International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 9, pp: 294-299 www.ijaem.net ISSN: 2395-5252

Automated Attendance System by Implementing Facial Recognition

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Date of Submission: 10-11-2020 Date of Acceptance: 24-11-2020

ABSTRACT – Attendance plays a very important role in education institutions as well as in the corporate sectors. A student or an employee's arrival and departure is recorded to enhance the efficiency. Even after so much evolvement in technology, most of the organizations as well as educational institutions maintains a manual record for attendance. In some organizations it was upgraded to digital attendance such as swiping the identity card, using digital signature or fingerprint. But these systems are not 100 percent secure. Face recognition is current trend now. The reason for this hype is its efficient implementation in various fields. And seeing the current scenario of covid-19, it has enhanced its value. It provides a functionality of detecting a face of a person and then recognizing him or her based on the trained set of data. Now there are various machine learning algorithms present based on which the system is trained to detect a face. For recognizing we need to train the system with a sample picture of that person and based on the trained data it will check whether the face shown in the webcam is matching any of the picture in the training set. If yes then it specifies the name of the person. For recording the attendance it first detects a face, then matches it with the database available and finally stores in the excel sheet with the time at which the face was detected.

Keywords – Attendance system, face recognition, biometric system, OpenCV, python.

I. INTRODUCTION

Attendance system is one of the oldest method to record the arrival and departure of one individual. From a long time this process was done manually by using pen and paper which is still in practice in most of the organizations. With the advancement in technology, this system evolved to use digital techniques. But now with the new technology in the market, which is artificial intelligence, we can recreate this system to be in the current trend. Humans recognize face on a daily basis. As soon as we see a face, immediately our brain responses and gives the identity of the person. Implementing this exact same mechanism in machines to detect and recognize a face will implement the concept of artificial intelligence. This technique is termed as Face detection and recognition.

Humans detect face based on feature like shape, color, nose, eyes etc. For machines it can be a bit complicated. To simplify this we can use the concept of Computer Vision. Computer vision is the trending technology that involves the processing of digital images and videos. It is the process of understanding the images at a high level and automate the machines to do that task that is done by the human intelligence. In this project we are going to use this technology which is termed as OpenCV. It is an open source library which uses the concept of computer vision to process an image or a series of images. Along with this we're using OpenFace and dlib for face recognition in python. The first part is to detect the face which can be done by various algorithms but for this project we

are going to use the Histogram of Oriented Gradients also known as HOG method. Once the face is detected, we need to make sure that the system recognizes that face irrespective of the direction of the face. This means that the system should be trained in such a way that whether it is a frontal face or non-frontal face, it should be able to recognize the person correctly. To highlight the features of a face we are going to use the face landmark estimation algorithm. After finding the landmarks, it is encoded and the system is trained using Convolutional Neural Network with 128 encodings of one face. Now to find the person's face from these encodings we're going to use simple SVM classifier to train the system that can input the measurements of the test image and provide the details of the closest match. If both the images has the same value then the picture matches otherwise not.

Once the recognition part is done we just need to store the time at which the face was detected in the database to have the record of the person entering the organization.

II. LITERATURE REVIEW

The objective of developing any system is to make sure that it is better and more enhanced version of the previous developed system. This is the exact thinking behind the idea of developing this automated attendance system using facial recognition that will take care of the problems that are being faced by the existing systems. The approach that is being followed here is using the picture of person to store it in the database and the train the machine to encode the system using the sample picture. Once the encoding is generated we can use the Linear SVM classifier to train the system with the image shown in the webcam. If the encodings match then the person is identified as the same person otherwise not. Now for finding the encodings, the first step is to detect a face from the picture which is done by using the Histogram of Oriented Gradients algorithm. The next step is to extract the feature which is done by using the algorithm called face landmark estimation which was proposed by Kazemi and Sullivan [1]. Then the encodings for the face is generated. The system is trained to generate about 128 encodings for one image.

In the previous implementation of the same system by Akbar et al [2], proposed a model which uses RFID along with facial recognition to record the attendance on a real time basis. RFID based system uses two components known as a reader and a tag. The data is transmitted using radio waves and the tag and reader are attached to an object. Then the algorithm that is used for face detection is the Haar-like feature.

Hapani et al [3], proposed another system which made the attendance monitoring automated by taking the video fragments of the classroom then preprocessing it to remove other distortions like noise. The step two of this system includes the use of image processing methods to detect faces given by Viola-Jones for face detection and recognition. The Viola-Jones algorithm uses Haar features for detecting patterns in a face which black and white pixels, creating an internal image which computes the sum total of pixel values in a image, Adaboost training is done to select the subset of feature and construct the classifier. Last but not the least is the cascade classifier which is trained with hundreds of "positive" face image sample and random "negative" images like background. For face recognition he has used the Fisher face algorithm for dimensionality reduction and classification.

