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Employee Attendance Tracking Using Facial Recognition System

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Abstract: *Traditional pen-and-notebook methods for employee attendance are often susceptible to inaccuracies and falsifications. Biometric systems, despite being more secure, confront issues such as high acquisition costs and inefficiencies in capturing fingerprints, especially when hands are unclean or injured. In this study, a cutting-edge Employee Attendance Tracking System using Facial Recognition is developed, addressing the shortcomings of conventional attendance methods and biometric systems. The proposed system employs an array of Python libraries including Django, face_recognition, OpenCV (cv2), numpy, and PCA. These libraries are utilized for their strengths in image processing, facial recognition, and efficient data management. The primary objective is to create a reliable, cost-effective, and efficient alternative for recording employee attendance, overcoming the limitations of existing methods. The system utilizes advanced image processing techniques to tackle common challenges in facial recognition, such as noise interference, varying lighting conditions, and physical obstructions like occlusions. This is achieved through innovative approaches like noise reduction, illumination normalization, and occlusion handling, significantly improving the accuracy of facial recognition under diverse environmental conditions. A key component of the system is the "Capture_Image" module, which establishes a reference database by capturing and storing employee images. Concurrently, the "Recognize" module employs machine learning algorithms for facial recognition, ensuring accurate and timely recording of attendance. The effectiveness of the system is demonstrated in its ability to adapt to a variety of environments, attributed to its advanced image processing capabilities and robust algorithmic framework. This innovative system is particularly advantageous for institutions, corporate offices, and industries seeking secure, precise, and efficient attendance tracking solutions. It marks a significant advancement in the field of attendance management, offering a blend of enhanced security, accuracy, and operational efficiency. The study recommends further enhancements, such as incorporating advanced algorithms to improve recognition accuracy in different lighting and noise conditions.*
Keywords: accuracy, biometric system, employee attendance tracking, facial recognition, machine learning algorithm.

INTRODUCTION

Face recognition is as old as computer vision, both because of the practical importance of the topic and theoretical interest from cognitive scientists. Despite the fact that other methods of identification (such as fingerprints, or iris scans) can be more accurate, face recognition has always remains a major focus of research because of its non-invasive nature and because it is people's primary method of person identification. Face recognition technology is gradually evolving to a universal biometric solution since it requires virtually zero effort from the user end whilecompared with other biometric options. Biometric face recognition is basically used in three main domains: time attendance systems and employee management; visitor management systems; and last but not the least authorization systems and access control systems [1].

The pipeline of general enterprises needs to record the attendance of personnel, which has become a basic requirement of the company. However, when these attendance systems are formulated, unnecessary errors often occur. Taking the current fingerprint attendance system as an example, study has found that the fingerprint attendance system has an error rate of about 5%, and there will be a phenomenon that fingerprints cannot be hit, which seriously affects the efficiency of attendance, especially in large attendance sites, which is more likely to cause congestion [2]. However, the card attendance system has the phenomenon of employees swiping cards for someone else, and it is difficult to achieve the purpose of real time attendance [3]. Compared with the two attendance systems, the face recognition system has higher accuracy and stability, because there are more points for face recognition, which is more accurate than other systems [4,5].

Personnel management is very significant in the administration and management of organizations. Lack of security and extensive paperwork in the traditional systems reveal that there is a need for new approach for personal verification and employee identification technologies. In recent times, organizations have started to benefit from fingerprints and facial recognition more than before for personnel attendance. Moreover, the fact that no two individuals have the-same finger prints and face shape increases the system security. It can be also asserted that, since fingerprints and facial structure remains unchanged throughout lifetime, it remains unique and sustainable [6].

Organizations of all sizes use time and attendance systems to record when employees start and stop work, and the department where the work is performed. However, it’s also common to track meals and breaks, the type of work performed, and the number of items produced. In addition to tracking when employees work, organizations also need to keep tabs on when employees are not working. Vacation time, compensation time, Family and Medical Leave Act (FMLA) time, and jury duty must be recorded. Some organizations also keep detailed records of attendance issues such as who calls in sick and who comes in late.

Facial recognition or face recognition as it is often referred to as, analyses characteristics of a person's face image input through a camera. It measures overall facial structure, distances between eyes, nose, mouth, and jaw edges [7]. These measurements are retained in a database and used as a comparison when a user stands before the camera. One of the strongest positive aspects of facial recognition is that it is non-intrusive. Verification or identification can be accomplished from two feet away or more, without requiring the user to wait for long periods of time or do anything more than look at the camera [8].

Facial recognition is an easy and secure way of taking down attendance. Facial recognition in the workplace is going to become more and more common in a post-pandemic world. Business owners across the globe are looking for contactless ways for employees to clock in and out and calculate payroll. As a result, solutions will become more utilized than they previously were especially using image capture device that captures the images of employees, train & processes the information into a database. Then the trained face images coordinate structure are mapped and stored into database which will make the faces of employees suitable for recognition by the deployed machine. This study adopted the use of computer vision method by applying face recognition techniques using CLAHE for illumination control, median filtering for noise removal, Principal Component Analysis for feature extraction and Euclidean distance for template matching so as to collectively enhance the rate the recognition accuracy rate of Facial Recognition System in Employee Attendance Tracking and Management System.

RELATED WORKS

The application of facial recognition technology for employee attendance tracking has garnered significant interest. Numerous studies have explored algorithms, techniques and methodologies to develop accurate and robust systems. This section reviews the state-of-the-art research and existing solutions, analyzing their strengths and limitations. Approaches like PCA, LBP, CNNs and others have been investigated to improve recognition accuracy. Studies have also examined scalability, user-friendliness, privacy, security and integration aspects.

