**Smart Attendance Monitoring System Based On Facial Recognition**

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***Abstract***

**The proposed smart attendance system represents a significant advancement over traditional methods like sign-in sheets and ID cards, which are often plagued by inefficiency and errors. By harnessing facial recognition technology, this project aims to streamline the attendance recording process and offer a more convenient and contactless experience for users. At the heart of this system are sophisticated algorithms such as FaceNet for efficient facial feature extraction and the K-Nearest Neighbors (KNN) algorithm for classification. These algorithms enable accurate identification of individuals without the need for physical identification, simplifying the attendance process for users. With a simple walk in front of a camera, users can have their attendance automatically recorded, eliminating the need for carrying or presenting physical IDs. One of the key advantages of this system is its scalability, making it suitable for deployment in large organizations where traditional methods may struggle to cope with the volume of attendees. Moreover, the system offers potential security benefits by providing an additional layer of verification and identification, enhancing overall safety measures. However, the project emphasizes the importance of responsible and ethical implementation. It prioritizes user consent and addresses privacy concerns to ensure that individuals' rights are respected throughout the process. By focusing on the front-end design and utilizing tools like the Haar Cascade classifier for efficient face detection, the system aims to facilitate real-time attendance recording while maintaining user privacy and security. In conclusion, the innovative design of this smart attendance system has the potential to revolutionize attendance management in various settings. By offering increased convenience, efficiency, and scalability, it addresses the limitations of traditional methods while upholding ethical standards and respecting user privacy. With its emphasis on responsible implementation, this system represents a significant step forward in the realm of attendance recording technologies.**

***Keywords***

*Face recognition (FR), Machine Learning (ML), Deep Learning (DL), K Nearest Neighbor (KNN), Haar Cascade Classifier, Convolutional Neural Networks (CNN), Generative adversarial network (GAN), Support Vector Machine (SVM)), Local Binary Pattern Histogram (LBPH), Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), FaceNet, Python and Flask*

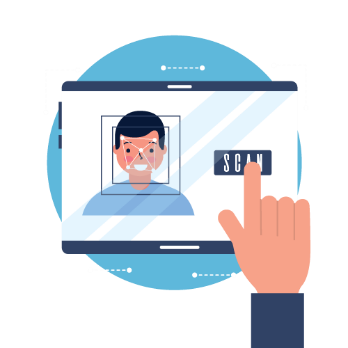
# **Introduction**

Facial recognition is one of the most advanced fields in artificial intelligence and computer vision, which has revolutionized the way we authenticate and identify individuals. This technology involves the accurate identification of individuals based on unique facial features, offering a promising method for attendance monitoring systems. The deployment of facial recognition in attendance monitoring systems has gained special attention due to its potential to address various important challenges present in traditional attendance systems.

Face recognition is a technology that uses computer algorithms and machine learning to identify and verify individuals by analyzing their facial features in images and videos. It mainly detects faces in the system, extracts unique characteristics, and compares them to known faces for tasks like authentication, security, access control, etc. It is also utilized in diverse domains, including law enforcement, customer service, and personalized marketing. It is also showcasing great potential to transform and develop various aspects of modern life and business operations.

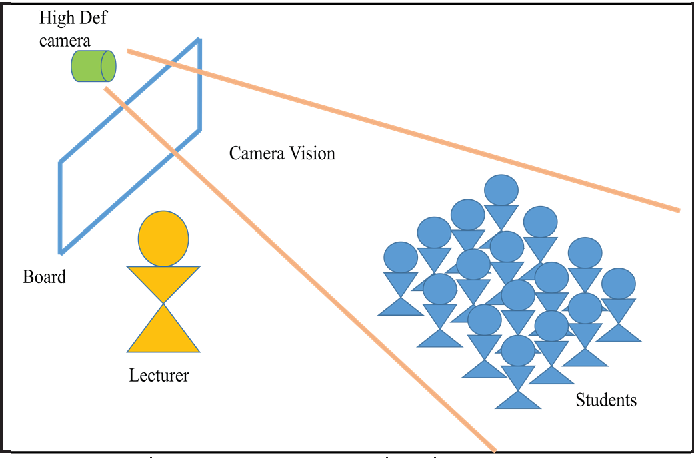
Figure(1): Person is trying to open mobile lock with help of face recognition and detection technique which is already preinstalled.

A smart attendance monitoring system is a real time solution with a modern face recognition system for handling people with their daily activities and can be used to detect human faces automatically with the help of capturing the current date, time, and location.



Figure(2): Person is trying to detecting face of themselves for marking attendance in class

A smart attendance monitoring system based on facial recognition is a better solution for atomizing and optimizing the process of tracking and recording attendance. This can utilize facial algorithms to identify individuals in a given area. This system eliminates the need for traditional manual methods and increases accurate, efficient, and secure attendance management. It can be used in educational institutions, businesses, and other organizations to improve attendance monitoring and overall system operation efficiency. This system improves security and reduces the risk of attendance fraud by ensuring that individuals are physically present during the checking process, making it a reliable and better solution for attendance management.



Figure(3): Single Camera is detecting face of all students present in class for marking their attendance

This review delves into the current state of research on implementing facial recognition for attendance monitoring systems, particularly focusing on the utilization of Facenet and K-Nearest Neighbors (KNN) algorithms. Recent advancements in deep learning techniques like Facenet have opened doors for highly accurate facial recognition. This, coupled with the efficiency and contactless operation of KNN-based approaches, presents a compelling solution for attendance management.

# **Survey Design**

This literature review will assess various papers and projects within this domain, dividing it into the methodologies, findings, and limitations of existing systems. By identifying gaps and shortcomings in the existing body of knowledge, this review aims to lay the groundwork for formulating accurate research objectives. The selection of papers was mainly based on three main aspects, which are machine learning, deep learning, and image processing. In finding out from the literature survey done, the methods used in the image processing model are Eigenface, Fisherface, Linear Binary Pattern, and Histogram of Oriented Gradients. And in the machine learning model are Support Vector Machine, Adaboost, XGBoost, Decision Tree, Viola Jonas, Regression, Clustering, PCA, and LDA. And in the deep learning model, mainly CNN and its types and GAN and its types. The primary algorithms used to implement facial recognition models are listed below. The survey is done over the period of time by identifying the problem statement and doing literature reviews on selected 30 papers based on machine learning, deep learning and image processing algorithms which are mainly find from IEEE and then finding the research gap in model for identifying the objective for implementing it in future.

