

Real Time Face Identification and Attendance System on Low Powered Devices Using Haar-Cascade and Hog

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ABSTRACT

In a world where we as human beings are gradually shifting towards leading a more comfortable life by automation and reduction of manual labor, attendance is one such thing that remains to be practiced manually in major parts of the world. It is a method of marking a group of people being in colleges, schools and offices that they were present on the day. This long on-going practice has been very primitive in the ways it is practiced. In this paper we propose an automatic attendance system using facial recognition integrated with a raspberry pie 4 model with its camera module. The dataset will be programmed on the respective students and then using snapshots from live video surveillance we can recognize the student based on the matching the features extracted with the trained grayscale images. Attendance is marked if the student is verified and an email will be sent to the concerned authority's email address in-case an unknown person is found breaching the premises of the class. This will have a diminutive effect on attendance related chicanery.

Keywords: Attendance, Feature Extraction, Facial Recognition, Raspberry Pi

Introduction

Attendance is a concept for the schools and the universities that has been prevailing since a long time to keep a check on ongoing staff and students' interest and his/her being consistent towards their work. It can be said that it measures how sincere or disciplined a person is towards the learning that he/she is pursuing. Moreover students are more likely to succeed in their academics if they attend their course consistently. Estimating student participation is more of a significant concern for the schools and universities as they rely on the magnitude of participation to rate their teaching as a proper feedback.

When it comes to taking the record of attendance, several methods had been implemented such as calling name or roll number where one has to constantly maintain the records and their attendance register manually which can get tiresome and time consuming if the number of students is large enough. Moreover there will be a lack of accuracy in that scenario. There are some automatic attendance systems that have come along quite well. One such system is a biometric attendance system that uses retina scanning and is also equipped with finger scanning. Then there is an RFID system in which ID cards are given to the students and they have to scan it on RFID reader to mark the attendance. However in biometric attendance system one has to physically engage with the

biometric machines which is not advisable considering the present situation since it can have adverse effects in spreading infections and again both these systems are quite costly and have to be maintained because of the heavily invested hardware hence cannot be installed in low budget schools and universities.

In this paper we are proposing an automatic contact less attendance system which is based on facial identification and recognition which can be further implemented on low powered devices such as raspberry pi, pocket beagle. Face recognition attendance based systems can be processed into two parts. First part will be capturing facial features which will be matched with the existing trained data by the algorithm and second part will help in marking of attendance with the help of recognized faces. Since the system will be on real time it should be fast, secure and reliable. The system will be an integration of mainly three algorithms.

A.) Haar Cascade:- Which will identify whether an object will be any human face or not when it faces the camera.

B.) Histogram Of Oriented Gradients (HOG):- Will help in extracting features of image data. This will extract both the gradient and the orientation of the edges.

C.) Support Vector Machine (SVM):- Will help in identification of faces.

Using Haar Cascade will help us in getting face identification faster because of its Haar-like features and robust calculation speed. Haar-features can be mapped with the classifier-cascade to form a powerful learner or classifier for face identification purposes.

There are several advantages of using Histogram of Oriented Gradients with the most prominent ones being:

It is simpler and despite being less powerful it is faster than its alternatives.

Moreover it doesn't require the use of an external GPU and features can easily be extracted using the laptop's CPU. This entirely gives us the advantage to run our model on low powered devices.

Literature Survey

Authors in [1] devised a method to use the framework by coordinating facial potentials using Eigen face information and Principal segment Analysis (PCA) along with MATLAB GUI. In this paper they come up with the algorithm that captures the image, pre-processes it and applies Eigenface generated dataset at that stage and matches the captured image with the eigen image. At this stage when the compatibility distance test scored more than the edge estimation of 0.3 then the system won't be able to recognize the face. If the system recognizes the face, attendance will be marked and further stored in the excel sheet with Matlab GUI.

In this paper [2] authors have utilized multimodal biometric person confirmation framework utilizing face, discourse and mark biometric highlights. Trial results obviously show the viability of multimodal frameworks in any event, when the biometric information is influenced by commotion. All the biometric information are influenced by commotion, the exhibition of unimodal framework is

around 0.6 on the scale of 10 and still the multimodal framework execution is around 0.95, demonstrating that face, discourse and signature biometric highlights comprise of a large set of data that can be misused.. The current work investigated just melding diverse unimodal biometrics at the score level

Authors in this research paper [3] came up with a countenance based facial recognition system called the Laplacian method. In association with Locality Preserving Projections (LPP), the facial-structure pictures are tagged into a facial subset for interpretation. LPP is contrastingly vivid from Principal Component Analysis (PCA) and Linear Discriminant Analysis(LDA) which only focus on the Euclidean system of facial structure. LPP comes up with a method that saves local data and gets facial subset that identify the important facial structure at its foremost capacity. The algorithm laplacianfaces are rectilinear estimates for the eigen function of the Laplace Beltrami value of face potentials. If we use the above mentioned method we can reduce the error rate considerably but there might be an increase in the usage of extra computational power as compared to its parallel methods.