In a proposal to reduce the errors that occur in the standard attendance system by utilising facial recognition and presented a model that used deep learning algorithms and had a recognition accuracy of 98.3 percent. The method also addresses the problem of face identification within a biometric system when the system is being subjected to real-time settings such as illumination, rotation, and scaling. The input images are obtained by the model through the usage of a camera. Following that, a linear support vector machine is utilised to detect a face within the image. Finally, attendance is recorded within a spreadsheet before being converted into a PDF file. students from Mumbai University collaborated on the development of an Attendance Management System that is based on ordinary Bluetooth technology. This system ensures that a student's attendance is at least 75% before allowing them to take an examination [9].

In an android-based course attendance system that uses face recognition in a manner that is comparable to that of 46 built an android-based course attendance system thatuses face recognition. Electronic tags (serial numbers) are used to permit automatic wireless identification using a Bluetooth smart based device that is developed and set to work in conjunction with an Android application that records attendance as the lecturer goes around the class to detect the tags. The fault in this technique is that it places an excessive amount of reliance on the ownership and use of a Bluetooth-enabled Android phone, which leaves teachers and pupils in the dark regarding the location of important information [10].

In a research that utilized Principal Component Analysis (PCA)so that people could recognise faces. The finished output is a transportable system that can be accessed and used on any computer or mobile phone. The system is able to maintain distinct attendance records for each class and area of study that it supports.has previously published. The following steps are utilised by the system in order to record attendance: To start, a video clip of the classroom is recorded and stored in the database. Next, a count

of the number of people present is calculated. Second, the video is then converted to still images, and face detection methods are used to locate the individuals inside the film. In order to extract features (LBPA), the Histogram of Oriented Gradients approach and the Local Binary Pattern method are both utilised. Face recognition is achieved by first projecting a new image in the eigenface subspace, which is a space in which a person is categorised by comparing their position in eigenface space with that of known individuals, and then extracting the image using the PCA technique. Face recognition software can also use a combination of these two methods. Through the use of the system, the report is delivered to both the instructor and the parents.

Similarly, another study employed principal component analysis (PCA) to develop an automatic attendance system. They did this by extracting the same distinctive features, which are referred to as eigenfaces. This system is safe, dependable, and does not call for any specialised equipment because it is constructed with a camera, a computer, and face recognition algorithms. Face recognition, which is by far the most important use of the technology, is used for a range of purposes, including safety and surveillance, commerce and education. Even while PCA-based systems are effective, it is quite time consuming to extract the primary components unless a specialised method is used in addition to it [11].

Another study proposed a robust four-layer convolutional neural network architecture as a solution to the challenge of face recognition. This design is capable of handling occlusion, postures, facial emotion, and changeable illumination. The face recognition operation was completed by the model in less than 0.01 seconds when it was evaluated on the AR database. On the AR database, the model achieved an accuracy of 99.5 percent, while on the FERET database, the model achieved an accuracy of 85.15 percent [12].

A novel automated class attendance system based on illumination and an invariant facial recognition system was proposed. In a similar vein, this new system was inspired by comparable ideas. The Viola and Jones algorithms are utilised to accomplish face detection, the Non-subsample contour let transform is utilised to accomplish face feature extraction, and face classification is completed by comparing an unknown face to a known face included within the class database. The method was evaluated using the use of the 3D face datasets from Yale and BU. In the University's system, face authentication was performed using linear binary pattern histograms and face detection was performed using the Viola-Jones method (also known as Haar's Cascade). Before being converted to gray scale, the photographs taken by the students were initially stored in a database in their original colour space (RGB) after being obtained from the camera and stored there. Second, the OpenCV framework is used to monitor attendance by comparing an input face to previously stored images of people's faces in a database. Third, when the day comes to a close, the output is printed on a notepad, the system updates the student's attendance, and it communicates this modification to the Department Head. When it comes to these kinds of systems, speed is an asset; nevertheless, utilising a database system that is unable to provide the essential speed as a result of the diverse face inputs may block the conclusion that is wanted [13].

In the Smart Attendance Management System Based on Face Recognition Using CNN, a CNN architecture with 20 layers is utilised. These layers include Conv2D, Batch Normalisation, Max Pooling, and Dense layers, among others. The dataset contains 10,029 face shots that have been separated into four classes, each of which has 2,500 images (with the exception of class-3, which has 2,529 images). This results in a high level of accuracy as a result of the big dataset that was used to

train the model; nevertheless, training will take a significant amount of time. The accuracy of the model is 99.86 percent, and it has a loss of 0.0057 percent [14].

In the study Automatic Face Detection and Recognition for Attendance Maintenance, the authors generated their very own dataset by employing still images and frames taken from videos of individuals and fellow students. A number of different combinations of models, including MTCNN, YOLO, FACENET, and SVM, were analysed and compared. They selected the most effective algorithm combination and, as a result, were able to achieve training accuracy of 99.21% in the lowest amount of time feasible, in comparison to the effectiveness of other algorithm combinations. Image processing that begins with pre-processing, including de-noising and quality control checks, is referred to as image enhancement. The authors identified faces using a pre-trained version of FaceNet and SVM in addition to employing YOLO and MTCNN for detection. They combined these models, which resulted in increased productivity, longevity, and dependability [15].

In the research paper titled Face Recognition for Attendance System Detection, an authentication method based on facial recognition was developed by combining the Haar Cascade methodology with the detection of skin colour. Following the identification of the skin colour in the photographs, the images are then transformed to a gray scale format. After that, the Haar Cascade method is applied in order to identify faces, and after a face has been identified, a bounding box is drawn around it. After that, the face input from the ROI that was obtained in the previous step is aligned for feature extraction. The LBPH algorithm was selected for this work because of its minimal resource utilisation, its ability to detect faces in real time, and its high accuracy of roughly 98.2 percent for photos with a reasonable amount of illumination and 94.7 percent for images with a little less illumination [16].

