# Improved and Efficient Face Identification System for E-Attendance Using Machine Learning Algorithm and Hybrid Haar Cascade Classifier

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**Abstract -** Machine learning techniques can be used to create Face Recognition in e-attendance, which plays a vital role in all organizations to monitor and track people who are present. That accurately recognizes human faces and this is the most largely used in biometrics for human identity authentication. This proposed work presents an automatic face recognition using a machine learning-based hybrid technique Haar Cascade classifier and a modified Local Binary Pattern Histogram algorithm. This technique recognizes user photographs, names, and IDs in the database. Face detection, feature extraction, and recognition are the three methodologies employed in the proposed technique.

**Keywords:** *Haar cascade, Face recognition, Binary Pattern, Hybrid technique, Machine learning*

## I INTRODUCTION

All organizations require a manual or automated attendance management system to track their staff. Maintaining the everyday presence of staff or students in class is essential for performance assessment and quality control. The usual approaches, which are time-consuming and insecure [37], are calling names or signing on papers. Contrarily, the majorityof automatic human identification classifications rely on time-tested techniques like fingerprints, passwords, and ID scans. Therefore, a sophisticated facial recognition pattern is the best way to guarantee total security and save history records [38]. It is a rapidly growing field in recent times, and it plays an important role in security as it is a very specific technique to identify and validate people [39] [40].

Face Recognition technology has improved its usability wherever it is applicable such as through databases in hospitals, organizations, social welfare schemes, etc. In the rapidly evolving technological world, this approach is very beneficial in bringing the world into the digital era. Face pattern identification is a popular technique that can identify human faces from

digital sources like cameras or videos by comparing them to a set of information that is kept in a database and it is a clever real-time tool that can be used anywhere and at anytime to provide effective results. The features of the human faces are captured by the face recognition attendance system, and their characteristics are extracted. Face recognition technology, which is quickly advancing, can be used in a variety of fields, including security systems, authentication, access control, tracking system, airport protection system, and surveillance systems since it is so effective at ensuring security and producing reliable results.A variety of techniques and technological tools are used to access this classification system, which can be processed using machine learning.

Making a machine think and function like a human using their prior knowledge and experiences is known as machine learning. It is a subset of artificial intelligence that imbibe machines with intelligence, enables them to carry out human functions, and enables them to think abstractly. Two sets of hybrid algorithms, the Local Binary Pattern Histogram and the Haar Cascade machine learning classifier are used in the proposed work.

The primary goal of this proposed work is to identify a solution for improved face identification for employees wherever working using a hybrid machine learning technique. The main focus of the proposed work takes both low and high-resolution images as input on face identification-based e-attendance and output is with less false positive rate using a modified hybrid technique.

The subsequent section of the paper is structured as follows. Section II review of the literature. Section III describes the system architecture. Section IV presented a comprehensive view of the proposed technique, Section V demonstrates the experimental validation of the proposed work and its result and Section VI concludes the article with a major contribution and scope of future enhancement.

## II REVIEW OF LITERATURE

A model for an automatic attendance system was put forth by the authors in [1]. The main focus of the model is on how face recognition and identification can be combined with Radio Frequency Identification (RFID) to identify and count recognized students as they enter and exit the classroom. This system preserves the record of the students and their attendance is preserved and stored it in a database that may be updated and stored automatically.

The authors of this study [2] have created and deployed an attendance system that makes use of iris biometrics. The attendees were initially asked to register their information and distinct iris template. The technology automatically records each student's attendance by taking their eye image, detecting their iris template, and comparing it to templates that are kept in the database. A web-based platform was used to access this application.

A facial recognition-based attendance system was suggested in [3]. Support vector machine (SVM) classifiers and methods like Viola-Jones and Histogram of Oriented

Gradients (HOG) features were used to create the system. Scaling, lighting, occlusion, and position were among the other real-time factors that were taken into consideration. Peak signal-to-noise ratio (PSNR) measurements were used as the basis for quantitative analysis, which was carried out using the MATLAB GUI.

The author in [4] research determines the optimal facial recognition algorithm provided by the Open CV 2.4.8 and incorporates it in the attendance system by comparing thereceiver operation characteristics (ROC) curve. Based on the investigations carried out in thisresearch, the ROC curve showed that Eigenface performs better than the fisher face. The Eigenface algorithm had an accuracy range of 70% to 90%.

Using a combination of discrete wavelet transforms (DWT) and discrete cosine transform, a method for monitoring student attendance in a classroom is presented in [5]. (DCT). These techniques were used to identify the characteristics of the student's face, after which the Radial Basis Function (RBF) was applied to classify the facial objects. This approach had an 82% accuracy rate.

