AI-Enabled Automatic Attendance Monitoring Systems

GK, Dayananda
Faculty of Electronics & Communication Engineering, Canara Engineering College

Sreerama Samartha JG
Faculty of Electronics & Communication Engineering, Canara Engineering College

M, Vayusutha
Faculty of Electronics & Communication Engineering, Canara Engineering College

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Dayananda GK[1],*, Sreerama Samartha JG[1], Vayusutha M[1]

[1]Faculty of Electronics & Communication Engineering, Canara Engineering College, Mangalore

*Author to whom correspondence should be addressed:
*E-mail: dayanand.gk@gmail.com

Abstract: The proposed facial recognition-based automatic attendance system appears to have a clear workflow. The system recognizes and separates facial regions of interest from video pictures using the Viola-Jones algorithm. The pre-processing stage involves scaling, noise-removal median filtering, and grayscale conversion to improve the image quality. Next comes contrast-limited adaptive histogram equalization. The system uses principal component analysis (PCA) and an expanded local binary pattern (LBP) to extract information from the face photos in order to recognize faces. By lessening the effect of illumination changes, the improved LBP hopes to raise identification rates. The features that were derived from test and training photos are then contrasted. To identify and recognize facial photos, the system combines the upgraded LBP algorithm with PCA, choosing the optimal outcome. When a student is successfully identified, the system logs their presence and saves the data in an Excel file. Furthermore, the technology has the ability to simultaneously recognize every student in a class when used with CCTV cameras with high megapixel counts. It's important to note that the solution presented here concentrates on the technical facets of attendance tracking and facial recognition. Additional factors, like data protection, permission, and ethics, should be considered for an effective deployment.

1. Introduction

In traditional educational settings, the process of manually taking attendance can be time-consuming, inefficient, and prone to errors. To address these challenges and streamline attendance tracking, modern technologies, particularly Machine Learning (ML), have emerged as powerful tools for automating attendance monitoring systems. Automatic Attendance Monitoring Systems using ML leverage advanced algorithms and image processing techniques to identify and verify individuals, transforming the way attendance is managed in educational institutions and beyond.

Machine Learning, a subset of Artificial Intelligence, enables systems to learn and improve from experience without explicit programming. By harnessing the potential of ML, Automatic Attendance Monitoring Systems can accurately and efficiently identify students or individuals present in a given setting, such as a classroom, workplace, or event.

The core technology behind this innovative system is facial recognition. By employing sophisticated ML algorithms like the Viola-Jones algorithm, facial regions of interest can be detected and segmented from images or video streams. This initial step ensures that the system focuses only on the relevant facial features necessary for recognition. The pre-processing phase is crucial to enhance image quality and improve the accuracy of the recognition process. Scaling, noise removal using median filtering, and conversion to grayscale are employed to standardize the images. Contrast-limited adaptive histogram equalization is utilized to further enhance image contrast and visibility, making it easier for the ML algorithms to extract facial features effectively.

For accurate face recognition, the system employs feature extraction techniques such as the extended Local Binary Pattern (LBP) and Principal Component Analysis (PCA). The enhanced LBP significantly reduces the impact of illumination variations, a common challenge in facial recognition systems, leading to improved recognition rates and more reliable attendance records.

During operation, the system uses the features extracted from test images and compares them with those from a database of pre-registered individuals (training images). The ML-powered classification process effectively

matches and recognizes the faces, ensuring a high level of accuracy and precision in attendance marking.

One of the most promising aspects of this system is its potential for scalability. When implemented in settings equipped with high-megapixel CCTV cameras, the system can detect multiple faces simultaneously, making it suitable for monitoring attendance in larger gatherings or events. While the technical aspects of this Automatic Attendance Monitoring System using ML are robust and impressive, it is essential to address non-technical considerations as well. Privacy, consent, and ethical implications associated with facial recognition technology must be carefully managed to ensure compliance with data protection regulations and to build trust among users.

Proposed system frees up valuable time for educators and administrators while providing reliable attendance data. Embracing this technology with responsible implementation opens new avenues for optimizing attendance management and streamlining administrative tasks across diverse sectors. The algorithm proposed in this project can recognize faces belonging to the following. three different background video sequence categories: 1) Moving faces, but unmoving camera, 2) Unmoving faces, but moving camera, and 3) Moving faces, with moving camera

1.1 Literature Survey

The research papers highlight some limitations of alternative attendance systems like the RFID card system, fingerprint system, and iris recognition system. These limitations have led to the proposal of a face recognition system for integration into the student attendance system. Let's discuss the disadvantages of the mentioned systems

RFID [1] card system: The RFID card system is simple to use, but it can be prone to misuse. Users can potentially help their friends check in by using their friend's ID card, leading to inaccurate attendance records. This system lacks a reliable way to ensure that the person presenting the card is the actual cardholder.

Fingerprint system [2]: While fingerprint systems are effective for identification, they can be time-consuming when it comes to the verification process. Users have to wait in line and go through the verification one by one, which can result in delays, especially in large groups. This can be inefficient for capturing attendance in a timely manner.

Iris recognition system [3]: The iris recognition system provides high accuracy due to the rich and unique details in the iris. However, the detailed nature of iris data raises concerns about user privacy. Collecting and storing such detailed information may raise ethical considerations and potential risks associated with the unauthorized use or misuse of personal data.

Voice recognition [4]: Although voice recognition is another biometric modality, it is mentioned that it is less accurate compared to other methods. Voice recognition systems can be affected by ambient noise, variations in speech patterns, or voice imitations, which may lead to false identification or authentication. Face recognition-based attendance management systems have gained significant attention due to their potential to automate and streamline the attendance tracking process [5]. This literature review aims to analyze and synthesize the findings of several scholarly articles and research papers related to the application of face recognition in attendance management systems.

Santhose, et al research focuses on the psychological impact of maintaining an attendance system using machine learning behavior on employee productivity. The study sheds light on the broader implications of machine learning-based attendance systems in enhancing psychological aspects of employee productivity [6]. Haq, et al study explores the application of iris detection using machine learning for attendance monitoring in educational institutes, particularly amidst the challenges posed by the pandemic. The research highlights the use of machine learning techniques for ensuring secure and efficient attendance monitoring in educational settings [7].