Moreover Authors in this publication [4] have devised a method for class interaction systems which uses face recognition techniques. The system actually centers around by using two computation analytics Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT) to differ the features of the facial structure. DCT is proven to be more adjustable and an important prospect for signal decay. Specifically it decays the image into its coefficients of wavelet. DCT has the responsibility of de-connection, power compactness of the image. Face preprocessing of the image is the preparation of under the study images which are subsequently used for matching the features of under the study's image. The performed examination has resulted in 82 out of 100 effectively take in input, 121 out of 148 successful facial recognition.

Proposed Method

Development of the proposed system for Attendance Management System is divided into five sections:

A.) Environment setup:

The system we purposed will be implemented on raspberry pi 4 model b. The specifications and requirements are as follows:

- Minimum of Quad core Cortex-A72 (ARM v8) processor (comes in built on raspberry pi)
- Micro SD card of minimum 8GB (boot Raspbian OS)
- Screen to connect with our Raspberry Pi
- Minimum 2GB Ram.
- VGA to micro HDMI cable
- Type C charger usb for charging purposes
- Camera module for capturing snapshots for live video surveillance.



Figure 1 Environmental Setup.

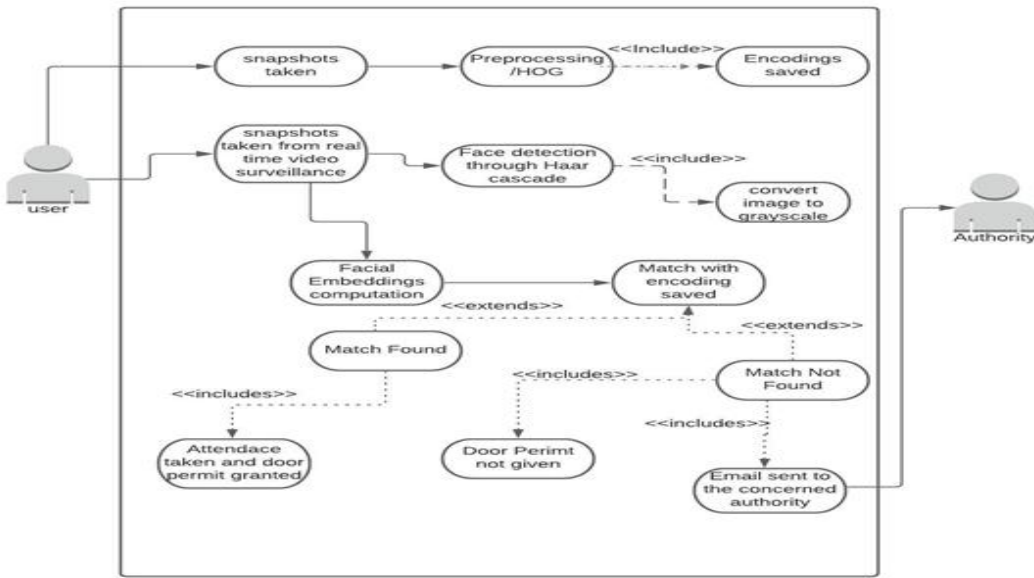


Figure 2 Architectural Diagram

B.) Methodologies

Haar Cascade

It is an object detection algorithm used in detection of face object in pictures or real time video surveillance. The model is provided with a dataset consisting of images having human faces and images devoid of human faces as well in order to facilitate for both positive and negative collection of dataset. Haar cascade consists of Haar features such as Line features, Edge features and Four Rectangle features. Each feature consists of a single value that is deduced by the difference between the aggregate of total number of pixels in white rectangle block and aggregate of total number of pixels in black rectangle block. If the edge of a particular image is having dark region on one side and lighter region on another side then the haar value will be close to 1 otherwise the value will be far away from 1.