The creator of [6] research developed a model that can recognize students in a classroom using a 360-degree rotating camera. Without the usage of technologies like the XAMPP controller, NetBeans, JavaAdvance, and MySQL for the front-end and back-end, the author claims that this system would not have been possible. Principal component analysis reveals the characteristics of the face (PCA). Parents and instructors will receive an email with a list of the names of the students who attended after they have registered.

Encountering faces and recognizing them The author of [7] requested PCA methods with machine learning and SVM for Extraction functionality. The histogram of the facial image was scaled and equalized to 100x100 as part of the author's reprocessing. It has been shown that neural networks can be utilized for facial identification, and semi-supervised learning techniques that successfully use SVMs for facial recognition may be on the horizon. Next is the subsequent processing, where attendance is made on a weekly or monthly basis and can be sent to parents or guardians.

The author [8] achieved good pre-processing results on a set of noisy pictures. Filtering, scaling, normalizing, and face cropping are examples of pre-processing procedures. To cut down on high-frequency noise components, a low-pass filter is used. PCA, DCT, and the combined spatial and frequency domain approach are contrasted before and after pre-processing. Facial detection taking place before image pre-processing is the main problem. Since the image must first be analyzed before any face identification or recognition can occur, this is not what many face recognition systems would anticipate.

Author [9] prescribed the system with hardware such as Raspberry Pi and a wired camera, but the software also consisted of using OpenCV. The very first step in facial recognition is to detect a face in a given image and afterward processed the recognition only if there is a face there. The face pinning was performed using Haar Cascade Classifier and face recognition was based on PCA.

Author [10] describes a system that uses Viola Jones as a face detection tool and Fisher face algorithm for face recognition. Uses a webcam to build the database and collect photos to process. It works well in good lighting conditions, but at different lighting conditions, it decreases the face recognition rate. The system has access to authority and participated via the cell phone interface with the login credentials.

Author [11] an automatic attendance system has been developed in which video is collected as input. Frames are captured when there is human presence detected. For face detection, Viola Jones is used, and PCA is used for face recognition, which also uses LBP for threshold purposes. The facial recognition rate is nearly accurate for the small number of students and the attendance of the student is recorded along with the entry time of the student.

## III SYSTEM ARCHITECTURE

Face pattern identification is a recent technology that can compare human faces in a video frame or digital image to a database of faces. In order to convert facial images into numerical expressions computer-generated filters are required that can be compared to find common features in facial recognition. These filters are often created utilizing artificial neural network-based deep learning and machine learning approaches.

The proposed technique can be carried out using three phases, they are face detection, feature extraction, and face recognition.

### 3.1 Face Detection

The first and most important stage in locating and using the attendance system is face detection. Face recognition is a technique for identifying human faces in pictures taken and stored with a camera or webcam, which is why they are referred to as digital pictures. In this phase, human faces are often scanned and photographed from a variety of angles, yielding hundreds of photos that may be easily accessed by the attendance system. Finding the size and placement of the organs in the face picture is the primary goal of the detection phase.

### 3.2 Feature Extraction

The facial recognition system's second phase is called feature extraction. In these stages, we take the facial traits of people out of the database that was compiled through

individual detection. In LBPH, the histogram is made for facial recognition after the binary

pattern images are generated. The human sensor organs are identified using the Haar Cascade, and each organ is coded with a value to make easy extraction possible. The basic word for this pattern of recognition is a template. A template is a collection of information that depicts the special and distinguishing characteristics of an identified face.

### 3.3 Face Recognition

Face recognition is a technique for comparing and analyzing a person's biometrics to identify and confirm a certain characteristic of their face. The data that are gathered from the live images and accessed using a camera or webcam as well as the stored images are typically used for identification.

Facial detection and face recognition technologies play a vital role because of their effective computer authentication technology. The technology will work in a variety of ways, including by using a laptop's web camera to take pictures that are later analyzed for face detection and which include stages like face alignment, preprocessing, feature extraction, and face matching before the image is converted to grayscale. The overall system architecture is shown in Figure 1.

