



ORIGINAL RESEARCH PAPER

Machine Learning

A SYSTEMATIC REVIEW OF ATTENDANCE SYSTEMS BASED ON FACE RECOGNITION

KEY WORDS: Attendance System, Face Detection and Recognition, Convolutional neural network (CNN), PCA, FaceNET Embeddings, YOLO, Viola-Jones

Shaunak Modak	Student of Computer Science and Business System, Mukesh Patel School of Technology Management and Engineering Mumbai, India
Hetvi Shah	Student of Computer Science and Business System, Mukesh Patel School of Technology Management and Engineering Mumbai, India
Ria Surana	Student of Computer Science and Business System, Mukesh Patel School of Technology Management and Engineering Mumbai, India
Dhirendra Mishra	Professor of Computer Engineering department, Mukesh Patel School of Technology Management and Engineering Mumbai, India

ABSTRACT

In this digital era, face recognition system plays a vital role in almost every sector. Face recognition is one of the most implemented biometrics across various different fields. Classroom attendance check is a contributing factor to student participation and the final success in the courses. Every institute follows their own way for taking attendance. Some are taking attendance manually using papers or a register file or different biometric techniques. Taking attendance by calling out names or passing around an attendance sheet is time-consuming, and the latter is open to easy fraud. In this paper, the comparative analysis of various existing approaches on attendance management system based on facial recognition that are used to monitor attendance in various institutions using Fingerprint, GPS, RFID etc. is discussed with their limitations.

I. INTRODUCTION

The majority of educational institutions still mark attendance manually using the traditional ways [14]. Since active engagement in class boosts learning effectiveness and success rates, most educational institutions are concerned about student attendance. Additionally, a high participation rate in the class encourages teachers and creates a conducive climate for more enthusiastic and informed instruction. Regularly taking attendance is the most common practice that has been shown to boost course attendance. Some teachers prefer to use profanity and assign grades for being present or absent. This non-technological method takes a lot of time and is vulnerable to fraud [5].

The manual attendance system generates a significant amount of paperwork. It uses a lot of paper and there is a chance for human error, which might delay or be problematic for the students when marking attendance. The manual attendance system is time-consuming; thus, many research has been conducted with the automatic or smart attendance management system to resolve this issue. One solution is the application of biometric attendance management system. However, it is difficult to verify each student in the classroom as there are many students who attend the class, and if the system cannot detect or recognize one student, it will interrupt the learning process. In addition, the biometric system needs much hardware that requires high cost and a lot of interaction with the students that makes it a time-consuming system. Our daily lives depend heavily on human faces, especially for identifying people. The research on applying real-time facial recognition in attendance management system has been a real challenge. Automatic attendance marking can solve the main issues such as the error when inputting the data from the sheet to the manual attendance system, especially there is a concern that the data is not 100% accurate in the traditional attendance marking method considering the extremely large number of students in a university.

Recent researches show there is a betterment in facial recognition systems. In the last ten years there is huge development in recognition techniques. But currently most of the facial recognition techniques is able to work fine only if the number of people in one frame is very few and under controlled illumination, proper position of faces and clear

images. For face recognition purpose, there is a need for large data sets and complex features to uniquely identify the different subjects by manipulating different obstacles like illumination, pose and aging.

This paper presents a review on Attendance and Monitoring Systems. There are various types of techniques use to records attendance and monitoring system such as YOLO, MTCNN, FaceNET Embeddings [14] for face recognition and Viola-Jones, DNN for face detection [18].

The next section will include Literature review of the previous research and how each researcher implements the attendance management system by using face recognition. The details of limitations will be introduced after the literature review.

II. LITERATURE REVIEW

This section includes the literature review which defines the different existing algorithms implemented for face recognition and various techniques implemented for attendance systems in general. Face recognition approaches are generally classified as feature-based and holistic approaches. In holistic based approaches, recognition is done based on global features from faces, whereas in feature-based approaches, faces are recognized using local features from faces [16].

A face recognition model was developed as a face attendance machine [7] using a hybrid feature extraction method using CNN-PCA was built using a combination of face detection and face recognition framework model using real-time cameras. The accuracy for this method was 98% but this was a web application and could be implemented on a single machine. Thus, taking attendance would be a tedious job.

