Comparison between attendance system implemented through haar cascade classifier and face recognition library

Samiksha Malhotra¹ *, Vaibhav Aggarwal ¹, Himanshu Mangal ¹, Preeti Nagrath ¹ and Rachna Jain¹
¹Department of CSE, Bharati Vidyapeeth’s College Of engineering New Delhi, India.

*E-mail: samikshamalhotra22@gmail.com

Abstract- Face detection and face recognition are the most widely used features of machine learning(ML) and deep learning(DL). These features are slowly gaining popularity in fields like surveillance through CCTV cameras, mobile phone security (biometric locks), etc. This paper presents a college attendance system based on the above mentioned feature which automatically marks the attendance of the students through the live feed by the CCTV cameras in the classroom. This system saves time, works more efficiently, than manually marking the attendance by the roll call. System was built with the haar cascade features, open CV and face recognition library. These are discussed in the proposed paper. We have presented a comparison between the two models discussed and concluded that haar cascade features work more efficiently than the inbuilt face recognition library for the college attendance system.

Keywords- Face detection, Face recognition, Open CV, Haar Cascade, Machine and Deep learning, Face recognition Library.

1. INTRODUCTION

Face detection and recognition [1] is one of the most important factors in today's world. Every Industry, from food to automobiles or from security to e-commerce are using these features. CCTV cameras are being equipped with Face recognition systems, which has proven of great benefit to security agencies in catching the culprit.[13]

Attendance plays a crucial role in any institute as it helps the student understand the value of attending lectures. With 75% of attendance criteria followed by most of the institutions, students and teachers are very specific about the database of the attendance that is created for every session. Keeping a record of every student in every lecture becomes a hurdle in teaching for the teachers. So to solve all these issues a virtual attendance system is created where computers equipped with a webcam can take over the extra burden of attendance off from the teacher's shoulder.

With further development in ML and DL, a system where facial images of students are captured through CCTV and their attendance is marked is built. This system helps in eliminating the chaos caused during attendance in lecture time. Another feature of this system is that it helps in scaling down the bogus attendance[14]. While this is a positive side of the system there is a negative side also that will be further discussed in the paper.

This sector is growing fast and is focussing on developing systems that have the capabilities to work like eyes, ears, mouth, and nose so as to eliminate the interruption of humans and is focussing on making the machines or systems input free. The main objective of the proposed paper and proposed model is to remove the traditional form of marking attendance i.e., either using a notebook for attendance record and marking it manually or using any biometric fingerprint scanner. As emerging technologies are banishing the traditional or old methods of working or teaching[18]. So here this paper focuses on abolishing the old methods of marking attendance in schools, colleges, or any other institutions. This system includes many features as well like the average attendance, total attendance, lowest attendance,
highest attendance, and percentage of attendance of all the students, reducing error percentage and any mistake. Similar to the smart attendance system there has been a lot of advancement in the field of ML and DL. Use of raspberry pi and Arduino with ML algorithms have created some very advanced and intelligent models. A smart system was developed using raspberry pi and camera module, in this model a camera was placed on the door to capture the image of the person, so whenever anyone requires permission to enter, the camera would recognize the face and the door gets open automatically. These types of systems were installed in hostel doors etc.[19]

In Section one, focuses on what, how, and why the model is proposed and why this topic is chosen for research. Section two, tells about the theoretical aspect of the proposed model. Section three explains the basic working of the system. It explains the process of input taking and providing the desired output. It also discusses the drawbacks and limitations of the system with the solution for the same. In section four, a table of comparisons is built with the differences found during the execution of both the models on the jupyter notebook. Section five tells about the future scope and development of the system and section six concludes the paper with the result.

2. PROPOSED WORK
2.1 Haar cascade classifier.
In open CV, there are basically two pre-trained classifier

![Haar cascade classifier](image)

\[\text{Figure 1-This image shows how the features are indicated in Haar cascade}\]

Paul Viola and Michael Jones discussed the concept of haar features.[1][20]. According to their paper [1], this classifier uses positive and negative images to train the cascade model. This trained model is used to detect different objects in different types of images. Like in a picture of a park; a tree, a bench, a slide, a kid, etc. can be detected. In a similar fashion, a haar cascade classifier distinguishes the image on the basis of nose, eyes, lips [16]. The image is divided into black and white traces depending upon the intensities, regions of the faces and the background[16].