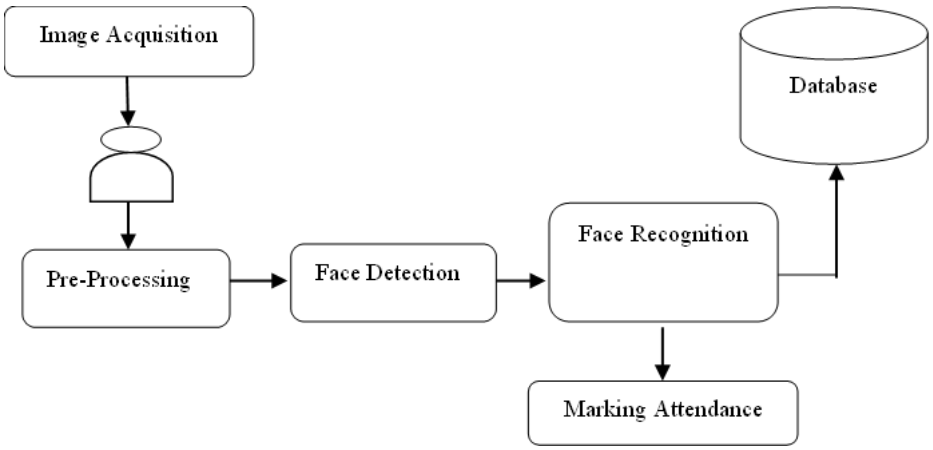



**Fig1. Overall System Architecture**

## IV PROPOSED TECHNIQUE

The proposed technique has five main phases, which are checking the Camera, capturing images, Train Images, Recognition and Mark Attendance, and Automatic Mail Generation. The proposed workflow process is shown in figure 2.


**Fig. 2. Flow Diagram of Proposed System**

### 4.1 Checking Camera

The initial and most important stage in face recognition is checking the camera. It is a vital phase in the face detection process. The camera was an all-purpose scrutiny device that was used to examine how well the process operated. The first step indicating that the application is ready for the process and it records the live-streaming human facial elements as video.

### 4.2 Capture Images

Face capture, often known as capturing images, is the process of converting a person's analog facial information into a collection of digital attributes. The act of storing and using information for later access is a key process and also records the name and ID of the employee. In this instance, the camera is opened and a number of photographs are capturedby the machine. A maximum of 10 to 15 images of the same employee are captured and stored under the name "Training Images," which will aid in accessing, identifying, and capturing the images.

### 4.3 Training Images

A series of algorithms called "Training Photographs" aid in locating employee images. This is the main idea behind face recognition technology. It is a machine learningtechnique that uses the modified and hybrid Local Binary Pattern Histogram and the Haar Cascade, two different types of algorithms. More than 15 images are collected in the training image collections utilizing these methodologies and strategies to recognize faces. It goes through multiple processes and uses several approaches to identify each and every image so that user faces may be easily recognized while registering attendance.

The proposed Modified Local Binary Pattern Histogram (MLBPH) algorithm divides the small portion of the trained image into pixel values these pixels are then classified into Threshold values and then the threshold value is divided into binary and decimal values. Using this method the unique feature of each and every individual helps in the easy identification of the person and their feature recognition.

**Algorithm 1** MLBPH Algorithm

Step. 1. Set ID for every Input Image(Face)

Step. 2. Convert the original face image into grayscale image

Step. 3. Use the parameters radius and neighbors to apply the sliding window concept to get the 3x3 matrix intensity of each pixel

Step. 4. Apply threshold value to define neighbors

Step. 5. Each neighbor of central value is set to the binary value

Step. 6. If t>=binary value then set 1, t<binary value then set 0 (1=true & 0=false)

Step. 7. Get only the binary value and compared it to the original image

Step. 8. Get the intermediate image of enhanced features of the original facial image

Step. 9. The output is feature extracted image

The four parameters of the MLBPH algorithm process are shown in figure 3.

- Radius: Usually takes a value of 1, it is the distance of a circular local binary pattern from its center pixel to its perimeter.
- Neighbors: Number of data points that make up a circular local binary pattern, neighbors typically, the number 8.
- GridX: There are typically 8 cells in the horizontal plane of a grid.
- GridY: There are typically 8 cells in the vertical plane of the grid.

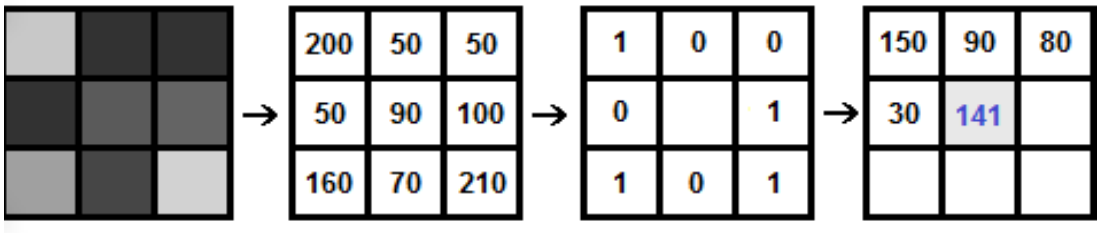



**Fig. 3. Flow process of MLBPH algorithm**

The proposed technique employs array values with sub-rectangular boxes to identify the basic components of the human face, such as the eyes, nose, and mouth, as opposed to identifying faces with pixel values. Different boxes are used for the various facial organs. This technique works with real-time applications and is highly helpful for feature extraction in many image-processing applications. Threshold face model for MLBPH showed in figure 4.

