Real-Time Attendance System Using Face Recognition

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Abstract

Attendance systems have evolved significantly over the years, and the traditional method of marking attendance using pen and paper has become obsolete. With advancements in technology, a more reliable and efficient attendance system can be developed using real-time face recognition techniques. This paper presents a real-time smart attendance system that uses live video capturing and face recognition based on the Histogram of Oriented Gradients (HOG) feature extraction technique and the OpenCV library. Here OpenCV is built on CNN. The proposed system can accurately and efficiently detect and recognize faces in a live video stream, allowing for real-time attendance tracking and monitoring. The system uses a HOG-based face detector to locate faces in the video stream, and then applies a face recognition algorithm based on OpenCV to recognize the faces and match them against a pre-existing data of registered students or employees. Attendance will be automatically displayed in a web application that can be accessed only by authorized person. Experimental results demonstrate that the proposed system achieves real-time performance and high accuracy, with an average recognition rate of 98%.

Keywords: OpenCV, Histogram of Oriented Gradients (HOG), Face Recognition, Haar cascade.

1. Introduction

Face recognition is currently a research field where several innovative techniques have been discovered for accurate and effective face identification. At many institutions, the conventional technique of marking travel times to work might be a tiresome process. Schools have an important duty to record attendance by identifying students, which might take up to five minutes for a complete session. This can be a lengthy process. As a result, various institutions started using a wide range of additional recording techniques, including fingerprint recognition and frequency identification (RFID). These web-based methods can, however, be time-consuming and disruptive. Attendance systems are used in various educational institutions and organizations to record the presence of employees or students. Traditionally, attendance was marked manually, but this method is time-consuming and prone to errors. Therefore, automated attendance systems have been developed to increase efficiency and accuracy.

1.1. Problem with Traditional Method

Automatic attendance systems based on RFID (Radio Frequency Identification) employ radio waves to identify and track people, typically using RFID tags placed in ID cards or badges. Although these methods can be useful and effective, there are a few potential issues that should be taken into account:

- Interference: Other electrical equipment or materials, such as metal, can interfere with RFID signals and cause disruptions, which might result in inaccurate attendance records.
- Proxy attendance is when someone falsely records their presence on behalf of someone else who isn't there. RFID based automatic attendance systems are susceptible to this kind of fraud and are not impervious to proxy attendance. For instance, even if the owner of the RFID ID card or badge is not there, they could still register attendance on their behalf if they have access to it.

1.2. Proposed Solutions

In order to avoid the above mentioned shortcomings, biometric based attendance systems can be used. The two common biometric identification technology are fingerprint recognition and face recognition. There are many fingerprint based attendance systems in use. But the major issue with fingerprint based system is that the accuracy is low and the performance depends on the sensors used and the environmental conditions (error rates are high during extreme winter or summer). The False Acceptance Rate (FAR) and False Rejection Rate (FRR) are high in fingerprint based systems (total error rate is 1% approximately). To

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overcome the above challenges faced by fingerprint based attendance systems, face recognition is adopted. Using face recognition, we can reduce the rate of error and thus build an accurate system. Also, face recognition systems are contact-less thereby limiting the spread of infections or illness. The system is highly secure compared to fingerprint based systems thereby preventing incidents like forgery or buddy punching.

2. Related Works

In this paper [1] Student Attendance System using Face Recognition proposed by S. Dev, they have used the images captured are ameliorated using Generative Adversarial Networks to retain texture information. For face detection, Haar classifiers are used and 68 landmarks of each face is taken into account. For feature extraction, Gabor filters are used. AdaBoost is used for removing redundant features. For face recognition, KNN, SVM and CNN are used and results are compared. Its advantages include the accuracy obtained using KNN is high. The system has low computational complexity and high precision. The result is invariant to different poses, lighting and appearance changes like beard specs etc. This system is cost efficient as well as needs less manual work. while its disadvantage is SVM is giving poor output. The time taken by the system is comparatively high. The system does not handle different facial expressions in a good manner.

In this paper [2] Automated Smart Attendance System using Face recognition proposed by K. Preethi, they have used Local Binary Pattern (LBP) Histogram. Its advantage actually include Records attendance along with time stamp Have reliable outcomes for pose variance, and illumination. Takes less time to process the whole image and its disadvantages include that it can only recognize one face at a time

In this paper [3] Design of Intelligent Classroom Attendance System Based on Face Recognition proposed by W. Zeng, they have used used deep learning-related ideas to improve the AlexNet convolutional neural network with the use of the WebFace data set to improve the network training and testing. Its advantages are efficient, stable, reduced attendance costs and its disadvantage is time-consuming.

