within a classroom setting, reducing manual intervention and minimizing errors associated with traditional attendance-taking methods. By leveraging IoT technology and face recognition, it offers real-time attendance updates, enabling teachers and administrators to access up-to-date records remotely. The use of Google Sheets for data storage ensures easy integration with other educational tools, facilitating further analysis of attendance patterns and trends.

The scalability of the system allows for easy expansion to accommodate larger schools or multiple institutions. Future developments could include integration with student information systems (SIS) for comprehensive performance tracking, real-time notifications for parents or guardians when a student is absent, and advanced data analytics to predict trends in student attendance and engagement. Moreover, improving the system's face recognition accuracy under varying environmental conditions, such as changes in lighting or camera angles, is another area of ongoing research.Overall, the proposed IoT-based class attendance system not only increases efficiency but also contributes to improving educational outcomes by fostering accountability and providing valuable data insights for academic performance and student well-being

Security is another critical aspect of the system. Since student data is sensitive, the implementation ensures secure storage and transmission of attendance records.

Utilizing Neuroevolution-Designed Face Patches for Enhanced Face Recognition in Attendance Systems with Significant Pose Variations [1]. Facial recognition, a type of artificial intelligence, enables a computer to identify individuals [4].

Widespread availability of cameras, facial recognition technology can now be implemented affordably. The facial recognition process involves two main steps. First, the system detects human faces in an image or video, extracts them, and encloses them in bounding boxes. [5].

The system then compares a person's face with the faces stored in its database to recognize and verify their identity. Automating the attendance tracking process was crucial for addressing the challenges posed by traditional methods. Various alternative approaches have been developed to achieve full automate on[6].

This level of automation significantly reduces administrative workload, minimizes the potential for human error, and enhances the overall accuracy of attendance records. Moreover, it provides a secure and efficient way to store and manage attendance data, ensuring that records are not easily lost or tampered with. As a result, facial recognition-based attendance systems are increasingly being adopted in educational institutions to streamline attendance management. modern facial recognition systems are capable of processing data in real-time, allowing for immediate attendance tracking without disrupting the flow of the class.

Andrea Generosi1 · Thomas Agostinelli1, Smart retrofitting for human factors: a face recognition-based system proposal [2] On the frontiers of pose invariant face recognition: a review [1], Computer vision systems face a significant challenge zin recognizing human faces across varied poses, aiming to match the natural capacity and capability of human perception. For surveillance applications, pose-invariant face recognition (PIFR) offers a significant advancement by tackling the unique challenge of recognizing faces from different angles. Achieving pose-invariant face recognition is crucial in scenarios where the subject may not always face the camera directly, such as in real-world surveillance or security applications. Traditional face recognition systems struggle with this variability, often requiring subjects to be in frontal poses for accurate identification. However, PIFR aims to overcome these limitations by employing advanced algorithms, deep learning techniques, and 3D modeling to analyze facial features consistently.

H s ahmed qasim muhammad shahzad deep method for face matching current advancements [3] [2], Face recognition is a challenging task, particularly in identifying and detecting an individual's identity accurately. Although extensive work has been conducted in the field of pattern recognition, many issues remain unaddressed in the existing literature. In this research, we present a comparative analysis of three well-known face recognition techniques: Principal Component Analysis (PCA) using Eigen faces, The Hidden Markov Model (HMM) combined with Singular Value Decomposition (SVD), and the Artificial Neural Network (ANN) using Gabor filters. These techniques were implemented and evaluated using several metrics, such as the false acceptance rate, false recognition rate, and others.

Rnd application of multimedia video data method to personnel attendance systems [3] indicates that face identification based access methods control systems are primarily used. rely on devices similar to fingerprint scanners for facial data collection and recognition. However, these systems often suffer from low recognition accuracy, leading to frequent issues in personnel attendance tracking. To address this, our study combines multimedia image and video analysis technology, utilizing multi-angle video capture for attendance monitoring. We employ Shumate's method for preliminary video processing and apply histogram equalization to enhance image quality. Additionally, by using a closing operation, discrete points in the skin color regions are connected, resulting in a more complete and enriched facial region. The system is built on this technological framework.

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Intelligent Retrofitting for Human Factors: Proposal for a Face Recognition-Based System [4], today, industries are grappling with the challenges of the 'Fourth Industrial Revolution,' commonly referred to as Industry 4.0. This revolution emphasizes new paradigms in manufacturing, such as flexibility, efficiency, safety, digitalization, big data analytics, and interconnectivity. However, the integration of human factors, despite being a core component, is often overlooked. Two of the most neglected aspects are the customization of the worker's user experience and onboard safety. Additionally, integrating cutting-edge technologies into legacy machinery is a critical issue, as it can significantly impact both the economic and environmental management of these machines by extending their life cycle.