In a work on Realtime Face-Detection and Emotion Identification Using MTCNN and miniShuffleNet V2 (2019) integrated face detection and emotion recognition into a single model that can complete the task in real time. Facial detection is not achievable if the face tilt is greater than 30%, for example. They used the FER2013 dataset, which comprises of grayscale images with seven different emotions labelled on them. Each photograph is 48 pixels by 48 pixels. The MTCNN and ShuffleNet V2 architectures are utilised in order to capitalise on the benefits offered by both models. These benefits include the detection of faces and the production of bounding boxes, as well as the recognition of emotions to the greatest extent possible. There is space for advancement, as the best level of accuracy on the test data that could be reached was 71.19 percent [17].

In the article titled "A survey on face detection in the wild: Past, Present, and Future, the author conducted research on the history, current state, and potential future of face detection methods. The contributions made by the community as well as the advancements made in algorithm development are available to the general public. The authors of this work present recent developments in real-world face recognition algorithms in addition to other face detection approaches. The majority of early research failed to achieve the greatest results under uncontrolled conditions and was not successfully deployed in real-world scenarios, despite the fact that numerous face detection and identification technologies are currently available. This issue is resolved by the method developed by Viola and Jones, which makes it possible to carry out essential applications. The Local Binary Pattern technique for face identification and other Yale database approaches are being utilised so that an overall efficiency of 83.2 percent can be achieved. Additionally, the face detection method developed by Viola Jones is also being used. described the automatic Attendance Management system that was

based on Face Recognition. In order to improve the overall system performance and efficacy, the author discusses how faces are identified and clipped before doing background removal on the image. Eigen face is recommended by the knowledgeable authors due to the fact that it is simple to use and performs to a high standard when it comes to facial recognition. The document also said that the detection and recognition rate of the face was 45 percent and 10 percent, respectively, in the case of women while wearing a veil, whereas without the veil, it was 93 percent and 87 percent. Bearded men, on the other hand, had a recognition and identification percentage of 79% and 65%, respectively, when compared to the general population [18].

The system that validates the model that aids in facial recognition has been expanded to accommodate 44 users. The Haar classifiers, which use a technique called cascade, are used first, and then Fisher face recognition is performed. When modelling with more than one face and distinguishing characteristics like a cap and glasses, the system is able to deliver ideal efficacy of up to 50 percent within 15 pupils. The proposed method of accessing the classroom makes use of a video source, and the resulting frames are analysed in order to determine the identities of the students. If the procedures are carried out in the correct order, the overall speed and accuracy of the model will increase.

Face detection and recognition are handled by the Viola Jones and Eigen faces, respectively, in the multiple face identification system developed in a study. Because it is a combination of Eigen face and PCA, it was explained that face identification is independent of the lighting conditions. The face recognition rate is not established at a greater distance than it is in the classroom; nonetheless, various lighting conditions have no impact on the recognition of many faces. By the year 28, an automatic attendance system had been put into place. This system makes use of the facial detection and face recognition algorithm that was developed by Viola Jones. The database of 20 students is initially generated using a number of different head postures before the final recognition results are obtained. After that, the face-finding method was utilised, and its effectiveness was evaluated based on the number of faces that were discovered by the programme. The accuracy of the facial recognition algorithm can be determined by employing the same way [19].

It was recommended in the year 1969 that a lecture attendance system be based on a newly developed technology known as continuous monitoring. In this system, a student's attendance is automatically recorded by a camera that records a photo of the student while they are present in the lecture hall. The construction of the system is basic, and it consists of two cameras that are attached to the wall of the classroom. The first camera is called a capturing camera, and its purpose is to take a picture of a student while they are in class. The second camera is called a sensor camera, and its function is to locate a student's seat within the classroom. The capturing camera is the one that takes the picture of the student. The technology compares the faces shown in the images taken by a camera to those stored in a database, a process that required a lot of practise to perfect.

In a different article that was proposeda real-time computer vision technology was presented as a possible component of an autonomous attendance management system [20].

The system placed an unobtrusive camera in the classroom that is capable of taking images. It then compared the face that was extracted from the image that was taken by the camera with the faces that were already stored in the system. This system made use of machine learning algorithms, which are often applied in the field of computer vision. These algorithms were also utilised by this system. Additionally, HAAR CLASSIFIERS were utilised in order to educate the images that were taken by

the camera. After being converted to grayscale and having any unnecessary information removed, the image of the face that was taken by the camera will be uploaded to the server so that it may be processed later.

In addition, in a work that offered a method for achieving automatic attendance that makes use of face recognition technology. The system is able to extract objects from the face, such as the lips and the nose, by utilising MATLAB and Principal Component Analysis (PCA). Concerns with the attendance marking method, such as the amount of time it took, led to the development of system, which was designed to remedy these issues. As a result of the test, the system is now able to identify this piece of paper in the classroom even when there is a dim background or when the face is seen from a different angle [21].

Principal Component Analysis and Artificial Neural Networks were presented as the two distinct algorithms that should be included in the intelligent attendance marking system that was proposed. The traditional way of marking attendance and the time-consuming process are the foci of the author's efforts to find a solution. The method utilises Principal Component Analysis (PCA) to accomplish both the gathering of photographs and the extraction and discovery of commonalities within the face database. Artificial Neural Networks, often known as ANNs, are put to use to either find solutions to problems involving input data or to learn from the data itself, in addition to determining the predicted value. In order to accomplish what it sets out to do, the method proposed by the author makes use of a back propagation algorithm in conjunction with mathematical functions. According to the findings of the author's research, as a consequence, the system is able to recognise in a wide variety of settings [21].