In this paper [4] Student Attendance System in the Classroom Using the Face Recognition Technique proposed by S. Lukas, techniques used were HFR has been widely used in many applications with a Combination of Discrete Wavelet Transforms (DWT) and Discrete Cosine Transform (DCT) to extract the features of the student's face which are followed by applying Radial Basis Function (RBF) for classifying the facial objects based on the known face recognition techniques in its endeavor to develop a specific computer application which can be used for recognizing any enrolled student feature extraction is involved with a purpose to extract features from any student's facial image that is required to come in a uniform size, in this case, 64x64 pixels. Its advantages are that it can be used for user authentication, recognition process becomes more robust. But it has one disadvantage Accuracy also varies when the image is blurred or dark

In this paper [5] Face Recognition System Face Recognition System proposed by Shivam Singh, they have used used KLT Algorithm, Viola-Jones Algorithm face detection which detect human face using Haar cascade classifier They apply a model combining to match the geometric characteristics of the human face. It is machine learning based approach where a cascade function is trained from images. It is used to detect objects in other images. Its advantage is that its automatically identifying a person from a still image or video frame reliable, secure and fast. It requires improvement in different lighting conditions which happens to be its disadvantage.

In this paper [6] an efficient automated attendance management system based on eigen face recognition proposed by E.Rekha, they have used PCA technique and it's advantages is to create a safe environment, it automatically update and save the attendance. Its disadvantage is that it time consuming and manipulation of attendance.

In this paper [7] Face Recognition Systems Under Morphing Attacks they have used robust algorithms proposed by U.Scherhag, printing and scanning technology. Its advantages are the manual annotation of images is very accurate automated detection of landmarks, reliable detection of morphed face images. Time consuming is a disadvantage.

In this paper [8] Integrating Conventional and Inverse Representation for Face Recognition research paper proposed by Y. Xu. They used conventional and inverse representation-based linear regression classification methods is used. Its advantage is that Face detection has proved successful when using the symmetry of the face, achieves extremely high precision and is fairly noise resistant. Its disadvantage is that contains large memory and is time taking.

In this paper [9] Face Recognition Based Attendance System proposed by Mekala, the technique is that the face recognition process is performed by using the Cognitive Face API which follows the PCA (Principal Component Analysis) algorithm. A collection of 25 photos taken from various angles is made for each student. Using the cognitive face API, features are extracted,

and a database is created. The benefit is that it makes an effort to prevent human error and serves as a high accuracy substitute for recording student attendance. Its drawback is that it has slow speed and insufficient storage space for the data of each student.

In this paper [10] PCA based Facial Recognition for Attendance System proposed by T. A. Kiran, few techniques like human face recognition (HFR), Optimal character recognition, Principle component analysis method are used. It is time saving and has No false acceptance are its advantages. Its disadvantage is that it takes more storage and more time to recognize.

In this paper [11] Attendance system based on face recognition system using CNN-PCA method and real-time camera proposed by Winarno .They used hybrid feature extraction method using CNN-PCA. Its advantage is that it is effective and accurate in recognizing human faces in real time.

In this paper [12] High performance and efficient real-time face detector on central processing unit based on convolutional neural network proposed by Putro. They used Central Processing Unit based Convolutional Neural Network. Its advantage is that it requires less computation cost. The disadvantage is that it requires more computation power.

3. Methodology

The proposed system uses a HOG-based face detector to locate faces in the video stream, and then applies a face recognition algorithm based on OpenCV face recognition method to recognize the faces and match them against a pre-existing database of registered students.

3.1. Architecture

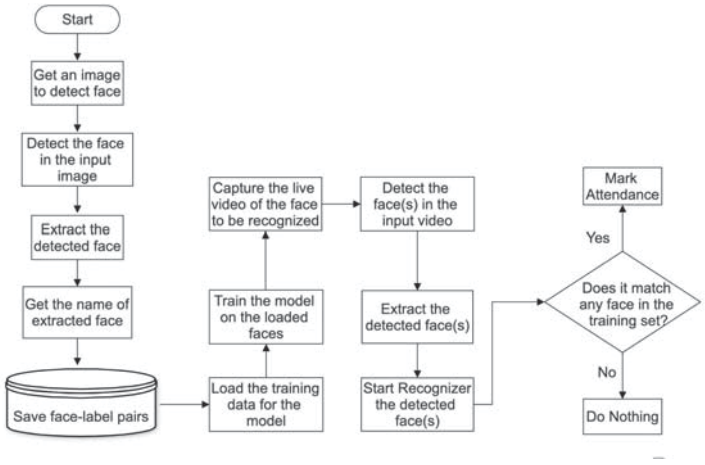

Fig. 1. System Architecture.