Sharmila, et al research delves into the development of an automatic attendance system based on face recognition using machine learning. The study contributes to the practical implementation of machine learning-based face recognition in attendance systems [8]. Dang, et al focuses on the development of a smart attendance system leveraging improved facial recognition techniques. The study explores the advancements in facial recognition technology and its application in smart attendance systems, emphasizing the role of machine learning in enhancing accuracy and reliability [9].

Joseph Jomon et al study highlights the development of an automated attendance management system based on face recognition technology. The research contributes to the practical implementation and implications of face recognition in attendance tracking [10]. Naeem Mohamad et al explores the role of face recognition as a tool for automated attendance systems. The study provides insights into the integration of face recognition within automated attendance management. [11] Muthu Kalyani.K et al delves into the development of a smart application for attendance management using face recognition. The research contributes to the practical implementation of face recognition technology in attendance systems. [12] Given these considerations, the proposed integration of a face recognition system aims to address some of the limitations of the aforementioned systems. Facial recognition offers simplicity, as the human face is always visible and requires less specific information compared to
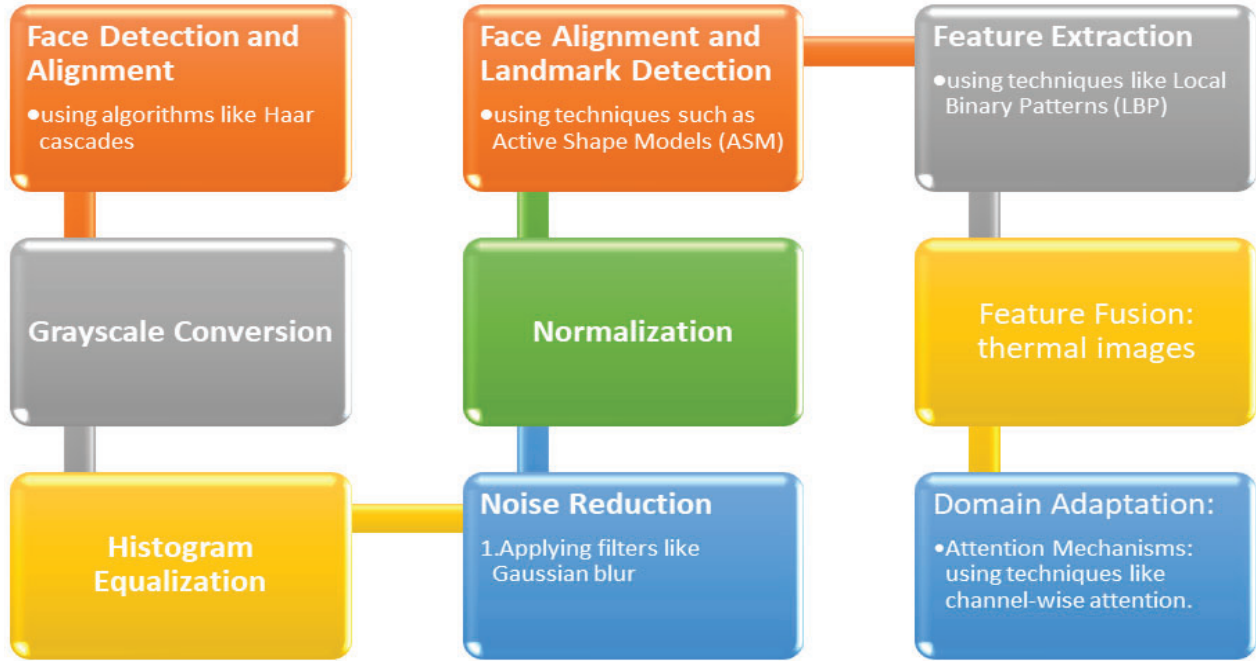
Fig 1.: Preprocessing techniques for improving the quality of images before analysis

other biometric modalities. However, it is important to ensure that privacy concerns and ethical considerations are adequately addressed when implementing any biometric system, including face recognition.

2. Methodology

Our approach involves evaluating student attendance using a single image captured in the classroom by a smartphone or a camera installed in the room. The captured image is then processed by a recognition system, potentially integrated within the college internal gateway. This system is tasked with detecting, aligning, and verifying the presence or absence of students, following the pipeline depicted in Fig. 1. Additionally, we consider three potential setups for the image capturing device to determine the most reliable approach while maintaining a cost-effective implementation. Figure 2. Preprocessing techniques for improving the quality of images before analysis

2.1 Face detection

Face detection focuses on identifying and localizing the presence of a face within an image or video, while face recognition goes a step further to identify the specific individual or match a face against a database of known faces[5-6].Among these methods, the Viola-Jones algorithm[13] is highlighted as a fast, robust, and efficient approach that provides a high recognition rate. It is particularly advantageous under different lighting conditions. The algorithm's ability to handle illumination, scaling, and rotation contributes to its effectiveness as shown in Fig. 2. Additionally, it is mentioned that the

Viola-Jones algorithm outperforms other algorithms such as AdaBoost, Float Boost, Neural Networks, S-AdaBoost, Support Vector Machines (SVM), and Bayes classifier in terms of efficiency [14].

Haar-like features are calculated using the integral image. For example, a simple Haar-like feature could be the difference between the sum of pixels in two adjacent rectangular regions:

$$\text{Haar-like feature} = \sum(\text{pixels in white region}) - \sum(\text{pixels in black region})$$

Adaboost Weight Update The weight of a misclassified sample is increased exponentially:

$$w_i^{(t+1)} = w_i^{(t)} \times e^{(\alpha^{(t)})} \qquad (2.1)$$

Where $w_i^{(t)}$: in equation (2.1) is the Weight of the ith training sample at iteration t. $\alpha^{(t)}$ is Weight of the weak classifier at iteration t. e is Euler's number (approximately 2.71828). The weight of a misclassified sample is increased exponentially by $e^{\alpha(t)}$, while the weight of a correctly classified sample is decreased by $e^{-\alpha(t)}$.