# **Literature Survey**

By considering the research papers selected from 2017 till present, they are classified into three major domains, which are “Image Processing (IP), Machine Learning (ML), and Deep Learning (DL)” as stated in the methodology.

One paper may have used various algorithms in different domains. So, the maximum number of algorithms used in particular domains in that paper will be classified as that domain paper.

E.g. Paper “Comparative Study of Feature-based Algorithms and Classifiers in Face Recognition for Automated Attendance System[3]” will be classified as Machine Learning domain paper as it consists of 2 Machine Learning and 1 Image Processing algorithms.

“Paper “Face Recognition for Identification and Verification in Attendance System: A Systematic Review[2]” is a literature review paper of other research papers, so that paper is considered in the Image Processing Domain.”

1. **Image Processing:**

“In the paper “Student attendance with face recognition (LBPH or CNN): Systematic literature review”, a systematic literature review using the PRISMA technique, conducted by authors Andre Budimana, Fabian, Ricky Aryatama Yaputara, Said Achmad, and Aditya Kurniawan[1]”, a total of 1130 articles were initially identified. From this pool, a survey was conducted on 30 articles focusing on CNN and LBPH algorithms, involving identification, screening, eligibility, and inclusion steps. The survey shed light on key aspects, such as the process of applying face recognition to class attendance, the comparative effectiveness of various face recognition algorithms, and the external factors influencing accuracy, including the use of surveillance camera videos and varied facial positions.

“Paper “Face Recognition for Identification and Verification in Attendance System: A Systematic Review” by Ahmad Anshari, Sulistyo Aris Hirtranusi, Dana Indra Sensuse, Kautsarina, and Ryan Randy Suryono[2]” conducted a systematic review based on the Kitchenham method, a method frequently employed in prior studies, such as those addressing issues in Peer to Peer (P2P) Lending. They performed a comprehensive background study on Attendance System, Face Recognition, Identification, and Verification, while their research encompassed planning, conducting, and documenting the review process. As a result, they gleaned insights into the utilization of Face Recognition technology in attendance systems across different organizational fields, identified the security methods commonly used, and outlined the success factors driving effective Face Recognition implementation.

“Paper “Face Recognition based Attendance Management System” authored by Smitha, Pavithra S Hegde, and Afshin[5]”, an automated attendance system model is presented. Students must register with the system by providing their information, and their photos are taken and saved in a dataset. The process encompasses four key stages: Dataset Creation, involving image capture, preprocessing, and region of interest extraction; Face Detection employing Haar-Cascade Classifier; Face Recognition with Local Binary Pattern Histogram-based recognition; and Attendance Updating streamlines attendance management by listing absentees and emailing them to the appropriate faculty members. Identified faces are tagged as present in an Excel sheet.

“In the paper “Facial Recognition Attendance Monitoring System using Deep Learning Techniques” authored by Dr. A Manjula, D. Kalpana, and Sanjay Guguloth[9]”, a Facial Recognition Model is introduced, employing Eigenfaces, Fisherfaces, and Local Binary Pattern Histogram (LBPH) algorithms. The methodology utilizes classifiers for face detection, distinguishing between faces (1) and non-faces (0) in images. The original image is improved via LBPH calculation, which highlights face features, resulting in a histogram containing 16,384 positions (8x8x256). Euclidean Distance is employed to identify the image with the closest histogram to the input image, facilitating effective facial recognition.

“In the paper “Face Recognition Based Attendance Management System Using Machine Learning” by authors Anju V Das, Anjana Shyju, Thomas Varghese, and Nisha Mohan P M[10]”, an effective and secure personal authentication technique based on facial recognition is developed and evaluated using Python, OpenCV, and TensorFlow. The model comprises five key components which are Feature Extraction, Person Identification, Face Verification, Data Augmentation, and Face Recognition. These methods work hand in hand to enhance the accuracy and security of the authentication system, with performance compared to existing systems, ensuring a robust and reliable framework for personal identification.

“In the paper “Face Recognition Based Automated Attendance Management System”, authors Aparna Trivedi, Chandan Mani Tripathi, Dr. Yusuf Perwej, Ashish Kumar Srivastava, and Neha Kulshrestha[11]” introduce system built using Python, specifically Django and Flask, along with CSV integration. The application, a Windows based system, utilizes Python's Django and Flask Application capabilities for easy web service development by invoking COM or COBRA components. MySQL serves as the backend database, facilitating two user categories which are Admin users who are responsible for uploading files with annotation details to the main storage, and end users who benefit from the system by searching for files through query keywords, streamlining attendance management and access.

“In the paper “Face Recognition Based Attendance System” authored by Anuj Singh, Nikhil Rawat, and Rajan Kesri[15]”, the proposed system focuses on live-streaming video from a classroom, with the primary objective of detecting faces. There are four major stages to the process: Dataset creation involves taking pictures of students from different angles and in different positions with a webcam; Face Detection, which is executed using a Haar-Cascade Classifier with OpenCV; Face Recognition, involving the preparation of training data, training the face recognizer, and prediction, utilizing the Local Binary Pattern Histogram approach; and finally, Attendance Updating, where recognized faces are marked as present in an Excel sheet, simplifying the attendance management process.

“Paper "Face Recognition Using Eigenface Algorithm on Laptop Camera" by Rika Rosnelly, Mutiara S. Simanjuntak, Ade Clinton Sitepu, Mulkan Azhari, Sandy Kosasi, and Husen[20]”, a method for face recognition using the eigenface algorithm on a laptop camera is proposed. The method involves capturing face images from the laptop camera, preprocessing them for noise removal, and training a face recognition model using the eigenface algorithm. The model calculates distances between new images and eigenfaces to identify matches. The proposed method achieves an 85% accuracy on a dataset, demonstrating its simplicity, effectiveness, and suitability for face recognition on laptop cameras with low-quality images.

1. **Machine Learning:**

“In the research paper “Comparative Study of Feature-based Algorithms and Classifiers in Face Recognition for Automated Attendance System” by Ms. Sarika Ashok Sovitkar and Dr. Seema S. Kawathekar[3]”, they propose a comprehensive face recognition model that integrates various concepts such as PCA, LDA, Eigenfaces, and geometric principles. The model is structured into five main components: Face Detection employing the Viola Jones algorithm, Preprocessing for noise removal and image enhancement, Feature Extraction including PCA and LDA for local feature identification, Face Recognition for matching features with a database, and Attendance Marking, marking attendance in an Excel sheet after successful face recognition, providing a well-structured approach to attendance monitoring and recognition.