Quality-based Representation for Unconstrained Face Recognition [4] significant advances in face recognition have been made over the last decade, largely due to the development of deep learning methods. However, recognizing faces in uncontrolled environments remains a challenging issue for the scientific community. In these settings, the performance of many deep learning-based methods significantly decreases due to the poor quality of face images.

In this work, we propose using an activation map to represent the quality of information in a face image. Different regions of the face are analyzed to assess their quality, and only the high-quality regions are used for recognition with a given deep face model. For the experimental evaluation, three challenging databases were chosen to simulate unconstrained environments: the Labeled Faces in the Wild Database, the Celebrities in Frontal-Profile in the Wild Database, and the AR Database. Three deep face models were used to test the proposed method on these databases, and in every case, the use of the activation map improved the recognition rates of the original models by a range of 0.3% to 31%.

The experimental results demonstrate that the proposed approach effectively selects face areas with greater discriminative power and sufficient identifying information, while ignoring regions with misleading or irrelevant data.

Smart gate unlocking systems have emerged as a confidentinal and efficient alternative to conventional locking mechanisms. By integrating technologies like face recognition and blink detection, these systems ensure both ease of access and enhanced security. This combination makes unauthorized access difficult, as it goes beyond static image recognition, requiring real-time interaction from the user.

System Overview: The smart door unlocking system uses two key technologies:

Face Recognition: Identifies the authorized user by comparing the captured image of the person's face with a stored database of authorized individuals.

Blink Detection: A secondary security layer, blink detection ensures the system recognizes live individuals, preventing unauthorized access using photos or videos.

Working Process:

Face Detection: When a person stands in front of the door, the system first detects the presence of a face using a camera installed near the door.

Face Recognition: The system compares the detected face with the stored database of authorized users. If a match is found, it proceeds to the next step.

Blink Detection: The system requests the user to blink or looks for natural blinking behavior in the real-time video feed. This step ensures that the detected face is of a live person and not a photo or video.

Face Recognition Algorithm: Typically, algorithms like deep learning models (e.g., Convolutional Neural Networks) are used to identify and verify faces. Pretrained models such as FaceNet or OpenCV’s face recognition can be utilized.

Enhanced Security: Combining face recognition with blink detection adds an additional layer of security, making it harder for attackers to fool the system using static images or video recordings

III. OBJECTIVE OF SYSTEM

- To achieve our goal of developing machine learning model to classify face, we need perform following tasks in the same order as stated.
- To detect the face segment from the video frame.

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- To extract the useful features from the face detected.
- To classify the features in order to recognize the face detected.
- To record the attendance of the identified student.

IV. PROPOSED SYSTEM

Face detection techniques then identify and extract faces from these images, which are clustered using a clustering algorithm. The system creates and updates a training database by matching extracted faces with the database. If a match is found, attendance is marked; if not, new images are added to improve accuracy. This system integrates image processing and machine learning to automate and streamline attendance management, enhancing efficiency and accuracy. A highly accurate automated attendance registration system that combines LBPH (local binary pattern histogram), HOG, and YOLOv7 algorithms.

SYSTEM ARCHITECTURE

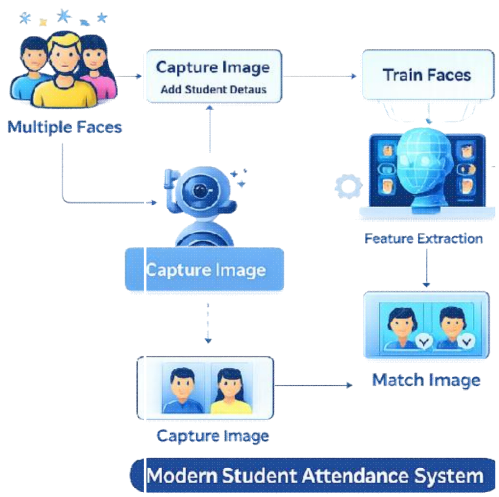

Fig 1. System Architecture

The diagram appears to represent a simple user interface or dashboard for a system.

Admin Login

Here in this module admin can login use system.

Add Students

In this module admin can add students once login at the time of add student add student name, mobile, address and other details also capture real time image using camera

Train Face

Once student faces are captured, the admin must train the system by associating each student's facial image with their corresponding profile in the database. This training process involves the system analyzing and learning the unique facial features of each student, ensuring accurate identification during attendance marking.