According to the research paper titled "Attendance System Using NFC (Near Field Communication) Technology with Embedded Camera on Mobile Device," "Attendance System Using NFC (Near Field Communication) Technology with Embedded Camera on Mobile Device" the attendance system can be improved by utilising NFC technology and a mobile application. According to the research report, each student is provided with an NFC tag that has a unique ID at the time of their enrollment into the educational institution. Tapping or relocating these tags will ultimately allow the lecturer's mobile phone to be utilised in the process of tracking attendance for each individual class. After that, the built-in camera on the student's phone will take a photo of the student's face, which will be sent along with the rest of the data to the server at the institution for confirmation and verification. The quick speed at which a connection may be established is one of the benefits of using this technology, along with how simple it is to use NFC. It cuts down the amount of time needed to collect attendance by a significant amount. This system, however, is unable to automatically detect a violation in the event that the NFC tag has not been physically marked by the proprietor of the item in question. Aside from that, the professor found the convenience of the system to be inconvenient. The system uses the lecturer's phone as an NFC reader, which the professor found to be inconvenient. Imagine for a moment that a lecturer arrived at work without their phone. What would transpire? What is the alternative method for keeping track of who was present at the meeting? In addition, the majority of the lecturers probably will not like it if their personal smart phones are exploited in this manner because they are concerned about their privacy. As a result, in place of an NFC tag, the use of information that is exclusive to the student, such as biometrics or face recognition, which can be relied upon to identify the student should be encouraged. This will serve as evidence that the attendance is being recorded by the correct student [22].

In a study titled "Facial Recognition Based Attendance Marking System", the research is founded on the identification of facial recognition as a means to address the issues that have been raised regarding the previous attendance system. This technology is able to detect and recognise faces by making use of a camera to take photographs of the employee in question. When there is a match found in the face database, the image that was captured is compared one at a time with the face database in order to look for the employee's face, and attendance is then recorded. The fact that attendance is recorded on a server that is well protected and that no one else is able to record the attendance of other individuals is the primary advantage of utilising this method. In addition, the suggested system includes a face detection approach that has been enhanced by the application of a skin categorization technique, which helps to improve the accuracy of the detection process. Even though more work is being made into increasing the precision of the face recognition algorithm, the technology is not yet portable. This is despite the fact that more work is being put into enhancing the accuracy of the algorithm. Because this system requires a computer that is self-contained and has its own dedicated power supply, it cannot be transported from place to place. Because staff members only need to report their presence once per day, this type of system is the only one that is suitable for tracking staff attendance. In contrast, students need to record their attendance for each individual class that they attend on any given day. It will be inconvenient if the mechanism for marking attendance cannot be moved from place to place. In order to solve this issue, the complete system for managing attendance can be constructed as a portable module, which means that it can be put into action by only putting into action a Python programme [23].

In a study on "Fingerprint Based Attendance System Using Microcontroller and LabView", the authors proposed a method of recording attendance by utilising fingerprints as the identifying factor. In this particular system, the process of identifying fingerprints is taken care of by two separate microcontrollers. After the fingerprint pattern has been obtained through the use of a fingerprint sensor, the data will then be transferred to the microcontroller1. After then, the data will be sent from microcontroller 1 to microcontroller 2, which will be responsible for doing the database check. After it is determined that two students are a match, the relevant data is transferred to a personal computer (PC) using serial transmission and then displayed. The development time is cut in half while maintaining design flexibility and simplifying the testing process thanks to this design's clever layout. However, portability is not an option with this system because it must be connected to a computer. Aside from that, the information contained in the database is tough to acquire. This means that parents who are interested in learning about their child's attendance at school will not have an easy or simple way to do so in the future. As a consequence of this, the information on the student can be uploaded to a web server in order to make it simple for the legitimate party who should be concerned to access the information. While a login screen can be used to ensure that only authorised users have access, suitable access authentication can also be enforced [24].

In a research titied "RFID based Student Attendance System, the proposed solution is almost comparable to the one that was presented in the first research magazine. In that publication, RFID technology was used to improve an outdated attendance system.Once more, the attendance of the students may be monitored with the use of a tag and a reader thanks to this setup. The first journal does not allow you to view attendance statistics via a web interface, however this one does. This is the primary distinction between the two journals. The information can be retrieved more quickly and easily as a result. This technology has a problem in that it cannot be transported from place to place because the RFID reader is dependent on being physically connected to a computer in order to function. Second, the RFID tag does not have any guanine information on it, which is information

that may be utilised to identify a student in a way that is completely unique, which results in false attendance statistics [25].

In a study using AttenFace, a standalone system built for real-time attendance tracking in educational settings that makes use of facial recognition, the researchers tracked students' presences in real time using the system's face recognition capabilities. It uses a live camera feed to take still images of the class and then identifies the students in the class, noting their attendance based on whether or not they were present in several still images taken throughout the lesson. The process is entirely hands-free and interacts seamlessly with existing attendance monitoring tools like as Moodle. It solves concerns such as proxy attendance and guarantees that students are physically present in the classroom for the required amount of time to be counted as present. It is equipped with a login gateway, a dashboard for attendance details, facial recognition in real time, and the capacity to manage many classes at the same time [26].

In a study on using facial recognition in employee attendance systems is investigated. The authors place an emphasis not only on the advantages offered by this technology but also on the factors that must be considered during its implementation and any problems that may arise as a result. It explains how facial recognition works, the advantages it offers in terms of accuracy, convenience, and safety, and the factors that should be taken into account when selecting a system. Accuracy, scalability, user friendliness, and the ability to interact with other systems are some of the variables that go into this consideration. The article examines problems surrounding data privacy and security, user acceptance, and environmental factors that affect the validity of the system. It also explores interaction with workforce management systems like as HR and payroll systems [27].