“In the research paper “Efficient Real Time Attendance System Based on Face Detection Case Study “MEDIU Staff”” by authors HUDA.H.Mady and Shadi M.S. Hilles[4]”, an automated attendance system was developed specifically for Al-Madinah International University (MEDIU), aiming to enhance the educational institution's attendance tracking. The model is structured into three main components: the creation of the MEDUE Staff Database (MEDUE-S-V-DB) comprising 20 videos, the acquisition of training and testing videos with various facial attributes, and the application of the face detection Viola-Jones method. This cascade detector utilized Viola-Jones for face detection and incorporated trained classification models, including frontal CART and Profile face classifiers, enhancing the accuracy and efficiency of attendance monitoring.

“In the paper “Student Attendance System Based on Face Recognition and Machine Learning”, authors Praveen K. Sah, Mamata Garanayak, Sujata Chakravarty, Bijay K. Paikaray, Rakesh Sharma, and Suneeta Satpathy[12]” proposed a comprehensive model employing Decision tree, Support Vector Machine, Convolutional Neural Network (CNN), VGG-19, and ResNet-50. Each model was separately fitted using a training dataset that is consist of 75% of the data, with the remaining 25% used for testing. The methodology included data preprocessing, involving face cropping, image reshaping, noise removal, feature extraction, and data splitting. The results demonstrated varying steps of accuracy and F1-scores, with CNN achieving the highest accuracy at 96.82% and an F1-score of 89.00%, showcasing its strong performance in the given context.

“The paper "2D-3D Facial Image Analysis for Identification of Facial Features Using Machine Learning Algorithms With Hyper-Parameter Optimization for Forensics Applications" by Gangothri Sanil, Krishna Prakash, Srikanth Prabhu, Vinod C. Nayak, and Saptarshi Sengupta[19]” introduces a method for identifying facial features in 2D and 3D facial images. It employs traditional techniques like SIFT and SURF for 2D feature extraction and MediaPipe for 3D feature extraction. A machine learning algorithm then receives these features as input, fine-tuned through hyperparameter optimization, and trained on labeled facial images. With a 95% accuracy on forensic facial images, this method stands out by its ability to leverage both 2D and 3D features, enhancing robustness to pose and lighting variations, offering potential applications in forensics like facial identification, matching, and reconstruction.

“In the paper "Face Recognition Using Fisherface and Support Vector Machine Method" by Syachrul Qolbi Nur Septiab, Intan Nurma Yulitaac, and Herlina Napitupuluab[21]”, a method for face recognition using the Fisherface algorithm and support vector machines (SVMs) is proposed. The method involves extracting features from face images using Fisher's linear discriminant analysis (FLD) and training an SVM classifier with these features. The SVM classifier is then utilized for recognizing faces in new images. The proposed method achieves a high accuracy of 99.76% on a face image dataset, showcasing its simplicity, accuracy, and resilience to changes in posture and lighting.

“The paper "Design of an E-Attendance Checker through Facial Recognition using Histogram of Oriented Gradients with Support Vector Machine" by Allan Jason C. Arceo, Renee Ylka N. Borejon, Mia Chantal R. Hortinela, Alejandro H. Ballado Jr., and Arnold C. Paglinawan[24]” presents a design for a facial recognition based electronic attendance checker system. For face identification and recognition, the system makes use of a support vector machine (SVM) classifier and the histogram of oriented gradients (HOG) feature descriptor. The grayscale image is first processed, extracting the HOG feature descriptor representing gradient orientations. The SVM classifier then categorizes the faces into different identities. On a dataset consisting of 37 students, the system's accuracy of 95.65% was quite good. Furthermore, the technology demonstrated resilience in the face of changes in ambient light levels and the distance between the pupil and the camera.

“The paper "The Role of the Eyes: Investigating Face Cognition Mechanisms Using Machine Learning and Partial Face Stimuli" by Ingon Chanpornpakdi and Toshihisa Tanaka[26]” uses machine learning and partial face stimuli to investigate the role of the eyes in face cognition. Making use of an RSVP, or fast serial visual presentation task, participants were presented with partial face stimuli that varied in the presence of facial features. Machine learning techniques were employed to analyze the ERP data, revealing that the N170 component exhibited a stronger response to partial face stimuli with eyes compared to those without eyes. Additionally, the P200 component displayed a stronger response to full face stimuli, indicating its association with holistic facial feature processing, while the N170 component was linked to local feature processing, particularly the eyes. The findings emphasize the critical role of the eyes in face recognition, offering insights into the neural mechanisms involved and potentially enabling the development of more robust face recognition methods against occlusions and variations in pose and lighting.

1. **Deep Learning:**

“In the paper “Face Recognition based Attendance System” authored by Dhanush Gowda H.L, K Vishal, Keertiraj B. R, Neha Kumari Dubey, and Pooja M. R.[6]”, a modern face verification system is proposed, where training and enrollment are distinct processes. The model is structured around a Face Recognition Model that employs deep metric learning techniques to create an effective metric space with reduced dimensions where pictures of the same class cluster together. To enable efficient training, metric loss and hard negative mining strategies are applied. The enrolment phase employs a smaller ResNet neural network, and the system can effectively detect and recognize faces, marking attendance by matching the new face to the enrolled faces in a 128-dimensional space.

“In the paper “Face Recognition Smart Attendance System using Deep Transfer Learning”, authors Khawla Alhanaeea, Mitha Alhammadia, Nahla Almenhalia, and Maad Shatnawia[7]” present a Face Recognition Smart Attendance System that makes use of networks that have already been trained, like SqueezeNet, GoogleNet, and AlexNet. The proposed system encompasses key stages: data collection involving 200 images captured with an iPhone 12 front facing camera, data formatting in JPG files, data augmentation to increase dataset size, and the training phase which involves parameter adjustments within the base architecture, comprising frequency of validation, number of epochs, training length, and learning rate, ultimately advancing facial recognition capabilities for smart attendance tracking.