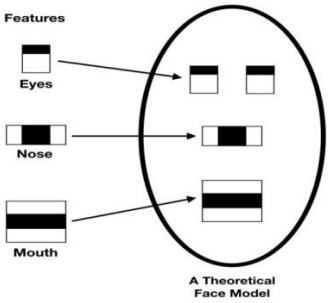



**Fig. 4. Threshold face model for MLBPH algorithm**

**Hybrid Haar Cascade Classifier**

The proposed machine learning feature-based technique uses Hybrid Haar Cascade Classifier (HHCC)for face identification. This classifier uses a machine learning process that incorporates a cascade operation from the images to find objects in the images. The feature-

extracted images are inserted as input to the HHC classifier and it produces “Authorized” for

the known person or “Unknown” for the unauthorized person. Each feature has a distinct value that is calculated by subtracting the total of the pixels in the white and black rectangles from each feature's total and it can recognize faces of different people in different situations. The calculation of any size of a Haar-like feature is possible using integral photos in constant time.

**Algorithm 2** Hybrid Haar Cascade Classifier Algorithm

Step. 1. The feature extracted image as input from MLBPH

Step. 2. Calculate the Haar pixel value using equation 1

Step. 3. Normalize the face image size and orientation

Step. 4. Image is processed and compared with the existing sample

Step. 5. Display output as “Authorized” or “Unknown”

Equation 1 calculates the Haar pixel value.

Haar pixel value calculation HHV=(SD/ND)-(SL/NL) (1)

Where, SD and SL are the Sum of the Dark pixel and the Sum of the Light pixel, ND and NL are the Number of Dark pixels and the Number of Light pixels respectively.

### 4.4 Recognition and Marking Attendance

Face recognition is performed in the comparison module. The camera detects faces by comparing the matching values of the face that is currently visible to those in the file. The face is detected and the name connected to that face is shown if the values match. The output shows that faces are recognized and matched with names that are displayed above the frame. The csv file, which includes the employee ID, name, registration date, and time, can be used to mark the user's attendance. This attendance can be stored in the csv file and then can beimported into the excel sheet this sheet can be then shared and stored for future analysis. Thisconsists of accurate and consistent data.

### 4.5 Sending Automail

Figure 5 represents the implementation process of the proposed technique. Automail generation is a method of automatically sending emails to the organization or to the person in charge of accessing and managing employee information. This aids in keeping and upgrading employee monitoring. The file with the name attendance and a CSV extension is used to generate the email. Each and every file is kept in excel format for future usage, and this attendance will be updated in accordance with the date and time. Excel files are simple to use and access when compared to other file formats.