Face Matching / Add Attendance

After the system has successfully been trained with student faces, it enters the operational phase where it matches the input faces (from a live webcam feed) with the pre-trained facial data. When a match is found, the system automatically records the student's attendance, eliminating the need for manual input

Multiple Faces:
The system is designed to capture images of multiple students, typically in a classroom setting. The goal is to recognize each individual face from the group of students for attendance purposes.

Camera:
A camera is used to capture images of the students. This camera is essential for taking both group images and individual student images for further processing.

Capture Image:
After the camera captures the images of students, the system requires input of student details, such as their names or IDs, along with the image. This is the registration phase, where the student's facial image is linked to their identity in the system..

Feature Extraction:
The system performs feature extraction after training. Feature extraction focuses on identifying unique facial characteristics such as the shape of the face, distance between eyes, nose, mouth, and other defining facial landmarks. These features are then stored as a set of numerical values, which make each face unique for the system to recognize. This method achieves an accuracy of 97% by using HOG for feature extraction

Match Image:
After the dataset is trained, the system is ready for real-time recognition. When an image is captured in the classroom, it compares (matches) the live image with the previously trained dataset of faces. Recognizes the detected face using a trained CNN.

V. METHODOLOGY

HOG
HOG is Histogram of Oriented Gradients. It is a feature extraction technique commonly used in image processing and computer vision to detect objects by capturing the gradient orientation patterns in localized portions of an image**.**
Gradient Calculation:

$$Gx = I(x+1,y)-I(x-1,y)$$
$$Gy = I(x,y+1)-I(x,y-1)$$

Where Gx and Gy are the gradients in the x and y directions, respectively, and I is the pixel intensity**.**

Gradient Magnitude and Orientation:

$$Magnitude=\sqrt{Gx2 + Gy2}$$
$$Orientation=tan-1\ (Gy/Gx)$$

Histogram Generation: Each cell generates a histogram of orientations, weighted by gradient magnitudes. The resulting HOG descriptor is a vector representing the image in a lower-dimensional space.

LBPH
Local Binary Pattern Histogram (LBPH) is a popular technique for face recognition, especially effective in scenarios where multiple faces need to be recognized.
LBPH captures the local texture information of facial images by comparing each pixel with its neighbors. This helps in highlighting the features that are crucial for distinguishing different faces. LBPH is relatively invariant to lighting

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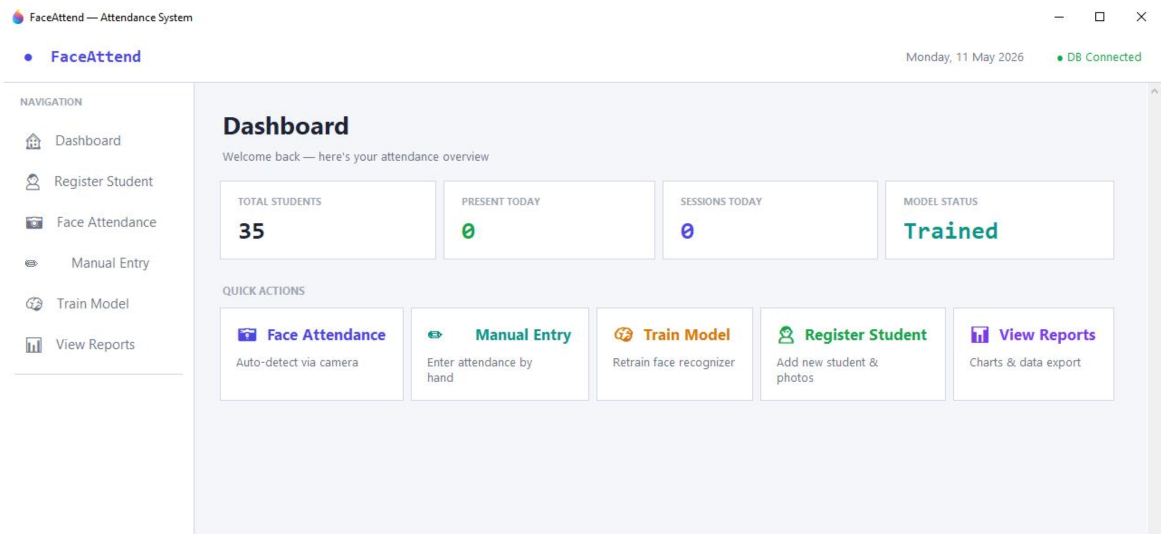
changes, which makes it suitable for recognizing faces under different lighting conditions, an important factor when dealing with multiple faces in varying environments. LBPH is an effective technique for multiple face recognition due to its robustness, efficiency, and ability to capture essential facial features across various conditions.