“In the paper “Single Sample Face Recognition Using Convolutional Neural Networks for Automated Attendance Systems”, research conducted by authors Foteini P. Filippidou and George A. Papakostas[8]”, they developed an automated attendance system using the SSPP face recognition method, applicable in both in-person and remote learning settings. They categorized SSPP face recognition methods into five groups: Generic databases, Virtual sample generation, Feature-based, Hybrid, and Others. The model's evaluation was based on CNN-based object classifiers, including MobileNetV2, ResNet50V2, DenseNet121, InceptionV3, and VGG16. The accuracy of these models ranged from 93.4% to 100%, demonstrating the system's effectiveness in diverse scenarios.

“Authors Soumitra Chowdhury, Sudipta Nath, Ashim Dey, and Annesha Das present an Automatic Class Attendance System using CNN-based Face Recognition in their article "Development of an Automatic Class Attendance System using CNN-based Face Recognition"[13]”. First, the system takes pictures of students' faces and groups them into a tagged dataset. Although the Histogram of Oriented Gradient (HOG) method can also be utilized for face identification, a Convolutional Neural Network (CNN) model is used for face recognition. The system's parts are organized into four main phases: Data Entry, Face Recognition, Dataset Training, and Attendance Entry. To enable effective attendance tracking, the system's default option is to take 20 images from a live video stream at 2-second intervals.

“In the paper “Face Recognition Based Attendance System” by Nandhini R, Duraimurugan N, and S.P. Chokkalingam[14]”, the system's objective is to capture and store students' facial data for attendance purposes, with a focus on detecting various facial features and even recognizing the students' seating positions and postures. To achieve this, a Convolution Neural Network (CNN) is employed, resembling a multilayer perceptron but designed for accelerated processing. In order to facilitate effective feature extraction and analysis, the CNN is composed of an input layer, an output layer, and a hidden layer with many components, such as convolution layers, pooling layers, fully connected layers, and normalizing layers.

“The paper "Unsupervised Face Domain Transfer for Low-Resolution Face Recognition" by Sungeun Hong and Jongbin Ryu[16]” offers a brand-new unsupervised domain transfer method to improve face recognition at low resolution. The technique maps high-resolution (HR) face photos to low-resolution (LR) equivalents using a generative adversarial network (GAN). Through GAN training, the generator creates LR face images that are nearly identical to authentic LR pictures, subsequently facilitating the training of a face recognition model on these generated LR face images. The approach surpasses existing methods, boasting advantages such as its unsupervised nature and task-specific mapping, making it practical and effective for various low-resolution face recognition applications, including security surveillance and video conferencing.

“The paper “Chinese Face Dataset for Face Recognition in an Uncontrolled Classroom Environment” by Nianfeng Li, Xiangfeng Shen, Liyan Sun, Zhiguo Xiao, Tianjiao Ding, Tiansheng Li, And Xinhang Li[17]” created UCEC-Face dataset consists of 7395 images of 130 subjects, photographed in a demanding educational setting. There are 86 females and 44 guys in it. To utilize UCEC-Face for face verification, gender, expression, and age recognition, four models, namely OpenFace, ArcFace, VGG-Face, and Mediapipe, were utilized. However, the accuracy achieved was only 69.7%. Despite this limitation, these Face recognition algorithms support social stability and play crucial roles in various domains, demonstrating their significance in multiple areas.

“In the paper "Out-of-Distribution Detection for Reliable Face Recognition" by Chang Yu, Xiangyu Zhu, Zhen Lei, and Stan Z. Li[18]”, a method for detecting out-of-distribution (OOD) samples in face recognition systems is proposed. The method utilizes the observation that face recognition systems are more confident in their predictions on in-distribution samples and that the feature representations of OOD samples differ from those of in-distribution samples. By calculating confidence scores and measuring the distance between feature representations, the proposed method effectively detects OOD samples without significantly impacting the system's performance on in-distribution samples. The method shows promise in enhancing the reliability of face recognition systems in various real-world applications.

“The paper "Low-Power Scalable 3-D Face Frontalization Processor for CNN-Based Face Recognition in Mobile Devices" by Sanghoon Kang, Jinmook Lee, Kyeongryeol Bong, Changhyeon Kim, Youchang Kim, and Hoi-Jun Yoo[22]” introduces a scalable, low-power 3D face frontalization processor intended for CNN-based mobile face recognition. The processor utilizes a pipelined architecture to achieve high throughput while minimizing power consumption. Techniques like weight quantization and zero-skipping are employed to reduce memory accesses. Implemented in 65nm CMOS technology, the processor achieves impressive performance with a throughput of 4.73 frames per second (fps) and a power consumption of 0.53 milliwatts (mW). Its scalability, low-power design, and real-time capabilities make it suitable for various mobile applications including facial recognition, video conferencing, and augmented reality.

“The paper "Occluded Thermal Face Recognition Using Bag of CNN (BoCNN)" by Sumit Kumar and Satish Kumar[23]” presents a method for a bag of convolutional neural networks for occluded thermal facial recognition (BoCNN). This method addresses the challenge of recognizing partially or fully occluded faces in thermal images, which are typically noisy and low-resolution. The proposed approach involves extracting features from the thermal image using multiple CNNs and concatenating them to form a bag of features. These features are then utilized to train a classifier for face recognition. The method achieves a commendable accuracy of 90% when evaluated on a dataset of occluded thermal images. Its robustness to noise and occlusions, along with its ability to handle pose and lighting variations, make it a promising solution for occluded thermal face recognition in applications.

“In the paper "Face Recognition Using Faster R-CNN with Inception-V2 Architecture for CCTV Camera" by Lavin J. Halawa, Adi Wibowo, and Ferda Ernawan[25]”, a face recognition method is proposed, leveraging Faster R-CNN for face detection and Inception-V2 architecture for feature extraction from CCTV camera images. The process involves real-time face detection, robustness to lighting and pose variations, and high efficiency, with face recognition performed on the extracted features. Evaluated on a dataset of 6 individuals with 50 face images each, the method achieved an impressive accuracy of 90%, offering a promising solution for CCTV-based face recognition applications.

“The paper “Adversarial Cross-Spectral Face Completion for NIR-VIS Face Recognition” by Ran He, Jie Cao Lingxiao Song, Zhenan Sun, and Tieniu Tan[27]” presents a method for cross-spectral face completion, aiming to generate visible (VIS) face images from near-infrared (NIR) face images. This task is challenging due to the differing spectral information captured by NIR and VIS images. A generative adversarial network (GAN) with a texture inpainting and a pose correction component is used in the procedure. The texture inpainting component, a convolutional neural network (CNN), learns to synthesize realistic VIS image textures by inpainting missing pixels in the NIR image texture. By warping the NIR picture, the pose correction component—an additional CNN—is trained to map NIR face images to frontal poses in the VIS domain. When tested on a dataset of NIR and VIS face images, the GAN components work together to produce high-quality VIS image completions and enhanced accuracy for NIR-VIS face identification.