The weight of a correctly classified sample is decreased as shown in equation (2.2):

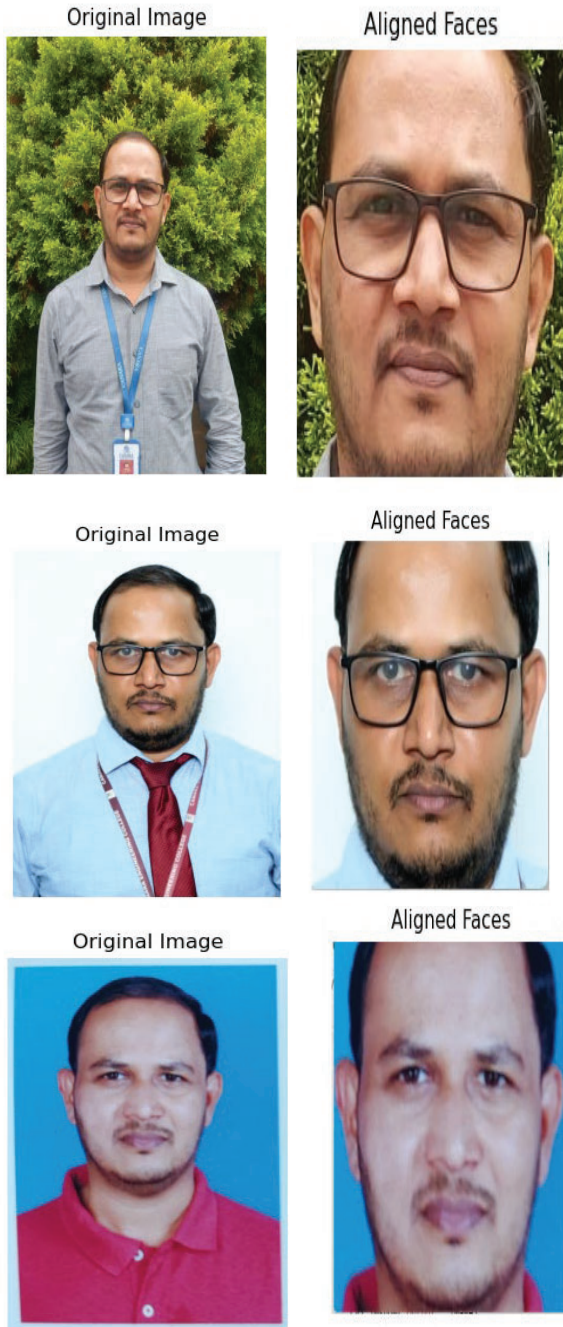$$w_i^{(t+1)} = w_i^{(t)} \times e^{-\alpha^{(t)}} \qquad (2.2)$$

Fig. 2.: Generated Face using Alignment image Viola-Jones

classifier using Adaboost. The cascade structure helps to reduce the number of false positives efficiently.

2.2 Pre-Processing

Preprocessing steps, such as scaling, are crucial for manipulating the size of images and improving the overall accuracy of face recognition[16-17]. Few key points to consider are as follows:
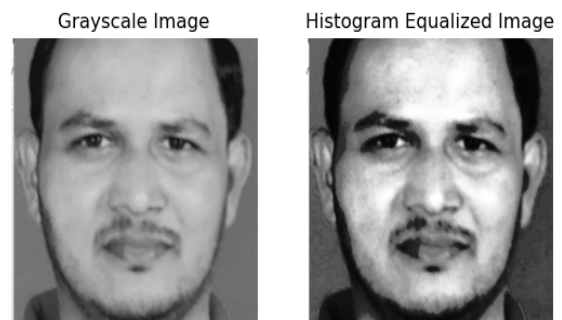
Scaling: Scaling refers to adjusting the size of an image. Resizing an image can have several benefits Spatial information in an image refers to the smallest detectable detail or the level of detail present in the image.

In face recognition, converting images to grayscale is a common preprocessing step. Grayscale images contain only shades of gray simplify image processing while retaining important facial features as shown in Fig. 3. Histogram equalization is a technique used to enhance the contrast and brightness of an image by redistributing pixel intensities. The noise reduction techniques help improve the quality of facial images by removing unwanted noise or distortions that may affect the accuracy of the recognition process. applying Gaussian blur can help smooth out noise and small details in facial images, making them more robust to variations in lighting conditions, facial expressions, and pose.

Normalization and standardization: To ensure consistent and comparable results, it is important to normalize and standardize the size of all images in the dataset. By applying scaling and maintaining the spatial information while normalizing the image sizes, preprocessing techniques contribute to improving the accuracy and reliability of face recognition systems recognition system.

2.3 Face landmark detection

Face landmark detection is a computer vision technique used to locate and identify key points on a human face, such as the corners of the eyes, the tip of the nose, and the corners of the mouth. These key points, often referred to as facial landmarks. They are crucial for various applications, including face recognition, facial expression analysis, and facial feature tracking as shown in Fig. 4.

Adaboost Strong Classifier is the final strong classifier $H(x)$ is a weighted sum of weak classifiers as shown in equation (2.3):

$$H(x) = \text{sign}\left(\sum_{t=1}^{T} \alpha^{(t)} h^{(t)}(x)\right) \qquad (2.3)$$

Where $h^{(t)}(x)$ is Output of the tth weak classifier for input x. Cascade Classifier Each stage of the cascade consists of multiple weak classifiers. - The output of each stage is determined by a threshold to minimize false positives.

This algorithm is implemented iteratively, training one weak classifier at a time and combining them into a strong
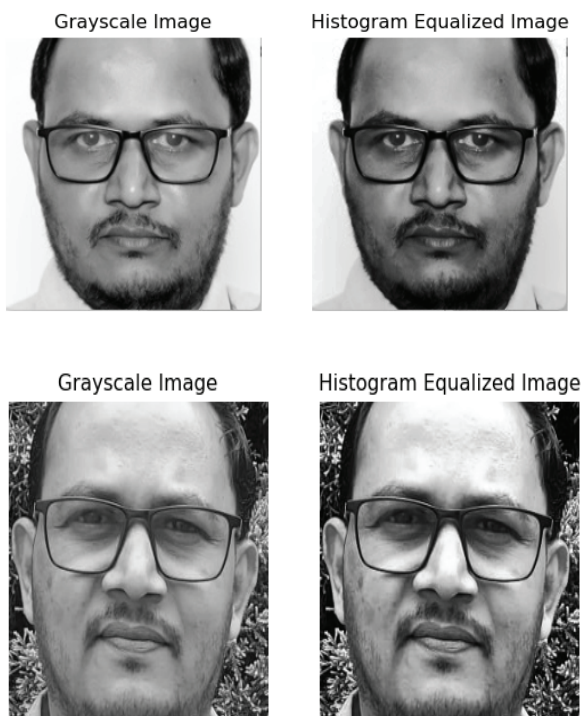
Fig. 3: Pre-Processing techniques applied for aligned face image.