A device was built that utilized a modified Haar cascade algorithm for human face detection, and a CNN algorithm is used for recognition [2] and got 94.6% accuracy on a real-time database for the attendance system.

Another novel approach of face augmentation was proposed for the purpose of extending the dataset. CNN cascade is used for a face detection and linear Support Vector Machine (SVM) [1] was applied for this classification task. The overall

accuracy was 95.02% on a small dataset of the original face images of employees in the real-time environment. Even though the datasets were small the noising and blurring of each employee had to be done before using Dlib (a python library for face image augmentation).

An Android based course attendance system using face recognition [10] was developed to ensure the student attend in the course, QR code contained the course information was generated and displayed at the front of classroom. The student only needed to capture his/her face image and displayed QR code using his/her smartphone. The proposed attendance system used some simple classifiers for face recognition, including logistic (LR), linear discriminant analysis (LDA), and k-nearest neighbor (k-NN). Achieved face recognition performance of 97.29% by employing LDA and only needed 0.000096 s for face recognition process in the server. The drawback for this system was that a student could give his/her attendance from another device as well.

A face recognition attendance system on the Android platform [11] was designed and implemented where the face is detected by the Adaboost cascade classifier and Local Binary Pattern (LBP), Fisherface and Eigenface are tested for face recognition. The drawbacks of these methods were that Adaboost takes a long time for training, and its effects depend on the selection of weak classifier and the time efficiency of LBP algorithm in the training stage of face recognition classifier is significantly higher.

An attendance system which can simplify and speed up the process by using a mobile application based on geofencing and face recognition [12] has also been developed where each of the employees has their own geofencing area which worked as a location virtual boundary. The face recognition process using k-Nearest Neighbors (k-NN) and Principal Component Analysis (PCA). The results obtained are 90% accuracy rate with a processing time of 1.5 seconds. The fastest time to do a complete presence is 3.4s which include a geofencing authentication and face recognition process. The drawback was that time to predict a face becomes longer as the datasets raises and a user can easily deceive the geofencing system as the user could be within the range of the radius but not actually in the premises of the organization.

A model was implemented for an automated attendance management system for students of a class by making use of face recognition technique, by using Eigenface values, Principal Component Analysis (PCA) and Convolutional Neural Network (CNN) and face detection by Viola-Jones algorithm [4]. The accuracy was high along with minimum human intervention but the drawback was that if a student face is not visible to classroom camera, he/she might not get the attendance.

A web-based attendance application implemented using CNN architecture to provide attendance of students using face recognition [3], in realtime. Data Augmentation technique is used to overcome the challenges of acquiring huge train and test datasets. The proposed CNN model showed an accuracy of 99% for small dataset but the proposed model is not robust for a greater number of students.

An attendance system which includes three different mobile applications for teachers, students, and parents to manage and perform the real-time attendance-taking process. Viola-Jones face detection method with Ada-Boost was used for face detection and three appearance-based face recognition techniques such as Eigenfaces, Fisherfaces and LBP are used in the system [5] and found that LBP gives very good results regarding speed and discrimination performance and in different lighting conditions. But the main drawback of this system was that with the increasing distance between camera

and student, accuracy decreased.

A face recognition-based attendance system using YOLO, MTCNN, FaceNet Embeddings [14] by applying multiple augmentations, picture quality check and de-noise methods. SVM with FaceNet is used for face recognition. The model showed an accuracy of more than 95%. Even though the concept of quality check and de-noise was used, the model still identified the student that was not the part of the training set as someone else and mark attendance. Another drawback was that the MTCNN has a complex architecture and took a huge amount of time to run.

A mobile attendance application equipped with face recognition and a GPS locator was developed [15]. This application used LBPH for face recognition and was integrated with Google Maps API for location. The efficiency ranged from 75% to 95% but the main drawback of LBPH was that it is highly prone to scaled images i.e., once the algorithm extracts a feature, the program can only identify the person when provided with an image at the same scale.