“The paper "A Face Emotion Recognition Method Using Convolutional Neural Network and Image Edge Computing" by Hongli Zhang, Alireza Jolfaei, and Mamoun Alazab[28]” introduces a approach that combines image edge computing with a convolutional neural network (CNN) for facial emotion recognition. The method begins by extracting edge features from the face image, utilizing image edge computing to capture robust representations of object edges. These edge features are then inputted into a CNN, which is trained on a labeled dataset of face images to establish associations between the edge features and corresponding emotions. When the suggested approach was tested on a dataset of annotated face photos, it demonstrated an impressive accuracy of 85%. The approach's benefits include its utilization of image edge computing for robustness against pose and lighting variations, as well as the CNN's ability to enhance accuracy and efficiency in learning the relationship between edge features and emotions during face emotion recognition.

“The paper "A Robust GAN-Generated Face Detection Method Based on Dual-Color Spaces and an Improved Xception" by Beijing Chen, Xin Liu, Yuhui Zheng, Guoying Zhao, and Yun-Qing Shi[29]” presents a novel approach for detecting GAN-generated face images. The method utilizes a dual-color space combining RGB and YCbCr, along with an enhanced Xception network, to extract features from the face image. After that, a classifier trained on a dataset of actual and GAN-generated face images is fed these features. The proposed method achieves an impressive 98% accuracy on a GAN generated face image dataset, offering robustness and improved performance compared to existing methods.

“The paper "Identity Aware Face Super-Resolution for Low-Resolution Face Recognition" by Jin Chen, Jun Chen, Zheng Wang, Chao Liang, and Chia-Wen Lin[30]” introduces a a technique for low resolution face recognition called identity aware face super resolution (FSR). The suggested method uses identification traits that are extracted from low resolution facial photos to direct the super resolution procedure. The technique produces the latest advances in terms of image quality and face recognition accuracy by training the super resolution algorithm on a dataset of high resolution and low resolution face photographs. The utilization of identity features and the inclusion of real world low resolution face images enhance the method's ability to preserve identity information and generalize to practical scenarios.