Active Shape Models (ASMs) are a class of statistical models commonly used for face landmark detection. The shape model in an ASM represents the spatial configuration of facial landmarks. It consists of a set of landmark points and their corresponding spatial relationships, often represented as a point distribution model (PDM). The shape model captures the average shape of facial landmarks and the variations observed in the training data.

Let S_i represent the ith landmark point in the shape model, where $i = 1,2 \dots N$ and N is the total number of landmark points.

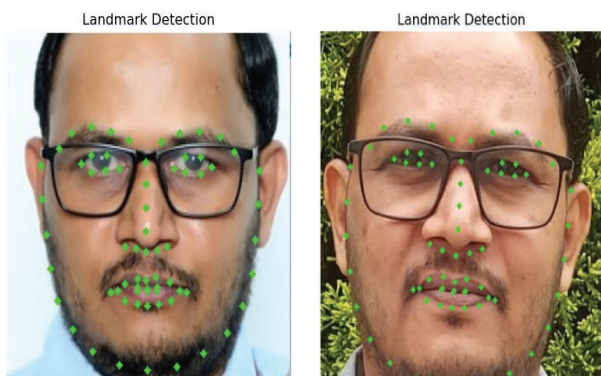The mean shape is computed as the average of all annotated landmark positions:

$$\bar{S} = \frac{1}{M}\sum_{j=1}^{M} s_j \qquad (2.4)$$

Where M is the total number of training samples. During the detection phase, the shape model is deformed based on the linear combination of principal components:

$$S = \bar{S} + \sum_{i=1}^{k} s_i v_i \qquad (2.5)$$

Where S_i are the coefficients of the principal components.

The appearance model captures the pixel intensity variations around each landmark point. It consists of texture templates extracted from the training images, aligned with the corresponding landmark points. The appearance model represents the variations in facial texture and illumination observed in the training data.

Let T_i represent the texture template around the ith landmark point in the appearance model, where $i = 1,2 \dots, N$ and N is the total number of landmark points. During the detection phase, the appearance model is deformed based on the linear combination of principal components:

$$T = \bar{T} + \sum_{i=1}^{k} a_i a_j \qquad (2.6)$$

Where a_i are the coefficients of principal components.

2.4 Feature Extraction

Particularly focusing on the Principal Component Analysis (PCA) algorithm[18]. Feature extraction plays a critical role in face recognition systems as it captures the essential characteristics of a face that can be used for identification. One popular technique for feature extraction in facial recognition is Local Binary Patterns (LBP). LBP is a texture descriptor that captures local patterns and textures in an image. It operates by comparing each pixel in an image with its neighboring pixels. It encodes the relationship between the intensity of a central pixel and the intensity of its neighbors into a binary pattern as shown in Fig. 5.
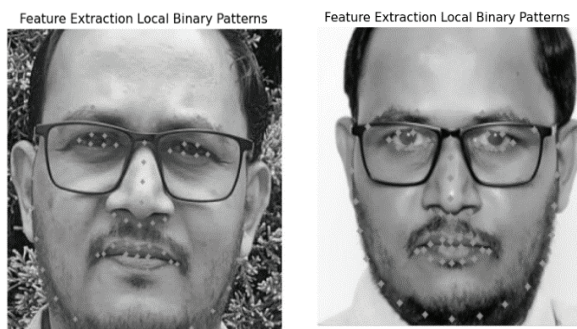

Fig 4: Landmark detected in facial image.

Fig 5: Feature extraction in facial recognition is done using Local Binary Patterns

Let $I(x_c, y_c)$ denote the intensity value of the central pixel at coordinates (x_c, y_c) in the image. Compare the intensity value of the central pixel $I(x_c, y_c)$ with the intensity values of its neighboring pixels in a circular neighborhood of radius R. Let P denote the number of neighboring pixels. The binary comparison result for each neighboring pixel (x_c, y_c) is shown in equation (2.7).

$$s_p = \begin{cases} 1, & \text{if } I(x_p, y_p) \geq I(x_c, y_c) \\ 0, & \text{otherwise} \end{cases} \qquad (2.7)$$

Encode the binary comparison results into a single binary pattern. Starting from a reference pixel, create a binary number by concatenating the binary comparison results in clockwise order around the circular neighborhood. The resulting binary pattern represents the local texture information around the central pixel. Convert the binary pattern to a decimal value to obtain the final Local Binary Pattern (LBP) value. the LBP value for a central pixel (x_c, y_c) in an image with P neighboring pixels is:

$$LBP(x_c, y_c) = \sum_{p=0}^{P-1} s_p \times 2^p \qquad (2.8)$$

Where: s_p in equation (2.8) is the binary comparison result for the pth neighboring pixel. P is the number of neighboring pixels in the circular neighborhood. $LBP(x_c, y_c)$ is the Local Binary Pattern value for the central pixel (x_c, y_c).

2.5 Enhanced Facial Recognition

Integrated Approaches for Enhanced Facial Recognition refers to a comprehensive strategy aimed at improving the accuracy and robustness of facial recognition systems by combining multiple advanced techniques.

2.5.1 Feature Fusion with Thermal Imaging

Thermal imaging involves capturing images based on the heat emitted by objects, including human faces. Feature fusion refers to the integration of information from multiple sources or modalities to enhance the overall understanding or representation of the data. By fusing features extracted from both types of images, the facial recognition system can leverage additional information about the thermal characteristics of faces, which beneficial in challenging conditions such as low light or variations in illumination as shown in Fig. 6.