There are several pre-trained algorithms available that can be used to detect faces of cats and dogs as well as of other mammals[11].It works on the principle where the image is divided into positive image set and negative image set. The positive image set is referred to as images with faces, and the negative image set is referred to as images without faces. To train a classifier so that it detects images with faces, a large number of positive image sets is required. Each feature is a single value obtained by subtracting the sum of pixels under the white rectangle from the sum of pixels under the black rectangle as depicted in fig 1. This classifier generates the output with no time, hence, is time efficient[3].

2.1.1 WORKING OF HAAR CASCADE CLASSIFIER.
Haar cascade classifier bifurcates the image based on Red, Green, Blue(RGB) which varies from 0 to 255 in values. These three primary colors help the system in distinguishing the features of the image. The first array matrix that is formed is of red color, the second array matrix formed is of green color and the third array matrix formed is of blue color and so on the matrices are formed for the rest of the colours present in the background. These arrays combine to form pixels, these pixels combine to form images and through these images the system detects the features of objects. The size of the image is calculated
by B*A*3. Each element of the matrix provides different intensities of RGB values[2][3]. For black and white images, it becomes simpler for the system to detect using a single channel.

![Image of Rainbow](image)

**Figure 2**- Showing how array matrices are formed through images.

The above figure illustrates the detection of RGB values from the picture of a rainbow. The pixel values are converted into an array of matrices and these matrices are stored in the dataset. Every colour will have a different matrix. The size of the array depends upon the number of colours present in the picture.

### 2.2 Local binary pattern (LBP) cascade classifier

![Example for LBP classifier](image)

**Figure 3**- Example for LBP classifier

The LBP classifier[9][10] is used for the detection of various things such as floor inspection, image detection, etc. This classifier has shown great results in these fields. In the proposed research this classifier is used for face detection. This operator uses the 3-by-3 pixel configuration with the centre as pixel value which results in the formation of binary number as depicted in figure 4.[12]

**2.2.1 Working Of LBP Classifier.**

Each pixel in an image can be identified and classified by the operator very accurately. The image is divided into several non-overlapping sections. LBP histograms are then formed for these non-overlapping sections.[8] The histograms so formed are then concatenated to form a single, enhanced histogram. This enhanced histogram can be used as a single histogram for the image. The below image shows how the non-overlapping sections are divided.[9]
3. PROPOSED WORKING OF THE SYSTEM

The above flow diagram gives an overview for the working of both the models. The Haar cascade model creates its own dataset by capturing the image using openCV [2][22] and storing the student information in the database. Whereas the face detection library model requires a predefined dataset for the working of the system. For the proposed model a predefined dataset was built first and then the program was executed.

To mark the attendance, the program is initiated. Students' faces are detected through the webcam and are matched with the database. If the face is recognised then the attendance is marked and a message is sent to the registered phone number and if the face is not verified then no message is sent. For sending the message, an online messaging service is used.

3.1 Haar Cascade model
The Haar Cascade model has been trained by the classifier so that it makes its own dataset. The model asks for the roll number and phone number of the student. It stores all this information in a CSV file or
in an excel file, then a web camera is used for capturing the facial image. This facial image is linked with the roll number and phone number and is stored in the dataset. Once the database is created, it can be used to automatically mark the attendance of the student.

This system greatly reduces the precious teaching time lost during every roll call in a lecture and most importantly with the higher number of students present during the lecture there will always be a probability of manual mistakes. The chaos created during attendance time is completely vanished using this system. Using this system, it becomes easier for the teachers to calculate the attendance of each and every student. It is time-efficient. Takes a few seconds or sometimes a minute when the dataset is very large to perform its actions. With some more modifications and research, this system can be made more efficient using support vector machines (SVM) [5] and SURF cascading techniques. [4] [6]. These types of SVM and SURF cascading techniques help the system become more precise and can even detect minute features. SVM is used to categorize the data. It is a data cleaning algorithm used in machine learning.