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| **Inferences out of literature review** | | | | |
| **Sr No.** | **Name Of Paper** | **Algorithms Used** | **Advantage** | **Disadvantage** |
| [1] | “Student attendance with face recognition (LBPH or CNN): Systematic literature review” | EigenFace, FisherFace, SVM, CNN, LBPH, MLP | High Accuracy and Stability | Many datasets are required, Affect by external factors |
| [2] | “Face Recognition for Identification and Verification in Attendance System: A Systematic Review” | This is review is literature surveys based on research questions. So, it was reviewed to get answer of questions | Information Security, Training and Insurance factors | Security Issues |
| [3] | “Comparative Study of Feature-based Algorithms and Classifiers in Face Recognition for Automated Attendance System” | PCA, LDA, Eigenface, Some geometrical model | The recognition rates of PCA, LDA, and Hybrid Approach for a face angle with a left- or right-side face image in good light conditions are 68%, 75%, and 86%, respectively. | The identification rate drops by up to 10% in poor lighting conditions, such as when it is foggy or dark and faces are not visible. |
| [4] | “Efficient Real Time Attendance System Based on Face Detection Case Study “MEDIU Staff”” | Viola Jonas algorithms | It can be used in commercial life, law enforcement and security be used in commercial life, law enforcement and security | Pose, illumination conditions, facial expressions, orientation, etc |
| [5] | “Face Recognition based Attendance Management System” | Local Binary Pattern Histogram, Haar-Cascade Classifier | Mark attendance with ID no. | Need of Good UI |
| [6] | “Face Recognition based Attendance System” | Deep Metric Learning, Metric Loss, CNN, Hard Negative Mining, ResNet neural network | This approach will respond faster and recognize more faces from a single frame with greater accuracy. | Training of Dataset need more time |
| [7] | “Face Recognition Smart Attendance System using Deep Transfer Learning” | AlexNet, GoogleNet, SqueezeNet, CNN | SqueezeNet, GoogleNet, and AlexNet are the three networks that attained validation accuracy of 98.33%, 93.33%, and 100%, in that order. | Using pretrained data |
| [8] | “Single Sample Face Recognition Using Convolutional Neural Networks for Automated Attendance Systems” | CNN based object classifiers, i.e. MobileNetV2, ResNet50V2, DenseNet121, InceptionV3, and VGG16 CNNs | By enhancing the frontal views to increase the training data, high performance was attained. | Implementing the model using maximum accuracy CNN |
| [9] | “Facial Recognition Attendance Monitoring System using Deep Learning Techniques” | Open CV, LBPH (Local Binary Pattern Histogram), Haar Cascade, Eigen faces algorithm, Fisher faces algorithm, Euclidean Distance | Highly efficient algorithm | Lighting conditions, no camera with an optimal resolution |
| [10] | “Face Recognition Based Attendance Management System Using Machine Learning” | Haar Cascade, Viola Jones Face Detection Algorithm, Ada-Boost | Obtained steady results around the 90% of accuracy, reaching a maximum of 95% and also use two different model | Dataset size |
| [11] | “Face Recognition Based Automated Attendance Management System” | CNN, Haar Cascade, Open CV, LBPH (Local Binary Pattern Histogram), Eigen faces algorithm, Fisher faces algorithm | Paperless Attendance | High usability and security |
| [12] | “Student Attendance System Based on Face Recognition and Machine Learning” | Decision tree, Support Vector Machine, Convolutional Neural Network, VGG-19, ResNet-50 | CNN, VGG19, ResNet50 accuracy is above 90% | SVM, Decision Tree accuracy is near 70% |
| [13] | “Development of an Automatic Class Attendance System using CNN-based Face Recognition” | CNN, Histogram of Oriented Gradient (HOG) method, the function face\_encodings in the face\_recognition library of Tkinter | Maximum accuracy of about 92% | Need Many Images of each one person |
| [14] | “Face Recognition Based Attendance System” | CNN (Convolution Neural Network) | Accuracy, high-precision speed | Poor lighting condition |
| [15] | “Face Recognition Based Attendance System” | Haar-Cascade Classifier, OpenCV, Local Binary Pattern Histogram | Mark attendance with ID no. | Need of Good UI |
| [16] | “Unsupervised Face Domain Transfer for Low Resolution Face Recognition” | Generative adversarial network (GAN) | Is capable of picking up a mapping function between HR and LR facial pictures. | Often difficult and expensive to obtain |
| [17] | “Chinese Face Dataset for Face Recognition in an Uncontrolled Classroom Environment” | OpenFace, ArcFace, OpenCV, SSD, Dlib, RitinaFace, VGG-Face, and Mediapipe | Comparsion between four different face recognition model. | Only 69.7% as accuracy Only |
| [18] | “Out of Distribution Detection for Reliable Face Recognition” | CNN, GAN, L2 norm, Evaluation Metrics, ResNet64, Gaussian mixture model | It is effective at detecting a variety of OOD samples, including noise, occlusions, and adversarial attacks | Minimal impact on the performance of the face recognition system |
| [19] | “2D-3D Facial Image Analysis for Identification of Facial Features Using Machine Learning Algorithms With Hyper-Parameter Optimization for Forensics Applications” | XGBoost, AdaBoost, Random Forest, Logistic Regression, Extra Tree Classifier, Light Gradient Boosting, SVM, Naive Bayes, Scale Invariant Feature Transform, Speeded up Robust Feature,MediaPipe | Achieved an accuracy of 90% using XGBOOST | Light Gradient Boosting has Achieved an accuracy of 62% |
| [20] | “Face Recognition Using Eigenface Algorithm on Laptop Camera” | Eigen value, Eigen vector, PCA | Accuracy of 85% on the test dataset, which is comparable to. It is relatively easy to implement and can be used on a variety of devices, including laptop cameras. | The system may be vulnerable to spoofing attacks. The system may not be suitable for real-time applications. |
| [21] | “Face Recognition Using Fisherface and Support Vector Machine Method” | FisherFace, SVM, PCA, LDA | Average Prediction Accuracy 99.76%, Precision 99.79%, and Recall 99.72% | It needs large time to executed due to Complex Calculation |
| [22] | “Low-Power Scalable 3-D Face Frontalization Processor for CNN-Based Face Recognition in Mobile Devices” | Local binary features, CNN, K-means Clustering, Regression, Euclidean distance | 4.73 frames per second (fps) of high throughput and 0.53 milliwatts (mW) of low power consumption | Need to implement on each device individually |
| [23] | “Occluded Thermal Face Recognition Using Bag of CNN (BoCNN)” | Convolutional neural networks and different types of its, LBP, LDP, LVP,LGHP and HOG | Accuracy of 90% | Need to implement with own dataset features extraction without transfer learning |
| [24] | “Design of an E-Attendance Checker through Facial Recognition using Histogram of Oriented Gradients with Support Vector Machine” | Histogrаm of Oriented Grаdients with Support Vector Mаchine, Raspberry Pi | It is accurate and efficient, with an accuracy of 95.65%. It is not affected by environmental factors such as luminance and distance | Only 37 students are used for evaluation |
| [25] | “Face Recognition Using Faster R-CNN with Inception-V2 Architecture for CCTV Camera” | Faster Regional Convolutional Neural Network, Region Proposal Network, Inception V2 | Achieved an accuracy of 90% | Evaluated the proposed method on a dataset of 6 people, with each person having 50 face images |
| [26] | “The Role of the Eyes: Investigating Face Cognition Mechanisms Using Machine Learning and Partial Face Stimuli” | ANOVA with Greenhouse-Geisser correction, xDAWN filter and linear SVM, Rapid serial visual presentation | Improved comprehension of the neurological processes underlying face recognition, as well as more resilient to occlusions, changes in posture, and illumination | Reduce the ERP level to get less accuracy |
| [27] | “Adversarial Cross-Spectral Face Completion for NIR-VIS Face Recognition” | Visible face image, Near-infrared face image, Generative adversarial network, Convolutional neural network | Improved the accuracy of NIR-VIS face recognition | The identities that are used for training and testing differ completely from just 357 identities. |
| [28] | “A Face Emotion Recognition Method Using Convolutional Neural Network and Image Edge Computing” | Haar classier, Adaboost, Histogram Equalization, Image edge computing, Convolutional neural network | More robust to variations in pose and lighting | Only achieved an accuracy of 85% on the dataset |
| [29] | “A Robust GAN-Generated Face Detection Method Based on Dual-Color Spaces and an Improved Xception” | GENERATIVE adversarial networks, and its types, Convolutional neural network, convolutional block attention module and multilayer feature aggregaion | Achieved an accuracy of 98% on the dataset | More Time is required for execution of model using GAN |
| [30] | “Identity-Aware Face Super-Resolution for Low-Resolution Face Recognition” | LFW, LightCNN\_v9, VGGFace2, Euclidean distance, CelebA, Low-Resolution Face Identification | High Accuracy | Separate the identity features for explicit supervision into features related to angles and magnitude. |

Table(1)

# **Research Gap**

Through a comprehensive review of existing literature on facial recognition based attendance monitoring systems, several critical research gaps have come to the forefront. Challenges include the arduous implementation of facial recognition in low-resolution images and videos, where pixelation and reduced image quality hinder reliable identification. The complex calculations involved make the process time-consuming, necessitating the development of more efficient algorithms or hardware acceleration solutions. Additionally, the difficulty of implementation in crowded environments, where multiple faces intersect, poses a formidable challenge. The predominant reliance on 2D recognition techniques limits the technology's effectiveness in 3D settings. Recognizing individuals from various angles remains problematic, and the impact of varying lighting conditions on recognition accuracy requires further exploration. Addressing these research gaps is paramount to advancing the field, driving innovation, and ultimately enhancing the accuracy and applicability of facial recognition in attendance monitoring systems.

**Objective**

The primary objectives include achieving marginal accuracy in identifying individuals within low-resolution images or videos, across various angles, and under different lighting conditions. Additionally, the focus extends to performing recognition on moving faces, particularly in real-time surveillance footage. Another key aim is to address the challenge of reducing the power consumption of face recognition systems, thereby enhancing their efficiency and applicability in diverse settings. These goals collectively contribute to advancing the capabilities of facial recognition technology, enabling more robust and versatile solutions for identity verification and surveillance applications.