$$LBP(x, y) = \sum_{i=0}^{7} S(Ii - Ic) \cdot 2i$$

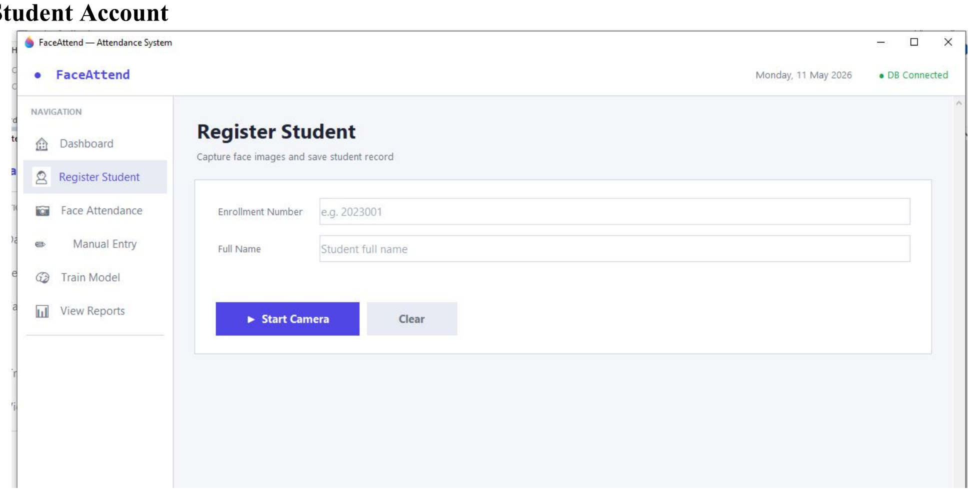
LBP(x, y): This is the Local Binary Pattern value for the pixel at position (x, y).
∑(i=0 to 7): Summation from 0 to 7 because, typically, the LBP compares a pixel to its eight neighbors (in a 3x3 grid around the central pixel).
Ii: Intensity of the i-th neighboring pixel (there are 8 neighbors in total).
Ic: Intensity of the central pixel (the pixel at position (x, y)).
S(Ii - Ic): This is a thresholding function that compares the intensity