![Figure 6](image.png)

**Figure 6**: Capturing of faces for the formation of a dataset.

### 3.2 FACE RECOGNITION LIBRARY MODEL

In python, like NumPy or Pandas library, there is another library called face detection library which can detect faces, gender or any object using the inbuilt functions or classifiers in the library. It is the simplest known library for face detection. Simple tweaking with this library can be used to create games like makeup or filter games and can also be used to create photo filters. It identifies each and every feature of the face and is thus effective in recognizing any person through the image that is stored in the dataset.

This library has also been used in the model, and one special point of this library is that it does not create its own dataset. So roll number and phone number are taken as inputs after capturing the image of the student. These images are then stored in a predefined dataset with roll numbers and phone numbers [21]. After capturing all the information, if the student is present in class, then his/her attendance will be marked automatically through the camera footage. The images from camera footage will be matched with the images in the dataset. After recognizing the image, it will mark present in front of the roll number associated with the image and will send a text message to the phone number associated with the image using an online text message sender.
Figure 7- Face recognition and attendance marked for roll number 14. The above figure shows the face recognized and matched with the face in the dataset. Roll number 14 that displays on the box around the face indicates that the face has been recognized and roll number linked with the face has been displayed on the screen.
Figure 8- Messages are sent to all the students who are marked present. 

The above picture shows the text message on the phone number received after recognizing the face of the person. An online text message sending system has been linked to the model for sending the “attendance marked” text to the registered phone number.

3.3 DRAWBACKS AND LIMITATIONS OF THIS MODEL

One of the drawbacks of using haar like features is that it is not capable of efficiently detecting tilted faces. It is capable of detecting faces on horizontal or vertical planes i.e. x or y-axis and not on the z-axis. If the face in any image is tilted by any angle other than 0, 90, 180, 270, 360 degrees then the model will give less accurate result.[7] Haar cascade classifiers also focus on facial features like the shape of eyes, lips, nose, or ear - which may be the same or similar to two people. So at that time, the system does not work properly.

3.4 SOLUTION

Haar cascade classifiers can be modified to capture the iris of the eye[16], as the iris is the distinguishing factor and can act as a primer key. If the system finds similar facial features then it can consider the iris image and can recognize the face. Like in some android smartphones the face lock opens with the similar face of the owner but in some smartphones with iris detection, only the person whose iris is recorded can unlock the smartphone. This iris recognition method prevents any intruder from unlocking the phone. Similarly, if this method is used in the proposed system then the system may give better accuracy.

4. COMPARISON BETWEEN THE TWO MODELS

Table 1- Comparison between the two models discussed

| HAAR CASCADE CLASSIFIER DETECTION | FACE RECOGNITION LIBRARY DETECTION |
|---------------------------------|-------------------------------------|
| Fast and time-efficient         | Slow and time inefficient.          |
| Requires less memory.           | Requires more memory.               |
| Captures the image in the form of an array to form its own dataset. | Does not capture the image.          |
| Many XML files for different expressions present to detect different images. | Single file is worked with different one line function to detect images. |
| Longer code                     | Shorter code                        |
Does not require a predefined dataset to function. Cannot function without a predefined dataset.

5. FUTURE SCOPE
High-resolution cameras, Raspberry pi 3 modules, or ANDROID-XU4 are used to increase the performance of the system. For the limited and accurate working of the system, remote control can be proposed[17]. Adding the iris detection technique to the model will make the model accurate, increasing the accuracy of the model.

6. CONCLUSION
The system works as an intelligent system eliminating any manual errors, reducing the workload. Being fully automated, it works more efficiently. The proposed system focuses on eliminating the traditional record books, RFID based system, or biometric fingerprint system.[17] Many smart systems are created using different methods and are compared to the other methods available, hence we can conclude that haar like features works best for the proposed system as the model is less time consuming, more precise, and efficient.

REFERENCES
[1] Viola, Paul, and Michael Jones 2001 "Rapid object detection using a boosted cascade of simple features.” In Proceedings of the 2001 IEEE computer society conference on computer vision and pattern recognition vol. 1,

[2] "OpenCV Python Tutorial - Computer Vision With OpenCV In Python",www.medium.com/eureka.

[3] Garg, Varun, and Kritika Garg 2016 "Face Recognition Using Haar Cascade Classifier", International Journal of Emerging Technologies and Innovative Research Vol. 3, pp 140-2.