2.5.2 Attention Mechanisms using Channel-wise Attention

Attention mechanisms are computational mechanisms that enable models to focus on specific regions or features of input data that are deemed most relevant for the task at hand. Channel-wise attention specifically focuses on

different channels or feature maps in neural networks, allowing the model to selectively attend to important features while suppressing irrelevant ones.
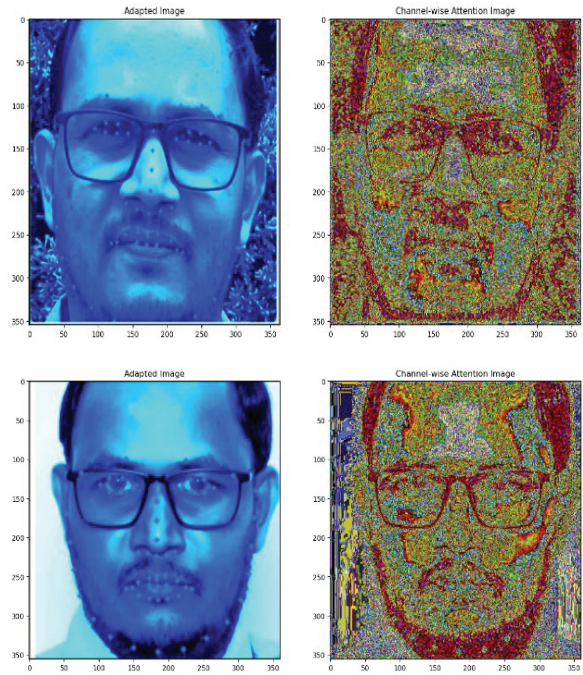

Fig. 6: Enhanced Facial Recognition using Thermal Imaging and Channel-wise Attention method

By incorporating attention mechanisms into the facial recognition system, the model can dynamically adapt its focus to different facial features or regions, improving its ability to capture discriminative information for recognition.

2.6 Evaluation

Evaluating a face recognition system on diverse databases is crucial for assessing its robustness and generalization capabilities across various real-world conditions. Let's summarize the key points mentioned:

2.6.1 Database selection

Previous researchers have utilized different databases that include variations in conditions such as illumination, expression, and pose. These diverse databases help justify the performance of the system and enable studying its behavior under different scenarios. Additionally, mention that project also uses own database for analyzing the system in a real-time application. This approach allows for a more comprehensive evaluation and validation of the system's performance.

2.6.2 Performance metric

The most common method used to evaluate the system's performance, as mentioned in the literature review, is recognition accuracy. Recognition accuracy indicates the percentage of correctly identified individuals in relation to

the total number of face recognition attempts. It provides a quantitative measure of the system's ability to correctly recognize individuals.

It's great that gathered information about various works related to this project. Literature reviews help provide a foundation of existing knowledge and approaches in the field, allowing to build upon previous research and identify the gaps that this project aims to address.

In the next chapter, as mentioned, discussing the overall concept for the implementation of face recognition will provide a solid framework for understanding how the system will be developed and deployed. This section can include details about the hardware setup, software components, system architecture, and any additional considerations required for successful implementation.

By integrating insights from previous works, defining the implementation concept, and leveraging appropriate evaluation databases, are establishing a strong foundation for the development of face recognition system.

3. System Design

3.1 OpenCV

OpenCV (Open-Source Computer Vision Library) and its capabilities. OpenCV is indeed a powerful and widely-used cross-platform library that enables the development of real-time computer vision applications and machine learning software.

OpenCV's extensive set of algorithms and functions, combined with its broad user base and cross-platform support, make it a valuable tool for developing computer vision applications and machine learning systems. Working on research, industry projects, or government applications, OpenCV provides a robust foundation for implementing a wide range of computer vision tasks.

3.2 IDLE

Python's Integrated Development and Learning Environment. IDLE provides a convenient environment for developing and running Python code. Here are some key points to highlight about IDLE:

3.3 Convolutional Neural Network

Convolutional Neural Networks (CNNs)[22-26] are a specialized type of artificial neural network designed primarily for image processing and computer vision tasks. They are inspired by the visual processing mechanism of the human brain and have been instrumental in achieving significant breakthroughs in various image-related tasks, such as image classification, object detection, segmentation, and more. The convolutional layer, sample layer, and output layer Fig.7 graphical representation of CNN Architecture
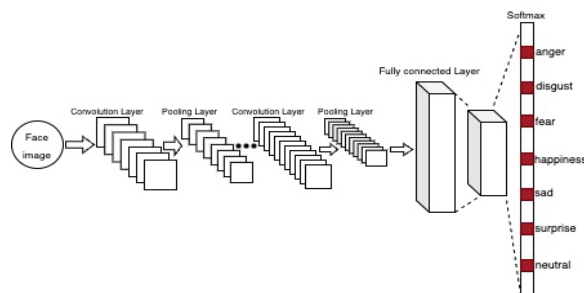

Fig.7: CNN Architecture

3.4. CNN layers

The key components and operations that make CNNs unique and powerful include:

3.4.1 Convolutional Layers:

The fundamental building blocks of CNNs are convolutional layers. These layers apply filters (also known as kernels) to the input image to detect specific patterns or features. By sliding these filters across the image and performing element-wise multiplication and summation, feature maps are generated, highlighting important patterns like edges, corners, and textures.

3.4.2 Activation Function:

After each convolution operation, an activation function, typically ReLU (Rectified Linear

Unit), is applied element-wise to introduce non-linearity into the network. This non-linearity enables the CNN to model complex relationships between image features effectively.

3.4.3 Pooling Layers:

Pooling layers help reduce the spatial dimensions of the feature maps while retaining essential information. Max pooling is a common technique used in CNNs, where the maximum value within a small region
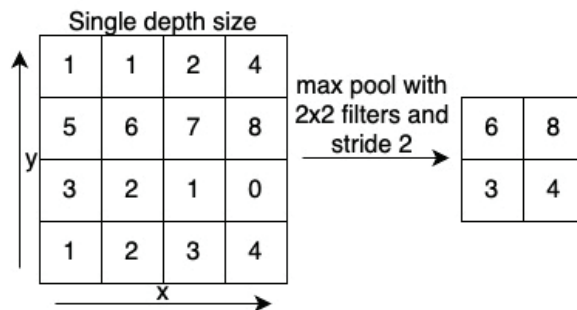

Fig. 8: Pooling Layer

(e.g., 2x2 window) is selected, and the rest is discarded. This down sampling process reduces computational complexity and makes the network more robust to variations in input positions as shown in Fig. (8).

3.4.4 Fully Connected Layers:

After several convolutional and pooling layers, the high-level features are flattened and fed into one or more fully connected layers, which act as a traditional neural network to perform classification or regression tasks.

4. Implementation

The system uses facial recognition, where each student in the class is photographed and their data is stored on a server. The system recognizes the faces and verifies the presence or absence of each student. Through comparisons, the system finds out the representative person in the crowd. All these results are stored in a file, distinguishing between the real person and the unknown person. The implementation of the project work is explained as shown in Fig. 9

The face recognition process involves multiple steps that aim to detect and recognize human faces in images or video frames.