Another mobile application that allows lecturers to generate class attendance and students to submit the attendance by scanning their faces using their mobile phone camera along with their location [16]. This application makes use of Azure Face API that has pre-loaded face detection and recognition algorithm and Admin-provided approval process for students that minimizes the effort on the admin of the system by allowing the students to register their faces. This application showed an accuracy of 90% but the major drawback was that the Azure face is not available for free.

A face recognition-based attendance scheme through mobile platform and face recognition technology to optimize manual attendance was developed [6]. Local binary pattern was used in this model for face recognition. It was concluded that LBP got trained faster compared to eigenface and Fisherface. But the only drawback was that the model could be trained only up to a certain number of images.

An attendance system based on a three sub-system model API service, face recognition using YOLO v5 and visitor identification system was propose [8]. The system took a lot of time to train but it was very accurate and could detect multiple faces at once. The only drawback was the requirement of a high-level GPU or else the model will take a lot of time to train.

A model for attendance system using local binary pattern algorithms with histogram equalization to obtain high resolution images to improve recognition rate was implemented [9]. It compared CNN and LBP on the datasets. And saw that LBP works better on small datasets and CNN works better on big datasets.

The fundamental working rule of the venture is that, the video caught information is changed over into picture to identify and perceive it [17]. CNN calculation is executed to recognize the faces. A CNN (Convolution Neural Network), utilizes a framework like a multilayer perceptron, intended to process the prerequisites faster. After the end of distinguishing and preparing the face, it is contrasted with the face's present in the understudy's database to refresh the participation of the students. The post- preparing component includes the way toward refreshing the names of the understudy into an exceed expectations sheet. The exceed expectations sheets can be kept upon a week after week premise or month to month premise to record the understudy's participation. The relative angle of the person's face affected the accuracy.

The identification of a person by facial features Known as facial recognition. A face feature can be used for various computer-based vision algorithms such as face recognition, emotion detection and multiple camera surveillance

applications. Face recognition system is attracting scholars towards it. In this, different methods such as SVM, MLP and CNN are discussed. DNN is used to “face detection” [18]. For SVM and MLP approaches, the features like PCA and LDA extracted using extraction algorithms. In CNN approach, images fed directly to CNN module as a feature. The approach shows good detection accuracy percentage for CNN based approaches. SVM, MLP and CNN achieve test accuracy of 87%, 86.5% and 98% on self-generated databases respectively. But the system had issues with performance and accuracy.

This system proposed that we need to catch the picture from the webcam or the outside camera. To do as such, in MATLAB, they introduce the drivers from the math works site dependent on the sort of camera we are utilizing. Next, they use any rate 500 to 1000 catches of every individual [19]. For getting higher level of exactness they used some HD camera so as to get results. For face distinguishing, we can do it utilizing the article falling class and we utilize the b-box technique. The caught countenances are trimmed into little pictures of goals 112x92. It would associate with 11 KB of size. The faces taken in the database are expected to stack into our workspace. We will stack the gallery images into that. All the HOG highlights separated are put away as exhibit list it restores a mark to which the given information matches or about coordinated. Higher accuracy of the system can be obtained using different methods.

III. DISCUSSION

This section discusses various techniques of face detection and recognition and research gaps discovered in literature survey.

Attendance is most important in any organization and various techniques are used to monitor attendance which will be discussed in this section.

Firstly, to mark the attendance, the images of students' faces will be required. This image can be captured from the camera, which will be installed in the classroom at a position from where the entire classroom is visible. This image will be considered as an input to the system. For efficient face identification, the picture should be upgraded by utilizing some image processing methods like grayscale conversion and histogram equalization. After image quality upgrade, the image will be passed to perform face detection. The face identification process is trailed by face recognition process. There are different strategies accessible for face recognition like Eigen face, PCA and LDA hybrid algorithm. Developing the face database is required with the end goal of comparison. Another major drawback is that with the increasing distance between camera and student, accuracy decreased. This problem can be solved by using mobile phones instead of placing camera in classroom for attendance. Most of the system used data augmentation for collecting huge amount of data. In order to achieve high accuracy, large volume of training data is required. This technique is used to generate new samples by manipulating the existing data [3].