.VI. RESULT

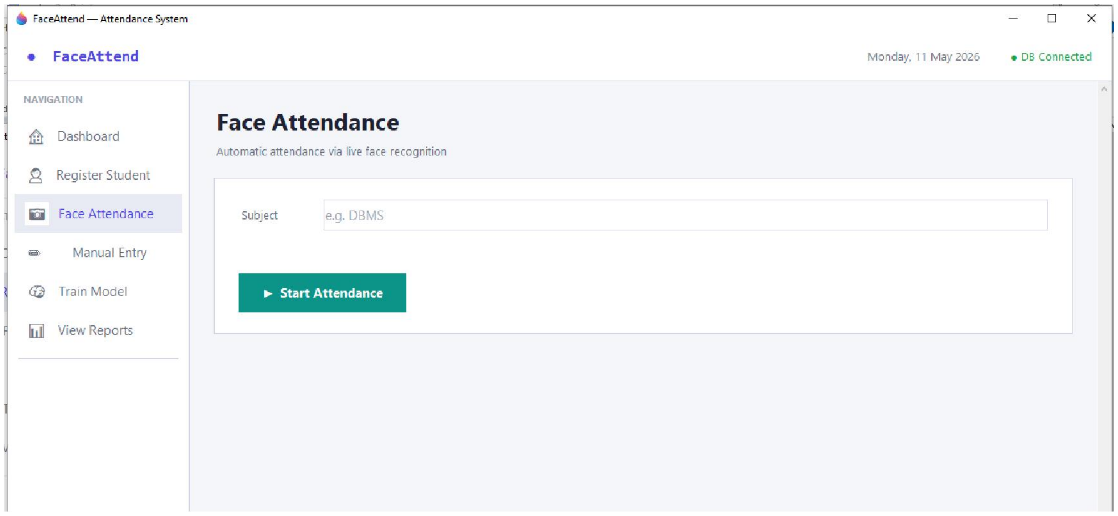
1. Dashboard



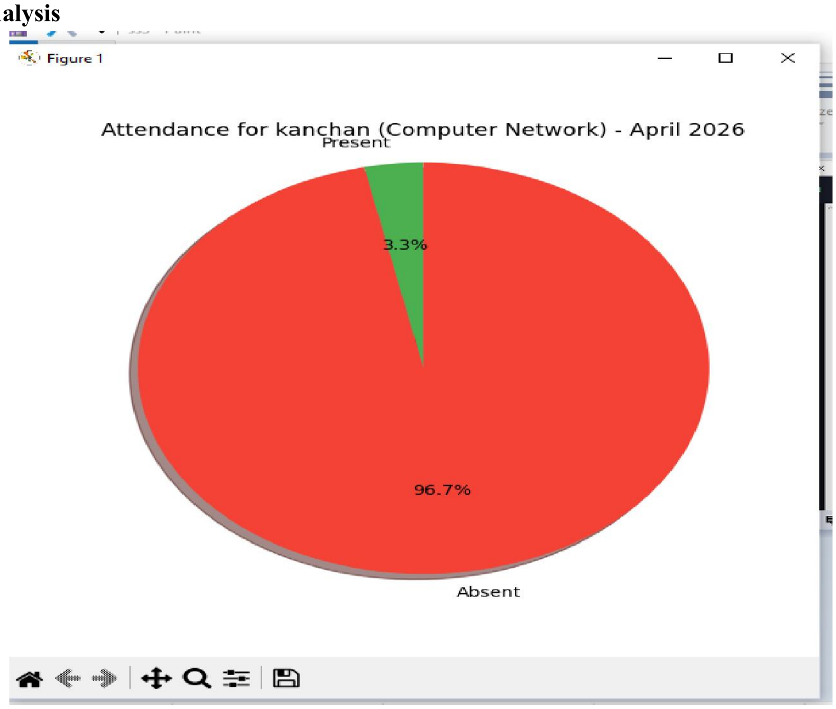
2. Create Student Account



3.Start Face Attendance



4. Attendance Analysis



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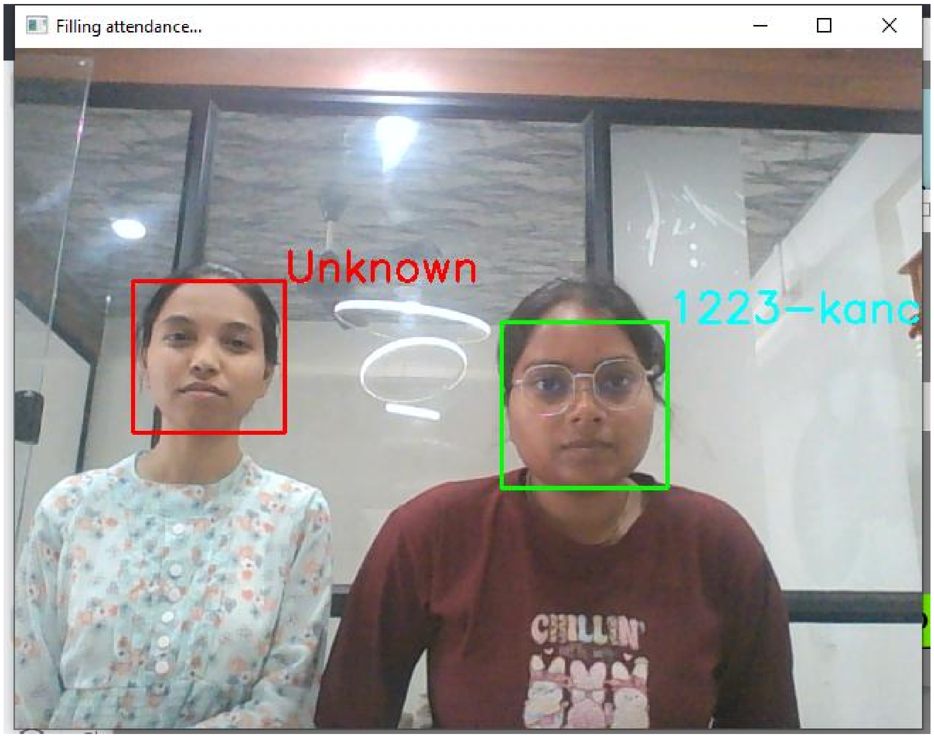
5. Face Matching



VII. CONCLUSION

Face recognition systems are part of facial image processing applications and their significance as a research area are increasing recently. Implementations of system are crime prevention, video surveillance, person verification, and similar security activities. The face recognition system implementation can be part of Universities. Face Recognition Based Attendance System has been envisioned for the purpose of reducing the errors that occur in the traditional (manual) attendance taking system. The aim is to automate and make a system that is useful to the organization such as an institute. The efficient and accurate method of attendance in the office environment that can replace the old manual methods. This method is secure enough, reliable and available for use. Proposed algorithm is capable of detect multiple faces, and performance of system has acceptable good results.

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