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Real Time Attendance System using One Shot Learning for Face Recognition

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ABSTRACT

Attending lectures plays an important part in the intellectual development of a student. Hence, attendance is given such great value in our education system. It is a useful measure of evaluating the performance of a student. Thus, we propose a real time attendance system which identifies and then recognizes students using their facial features. This system will record and mark attendance of all the students present in the classroom with the help of advancements in machine learning. The various technologies used in face recognition include Convolution Neural Network (CNN), Recurrent Neural Network (RNN), Siamese Neural Network and many more. We will be working with the lattermost that is, Siamese neural network for One shot learning. The steps described in this paper include capturing video and converting it into a picture, face detection, face recognition using feature extraction and classification. Multiple cameras ensure accuracy and accountability of the system. This automated system can transform the manual and tedious work of taking attendance to a simpler and automated one.

Key words: Convolution Neural Network (CNN), Machine Learning, Face Detection, Face Recognition, Siamese neural network.

1. INTRODUCTION

Machine learning has proven to be a boon for humanity, by making our tasks simpler [1]-[8]. This very characteristic of machine learning has been used to devise a real time automated attendance system. A teacher spends about 8 to 12 minutes on an average to take attendance by using manual mode for attendance. This process of manual attendance is not only cumbersome for the teacher, but also for the students. A drawback of manual attendance also includes that a teacher may miss out on some names of the students or a particular student may answer multiple times for his or her friends.

Using an automated attendance system like the one proposed here, the student is marked present or absent using face recognition thus, avoiding many such drawbacks of manual attendance.

Face recognition is being widely used nowadays since it requires virtually zero effort from the user end as compared other biometric means of attendance [10]. Many algorithms for face recognition have been created, and each has its own strengths. Humans make use of facial recognition every day. We see a face, and if we know the person, recognize him or her at once. This skill possessed by humans, if possibly implemented with the help of computers, can be of significant use in various systems.

In the proposed system, the students' attendance can be recorded with the help of a high quality camera. We aim to not make use of any special light sensors, gloves, etc. We only use cameras to make detections. We have used a feature based approach that is, focusing on comparison of local facial features and their geometrical relation.The methodology used is primarily mathematical, and is based on histograms and grey scale. The subsequent sections in the paper highlight the details of literature survey, system overview and implementation, results and conclusions derived.

2. LITERATURE SURVEY

Humans have evolved from manual attendance to the use of artificial intelligence and machine learning [9]-[10]. This saves not only time but also human energy. Some of the work in the automatic attendance is listed below:

2.1 RFID based attendance system

This type of attendance system uses RFID tag to register a person to the system. Every person in the organisation gets an RFID. To mark one's presence one has to flash the card in front of the scanner. While this was successful in automating the manual task but failed in the situation where a person can mark attendance for multiple people as one can carry multiple RFIDs' to mark others attendance which defies the whole purpose of attendance [11].

2.2 Biometric attendance system

After the flaw of RFIDs came into light, the biometric or fingerprint attendance system was established which was more reliable system in terms of reliability and accuracy. This system got very popular due to all its advantages over RFIDs', but it also had its own flaws. Firstly it was not fully automated as the person has to go and register their fingerprint to mark their presence in the system [12]-[13]. In an organisation where people enter the facility in mass, this method is difficult and time consuming as people gather in queues to register themselves in the system. Also in the recent times these systems had to shut down because of the fear of spreading COVID-19 as it is so contagious that only one person can spread it to multiple people through contact that is, through these biometrics scanners. Due to all these shortcomings there is a need of a contactless and secure automated system.

2.3 Voice based attendance system

This is a less famous and non-trivial solution to the attendance system. This uses the voice of the person to recognize the person's identity and mark the presence of the person. In this system, the person needs to speak in the microphone and the machine processes the voice to identify the person through the audio sample which is used to register the user. While this method eliminates the touch factor of biometrics but it also has some issues related to it, especially in the crowded places where it can be very difficult for one to register him or her in the system [14]-[15].