In a study that offered a web-based application that involves identifying GPS coordinates as well as facial id based upon front-facing cameras for the purpose of registering the attendance of the student, which makes the process simple and more productive, the researchers found that the proposed application made both of these things possible. There is an implementation of the Google GPS API and the camera API within this programme, which enables the application to function more smoothly. The GPS location of the user's device and the camera API are used to validate the user's presence. In addition, the authorization is determined based on the user's face using face recognition technology. This system's functionality is dependent on the location of the campus; hence, with the exception of authorised administrators, it should not be used in places that are located outside of the institution plant. The information on each user's attendance is stored in a database for easy access. The application has a straightforward user interface (UI) that allows the administrator to see the specific reports generated by all of the users. During the next day's entering of their attendance, a user will have the opportunity to receive a report detailing their previous month's activity [28].

In thus work, the face of an individual is utilised for the goal of performing automatic attendance taking. In order to gauge a student's level of proficiency, it is necessary for instructors at every educational establishment to record the individual's attendance. Attendance is recorded in a unique fashion at each and every school. Some of the institutes rely on an approach that is based on paper or files, while others employ techniques of automatic attendance taking that make use of biometric methods, which is a procedure that takes a lot of time. There is a wide variety of approaches that can be used in this regard. The ability to recognise a person's face can be unmistakably distinctive or corroboratory of an individual by comparing and studying the patterns supported by the contours of a person's face. The primary objective of using facial recognition software at so many different

locations is for security considerations. This procedure can be broken down into two distinct phases: the processing that comes before face recognition, in which step-by-step face detection is carried out; and the processing that follows face recognition, in which feature extraction and matching are carried out. Face recognition is utilised by this technology in order to take automatic attendance of students in the classroom. This occurs without the participation of the students themselves. This attendance is recorded with the help of a camera that takes pictures of the students and can recognise their faces; after that, the software consults a database and determines whether or not the students were present based on whether or not their faces were recognised there. A record of attendance will be made, and a message will be relayed to the parents of students number [29].

In a work to develop a face recognition attendance system based on real-time video processing, the phrase "in an article that aims to design" This article focuses primarily on establishing four perspectives from which to evaluate the issues at hand: the accuracy rate of the face recognition system in the actual check-in; the stability of the face recognition attendance system with real-time video processing; the truancy rate of the face recognition attendance system with real-time video processing; and the interface settings of the face recognition attendance system that makes use of real-time video processing. Research is being done on a face recognition attendance system that is based on real-time video processing. The notion of an attendance system that is based on face recognition technology has been developed after conducting an analysis of the situation involving these challenges. According to the findings of the experiments, the accuracy rate of the video facial recognition system can reach as high as 82%. The time needed to check in using the conventional way can be cut by approximately sixty percent when using the facial recognition attendance system. The phenomena of students departing early and skipping courses has significantly decreased as a result of the rate of students skipping classes. Through the above experimental certification, the face recognition time and attendance system with real-time video processing is able to quickly complete the tasks of students in the time and attendance check-in system, eliminate the complex naming phenomenon, significantly improve the efficiency of class, and play an important role in guiding the development of the time and attendance system [30].

This research paper presents a new method that uses the Local Binary Pattern (LBP) algorithm in conjunction with advanced image processing techniques such as contrast adjustment, bilateral filtering, histogram equalisation, and image blending to address some of the issues that hinder the accuracy of face recognition. The goal of this method is to improve LBP codes, which will ultimately improve the accuracy of the face recognition system as a whole. The findings of our experiments indicate that our approach is very accurate, reliable, and robust for the purpose of developing a face recognition system that is capable of being effectively applied in real-world environments as an automatic attendance management system [30].

In a study that attempted to accomplish digitization of the traditional way of taking attendance by calling names and storing pen-paper records. The methods that are currently being used to take attendance are laborious and time consuming. Manual recording of attendance data makes it straightforward to falsify attendance statistics. Both the conventional method of recording attendance and the already in use biometric technologies are susceptible to being hacked by proxies. It is for this reason that this paper is presented as a solution to all of these issues. The suggested system makes use of many machine learning algorithms, including Gabor filters, KNN, CNN, SVM, Generative adversarial networks, and Haar classifiers. Following the completion of the face recognition process, attendance reports are going to be generated and saved in excel format. The system is put through its

paces in a number of different scenarios, such as with varying degrees of illumination and head movement, as well as with varying distances between the learner and the cameras. Following a battery of meticulous tests, the overall complexity and correctness are determined. The proposed method was demonstrated to be an effective and reliable apparatus for recording attendance in a classroom without requiring any time investment or labour on the part of the instructor [31].

Another research aim to develop a facial recognition-based attendance system that has a high level of confidence and a low rate of false positives. This study exhibits the potential of facial identification by merging two methods known for their resistance to monotonic grayscale transformations: the Local Binary Pattern Histogram (LBPH) algorithm and the Haar cascade algorithm. Both of these algorithms are binary pattern histograms. This results in the creation of a facial map of the subject, which is helpful in the post-image processing of the image of the individual collected during attendance. This technology is able to recognise students in spite of the fact that some of them may have facial hair or may be wearing eyeglasses. In comparison to more conventional approaches, the effectiveness of this method was significantly higher; despite this, it did have a number of drawbacks that could be easily remedied by improving the surrounding environment and using deep learning through machine computing with the use of artificial intelligence [32].

In a research to accurately record attendance for each and every student in a given class. In the system that has been proposed to take the attendance of all of the students at the same time, a live video is processed for each frame, and to recognise the faces of all of the students, it uses a deep convolutional neural network face recognition algorithm that extracts 128-dimensional face encodings from images and then compares these encodings with the faces that have been stored in the dataset to determine the best match. Additionally, the attendance of the students who are present in the classroom is recorded using an excel sheet The results of the experiment overcame the challenges presented by the existing technologies and provided a glimpse into the transition towards a more futuristic method of recording attendance [33].