Viola-Jones, a face detection algorithm is only used to detect frontal faces by using AdaBoost for selecting best subset features [5]. One of the most used object detection technique is YOLO You only live once that detects objects in real-time with great accuracy.

The system using YOLO took a lot of time to train but it was very accurate and could detect multiple faces at once. The only drawback was the requirement of a high-level GPU or else the model will take a lot of time to train [8]. If one algorithm fails to identify the object, the overall accuracy of the model gets decreased. So using combination of two algorithms was introduced for face detection [14]. If one algorithm fails to identify the object, it will be passed to next

algorithm thus increasing the durability of the model.

CNN algorithm is a machine learning method for manipulation of 2-D objects. One drawback of the system that uses this algorithm is the database was too large as they had 60 images per student for training the model [2]. Thus, this algorithm is not robust for large datasets [3]. FaceNET directly learns a mapping from face images to a compact Euclidean space where distances directly correspond to a measure of face similarity. This face recognition was used by applying multiple augmentations, picture quality check and de-noise methods. It was observed that if image de-noising and quality check was not done accuracy decreased. PCA is a statistical approach used for reducing the number of variables in face recognition. In PCA, every image in the training set is represented as a linear combination of weighted eigenvectors called Eigenfaces. The real-time attendance management system requires low computational process time. Therefore, three appearance-based face recognition techniques such as Eigenfaces, Fisherfaces and LBP are used in the tested system. Fisherfaces and eigenfaces techniques have a varying success rate, depending on different challenges, like pose variation, illumination, or facial expression. Fisherfaces is especially useful when facial images have large variations in illumination and facial expression. Fisherfaces removes the first three principal components responsible for light intensity changes and thus it is better than eigenfaces. LBP which relies on pixels of image method gives very good results regarding speed and discrimination performance as well as in different lighting conditions.

Geofencing system that uses GPS which defines the virtual boundary was not accurate as the user could be within the range of the radius but not actually in the premises of the organization [12].

Many studies have explored the various aspects of attendance system based on face recognition along with other functionalities like GPS, QR code scanner etc. The major drawbacks of the existing systems were students could easily stand-in place of other students to mark their attendance, GPS proposed systems the attendance could be recorded even if the user was outside the premises but within the specified range. Most of the applications have high chances of proxy as students can give their attendance from anywhere and at any time during the lecture. The drawbacks related to face recognition were some of the algorithms like CNN required a large dataset for a particular employee/student which becomes a relatively tedious task, other algorithms like PCA were sensitive to head orientation and illumination variations, some of the applications on which these methodologies were implemented were paid applications e.g., Azure.

IV. CONCLUSION

Students' engagement and performance in class are supported by regular attendance verification. There are various existing systems for attendance management but facial recognition turns out to be a viable option because of its high accuracy along with minimum human intervention. This paper explained all the methods and limitations of each method.

There are various different methodologies implemented for attendance systems using multiple algorithms and different functionalities like attendance based on OTP, GPS, Face recognition, RFID, QR scanner as well as a combination of these methods. But still there are high chances of proxy and problems related to illumination variation and head orientation persists. Thus, the attendance management systems based on facial recognition still have issues, allowing researchers to improve on the current research in order to make the attendance management system work more efficiently.