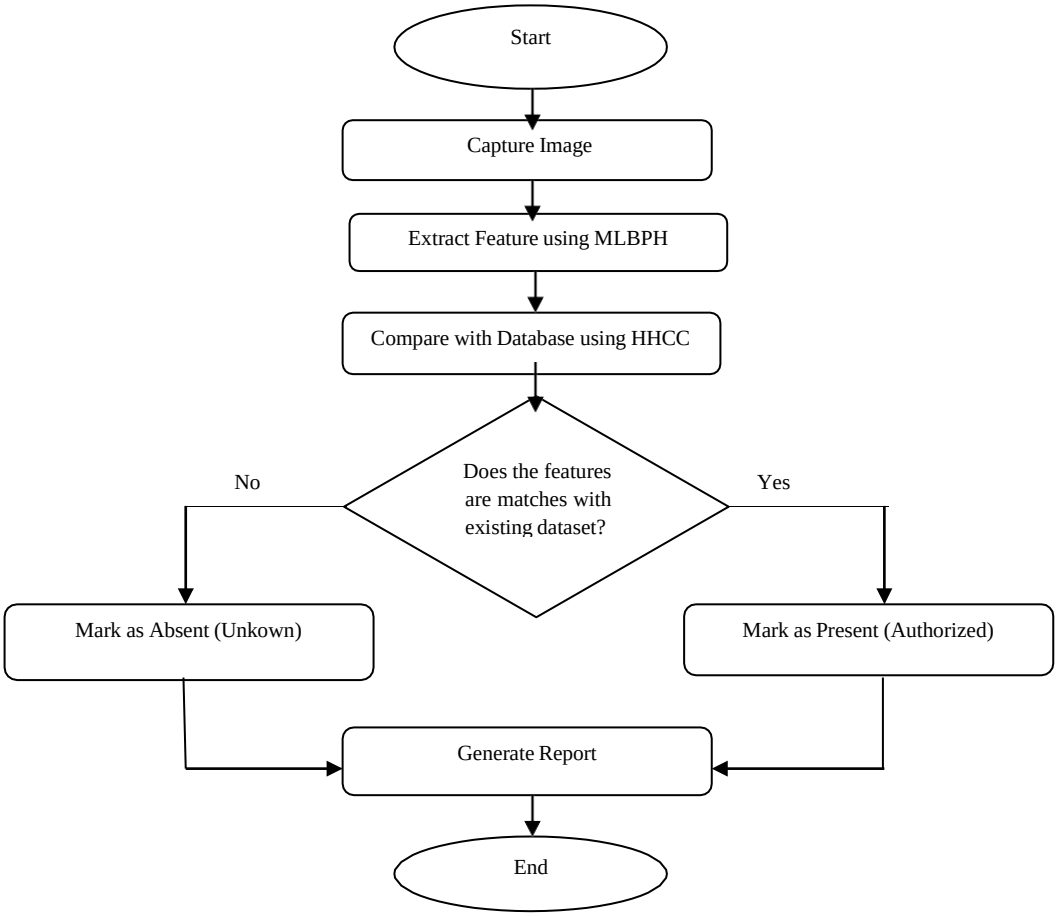



**Fig. 5. Work flowchart**

## V EXPERIMENTAL RESULT AND DISCUSSION

The Proposed technique produces the result for the face recognition system as shown in table 1 and equation 3 calculates the accuracy with a less false positive rate for both low and high-resolution images and which shows 1 false (actually it's true) as output from 5 sample images due to mismatch of original features in the already trained image dataset which implemented in python libraries.

To compute an integral image the following formula is used and shown in Equation 2

$$X(a,b) = \sum_{\substack{a^F \le a \\ b^F \le b}} x(a', b') \quad (2)$$

Where x(a,b) is the value of the pixel at (a,b) and it reduces the computation time.

Accuracy Calculation

$$\text{Accuracy} = (PP+PN)/(PP+PN+FP+FN) \quad (3)$$

Where,

PP=Pass Positive
PN= Pass Negative
FP= Fail Positive

FN= Fail Negative

- The image identified as negative is denoted Fail Negative Rate (FNR)= FN/(FN+PP)
- The image identified correctly is denoted as Pass Positive Rate (PPR)= PP/(PP+FP)

The sample test of the proposed work is described in figure 6 to figure 11.

**Test Cases**

| S.no. | Actions | Input | Excepted Result | Actual Result | Test Result |
|---|---|---|---|---|---|
| 1. | Acquire Image | Human Face | Images are taken and kept | Images are captured and Stored | Pass |
| 2. | Image dataset to be trained | Stored face Images | Histogram creation and value storing | Values are stored and histogram is produced | Pass |
| 3. | Face Identification | A person live stream | The name of the discovered individual is shown on the screen. | The name of the discovered individual is shown on the screen. | Pass |
| 4. | Update many people's attendance at once | From a live video transmission, numerous faces | Detected faces' updated attendance | Only live faces are updated for attendance. | Pass |
| 5. | Find more than seven faces. | Seven people are shown in the images. | Find each of the seven faces in front of the camera. | Only two faces can be recognized at once. | Fail |