Face Detection: The first step is to detect the presence and location of faces in the input image or video frame. Viola-Jones algorithm used for this process. The output of this step is a set of bounding boxes around the detected faces.

Preprocessing: Once the faces are detected, the next step involves preprocessing the face regions to standardize them for further processing.

Feature Extraction: The key to face recognition is extracting informative and discriminative features from the preprocessed face images.

Feature Representation: The extracted features are transformed into a more compact and meaningful representation to facilitate efficient comparison and matching.
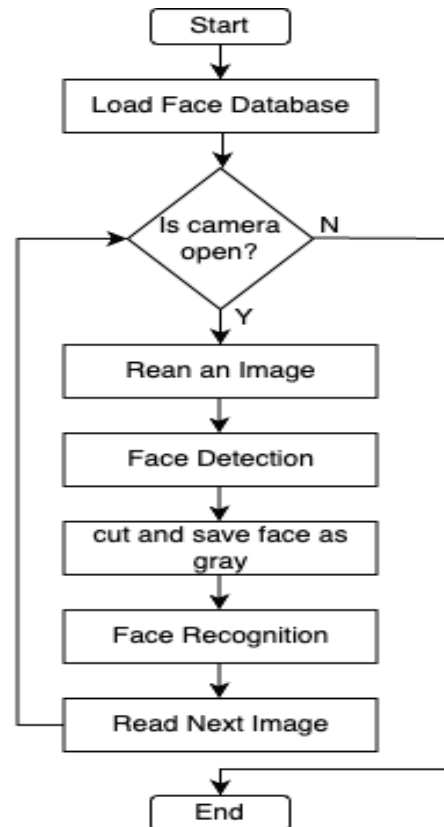

Fig. 9: Design Flow

Face Recognition Model: A face recognition model is trained using the transformed feature representations from known individuals (training data).
The model learns to associate the extracted features with specific individuals, effectively creating a face database with known identities.

Recognition and Matching: During the recognition phase, the preprocessed face images from the input data are passed through the trained face recognition model.
Post-processing and Decision Making: Depending on the application and use case, post-processing steps can be applied to improve the recognition results.

4.2 SOFTWARE IMPLEMENTATION

Four essential phases of the face detection process using the Viola-Jones algorithm
Integral Image: The integral image is a key concept introduced in the Viola-Jones algorithm to speed up the computation of rectangular features.
It is a two-dimensional array that stores the cumulative sum of pixel intensities of the original image from the top-left corner to each pixel location.
Haar-like Features: Haar-like features are simple rectangular filters used to capture local image patterns that represent facial features, such as edges, lines, and contrasts. These features are applied to the integral image

to efficiently compute the sum of pixel intensities within the corresponding rectangular regions.

AdaBoost (Adaptive Boosting): AdaBoost is a machine learning algorithm used to select the most relevant Haar-like features for face detection. During the training phase, AdaBoost assigns weights to training samples and iteratively focuses on misclassified samples to improve their detection accuracy.

Cascading Classifier: The cascading classifier is a crucial concept to optimize the face detection process and reduce computation time. It organizes the Haar-like features into stages, where each stage contains multiple weak classifiers. The classifiers are arranged in a cascaded manner, and the input image goes through these stages sequentially. The combination of these four phases makes the Viola-Jones face detection algorithm highly efficient and well-suited for real-time applications. By exploiting the integral image and using Haar-like features within a cascading AdaBoost framework, the algorithm achieves both accuracy and speed, making it a popular choice in various face detection systems.

4.2.1   Export data into excel sheet

If the input image and already stored images are matched for those students. This data will be exported in excel sheet details of attendance will be marked with time and date. If any of the student's name is not stored in excel sheet it shows that he is absent in the class

5.   Result and analysis

The proposed system will effectively be monitoring attendance of the students for classes using face recognition techniques. The system will be able to mark attendance by facial recognition. It detects faces using a webcam and then recognizes the faces. Then it displays the enrollment number and name of the recognized
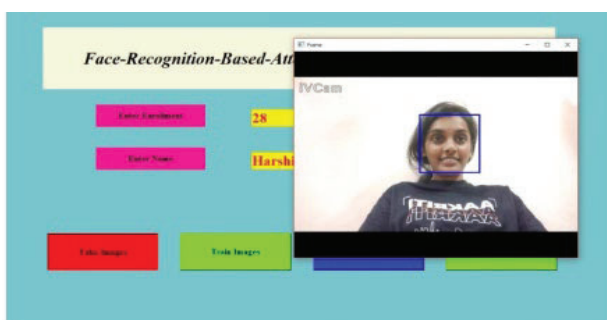

Fig 10: Student registration process-screen shot 1

students along with the date and time and stores the attendance as shown in Fig. 10.

The Figure 11 shows that the registration process of the individual student. Here students USN number and name of the students are require for the process. After filling the information of student, he should click on the take
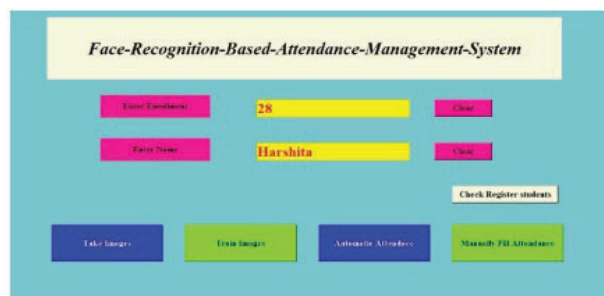

Fig 11: Student registration process-screen shot 2

image icon as shown in Fig. 11. Then the camera will be opened and capture the random photos of the student as shown in Fig. 12. Around 200 different angled pictures are stored in database within 30sec.
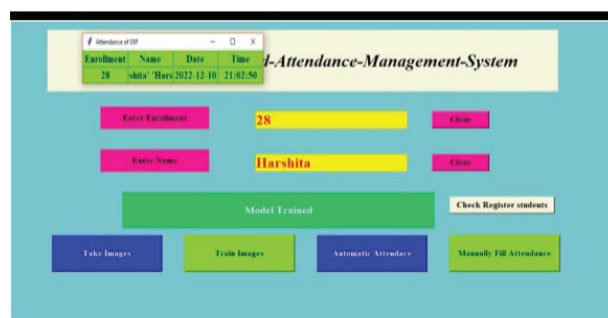

Fig 12: image recognition window

Fig. 12 and Fig. 13 shows the training images and recognition of images using the Viola-Jones method. When particular subject lecturer enters the class, he will click on the subject attendance icon than the separate slide will be opened where we have to enter the subject name and after clicking on fill attendance the camera will be opened in order to take whole class picture at a time as shown in Fig. 14.