**Methodology**

1. FaceNet Model:

Google researchers Florian Schroff, Dmitry Kalenichenko, and James Philbin introduced FaceNet in 2015, a facial recognition system that uses deep learning to create a unique 128-point identifier for each face. This innovative system efficiently compares faces by measuring the distance between their identifiers in a special mathematical space.

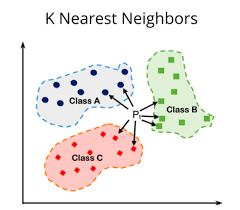


Figure(4)

1. KNN:

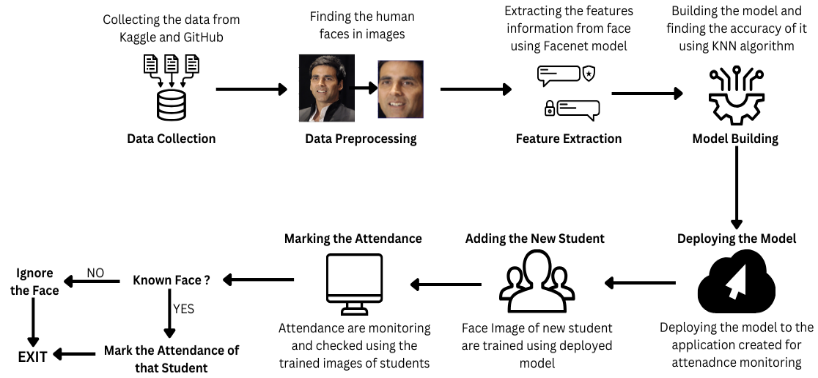
k-NN is a type of classification where the function is only approximated locally and all computation is deferred until function evaluation. Since this algorithm relies on distance for classification, if the features represent different physical units or come in vastly different scales then normalizing the training data can improve its accuracy dramatically.

The neighbors are taken from a set of objects for which the class (for k-NN classification) or the object property value (for k-NN regression) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required.



Figure(5)

# **Proposed System**



Figure(6)

1. Data Collection:

The system begins by gathering data from two sources: Kaggle and GitHub. This data likely consists of images containing faces.

1. Data Preprocessing:

Once collected, the data goes through a preprocessing stage. This stage may involve cleaning the data, removing irrelevant information, and formatting it for use in the system.

1. Feature Extraction:

After preprocessing, the system extracts features from the facial images. Facial recognition systems typically work by identifying specific features in faces, such as the distance between the eyes or the shape of the jawline. In the proposed system, a model called Facenet is used for feature extraction.

1. Model Building:

Once features are extracted, a model is built using a KNN algorithm to identify faces in images. The system likely trains the model on a dataset of labeled images, where each image has been identified as containing a face or not containing a face.

1. Marking Attendance:

The system is now ready to mark attendance. When a new image is presented to the system, it first goes through a process to determine if a human face is present in the image.

1. Known Face?

If a face is detected, the system then tries to determine if the face is a known student. It accomplishes this by comparing the extracted features from the new image to the features of faces in the trained model.

If there is a match, the system recognizes the student and marks their attendance.

If there is no match, the system concludes the face is an unknown student.

1. New Student

In the case of an unknown student, the system prompts the user to add the new student's information. The system likely captures an image of the student's face at this point.

Once the new student's information is added, the system uses the deployed model to train the student's facial data into the system.

1. Deployment

Finally, the system is deployed, likely meaning it is integrated into an application designed to monitor attendance.

Overall, this proposed system diagram outlines a facial recognition system designed to automate the process of marking student attendance.

# **Data Collection**

1. Labeled Faces in the Wild (LFW):

Briefly describe LFW as a collection of celebrity images gathered from online sources like news articles and websites.

1. Kaggle Original Images Dataset:

Briefly describe the content of these datasets, focusing on aspects relevant to facial recognition (image types, number of individuals, variations in pose, lighting, etc.)

1. Masked Face Dataset:

Explain the rationale behind including masked faces. Is it to assess the model's performance under occlusion or to simulate real-world scenarios with masks?

1. Olivetti Faces Dataset:

Briefly explain the nature of the Olivetti Faces Dataset, mentioning its focus on grayscale images with variations in lighting and facial expressions. Emphasize the importance of using datasets with diverse characteristics to improve model generalizability.

# **Data Analysis**

Final Dataset is created using combination of LFW(1000 images), Original Face Image of Kaggle (4500 images), Face Embedding Dataset from GitHub (4000 images).

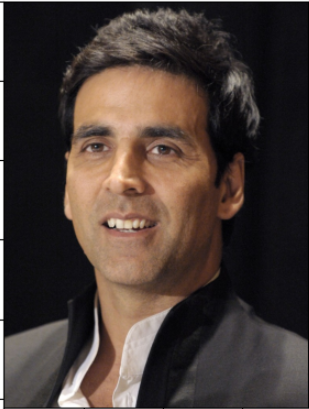
Total number of dataset used are four.(Figure 7)

Figure(7)

|  |  |  |  |
| --- | --- | --- | --- |
| Dataset Name | Datset Website | Number of Images | Accuracy of Model |
| LFW | Kaggle | 13000+ | 76.65 |
| Original Faces | Kaggle | 4000+ | 96.78 |
| Masked Face | GitHub | 4000+ | 56.32 |
| Combination | Kaggle + Github | 10000+ | 97.76 |

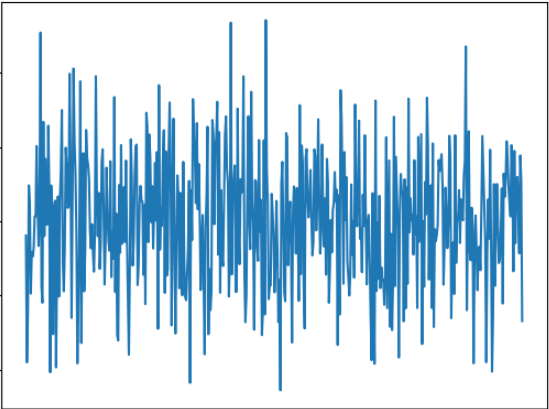
Table(2)

# **Results**

Figure(8)