Another research done by H S Mohana [4], proposed a smart digital monitoring for attendance uses the Haar features for face detection and SURF algorithm for comparing the train image and the test image. SURF basically detects the features in the train images and searches for the exact same features in the test images. Then it uses the Euclidean Distance, to compare the points having minimum distance.

Adrian Rhesa Septian Siswanto [5], also proposed a biometric based attendance system which implemented the facial recognition. The concept used by Siswanto is Principal Component Analysis and Linear Discriminant Analysis for facial recognition. The algorithms which are based on these concepts are EigenFace and FisherFace respectively. Then he used the False Match Rate (FMR) and False Non-Match Rate (FNMR), Receiver Operating Characteristics (ROC) as criterion for performance measurement in the biometric system. Receiver Operating Characteristics or ROC depicts the interchange between FMR and FNMR. The identical value between accept and reject errors is known as equal Error Rate (EER). His research provides a ROC

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curve that is the comparison of performance of EigenFace and FisherFace algorithm.

Palanivel N. [6], in his paper proposed a system of smart attendance using facial recognition by K-Means algorithm. The approach comprises of two parts – the training part and the testing part. In training segment, all the details of the student is collected and stored in the database. Using this database of the student, the clustering of images is done by the K-Means clustering algorithm. Then the prediction of face is done by a trained system using features. In testing segment, the input image carries a bunch of students. From the cluster image, every known face is cropped and stored as an individual image. Then the cropped images is matched with the image stored in the database. If it matches then the sheet is marked with the attendance of the student otherwise absent.

III. EXISTING SYSTEM

Manual system: This is the basic system of recording attendance which is very much time taking and error prone. There has been a lot of enhancement in this system but in some of the institutions and organizations it is still in practice.

RFID: RFID [7][8] system is quite expensive as it involves a lot of hardware expenditure. It becomes more expensive because it when there is lot people to record the attendance. Purchasing tags for each and every one is going to cost a lot. And since this system is not one of the biometrics system, it is less secure and more prone to manipulations.

Biometrics system: Usually a biometric system makes two types of errors, False Acceptance Rate (FAR) and False Rejection Rate (FRR). FAR happens when the system accepts an unaccredited person and FRR happens when the system rejects an authorized person. This can create a lot of chaos in the security system. Then the type of hardware's used in the biometrics can be costly. Another problems with biometric is that it is not contactless which can be unhygienic because a lot of people will touch it. [9][10][11]

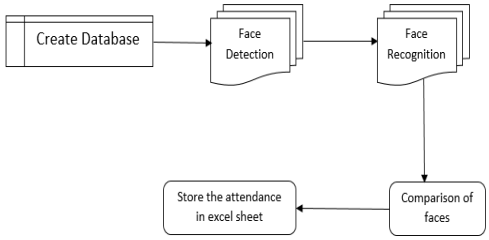
Digital signature: The main problem for digital signature based system is the forged signature. This is very common lapse in the security system as anyone can forge the signature of another person and in that it will never be secure. Again the possibility for proxy and manipulation exists here also. [12]

Face recognition: This is the most secure as it provides unique identity for every person and reduces the possibility of proxy and manipulations. With the evolvement of artificial intelligence, we have got various algorithms which can be used to detect and recognize a face but every concept has its own disadvantage. To make sure that our system if efficient, we should also choose the algorithm wisely as it will also affect the efficiency of the system.

IV. PROPOSED SYSTEM

The proposed system is brought forward by keeping in mind the current scenario of covid-19 as it has become very important for all of us to maintain the social distancing and avoid as much contact with things as we could. This system basically wipes out all the disadvantages of the existing system be it the manual, RFID, biometric based or digital signature. The only hardware requirement for this system is a webcam so it reduces the cost as well. And it also remove the burden of carrying individual tags for identity because the face of the person itself works as the most secure identity which can never be forged or manipulated.

The below shown block diagram will explain the mechanism of the system:



Steps is same as shown in the above diagram:

- Create a database of pictures of the employee or student who visit daily to the institution.
- Detect faces from the picture. This step involves various mechanisms for detecting a face. Once it detects the next step is to create landmarks of the face. These landmarks extracts the feature of the face based on which we can find face distance or encode them in numbers which makes it easy for comparison.
- Face recognition is done by encoding the features of the face which is unique for every person. The algorithm used generates around 128 encodings for which the convolutional

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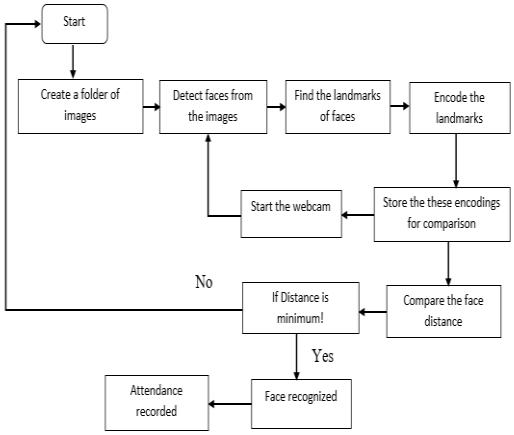
neural network is created which makes it easy for the creator to train the system.

