Facial Recognition based Attendance System using Haar Cascade and LBP classifiers

A Report

Submitted in partial fulfillment of the requirements for the award of the Degree of

Bachelor of Technology

in

Information Technology

By

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APPROVAL OF THE GUIDE

Recommended that the B. Tech. Summer Internship Project titled “Facial Recognition based Attendance System using Haar Cascade and Local Binary Platform Histogram Classifier Algorithm” submitted by BTECH/10538/21 , Mudit Rai is approved by me for submission. This should be accepted as fulfilling the partial requirements for the award of Degree of Bachelor of Technology in **Information Technology**. To the best of my knowledge, the report represents work carried out by the student in **BIT Mesra** and the content of this report is not form a basis for the award of any previous degree to anyone else.

Date: 16th July, 2024.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA.

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CERTIFICATE OF APPROVAL

This is to certify that the work embodied in this Summer Internship Report entitled " **FACIAL RECOGNITION BASED ATTENDANCE SYSTEM USING HAAR CASCADE AND LBP CLASSIFIERS** "is carried out by **Mudit Rai (BTECH/10538/21)** has been approved for the degree of Bachelor of Technology in Information Technology of Birla Institute of Technology, Mesra, Ranchi.

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ABSTRACT

The purpose of the attendance system is to keep tabs on a student's attendance.There are various kinds of attendance systems, including facial recognition, biometric, Radio frequency card, and traditional paper-based systems framework.

The biometric method for face detection is called facial recognition. Using the facial recognition approach, a face is validated or recognized from the multi-media photos. Face identification has become increasingly crucial as advanced culture has developed. Face detection and identification have increased globally. It owes the requirement for security, including authorization, national security, and other essential conditions.

A facial recognition-based attendance system is the most time- and security-efficient of them all. Numerous study studies concentrate solely on the pupils' recognition rate. This study focuses on a face recognition-based attendance system that detects unknown people and saves their photos while obtaining a lower false-positive rate utilizing a threshold to confidence, or euclidean distance value
.

Numerous algorithms exist for the purpose of facial recognition. The goal of this research is to compare two face recognition methods that are taught for classification: Haar Cascade and Local Binary Pattern. As a result, Haar Cascade outperforms Local Binary Pattern in accuracy but outperforms Local Binary Pattern in execution time.

The Local Binary Pattern Histogram (LBPH) approach performs better when compared to other euclidean distance-based algorithms such as Eigen faces and Fisher faces. Because of its robustness, we employed the Haar cascade for face detection and the LBPH for face recognition method.

It can withstand monotonic grayscale changes with ease. To assess our system, scenarios like face recognition rate, false-positive rate for that, and false-positive rate with and without a threshold in identifying unknown persons are taken into consideration.

The facial recognition rate of students that we obtained was 77%, with a false-positive rate of 28%. Students can be recognized by this technique even if they have grown a beard or wear glasses. The facial recognition accuracy for unknown individuals is about 60% in both scenarios when a threshold value is applied. With and without adding a threshold, its false-positive rate is 14% and 30%, respectively.

Index Terms: Haar Cascade, LBPH algorithm, Face detection, Face recognition.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to everyone who has contributed to the successful completion of this project.

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Date: 16th July. 2024.

(Signature)
Mudit Rai
BTECH/10538/21

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LIST OF ABBREVIATIONS

1 LBPH – LOCAL BINARY PATTERN HISTOGRAMS

2 URL – UNIFORM RESOURCE LOCATOR

3 RFID – RADIO FREQUENCY IDENTIFICATION

4 CSS – CASCADING SYTLE SHEETS

5 LBP – LOCAL BINARY PATTERN

6 CV – COMPUTER VISION

7 HTTP – HYPER TEXT TRANSFER PROTOCOL

8 NPM – NODE PACKAGE MANAGER

CHAPTER 1

INTRODUCTION

Automation is the use of various technologies based on computer software to control machines and their processes. These developments have shown to boost accuracy in the present era while also assisting us in raising our standard of living. These kinds of innovations save a ton of labor.

Recognition can take place biometrically which is the statistical data analysis of an individual's rare behavioral and procedural and real life characteristics; it is primarily used for security and identification.

Examples of biometric recognition include fingerprints, facial features, retinas, irises, voices, gaits, palm prints, and other distinct physical and behavioral traits.

.

The Attendance system which is based on the principle Automation with the help of procedural systems, which has replaced the antiquated and conventional method of taking, viewing and evaluating attendance in its systems, is one innovation in automation. The paper-based approach to attendance tracking takes a lot of time, and as overall strength rises, so does its complexity.

The current scenario is dismissed in its automated form since it saves our effort in terms of time taken by the system and improves security by assisting in the prevention of proxy attendance.