3. SYSTEM OVERVIEW

The present authors have used python as their implementation language. The main component used here is OpenCV. One of the aims of OpenCV is to offer a simple-to-use computer vision platform that lets people develop relatively complex vision applications easily. OpenCV library includes over 500 functions that span multiple fields of vision. OpenCV is the main technology behind Facial Recognition [16].

The project's key working concept is to detect and identify the video captured data and transform it into an image. The image is further processed to recognize the student. The recognized student is then granted attendance, otherwise the system labels the database entry as absent [17]. A broad overview of the steps involved has been depicted in figure 1.

4. SYSTEM IMPLEMENTATION

The steps for implementation of this system constitute of the following:

4.1 Training the model

A labelled dataset comprising of images of different students of the class along with their name and roll number is fed to the One-Shot learning model, which internally uses Siamese neural network.

This network uses the concept of facial landmarks on every face, marks the points along the border of the face, eyes, nose etc. starting from 0 to 67.

4.1.1 Computing vector

The first part of the neural network computes a 128 dimensional vector which are the encodings of a face. Different images of the same person have same encodings. The numbers of this encoding lies between -1 and 1.

4.1.2 Triplet loss function

This is a loss function used in Siamese Neural Network where an anchor that is, the input is compared to positive and negative inputs. The algorithm looks at the distance between each of those three images. It trains the neural network in such a way that it makes sure that the distances it generates for anchor and positive are slightly closer. It also makes sure that the measurements for positive and negative are slightly further apart [18].

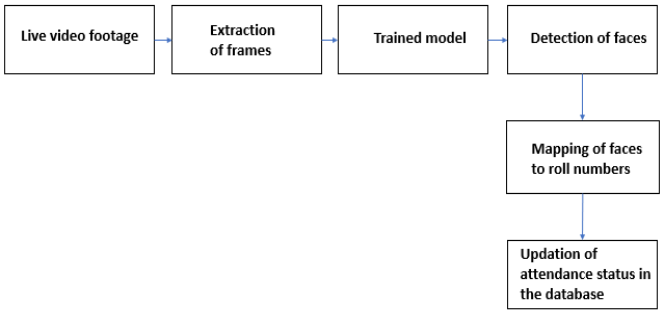

Figure 1: Steps for implementation

4.2 Detect faces in an image

The video recorded using the high definition camera needs to be converted into frames per second for better and more accurate detection and recognition of the students. The steps involved have been shown in figure 2.

4.2.1 Preprocessing

The first part of the solution is face detection which is accomplished by two methods, sliding window and Histogram of Oriented Gradients (HOG). It takes in the image containing faces in it and gives a bounding box drawn around the faces.

4.2.1.1 Sliding Window

A sliding window is a rectangular box that slides over an image line by line in order to find a region of interest, that is, in this case, a face. On finding an image the widow stops moving and highlights the area of the face as shown in figure 3.

4.2.1.2 Image pyramid

As the name suggests an image pyramid is a hypothetical pyramid with the actual image as the base layer, and the subsequent layers consists of the same image scaled by a decided factor resulting in smaller and smaller images as we move to the top. The sliding window starts with the lowermost layer of this pyramid to find a face, if it fails to do so, it moves on to the next scaled layer and so on.

4.2.1.3 Histogram of Oriented Gradients (HOG)

Histogram of oriented gradients (HOG) is a feature descriptor that can be used for face detection [19]. The HOG descriptor technique counts gradient orientation occurrences in the localized portions of an image-detection frame, or area of interest.

Implementation of the HOG descriptor algorithm consists of the following steps:

1. Break the image into small connected regions called cells, and measure a histogram of gradient directions or edge orientations for the pixels inside the cell, for each cell.
2. Discretize each cell into angular bins according to the orientation of the gradient.
3. Pixel of each cell contributes weighted gradient to its respective angular bin.
4. Adjacent cells are grouped into a block. This forms the basis for normalization of histograms.
5. The group of normalized histograms is called the block histogram. These block histograms combine together to form the descriptor.