- Then the face detected by the webcam is also encoded and compared with the image stored in the database to check whether the person in front of the camera is authorized person to enter the organization or not.
- Once the reading matches, the name of the person along with the time at which the face was detected is stored in the csv file. This marks the attendance of the person entering or leaving the organization.

E-R Diagram –



V. ALGORITHM

The various algorithms that are used in this system are given below:

Face Detection

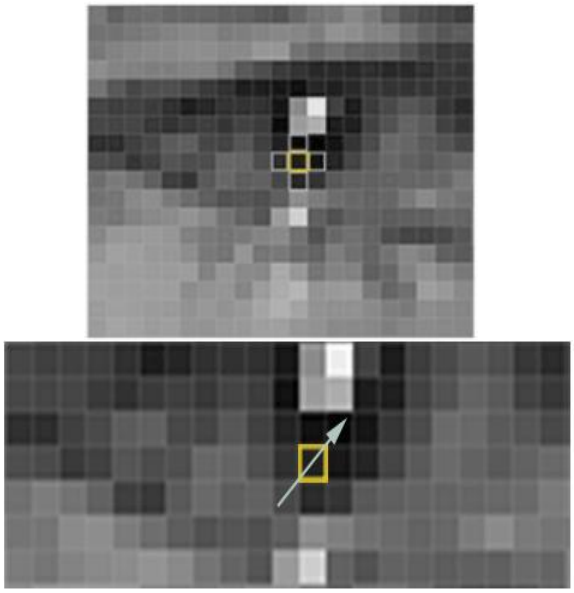
Face detection is an amazing feature for cameras. Nowadays almost every phone company is implementing this feature to focus on the face and blurring out the rest of the images. Here in this project I'm using it for a different purpose. Face detection was trending in the early 2000s. The proposed method of Viola and Jones [14] for face detection was fast enough but now we have many more reliable methods. In this implementation, I have used the HOG method which was proposed in 2005, known as Histogram of Oriented Gradient. The steps to calculate Histogram of Oriented Gradient are:

1. Preprocessing

The preprocessing involves the cropping of the images into an image patch which have a fixed aspect ratio. For example if we are taking the aspect ratio as 1:2 then the image patch should have the size as 100x200, 128x256, 1000x2000 and so on. Once the patch is ready, then we can move on to the next step.

2. Calculate the gradient image

For calculation the HOG descriptor, we first need to calculate the horizontal and vertical gradient. This is done by taking one pixel of an image at a time. For every pixel, we need to check the darkness of the pixel compared to its surrounding pixels. Then we pull out an arrow pointing towards the darker pixel. When this process is repeated several times, we end replacing every pixel with an arrow. These arrows are called gradients.



Pixels surrounded by immediate pixels; Arrow pointing toward darker pixel.[13]

3. 16x16 block normalization

Now having a gradient for every pixel is just too much data for us to gather. So to normalize this, we can break the image into small squares of 16x16 pixels each. Then we count up the number of gradients points in each major directions, in each square and replace the square with the strongest gradient.The end result is visualised as given:

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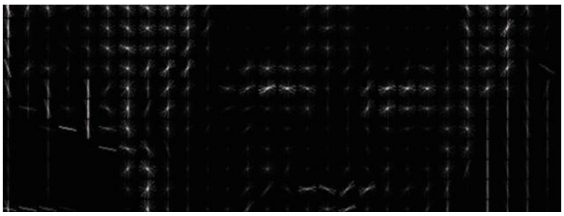


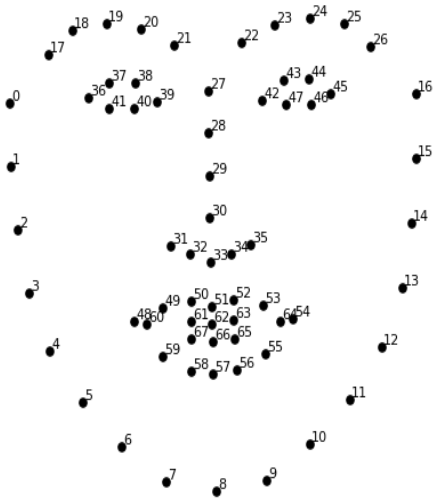
HOG representation of the face.[13]

Face Recognition

After detecting the face of a person from the image, we need to recognize that person. Now the problem is that what if the face is non frontal. In that case, the machine may deny that the face is not matching with the database.So we will go step wise and see how to recognise the person.