Fig 13: Testing recognition using video frame
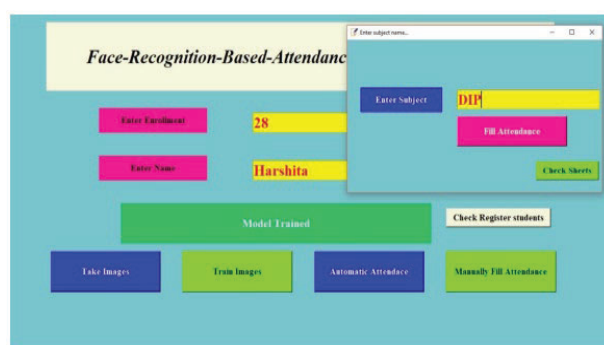
It is described the workflow of the proposed face recognition-based automatic attendance system for students. Let's summarize the key points:

Face Recognition and Attendance: The system matches the faces of students present in the class with the images stored in the database as shown in Fig. 11. If a match is found, the system marks the presence of the student in the

Excel spreadsheet, along with the corresponding date and time. If a student's name is not found in the spreadsheet, it indicates their absence from the class.

Comparison with Training Images: The system uses face recognition techniques to compare the input image captured from the video recording with the training images stored in the database shown in Fig. 11. By comparing the facial features, it determines if the face belongs to a known student.

Face Detection and Localization: The proposed approach includes a mechanism to locate and identify faces within the input image obtained from the video recording. This step is crucial for isolating and extracting the facial region for further analysis.

Pre-processing for Image Enhancement: The system incorporates a pre-processing phase to improve image quality and enhance the contrast. This helps to reduce the negative effects of illumination variations and optimize the input images for accurate face recognition.

By combining these elements, the proposed approach enables the identification and attendance tracking of students using face recognition. It provides a systematic and automated method for processing video images, comparing them with training images, and marking attendance in an Excel spreadsheet.

Fig. 14: Faculty entering attendance subject wise

This detailed description showcases the key components and functionality of the face recognition-
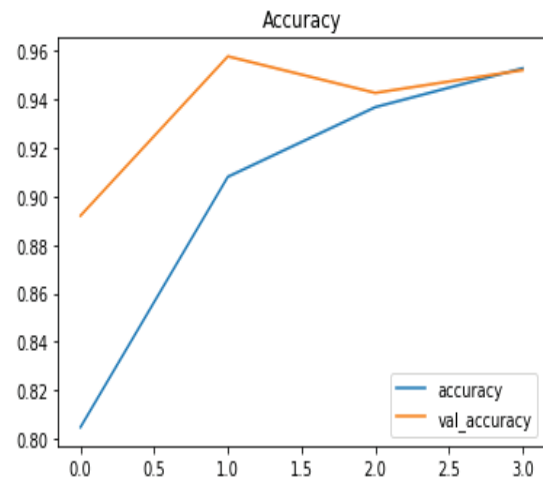

Fig. 15: Training and accuracy

based automatic attendance system, emphasizing its ability to recognize individuals and improve image quality through pre-processing techniques.
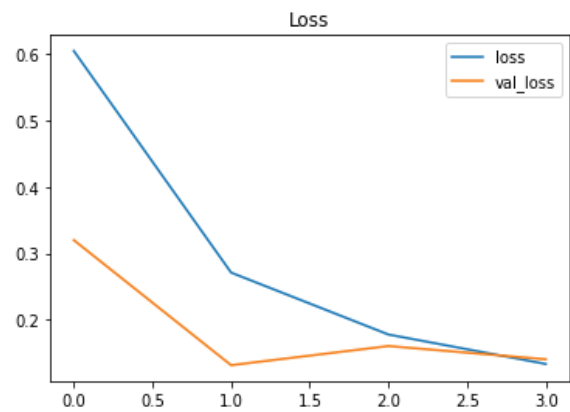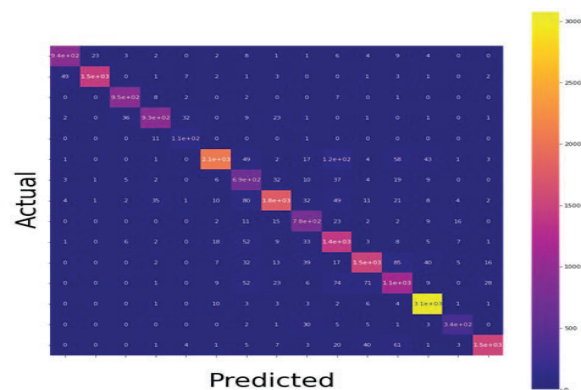

Fig. 16: Training and loss

Fig. 17: Confusion matrix for face recognition.

Table1. Confusion matrix Actual v/s Predicted value(P*-Person)

ACTUAL							
P1	**88.3**	7.3	0	2.5	1.9	0	0
P2	3.1	**95.8**	0	1.1	0	0	0
P3	0	0	**92.3**	1.5	2.5	1.4	2.3
P4	8.3	1.2	1.2	**88.7**	0.6	0	0
P5	0	3.4	2.1	1.1	**91.2**	2.2	0
P6	2.3	0	0	1.6	2	**94.1**	1.2
P7	5.1	2.1	1.1	0.5	0	0	**91.2**
	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**

PREDICTED

Figure 17 and Table 1 shows Confusion matrix of Actual v/s Predicted value. After 100 training epochs, the proposed model achieves an accuracy of 92.66% as shown in Fig. 15. Interestingly, both the proposed method and Test Model-1 exhibit a similar accuracy of 95.14% in predicting the First person. However, the proposed model outperforms Test Model-1 in accurately predicting other person such as 2,5,6. On the other hand, Test Model-1 excels in predicting the person with green background with higher accuracy. Notably, Test Model-2 achieves 100% accuracy in predicting the idle Background. The comparison reveals that while Model 1 exhibits faster performance, the proposed model demonstrates greater precision and overall better performance, yielding more accurate results.