[4] Li, Jianguo, and Yimin Zhang 2013 "Learning surf cascade for fast and accurate object detection.” In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 3468-75.

[5] Rätsch, Matthias, Sami Romdhani, and Thomas Vetter 2004 "Efficient face detection by a Cascaded support vector machine using haar-like features.” In Joint Pattern Recognition Symposium, pp. 62- 70.

[6] Kim, Donghoon, and Rozenn Dahyot 2008 "Face components detection using SURF descriptors and SVMs.” In 2008 International Machine Vision and Image Processing Conference, pp. 51-56.

[7] Du, Shaoyi, Nanning Zheng, Qubo You, Yang Wu, Maojun Yuan, and Jingjun Wu. 2006 "Rotated haar-like features for face detection with in-plane rotation.” In International Conference on Virtual Systems and Multimedia, pp. 128-137.

[8] Truong, Hung Phuoc, and Yong-Guk Kim 2018 "Enhanced Line Local Binary Patterns (EL-LBP): An Efficient Image Representation for Face Recognition.” In International Conference on Advanced Concepts For Intelligent Vision Systems, pp. 285-296.

[9] Chen, Ying, Shiqing Zhang, and Xiaoming Zhao 2014 "Facial expression recognition via non-negative least-squares sparse coding." Information 5, no. 2 pp 305-18.
[10] Ismail, Nurulhuda, and Mas Idayu Md Sabri 2009 "Review of existing algorithms for face detection and recognition." WSEAS International Conference on Computational Intelligence, Man-Machine Systems and Cybernetics, 8, pp. 30-39.

[11] Parkhi, Omkar M., Andrea Vedaldi, Andrew Zisserman, and C. V. Jawahar 2012 "Cats and dogs." IEEE conference on computer vision and pattern recognition, pp. 3498-3505.

[12] Chang-Yeon, Jo. 2008 "Face Detection using LBP features." Final Project Report 77.

[13] Manju, D., and V. Radha 2020 "A Novel Approach for Pose Invariant Face Recognition in Surveillance Videos." Procedia Computer Science 167 pp 890-9.

[14] Devan, P. Arun Mozhi, M. Venkateshan, A. Vignesh, and S. R. M. Karthikraj 2017 "Smart attendance system using face recognition." Advances in Natural and Applied Sciences 11, no. 7 : pp 139-145.

[15] R.S, Dr.Sabeenian & S, Aravind & P, Arunkumar & Joshua, P. & G, Eswaraj 2020 Smart Attendance System Using Face Recognition. Journal of Advanced Research in Dynamical and Control Systems. 12. 1079-84.

[16] Lin, Yi-Nan, Tsang-Yen Hsieh, Jr-Jen Huang, Cheng-Ying Yang, Victor RL Shen, and Hai Hoang Bui 2020 "Fast Iris localization using Haar-like features and AdaBoost algorithm." Multimedia Tools and Applications : pp 1-24.

[17] Jadhav, Prakash, Chilukuri Madhu Vamsi Krishna, V. Chandana, L. Krithika, and Anusha Shetty. "Facial Recognition Based Attendance Management System Using Raspberry Pi."

[18] Gomes, Clyde, Sagar Chanchal, Tanmay Desai, and Dipti Jadhav 2020 "Class Attendance Management System using Facial Recognition." In ITM Web of Conferences, vol.32.

[19] Savita Paharekari, Chaitali Jadhav, Surabhi Nilangekar, Jitesh Padwal “Automated Attendance System in College Using Face Recognition and NFC” International Journal of Computer Science and Mobile Computing A Monthly Journal of Computer Science and Information Technology.

[20] Wang, Yi-Qing 2014 "An analysis of the Viola-Jones face detection algorithm."

Image Processing On Line 4 : 128-148.

[22] Hakan Cevikalp, William Triggs 2010 Face Recognition Based on Image Sets. IEEE Conference on Computer Vision and Pattern Recognition pp.2567-73.

[23] Goyal, Kruti, Kartikey Agarwal, and Rishi Kumar 2017 "Face detection and tracking: Using OpenCV." In 2017 international conference of Electronics, Communication and Aerospace Technology (ICECA), vol. 1, pp. 474-8.