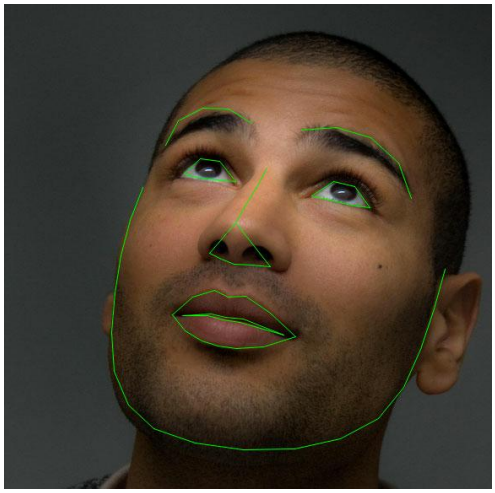
1. Projecting the face

When the face is in different direction, we will try to wrap up the face so that the eyes and lips are in the same place as that of the image. We will be doing this with the help of an algorithm called face landmark estimation which was given by Kazemi and Sullivan in 2014. The basic idea is to find the 68 specific points called landmarks that exist on the face and then train the machine learning algorithm.



The 68 landmarks located on every face.[13][17]

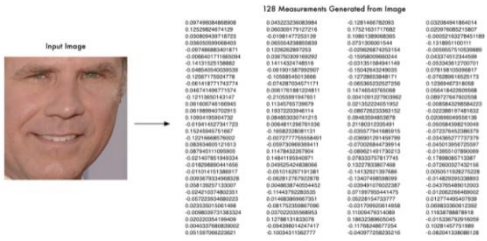
When the above mechanism is applied on a test image is gives the result is shown as below.



Facial landmarks identify the key features of the face.[19]

2. Encoding faces

This step involves the way to extract few basic features of each face. Then encode the unknown face and match the measurements. The closest measurement of both the face will give the desired result. Once the encoding part is done we can pass this image to a neural network which will be trained in measuring the features of the face. In this this system, it will generate 128 measurements.



128 emcodings of given face.[13]

3. Recognize from the encodings

Once the encodings have been generated, we just need to match the measurement of each face with the face infront of the camera. The moment we get the closest measurement, that's the person we were looking for. So to validate the person we can display the name of the person with the rectangular box around it's face.

VI. RESULT

The result of the givenimplemented method is that it will store the name of the person recognised by the system and the time at which it

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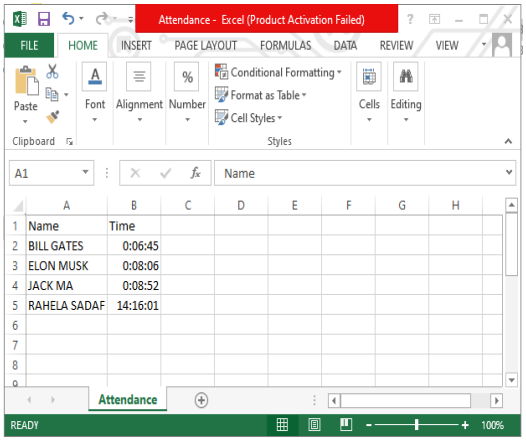
was detected in the camera. This will generate a record of that person as an attendance.



Excel sheet to store attendance.

VII. CONCLUSION

As we all know that human face is the most vital identity for every person or individual as it provides the most unique identification. This unique identity provides most accurate validation and maintains the integrity in every environment. To create an automated attendance system, we need the most unique identification feature which can never be forged or manipulated in any circumstances. And Face recognition helps us in that department. Face recognition works as a biometric for implementing the security features in any system. To recognize whether the person is an authorized person or not, face recognition gives the most accurate answer.

In this project we have achieved our objectives to create an automated system just by recognizing a person from its face and record the attendance i.e. the time at which the person entered the organization. The Algorithm to implement the face recognition was given by Adam Geitgey [13] who have used the HOG method for face detection and face landmark estimation for have the estimation for non-frontal face. Convolutional Neural Network plays a crucial role in this algorithm of facial recognition. Once the face is recognized, we create a csv file to record the name of the identified person along with the time at which the face was detected.

VIII. FUTURE SCOPE

The proposed system given in this paper is a raw system without an interactive GUI. The future enhancements which can be done are:

- A GUI can be created for the given system.
- An interactive interface will provide a better interaction with the system user.
- The scope of database can also be extended if we want to record other details along with the time.
- It can also be combined with a NoSql database which will provide them scalability and flexibility.

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