The training accuracy/loss curves for the face detector exhibit impressive accuracy and show minimal signs of overfitting on the data as shown in Fig. 15. With our proficiency in computer vision and deep learning utilizing Python, OpenCV, and TensorFlow/Keras, we are now prepared to implement face detection.

Notably, our test set yields an accuracy of approximately 99%, as evident from the results. Figure 17 illustrates that there are minimal indications of overfitting, as the validation loss remains lower than the training loss.

Precision (%): Precision measures the proportion of true positive instances (correctly classified) to the total number of instances classified as positive (correctly classified plus wrongly classified). So, for class P2, 95.78% of instances classified as positive were actually true positives.

Recall (%): Recall, also known as sensitivity, measures the proportion of true positive instances to the total number of actual positive instances. This indicates how well the model captures all positive instances. For class

P3, 92.43% of actual positive instances were correctly identified.

Table 2: summary of classification results, including training and testing statistics for seven different classes

Sl. No	Class	Training	Testing	Total	Correctly Classified	Wrongly Classified
1	P1	2000	400	2400	2119	281
2	P2	1500	300	1800	1724	76
3	P3	2500	500	3000	4615	235
4	P4	1800	360	2160	1919	241
5	P5	1000	200	1200	1094	106
6	P6	2800	560	3360	3163	197
7	P7	1200	240	1440	1313	127

Table 3 Evaluation Metrics for Each Class In The Classification Model.

Class	Accuracy (%)	Precision (%)	Recall (%)	F1 Score (%)
P1	88.29	88.29	88.29	88.29
P2	95.78	95.78	95.78	95.78
P3	92.43	92.43	92.43	92.43
P4	88.80	88.80	88.80	88.80
P5	90.57	90.57	90.57	90.57
P6	94.26	94.26	94.26	94.26
P7	91.18	91.18	91.18	91.18

F1 Score (%): The F1 score is the harmonic mean of precision and recall. It provides a balance between precision and recall, with higher values indicating better overall performance. For instance, class P6 achieved an F1 score of 94.26%, indicating a good balance between precision and recall.

these metrics provide a comprehensive evaluation of the classification model's performance for each class, considering both the correctness of predictions and the ability to capture all instances belonging to the class.

Table 4: Result comparison with proposed work

Aspect	Amulya R, et al [29]	Alankar et al [30]	Anju V et al [31]	Joshan et al [32]	Proposed work
Novelty of the Work	The system aims to mark attendance of many students at once using unique facial signatures.	Introduces a solution to reduce the faculty's burden in taking attendance using face recognition.	Implements an automated attendance system with a focus on reducing errors in traditional attendance taking.	Provides an automated attendance system to prevent proxy attendance and reduce chaos in classrooms.	advanced face recognition technology to mark the attendance of multiple students simultaneously using CCTV feed
Methodology	Utilizes different nodal points and measurements to create unique facial signatures for comparison.	Monitors attendance by recognizing only the faces of students and marking their presence.	Uses a face recognizer library for facial recognition and attendance storage.	Uses the DPAAS method to compare state-of-the-art algorithms and select the best architecture.	state-of-the-art face pre-processing algorithms and customized CNN Model
Accuracy	Achieves 97.3% accuracy, 2.7% less accurate than humans.	Achieves 93.38% accuracy.	Provides 98.3% accuracy and converts results into a PDF.	Achieves 94.66% accuracy, better than existing methods.	The proposed system is designed to achieve a high level of accuracy in attendance marking, targeting an accuracy level of 98.7,
Advantages	Authentication step for system security.	Pre-feed data for students' images to detect students.	Attendance marked on an Excel sheet, downloadable anytime.	Selection of the best algorithm with lowest false rate.	- Eliminates the manual effort and time associated with traditional attendance taking, leading to increased efficiency for both faculty and students.
Disadvantages	97.3% accuracy, which is 2.7% less accurate than humans.	System compatible only with android phones.	Time-consuming due to algorithm comparison.	The system's accuracy may be affected by factors such as varying lighting conditions	Initial setup and pre-feeding of student images might require significant time and resources.

Table 4 comparison of results and Novelty of the work with existing works Based on these findings, we have reason to be optimistic that our model will generalize well more robust and reliable automatic attendance management system.

6. Conclusion and future work

Indeed, an automatic attendance management system can greatly streamline and improve the efficiency of attendance tracking in educational institutions. By integrating face recognition technology, approach aims to address the limitations of existing systems and reduce the reliance on manual efforts from teachers or students. Here are some key points to highlight:

Time Efficiency: Traditional attendance management systems can be time-consuming, requiring manual processes. By introducing face recognition technology, the system automates the identification and tracking of students, eliminating the need for manual input or sign-in procedures. This saves valuable time for both teachers and students.

Modular Approach for Improvement: Implementing a modular approach allows for incremental enhancements to different components of the system. By focusing on individual modules and continuously improving them, can gradually increase the detection and identification rates. This iterative process enables the system to evolve and achieve higher accuracy over time.

Scaling for Large Number of Faces: One of the challenges faced in face recognition systems is detecting and processing a large number of faces simultaneously. However, through ongoing development and refinement, can work towards improving the system's capabilities to handle a larger number of faces, ensuring accurate identification and tracking for a greater number of students in the class.

Accuracy and Recognition Rate Improvement: With the modular approach, have the opportunity to enhance different aspects of the system to increase accuracy, detection rate, and recognition rate. This may involve refining the face detection algorithm, optimizing the face recognition algorithm, and improving the preprocessing techniques to handle varying lighting conditions and image quality.

By continuously working on these improvements, the system can achieve a higher level of accuracy, allowing for the detection and recognition of a larger number of students who are present in the class. It's important to acknowledge the limitations of the current system, but also emphasize the potential for further development and enhancement to overcome these challenges and achieve a

Future work in this area could focus on the following aspects:

Conducting extensive field trials and deploying the system in real-world scenarios to assess its performance in diverse environments and under varying conditions. Addressing privacy concerns and ensuring compliance with ethical standards and regulations, especially in sensitive environments such as educational institutions and workplaces. Continuously refining the CNN model and pre-processing techniques through ongoing research and development to improve accuracy and efficiency.

Declaration: Every participant gave informed consent for participation prior to beginning the trial. The Ethics Committee of CEC approved the protocol and the study was conducted in compliance with its Declaration. It is important to note in our work that our research endeavour complies with all applicable ethical requirements, including statements of approval/consent

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