Figure 3 Edge Detection

Adaboost

There are a set of features which would catch certain facial constructions like eyebrows or the extension between both the eyes, or the lips and so forth. But the catch is that the number of features is quite high. It would take a lot of time to parse all the features and moreover would use a lot of computational power. A majority of these features would be useless or irrelevant for face detection. This is where adaboost comes into play. It works as a feature selector that selects only the major features from a large set that would be required for facial detection. The entire idea of haar cascade is to cross the image data pixel by pixel from top left to bottom right so that all possible haar features can be applied.

Histogram of Oriented Gradient

Histogram of Oriented Gradients, is a component descriptor that is regularly used to separate highlights from picture information. Feature descriptors are important as it extracts the major feature from the image. HOG is that feature descriptor which extract both the gradient and orientation (or we can depict it as magnitude and direction) pixel by pixel. The HOG feature extraction first begin by preprocessing the image data and resize into 1:2 so that image can be easily divided into small several blocks and then for each block pixel matrix will be generated. Gradient is basically a small change in X and Y direction. It will be calculated with the help of pixel matrix shown below.

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

Figure 4 Pixel Matrix

Here supposedly to calculate the gradient for 85:

Change in X direction($G(x)$): $85-78=11$

Change in Y direction ($G(y)$): $85-68=8$

Then the magnitude and direction will be calculated.

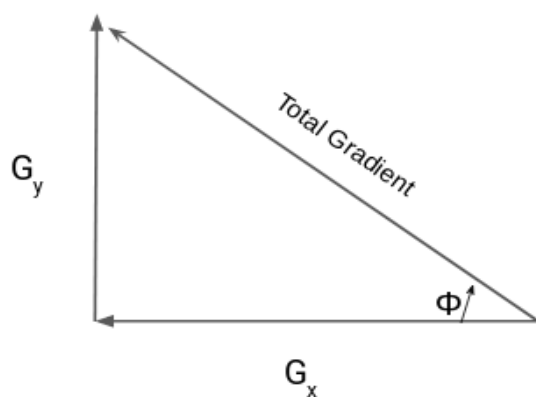


Figure 5 Gradient Calculation

By pythagoras theorem: Total Gradient Magnitude $\sqrt{G(x)^2 + G(y)^2}$

Total Gradient direction : $\tan\theta = G(y)/G(x)$

$$\theta = \tan^{-1} (G(y)/G(x))$$

These orientations will be calculated for each block in an image data and Histogram will be generated for the same. Gradients need to be normalized in order to reduce the lighting contrast because there might be possibility that some portion of image will be bright with respect to other portions. For normalization each value will be divided by the square root of sum of square of all the values. Let us assume values are stored in vector V1.

$$V1 = [A, B, C, D, E, \dots, A_m]$$

$$H = \sqrt{A^2 + B^2 + C^2 + D^2 + E^2 + \dots + A_m^2}$$

$$\text{Normalization Vector } N1 = \left[\frac{A}{H} + \frac{B}{H} + \frac{C}{H} + \frac{D}{H} + \frac{E}{H} + \dots + \frac{A_m}{H} \right].$$

HARDWARE IMPLEMENTATION

The proposed system will be deployed on Raspberry Pi 4 Model B with 2 GB ram. It has a Quad core Cortex-A72 (ARM v8). It has a type c port, 2 micro HDMI slots, 2 USB 3.0 and 1 USB 2.0 along with micro SD card slot. Moreover it has 2 lane MIPI camera port.

The preliminary stage for raspberry pi setup is to flash the raspbian OS on our micro SD card. We can use an imager to flash the Raspbian OS on our sd card. Now we connect the type C cable to supply power to the Raspberry Pi. Fit the booted SD card in the given slot and integrate the camera module on the raspberry pi board.

We would also need peripheral devices such as a keyboard and a mouse to be attached with the USB slots of the raspberry pi board .Last but not the least, we would require a VGA to micro HDMI cable for associating our monitor screen with our raspberry pi. Run the following commands on the terminal, for the purpose of software update or installation:

```
$ sudo apt-get update,  
$ sudo apt-get upgrade,  
$ sudo apt-get install.
```



Figure 6 Raspberry Pi 4 Model B

DATASET COLLECTION

For successfully marking the attendance of a class, the proposed system needs to process the dataset of each and every student in different scenarios like lightened areas , less- lightened areas , with specs , without specs , smiling, straight face also with all different angles possible including sideways, upwards and downwards.