In the Fig.1, we give input as an image to detect the face and from that we extract features. Once we extract, we get the name for that individual in the image and save the face-label in the database. Then the training phase begins where we start to load the training data and train the model. We then proceed to the live stream video from which we need to detect the face and extract features from it. Once detection of face is completed, we move to the face recognition where the model will tell us whether the face recognized from live stream video matches in the training set. If it matches it will mark attendance , else it will do nothing.

3.2. Histogram of Oriented Gradients

A prominent feature extraction technique for object detection is Histogram of Oriented Gradients (HOG). HOG works by extracting gradient information from images and using it to represent the shape and look of an item. HOG is especially good at detecting objects with well-defined edges and texture, making it a good feature extraction technique for a real-time face recognition-based attendance system.

The HOG feature extraction process involves the following steps:

- Image Preprocessing: The input image is Preprocessing to remove noise and enhance contrast.

- Gradient Calculation: The image gradient is calculated using derivative filters such as Sobel, Prewitt or Scharr operators. The gradient is a measure of the rate of change of intensity at each pixel in the image.
- Orientation Binning: The image is divided into small cells, and the gradient orientation and magnitude of each pixel in the cell are computed. The orientations are then quantized into a fixed number of bins (e.g., 9 bins), and the magnitude is used to weight the contributions of each pixel.
- Histogram Calculation: A histogram of the orientations within each cell is computed by summing the weighted magnitudes of the gradients. The histograms are then concatenated to form a feature vector that represents the shape and texture of the object in the image.
- Normalization: The feature vector is normalized to reduce the effects of illumination variations and to make the feature vector more robust to changes in scale.

3.3. Open Source Computer Vision Library

For a variety of image and video processing applications, OpenCV (Open Source Computer Vision Library) is a free machine learning software library. Due to its capability to do real-time face detection and recognition, it is frequently utilized for face recognition applications. For face identification, OpenCV offers a number of pre-trained classifiers, such as Haar Cascades, Local Binary Patterns (LBP), and Histogram of Oriented Gradients (HOG). These classifiers operate by examining the image and locating the facial traits that are distinctive to faces. OpenCV provides solutions for face recognition, feature extraction, and facial landmark identification once a face has been identified. Moreover, OpenCV offers a user-friendly interface with tools for developing and managing face databases, recording live video streams, and showing identification results for face recognition applications.

3.4 Face Detection

Face detection is necessary because the image captured by the camera is fed to the system, and the face detection algorithm is applied to determine the presence of human faces in that image. Several image processing algorithms are utilized for detecting faces in images and the location of each of the identified faces. We used the HOG method to detect human faces in the provided image.

3.5 Face Positioning

A human face comprises 68 locations. This step's primary purpose is to detect particular points on faces and position the image. Face recognition algorithm is used to identify face points and the location of the face as precisely as possible without blurring the picture.

3.6 Face Encoding

The next stage is to extract the distinctive facial characteristic that can be utilized for recognizing each image after faces have been found in the input image. Whenever we obtain face localization, facial points are accurately retrieved for each input picture and stored in data in a folder for recognizing faces.

3.7 Face Matching

The method of facial recognition concludes at this phase. Deep learning, is one of the finest learning methods and generates feature vectors with real value. Our system creates ratification for each face after validating it. The face enc.py procedure is being used internally to estimate the faces in each image and the whole dataset. If the actual picture matches, it will move to attendance marking.

4. Result

In our project, we are not using any existing or available image data set in this instance. By capturing pictures of our classmates in various poses, angles and storing them as distinct classes, we created our own data set. A phone is used to take photos for the data set. Confusion Matrix determines the proportion of accurate and inaccurate estimates, which is then summed with the number of count values and their breakdown per class. It may be employed to measure things such as recall, precision, and accuracy. The sklearn metrics module provides a confusion matrix. The confusion matrix containing TP, FP, FN, and TN is shown in Table. Our model has an accuracy of 98%.

Table 1. Evaluation Metrics.