**Table 1. Accuracy test case**

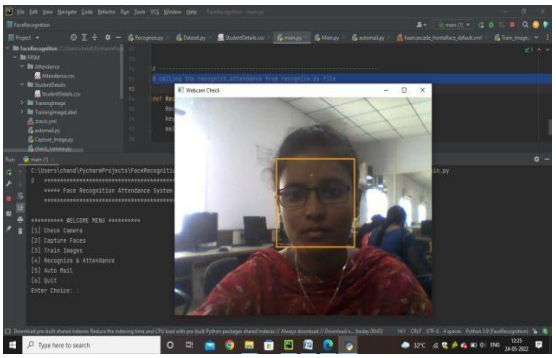


**Fig. 6. Checking Camera**

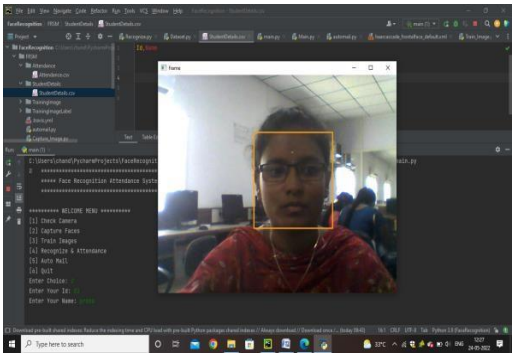
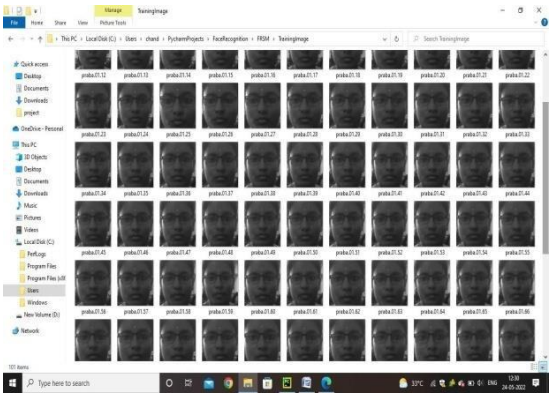


**Fig.7. Capture Image**



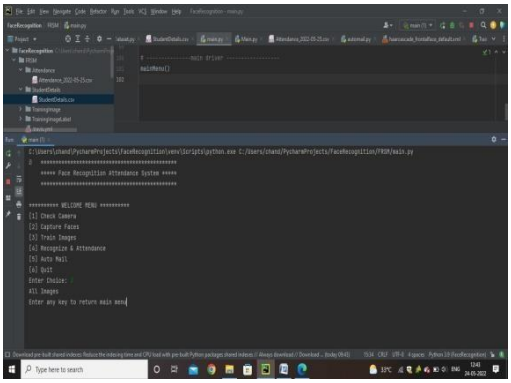


**Fig. 8. Train Image**

**Fig. 9. Recognition of face**

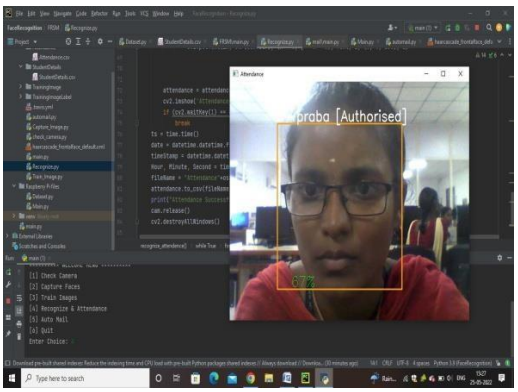



**Fig. 10. Marking Attendance**

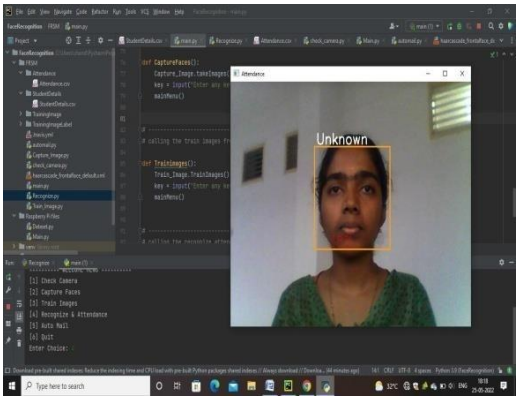



**Fig.11. Sample Output for Untrained Image**

**Performance Analysis of the proposed technique**

From the study, it is observed that the proposed MLBPH and HHCC technique is efficient in marking a smart attendance with high accuracy and less false positive rate in the smaller dataset using both high and low-resolution images and it consumes less time. The overall findings and results are presented in table 2.

| Algorithm | Working Ability | Result |
|---|---|---|
| Eigen Face/ Kernel PCA | High speed in training and recognition | Accuracy(Ac)=77.97& FP not defined |
| Fisher Face/ LDA | Images of an individual with different illumination, and facialexpressions able to be recognized if more samples are Trained | Ac=82.45%& FP not defined |
| Neural Network | High Accuracy only with a large dataset | Ac=Less than 50 %& FP not defined |
| **Proposed MLBPH and hybrid Haar Cascade Classifier** | **It is able to overcome a variety of facial expressions, varying illumination, image rotation and aging of the person (high/ low quality images)** | **Ac=91.93% FP=20%** |

**Table 2: Findings of the proposed algorithm**

## VI CONCLUSION AND FUTURE WORK

The proposed technique uses MLBPH and Hybrid Haar Cascade Classifier and it correctly identified human faces and handled a variety of facial expressions and automatically updates each person's attendance and marks them as present or absent on a CSV file. The accuracyof the suggested technique is 91.93% for high-quality images, 94.12% for low-quality images. A face recognition attendance system may be created in the future to serve as a verification system for various organizations, as well as in the public and private sectors ofthe economy. A tracking system for identifying the people can also be constructed using this technique. Voter

identification, passport, driver's license, and many more document verification centers can be found using this system. Additionally, this methodology is used for authentication procedures at places like exam centers and ATMs.