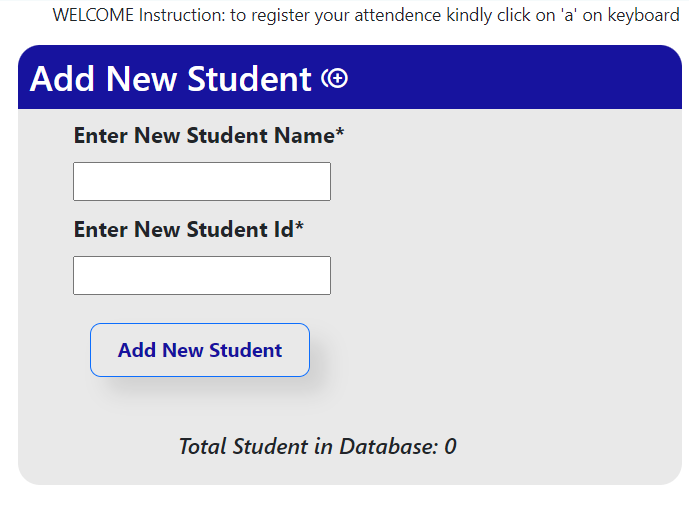
Figure(8) is an example of face detection using the FaceNet model.



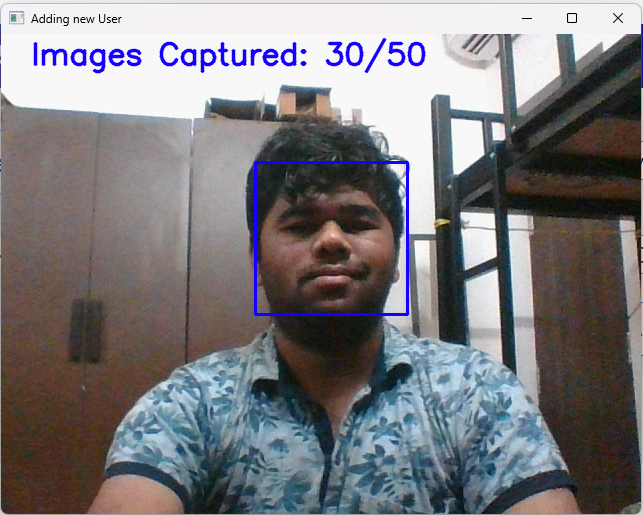
Figure(9)

Above Figure(9) is the accuracy graph of the entire dataset.

The final training accuracy of model is 97.76% and the testing accuracy is 96.53%.

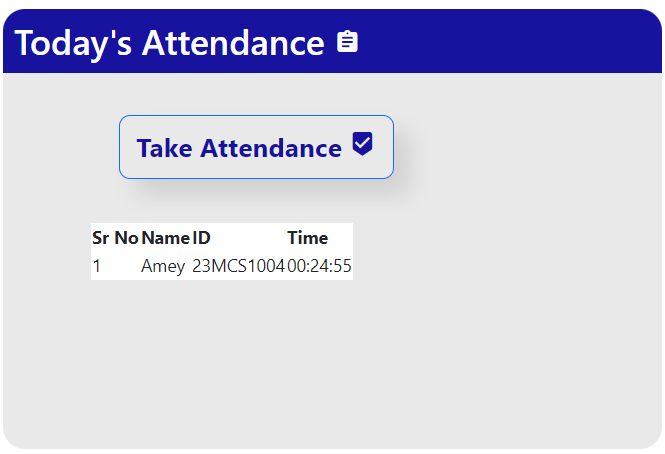


Figure(10)

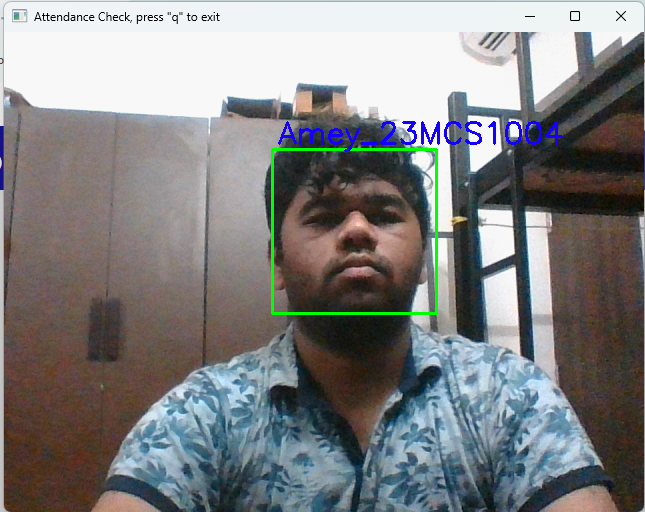


Figure(11)

Figure(10) and Figure(11) are the windows for adding new students into the dataset for processing the image with built model for future references.



Figure(12)



Figure(13)

Figure(12) and Figure(13) are the windows for checking the attendance of students using the created dataset of students in the model.

Figure(10-13) is a model built for adding new students and checking the attendance of those students.

# **Discussion**

The project's primary goal was to achieve high accuracy in identifying individuals in challenging conditions. Additionally, we aimed to enable facial recognition on moving faces, particularly in real-time surveillance scenarios. Another important objective was to minimize the power consumption of face recognition systems to enhance their efficiency and suitability for various environments. By achieving an impressive accuracy rate of 97%, our project demonstrates significant progress in meeting these objectives. This success signifies advancements in facial recognition technology, paving the way for more reliable solutions in identity verification and surveillance applications.

# **Conclusion**

After carefully studying various ways to make facial recognition technology work better, we found that there were some important gaps in how these methods were being used. To fill these gaps and improve facial recognition systems, we came up with a new approach. This approach brings together different techniques like FaceNet for building the main part of the system, KNN for checking how well it works, Haar Cascade for spotting faces, and Flask for making it easy to use. Our project using these methods achieved an accuracy rate of 97.76%, which is good. It shows that we're making progress in creating facial recognition systems that can be very useful in many situations.

##### **Future Scope**

The future scope for this project is vast and promising. With its high accuracy rate and robust performance, the system can be scaled up for large-scale implementation, addressing the challenge of adding one student at a time. By leveraging CCTV infrastructure, facial recognition technology can be seamlessly integrated into existing surveillance systems, enhancing security measures and streamlining attendance monitoring processes in various settings such as schools, universities, and workplaces. Additionally, the project lays the groundwork for further advancements in facial recognition technology, opening up possibilities for broader applications beyond attendance monitoring, including access control, personalized services, and targeted advertising. Overall, the project's success paves the way for widespread adoption and continued innovation in the field of facial recognition based solutions.

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