Dataset	TP	TN	FP	FN	Se.	Sp.	Acc.
IMPA-FACE3D	113	0	0	0	1.0	0.0	1.0
Work Dataset	43	2	1	1	0.9770	0.6667	0.9575
Total	156	2	1	1	0.9936	0.6666	0.9857

(a) (b) (c)

Fig. 2. Training Data (a) Face Recognized as Unknown Before Training and (b) Face Recognized as Per Their Name After Training and (c) Face Recognized as Per Their Name in Different Pose.

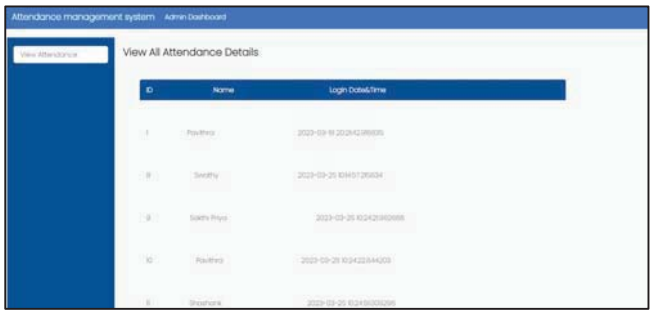

Fig. 3. Attendance Displayed In Web Application

5. Conclusion and Future Work

In this paper, we proposed a real-time face recognition based attendance system using HOG for face detection and OpenCV for face recognition. The proposed system achieved high accuracy of 98% and speed, making it suitable for practical applications. The proposed system can be further optimized by using more sophisticated feature extraction techniques and classifiers. The solution in our model is cost effective and efficient when compared to other biometric solutions. The data acquired for real time face recognition is large the cost and time are saved in this model. Since the whole process is automated with less intervention of humans, so there is no requirement of additional labour to perform the work manually. This model can be developed without the need for any specialized hardware. To develop real-time attendance system using face recognition a laptop with camera is sufficient. Future work can also explore the use of deep learning techniques for face recognition in real-time attendance systems.

References

1. Dev, S. and Patnaik, T., 2020. Student attendance system using face recognition. In 2020 international conference on smart electronics and communication (ICOSEC), IEEE, p. 90-96.
2. Preethi, K. and Vodithala, S., 2021. Automated smart attendance system using face recognition. In 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS), IEEE, p. 1552-1555.
3. Zeng, W., Meng, Q. and Li, R., 2019. Design of intelligent classroom attendance system based on face recognition. In 2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC), IEEE, p.611-615.
4. Lukas, S., Mitra, A.R., Desanti, R.I. and Krisnadi, D., 2016. Student attendance system in classroom using face recognition technique. In 2016 International Conference on Information and Communication Technology Convergence (ICTC), IEEE, p. 1032-1035.
5. Singh, S. and Jasmine, S.G., 2019. Face recognition system. International Journal of Engineering Research Technology (IJERT), 8(5).
6. Rekha, E. and Ramaprasad, P., 2017. An efficient automated attendance management system based on Eigen Face recognition, 7th International Conference on Cloud Computing, Data Science & Engineering-Confluence, IEEE, p. 605-608.
7. Scherhag, U., Rathgeb, C., Merkle, J., Breithaupt, R. and Busch, C., 2019. Face recognition systems under morphing attacks: A survey. *IEEE Access*, *7*, p.23012-23026.
8. Xu, Y., Li, X., Yang, J., Lai, Z. and Zhang, D., 2013. Integrating conventional and inverse representation for face recognition. IEEE transactions on cybernetics, 44(10), p.1738-1746.
9. Mekala, V., Vinod, V.M., Manimegalai, M. and Nandhini, K., 2019. Face recognition based attendance system. International Journal of Innovative Technology and Exploring Engineering, 8(12), p.520-525.
10. Kiran, T.A., Reddy, N.D.K., Ninan, A.I., Krishnan, P., Aravindhar, D.J. and Geetha, A., 2020, September. PCA based Facial Recognition for Attendance System, International Conference on Smart Electronics and Communication (ICOSEC), IEEE, p. 248-252.
11. Winarno, E., Al Amin, I.H., Februariyanti, H., Adi, P.W., Hadikurniawati, W. and Anwar, M.T., 2019, December. Attendance system based on face recognition system using cnn-pca method and real-time camera, International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), IEEE, p. 301-304.
12. Putro, M.D., Kurnianggoro, L. and Jo, K.H., 2020. High performance and efficient real-time face detector on central processing unit based on convolutional neural network. IEEE Transactions on Industrial Informatics, 17(7), p.4449-4457.