The machine learning-based Modified LBPH and Hybrid HCC technique showed high performance in terms of accuracy in lesser false positives and training time. The results reveal that the recognized face can be authorized or unknown on the screen.

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The authors have declared no conflicts of interest in this article

**COMPLIANCE WITH ETHICAL STANDARDS**

This article is a completely original work of its authors; it has not been published before and will not be sent to other publications until the editorial board decides not to accept it for publication.

**DATA AVAILABILITY STATEMENT**

Data sharing is not applicable to this article because they are publicly available.

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**REFERENCES:**

1. https://www.alibaba.com/product-detail/Original-Hik-vision-8MP-WDRH_60752337217.html?spm=a2700.details.deiletai6.1.584755a0Lhzdop
2. http://www.ni.com/en-lb/shop/select/labview?skuId=495092
3. Jam, Jireh. (2018). Face Detection and Recognition Student Attendance System., research gate publication
4. http://erepository.uonbi.ac.ke/bitstream/handle/11295/76598/Kagiri_Enhancing%20community%20based%20health%20information%20system%20CBHIS%20reporting?sequence=4&isAllowed=y
5. Facial recognition-based attendance monitoring system for educational institution by tan shujing (15acb03979) supervised by Mr. Teoh shenkhang
6. LC Paul and Abdulla Al Sumam. (2012). Face Recognition Using Principal Component

Analysis Method. IJARCET, V1 (9).

7. D. Nithya (2015). Automated Class Attendance System based on Face Recognition using PCA Algorithm. International Journal of Engineering Research and, V4 (12).
8. Suman Kumar Bhattacharyya & Kumar Rahul. (2013), "Face Recognition by Linear Discriminant Analysis", International Journal of Communication Network Security, V2(2), pp 31-35.
9. Ojala, T., Pietikainen, M. and Maenpaa, T. (2002). Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. IEEE Transactions on Pattern Analysis and Machine Intelligence, 24(7), pp.971-987.
10. Md. Abdur Rahim (2013), Face Recognition Using Local Binary Patterns. Global Journal of Computer Science and Technology Graphics & Vision V13 (4) Version 1.0.
11. Kasar, M., Bhattacharyya, D. and Kim, T. (2016). Face Recognition Using Neural Network: A Review. International Journal of Security and Its Applications, 10(3), pp.81-100.
12. Taigman, Y. et al., 2014. DeepFace: Closing the Gap to Human-Level Performance in Face Verification. IEEE Conference on Computer Vision and Pattern Recognition.
13. Divyarajsinh N Parmar et al. (2013).Face Recognition Methods and Applications. Int.J.Computer Technology & Applications,Vol 4 (1),84-86.
14. Deepesh Raj (2011), A Realtime Face Recognition system using PCA and various Distance Classifiers. CS676 : Computer Vision and Image Processing. Available at: http://home.iitk.ac.in/~draj/cs676/project/index.html [Accessed March 25, 2018].
15. Kamila, NK. (2015.). Handbook of research on emerging perspectives in intelligent pattern recognition, analysis, and image processing. Lee, S. and Li, S. (2007). Advances in Biometrics. Berlin: Springer.
16. Kalyan Sourav Dash. (2014). Face recognition using PCA - File Exchange - MATLAB Central. [online] Mathworks.com. Available at:https://www.mathworks.com/matlabcentral/fileexchange/45750- face-recognitionusing-pca [Accessed 11 Apr. 2018].
17. Mathworks.com. (2018). Detect objects using the Viola-Jones algorithm - MATLAB. [online]Availableat:https://www.mathworks.com/help/vision/ref/vision.cascadeobject detectorsystem- object.html [Accessed 22 Apr. 2018]. Cvc.cs.yale.edu. (1997).
18. L. Zhi-fang, Y. Zhi-sheng, A.K.Jain and W. Yun-qiong, 2003, "Face Detection And Facial Feature Extraction In Color Image", Proc. The Fifth International Conference on Computational Intelligence and Multimedia Applications (ICCIMA'03), pp.126-130,

Xi'an, China.