REFERENCES

- [1] M. Arsenovic, S. Sladojevic, A. Anderla and D. Stefanovic, "FaceTime — Deep learning based face recognition attendance system," *2017 IEEE 15th International Symposium on Intelligent Systems and Informatics (SISY)*, 2017, pp.000053-000058, doi:10.1109/SISY.2017.8080587.
- [2] P. Patil and S. Shinde, "Comparative analysis of facial recognition models using video for real time attendance monitoring system," *2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, 2020, pp. 850-855, doi: 10.1109/ICECA49313.2020.9297374.
- [3] S. Kakarla, P. Gangula, M. S. Rahul, C. S. C. Singh and T. H. Sarma, "Smart Attendance Management System Based on Face Recognition Using CNN," *2020 IEEE-HYDCON*, 2020, pp. 1-5, doi: 10.1109/HYDCON48903.2020.9242847
- [4] S. Sawhney, K. Kacker, S. Jain, S. N. Singh and R. Garg, "Real-Time Smart Attendance System using Face Recognition Techniques," *2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, 2019, pp.522-525, doi:10.1109/CONFLUENCE.2019.8776934.
- [5] R. Samet and M. Tanriverdi, "Face Recognition-Based Mobile Automatic Classroom Attendance Management System," *2017 International Conference on Cyberworlds (CW)*, 2017, pp. 253-256, doi: 10.1109/CW.2017.34.
- [6] X. Bai, F. Jiang, T. Shi and Y. Wu, "Design of Attendance System Based on Face Recognition and Android Platform," *2020 International Conference on Computer Network, Electronic and Automation (ICCNEA)*, 2020, pp. 117-121, doi:10.1109/ICCNEA50255.2020.00033.
- [7] E. Winarno, I. Husni Al Amin, H. Februariyanti, P.W. Adi, W. Hadikurniawati and M. T. Anwar, "Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera," *2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*, 2019, pp. 301-304, doi: 10.1109/ISRITI48646.2019.9034596.
- [8] Mardiana, M. A. Muhammad and Y. Mulyani, "Library Attendance System using YOLOv5 Faces Recognition," *2021 International Conference on Converging Technology in Electrical and Information Engineering (ICCTEIE)*, 2021, pp.68-72, doi:10.1109/ICCTEIE54047.2021.9650628.
- [9] H.-W. Lee, W.-T. Gu and Y.-Y. Wang, "Design of Face Recognition Attendance," *2020 IEEE 5th International Conference on Image, Vision and Computing (ICIVC)*, 2020, pp.222-226, doi:10.1109/ICIVC50857.2020.9177492.
- [10] Sunaryono, Dwi & Siswantoro, Joko & Anggoro, Radityo. (2021). An Android Based Course Attendance System Using Face Recognition. *Journal of King Saud University - Computer and Information Sciences*. 33. 304-312. 10.1016/j.jksuci.2019.01.006.
- [11] X. Bai, F. Jiang, T. Shi and Y. Wu, "Design of Attendance System Based on Face Recognition and Android Platform," *2020 International Conference on Computer Network, Electronic and Automation (ICCNEA)*, 2020, pp. 117-121, doi:10.1109/ICCNEA50255.2020.00033.
- [12] A. S. Shahab and R. Sarno, "Android Application for Presence Recognition based on Face and Geofencing," *2020 International Seminar on Application for Technology of Information and Communication (iSemantic)*, 2020, pp. 208-213, doi:10.1109/iSemantic50169.2020.9234253.
- [13] D'Silva, K., Shanbhag, S., Chaudhari, A., Patil, M.P.: Spot me-a smart attendance system based on face recognition. *Int. Res. J. Eng. Technol. (IRJET)* 6(3), 4239 (2019)
- [14] N. Darapaneni et al., "Automatic Face Detection and Recognition for Attendance Maintenance," *2020 IEEE 15th International Conference on Industrial and Information Systems (ICIIS)*, 2020, pp. 236-241, doi: 10.1109/ICIIS51140.2020.9342670.
- [15] Baskaran, Geetha. (2016). Attendance System Using a Mobile Device: Face Recognition, GPS or Both?. *International Journal of Advances in Electronics and Computer Science*. 3. 26-32.
- [16] M. S. Mubarak Alburaiqi, G. Md Johar, R. A. Abbas Helmi and M. Hazim Alkawaz, "Mobile Based Attendance System: Face Recognition and Location Detection using Machine Learning," *2021 IEEE 12th Control and System Graduate Research Colloquium (ICSGRC)*, 2021, pp. 177-182, doi: 10.1109/ICSGRC53186.2021.9515221.
- [17] *International Journal of Engineering and Advanced Technology (IJEAT)* ISSN: 2249 – 8958, Volume-8, Issue-3S, February 2019 Face Recognition Based Attendance System. Nandhini R, Duraimurugan N, S.P. Chokkalingam
- [18] R. C. Damale and B. V. Pathak, "Face Recognition Based Attendance System Using Machine Learning Algorithms," *2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS)*, 2018, pp. 414-419, doi:10.1109/ICCONS.2018.86629