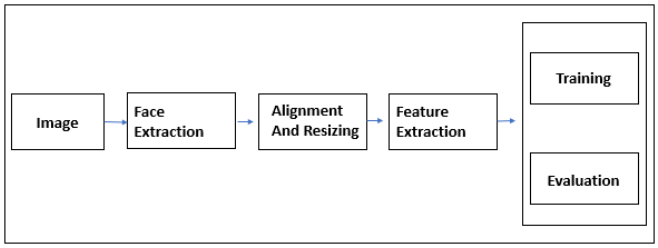

Figure 2: Steps for face recognition

4.2.2 Feature Extraction and Alignment

The image obtained from the previous computation is to be aligned to make it centered, rotated such that eye lies on a horizontal axis and scaled such that each image is approximately identical in terms of size. So, scaling and rotating of the image is done to obtain an aligned face in the image [20]-[21].

4.3 Classifying the image

A linear SVM is a trained classifier which is used here that takes in the measurements from anew test image and tells us which unknown person is the closest match. The result of this classifier is the name of the person [22]-[23].

4.4 Post-Processing

The name of the person obtained from previous computation is searched in the database and the person is marked as present for the running lecture. The database also has the potential to produce the students' attendance records monthly or by week.

The absent students can also be notified via email by teachers and other faculty members.

5. RESULT

The proposed attendance management system is simple and easy to use. It works with high efficiency. The output is in the form of a photo, that is, the frame that is captured through camera and contains bounding box of the single or multiple detected faces along with an ID assigned to them in the training data set as shown in figure 3. It is accurate and capable of being executed in real-time.

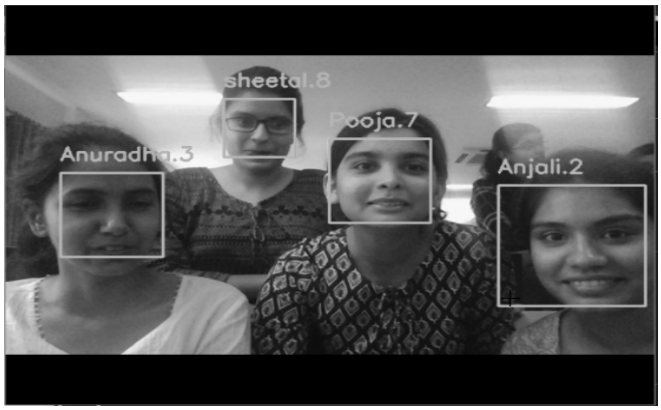

Figure 3: Output of the attendance management system.

The ID is then analyzed to obtain the roll number of the student and then corresponding name is marked present in the database.

The Evaluation parameters used are accuracy [24], confusion matrix and F1 score figure 4 and figure 5 show the information regarding accuracy, F1 score and confusion matrix respectively.

Confusion matrix	Actual Positive	Actual Negative
Predicted Positive	15	1
Predicted Negative	1	15

Figure 4: Confusion matrix for the test scenario.

Accuracy	0.9375 / 93.75%
F1 Score	0.9375 / 93.75%

Figure 5: Accuracy and F1 score measures.

The faculty members are provided with a user interface wherein they can retrieve records of a particular class or student of a particular class by day, week or month. This is done using SQL

queries. Thus, by clicking on various buttons provided, the teachers and other staff members can access the student records as shown in table 1. There is a password facility so that only the authenticated users may access the portal.

Table 1: Records of students for a particular class

Roll No.	Name	Status
1	Aman	Absent
2	Anjali	Present
3	Anuradha	Present
4	Parikshit	Absent
5	Shumaila	Absent
6	Umang	Absent
7	Pooja	Present
8	Sheetal	Present

6. CONCLUSION

The Automated Classroom Attendance System essentially aims to improve the accuracy and speed to reach the high-precision real-time attendance and satisfy the automated needs.

The main steps of the proposed system are to capture the students' video, convert it into photos, and accordingly mark them present or absent and keep attendance records of students. Based on studies, SVM and Bayesian are better when compared to the other various distance classifiers.

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