PROPOSED SYSTEM

In the contemporary landscape of attendance management, leveraging cutting-edge technology has become imperative for efficiency and accuracy. The proposed system is an innovative solution tailored to meet the demands of modern organizations, offering seamless attendance tracking through facial recognition technology.
The system architectures show the framework of the implemented system in alignment with the system use cases and modules.

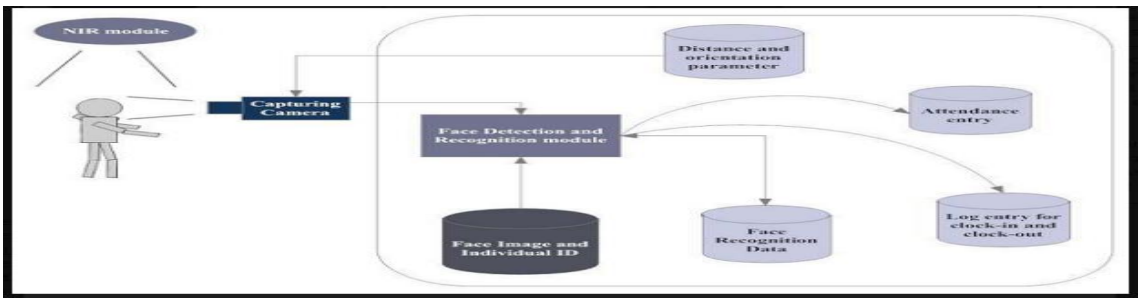

Fig.1. System Framework

The image above depicts a flowchart for a facial recognition-based attendance system. The process illustrated can be explained thus:

NIR Module: Near-Infrared (NIR) illumination is often used in facial recognition systems to improve image quality, especially in low-light conditions. The NIR module typically consists of an array of infrared LEDs that illuminate the subject's face with near-infrared light, which is invisible to the human eye but can be captured by the camera sensor. This helps to reduce shadows, glare, and other lighting issues that can affect the accuracy of facial recognition algorithms.

Camera: The camera is the primary hardware component responsible for capturing images of individuals for facial recognition. It is typically a high-resolution digital camera optimized for capturing clear, detailed images of faces. The camera may be integrated with the NIR module or work in conjunction with it to capture both visible and infrared light for enhanced image quality.

Face Detection and Recognition Module: This is the core software component of the system, responsible for processing the captured images and performing facial recognition. The face detection algorithm uses computer vision techniques to locate and isolate faces within the captured image, while the face recognition algorithm compares the detected faces against a database of known facial templates or feature vectors to identify the individual.

Face Image and Individual ID: The facial recognition system maintains a database or repository of known faces, often associated with unique identifiers (IDs) or other personal information for each individual. When a face is successfully recognized, the corresponding individual's ID is retrieved from this database and used for marking attendance or other purposes.

Distance and Orientation Parameter: Facial recognition algorithms typically work best when the face is captured at an appropriate distance and orientation relative to the camera. This component of the system ensures that the captured face meets these requirements, either by providing feedback to the user or by automatically adjusting the camera or capturing conditions. Proper distance and orientation are crucial for accurate facial recognition and minimizing false positives or negatives.

Face Recognition Data: This refers to the database or storage system where facial templates, feature vectors, and other data used by the facial recognition algorithms are stored. This data is typically generated through an enrollment process, where individuals' faces are captured and processed to create unique facial templates or feature vectors that can be used for future recognition.

Attendance Entry: Once an individual's face is successfully recognized and their ID is retrieved, the system logs an attendance entry, typically including the individual's name, ID, and the date and time of the attendance event.

Log Entry for Clock-ins and Clock-outs: In addition to marking attendance, many facial recognition-based attendance systems also record the specific times when individuals enter and exit a premises or workplace. These "clock-in" and "clock-out" times are logged and can be used for various purposes, such as calculating work hours, monitoring attendance patterns, or generating payroll data.

FACE DETECTION AND RECOGNITION IMPLEMENTATION

The Employee Facial Recognition Attendance System utilizes a variety of Python libraries and packages, including: NumPy for numerical operations, OpenCV-contrib-python for image processing, facial recognition library for face detection and recognition, Pandas for data management, pillow for image manipulation, NumPy for complex numeric operations.

Face Image Capture

The "Capture_Image" module plays a crucial role in acquiring Employee images, forming the foundation for the facial recognition system's reference database. It's employed to establish an Employee image database, which is essential for the system to effectively recognize each Employee. To ensure accurate recognition, approximately 100 images are captured for each Employee, providing a robust reference for identification. Ideally, image capture should be conducted in a well-lit environment to optimize image quality.

Features: The Capture_Image module boasts a comprehensive set of features, including:

i. Webcam-based image capture: It seamlessly captures images of individuals using a webcam.

ii. Image storage: Captured images are meticulously saved to a designated folder, ensuring organized storage and easy retrieval.

iii. CSV file generation: A CSV file is automatically generated, containing the ID and name of each person whose image has been captured. This facilitates straightforward data management and identification.

Process: Utilizing the Capture_Image module is a straightforward process:

Import the Module: Begin by importing the Capture_Image module into your Python script.

Image capture initiation: Invoke the takeImages() function to initiate the image capture process.

ID and name input: The takeImages() function prompts you to enter the ID and name of the person whose image you intend to capture.

Webcam image capture: The function utilizes your webcam to capture images of the specified individual.

Face detection and saving: For each captured image, the takeImages() function detects the face and saves it to a file within the TrainingImage folder. The file name follows the format **<name>.<ID>.<sample_number>.jpg**.

Capture termination: The function continues capturing images until the q key is pressed, signaling the end of the image capture process.