19. S. Kherchaoui and A. Houacine, 2010, "Face Detection Based On A Model Of The Skin Color With Constraints And Template Matching", Proc. 2010 International Conference on Machine and Web Intelligence, pp. 469 - 472, Algiers, Algeria.
20. Design of a Face Recognition System (PDF Download Available). Available from: https://www.researchgate.net/publication/262875649_Design_of_a_Face_Recognition_System
21. Akshara Jadhav. (2017) .Automated Attendance System Using Face Recognition. International Research Journal of Engineering and Technology.V4 .
22. P. Arun Mozhi Devan et al., (2017). Smart Attendance System Using Face Recognition. Advances in Natural and Applied Sciences. 11(7), Pages: 139-144
23. Rahul V. Patil and S. B.Bangar. (2017). Video Surveillance Based Attendance system. IJARCCE, 6(3), pp.708-713.
24. Mrunmayee Shirodkar. (2015). Automated Attendance Management System using Face Recognition. International Journal of Computer Applications and International Conference and Workshop on Emerging Trends in Technology.
25. Naveed Khan Balcoh. (2012). Algorithm for Efficient Attendance Management: Face Recognition based approach.International Journal of Computer Science Issues, V9 (4), No 1.
26. Varsha Gupta, Dipesh Sharma. (2014), "A Study of Various Face Detection Methods", International Journal of Advanced Research in Computer and Communication Engineering), vol.3, no. 5.
27. P. Viola, M. J. Jones. (2004), "Robust Real-Time Face Detection", International Journal of Computer Vision 57(2), 137–154.
28. Mekha Joseph et al. (2016). Children's Transportation Safety System Using Real Time Face Recognition. International Journal of Advanced Research in Computer and Communication Engineering V5 (3). 62
29. SrushtiGirhe et al. (2015). Computer Vision Based Semi-automatic Algorithm for face detection. International Journal on Recent and Innovation Trends in Computing and Communication V3(2).
30. BurakOzen. (2017).Introduction to Boosting Methodology &Adaboost algorithm. [online] Available at: https://www.linkedin.com/pulse/introduction-boostingmethodology-adaboost-algorithm-burak-ozen [Accessed 12 Apr. 2018].
31. Chris McCormick. (2013). Adaboost Tutorial. [online] Available at:

http://mccormickml.com/2013/12/13/adaboost-tutorial/ [Accessed 12 Apr. 2018]. Kihwan Kim. (2011).Rapid Object Detection using a Boosted Cascade of Simple Feature and Fast Face Detection via Morphology-Based Pre-processing.

32. Subhi Singh. (2015). Automatic Lecture Attendance System Using Face Reorganizationmatrix. Academic International Online Journal of Engineering and Technology.V3 (1).
33. ShireeshaChintalapati, M.V. Raghunadh. (2014), "Automated Attendance Management System Based On Face Recognition Algorithms", IEEE International Conference on Computational Intelligence and Computing Research.
34. Gonzalez, R. C., & Woods, R. E. (2002). Digital image processing. Upper Saddle River, N.J., Prentice Hall.
35. Kanan, C. and Cottrell, G. (2012). Color-to-Grayscale: Does the Method Matter in Image Recognition?.PLoS ONE, 7(1), p.e29740.
36. Pratiksha M. Patel (2016). Contrast Enhancement of Images and videos using Histogram Equalization. International Journal on Recent and Innovation Trends in Computing and Communication.V4 (11).
37. M. Karunakar, C. A. Sai, K. Chandra and K. A. Kumar, "Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment," International Journal for Recent Developments in Science and Technology, vol. 4, no. 5, pp. 194-201, 2020.
38. S. Bhattacharya, G. S. Nainala, P. Das and A. Routray, "Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environmen," in 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), 2018.
39. G. Hua, M.-H. Yang, E. Learned-Miller, Y. a. T. M. Ma, D. J. Kriegman and T. S. Huang, "Introduction to the special section on realworld face recognition," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 33, pp. 1921--1924, 2011.
40. F. P. Filippidou and G. A. Papakostas, "Single Sample Face Recognition Using Convolutional Neural Networks for Automated Attendance Systems," in 2020 Fourth International Conference On Intelligent Computing in Data Sciences (ICDS), 2020.
41. I. B. Gurevich V. V. Yashina On Modeling Descriptive Image Analysis Procedures on a Specialized Turing Machine, Content type: KEYNOTE PAPERS OF THE 8th INTERNATIONAL WORKSHOP "IMAGE MINING. THEORY AND

APPLICATIONS" Published: 19 October 2022 Pages: 469 - 476

42. Identity-Preserved Face Beauty Transformation with Conditional Generative Adversarial Networks Authors Zhitong Huang Ching Yee Suen Content type:THE PAPER OF IAPR K.-S. FU PRIZE WINNER Published: 21 September 2021 Pages: 364 - 375