We have created our own manual dataset which consists of 50 pictures per student and hence the total dataset would comprise of $50 \times n$ images where n is the total number of students in a class. The number of pictures per student can be increased in case when the strength of students is extremely large. The entire dataset will be then converted into grayscale format for feature extraction and face detection as well as recognition. The images collected for our dataset will be of significant use when training our model.

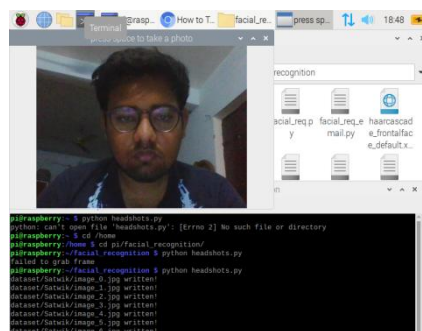


Figure 7 Manual Dataset Collection

MARKING THE ATTENDANCE

First our model would be trained on the faces of the students of a particular classroom. Then the entire setup of the camera module integrated with raspberry pi can be installed on the classroom door entrance. Now whenever a student comes to enter the classroom through the entrance, the system starts capturing images from the real time video surveillance, detects the faces from the existing database and if that person is identified by our model then his attendance will be automatically marked. If under any case, an unidentified person tries to get into the class then an automatic email will be sent to the class authority with an attached snapshot of the unknown informing her of the same.

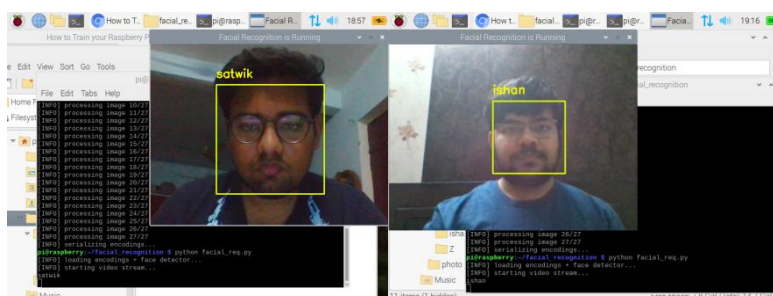


Figure 8 Faces Successfully Recognized

After recognizing all the students of a particular class an excel file would be generated for keeping the records.

Name	Date	Time
Ishan	05-03-2021	11:59:50
Satwik	05-03-2021	11:59:58

Figure 9 Excel File Generated

FUTURE ENHANCEMENT

- **Encryption :-** There are several encryption techniques like pycrypto , sha256 hash which changes the image in plain text format. There are several advanced encryption techniques as well. It would be beneficial when transferring data on the internet or saving it in a location.
- **Chip Microcomputer :-** The project if needed will be able to run in other low-powered devices like arduino, pocket beagle etc.it will be useful in terms of attaching itself with various peripheral devices which comes with it and will also reduce the cost of the project.
- **Scalability :-** The project if needed could be scalable for the organization while using however it will need low-latency internet connection for using mail services otherwise the program might get hindered, with consent the scalable system could also be used to get a better dataset to be better trained which will enhance the efficiency of the system.
- **Gateway :-** Gateway is beneficial in terms of securing the system; it will provide an extra layer of security between different systems in different locations. One of the gateways is Zuul-Netflix gateway. Zuul is developed by Netflix and it is built to enable dynamic routing, monitoring, resiliency, and security. If a hacker gets into the system they won't be able to access the server directly because everything will be coming from zuul itself.It is open source however it will only be of any use when there are separate machines involved in the system like microprocessors.
- **Smart Door :-** In order to automatically grant access to the authorized students and not allow the unidentified ones , we can use a smart door. For this we will need to integrate a servo-motor with our raspberry pie and this would prove to be an excellent feature.

CONCLUSION

This paper gives us a contactless manner for monitoring the attendance management system in schools organization. It aims at improving the attendance management as the automatic system of attendance saves a lot of manual labour and plays an important role during examinations where time is crucial. The system is centered around low powered devices such as raspberry pi which is totally portable and can be installed anywhere.

Our Proposed system allows operators to take attendance in a more effective manner as compared to the traditional system. It uses low computational power and resources as compared to other advanced systems. The system is easy to install and has very low maintenance cost for future various steps could be undertaken for betterment of the system like using better microprocessor , wide angle camera and better dataset.

Last but not the least, our system has shown that it could be used as a attendance system in institutions and organizations at a large scale and is easily scalable according to the need and will solve the problems possessed by the traditional system.

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