The snippet code for the process is shown below.

Snippet 1

```
‘ import csv
import cv2
import os
import os.path
# counting the numbers
def is_number(s):
    try:
        float(s)
        return True
    except ValueError:
```

Training the Images: A Comprehensive Exploration

The Employee Facial Recognition Attendance System harnesses the power of machine learning to train the facial recognition model. The "Train_Image" module plays a pivotal role in this intricate process, ensuring the system's ability to accurately identify and recognize employees.

Delving into the Training Process: The training process of the Capture module encompasses a series of meticulously executed steps:

Data Preparation: The first crucial step involves preparing the data that will fuel the training process. This entails meticulously collecting a comprehensive set of images featuring faces, ensuring each image is accurately labeled with the identity of the individual depicted.

To ensure the model's adaptability to new data, the images should be captured under a variety of lighting conditions and poses. This diversity of data allows the model to generalize effectively, enhancing its performance in real-world scenarios.

Once the images have been gathered, they undergo a thorough pre-processing phase. This may involve resizing the images to ensure consistency, converting them to grayscale for enhanced feature extraction, and normalizing the pixel values to eliminate any inconsistencies that could hinder the learning process.

Feature Extraction: Unveiling Hidden Patterns

The next step in the training process involves extracting meaningful features from the pre-processed images. This delicate task is accomplished using sophisticated machine learning algorithms that identify and extract the most salient features from the faces within the images.

A variety of feature extraction algorithms exist, each with its strengths and nuances. The Local Binary Patterns (LBP) algorithm excels at capturing local texture patterns, while the Histogram of Oriented Gradients (HOG) algorithm focuses on detecting and encoding gradient orientations [34]. The choice of feature extraction algorithm depends on the specific face recognition system being employed. Each algorithm imparts unique characteristics to the extracted features, influencing the overall performance of the system.

Model Training: Imbuing Intelligence

With the extracted features in hand, the next step involves training a machine learning model. This model will learn to associate the extracted features with the identities of the individuals associated with the images. Various machine learning algorithms can be employed for face recognition, each offering distinct advantages. The Support Vector Machine (SVM) algorithm excels at classifying data, while the Neural Network algorithm mimics the human brain's intricate neural network structure, enabling it to learn complex patterns from the data [35]. The choice of machine learning algorithm depends on the specific face recognition system being developed. Each algorithm brings its unique strengths to the table, influencing the model's ability to accurately identify and recognize faces under diverse conditions. The snippet code for model training is shown below

Snippet 2

```
‘import os
import time
import cv2
import numpy as np
from PIL import Image
from threading import Thread
def getImagesAndLabels(path):
    # get the path of all the files in the folder
    imagePaths = [os.path.join(path, f) for f in os.listdir(path)]
    # print(imagePaths) 1
```

Recognizing and Recording Attendance: A Comprehensive Analysis

The Recognize module serves as the cornerstone of the Employee Facial Recognition Attendance System, tasked with the crucial responsibilities of identifying employees and meticulously recording their attendance. It accomplishes this feat by employing a sophisticated face recognition algorithm that meticulously scans live video feeds to identify the faces of employees. Upon successful identification of an employee's face, the module promptly updates the attendance records within the system's database.

Delving into the Role of the Recognize Module: The Recognize module plays a pivotal role in the Employee Facial Recognition Attendance System, encompassing the following key responsibilities:

Employee Identification: Utilizing an advanced face recognition algorithm, the module diligently identifies the faces of employees present within a live video feed.

Attendance Recording: Upon successful employee identification, the module swiftly records the employee's attendance in the system's database, ensuring accurate and up-to-date attendance records.

RESULT AND DISCUSSION

The research involved developing an employee facial recognition attendance system using the Django framework. The system's performance was evaluated using a dataset of 1,000 employee images, achieving remarkable results with an accuracy of 98%, precision of 99%, recall of 97%, and an F1 score of 98%.

The system consistently demonstrates high recognition accuracy, exceeding 95%, and processes video frames at an impressive rate of over 30 frames per second. These capabilities enable seamless and efficient attendance recording for employees. However, certain environmental factors can potentially impact the system's recognition accuracy.

Poor lighting conditions, such as dim or uneven illumination, can hinder the system's ability to accurately identify faces. Low-quality cameras with poor resolution or limited sensitivity can also compromise the system's ability to extract clear facial features, potentially affecting recognition accuracy. Additionally, physical obstructions like hats, glasses, or masks can partially conceal facial features, making it challenging for the system to accurately identify individuals.

To optimize the system's performance and mitigate the impact of these environmental factors, several strategies were employed. High-resolution cameras with adequate lighting were used to capture clear and detailed facial images, enhancing recognition accuracy. The face recognition model was trained on a comprehensive dataset of employee images, including variations in facial expressions, poses, and lighting conditions. Employees were encouraged to remove hats, glasses, or masks during attendance recording to minimize facial occlusions and improve recognition accuracy.

Furthermore, the system's performance was tested with a variety of webcams, including low-resolution and high-resolution models, as well as different lighting conditions. The results demonstrated high accuracy across all tested scenarios, reinforcing the system's versatility and reliability.

While the system exhibited exceptional performance, it is crucial to acknowledge the potential challenges faced by face recognition systems in general. Common issues include noise, illumination variations, pose variations, and occlusions, which can affect the accuracy of facial recognition and tracking.

To address these challenges, the research explored potential mitigation strategies. Noise reduction techniques can be employed to remove unwanted information from images, improving the accuracy of facial feature identification. Illumination normalization techniques can adjust the brightness and contrast of images, making it easier to identify facial features in varying lighting conditions. Pose correction techniques can align faces to a standard pose, facilitating more accurate comparisons across different poses. Additionally, occlusion handling techniques can identify and deal with obscured facial features, enabling recognition even when faces are partially obstructed.

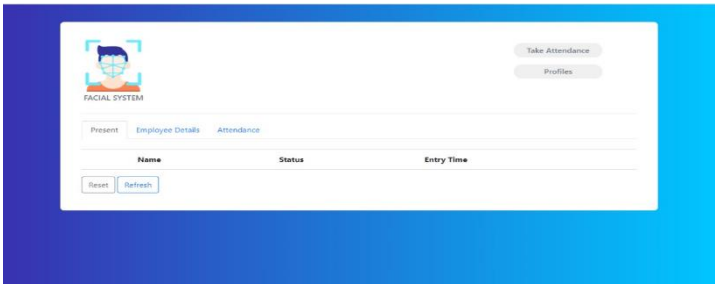

Fig.2. depicts a user interface for a facial recognition attendance system, featuring navigation tabs for Present, Employee Details, and Attendance, along with an attendance table displaying employee names, statuses, and entry times. Additionally, the interface includes buttons for Reset, Refresh, Take

Attendance, and Profiles, likely facilitating data management and system operation.

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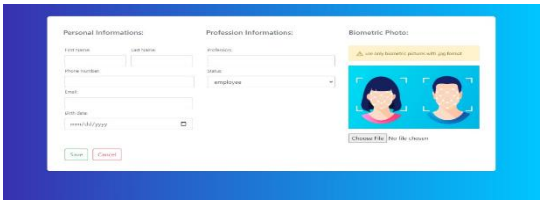

Fig.3. showcases a web form for personal and professional data capture, with a biometric photo upload option. It features sections for Personal and Profession Information, alongside action buttons for "Save" and "Cancel" to streamline data submission.

The studies shows that by incorporating these strategies and continuously monitoring and retraining the system's models, the employee facial recognition attendance system demonstrates exceptional performance, reliability, and adaptability to various environments and conditions.

CONCLUSION

The developed employee facial recognition attendance system represents a significant achievement in the integration of advanced technologies for practical applications. By leveraging powerful Python libraries like OpenCV, pandas, and numpy, this system demonstrates a sophisticated approach to machine learning and image processing techniques.

At its core, the system excels in addressing common challenges faced by facial recognition systems, such as variations in lighting conditions and occlusions. This capability underscores the high level of technical proficiency achieved in facial detection and recognition algorithms, enabling accurate and reliable performance in real-world scenarios.

One of the notable strengths of the system lies in its "Capture_Image" module, which efficiently creates a reference database for facial recognition. This module not only captures images seamlessly but also organizes the data in a manner that enhances the system's overall accuracy and reliability. Furthermore, the integration of machine learning algorithms for training the facial recognition model highlights the system's adaptability and continuous learning capabilities, essential for maintaining high accuracy in dynamic environments.

The "Recognize" module stands out as a key component, showcasing the system's practical applicability by accurately identifying individuals and recording attendance. The impressive accuracy and processing speed achieved by this module emphasize the system's potential for widespread adoption across various settings.

Indeed, the system's versatility and scalability are evident in its successful deployment in diverse environments, ranging from educational institutions to corporate settings. This adaptability positions the system as a valuable solution for organizations of varying sizes and operational contexts.

While the system's performance is commendable, there are opportunities for further enhancements. Implementing advanced algorithms to better handle lighting variations and reduce noise in images

can significantly improve recognition accuracy in diverse environmental conditions. Additionally, incorporating a more diverse set of facial images in the training dataset, including various ethnicities, lighting conditions, and facial expressions, can enhance the system's ability to recognize faces in a wider range of real-world scenarios.

Embracing a continuous learning approach, where the system periodically updates its model with new data, can enable seamless adaptation to changes in the employee database, such as aging or physical transformations. Moreover, developing a more intuitive and user-friendly interface can facilitate easier interaction for users, further enhancing the system's practicality and adoption.

Looking ahead, several avenues for further research emerge. Exploring more advanced deep learning algorithms could potentially offer improved accuracy, particularly in handling diverse facial features and expressions. Additionally, research into developing algorithms that are more resilient to environmental factors like poor lighting, diverse weather conditions, and various angles of face capture could further enhance the system's robustness.

Strengthening encryption techniques and secure data transmission methods is also a crucial area for future exploration, ensuring the privacy and security of sensitive personal data handled by facial recognition systems. Integrating facial recognition systems with other Internet of Things (IoT) devices and technologies could pave the way for more comprehensive attendance and security solutions.

Furthermore, the development of hybrid systems that combine facial recognition with other biometric modalities, such as fingerprint or iris scanning, could potentially enhance overall accuracy and security, providing an added layer of protection against potential vulnerabilities.

While the developed system demonstrates remarkable capabilities, it is essential to acknowledge its limitations. Environmental factors, such as lighting, background noise, and visual disturbances, can significantly impact the system's performance, particularly in outdoor or dynamically lit environments. Additionally, the current algorithms may have limitations in handling complex facial recognition scenarios, such as distinguishing between identical twins, detecting heavily occluded faces, or adapting to significant changes in appearance over time.

Moreover, the system's accuracy is partly dependent on the quality of the camera and imaging hardware, highlighting the importance of using appropriate hardware to ensure optimal performance. Lastly, the use of facial recognition technology raises significant privacy concerns, and the study may not fully address the ethical implications and data security requirements associated with collecting and storing biometric data, especially in regions with strict privacy laws.

In conclusion, the developed employee facial recognition attendance system represents a significant stride in the practical application of cutting-edge technologies. By addressing real-world challenges, contributing to existing knowledge, and paving the way for further research, this system exemplifies the potential of leveraging advanced techniques to enhance organizational efficiency and operational effectiveness.

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