Of all these techniques, face detection is thought to be the most accurate and secure. The process of identifying someone's face through the estimation and face recognition is the assessment of themes based on their distinct face identifiers.

Biometric software is used for this. A person's face can be recognized using a variety of techniques. Two of these are face detection based on generalized matching and adaptive regional blend matching.

The values of the subject's facial nodal points are an important part of the face recognition system. There had been a great deal of research done on LBP. along with Haar cascading techniques.

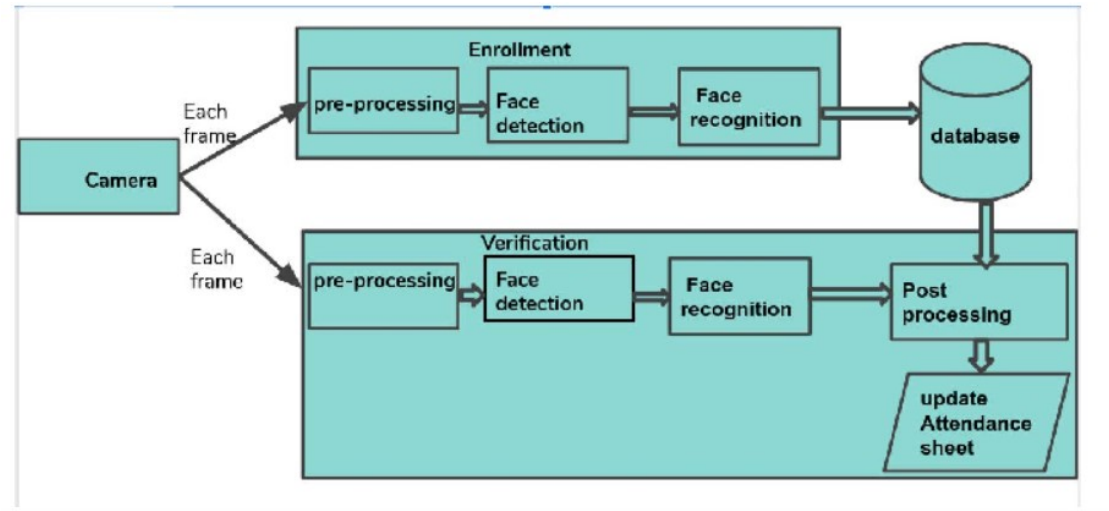

FIG 1.1) THE ENTIRE PROCESS OF THE "FACIAL RECOGNITION BASED ATTENDANCE SYSTEM"

Our suggested software machinery goal is to develop an "FACIAL RECOGNITION BASED ATTENDANCE SYSTEM" with lowering the value which can be termed as the false positive rate in identifying unfamiliar individuals by putting a thresholding value lets assume BETA in our case, in place and saving their photos.

Because of their resilience, we chose the LBP algorithm for face analysis or the ability to know what it is and the Haar cascade to detect if there is a face or not. It can withstand repeated grayscale changes with ease. Even the photos of any unidentified students of the school whose data is missing from the system architectural database are recognized and saved by our system.

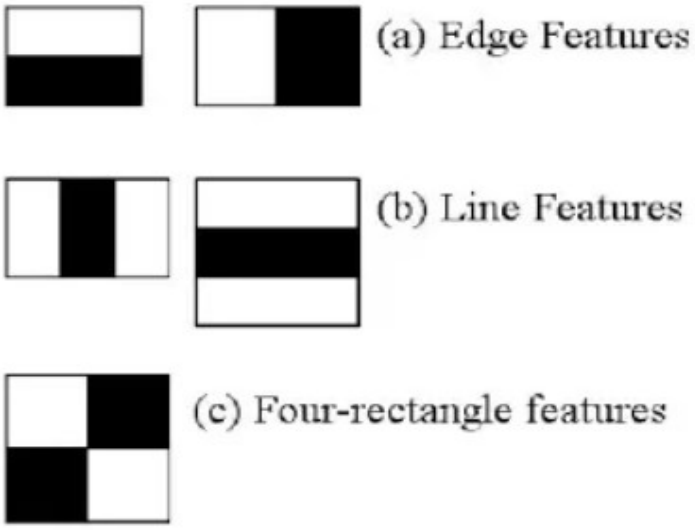

FIG. 1.2)THE DIFFERENT TYPES OF FEATURES IN AN IMAGE

That being said, it seems like they are either identifying a single face in the picture or they are only using one technique.
The current study uses two algorithms to detect faces in a picture with many faces in order to assess accuracy. The obtained accuracy is then compared by drawing a curve and bar graph in order to identify the technique that is most efficient.

Positive and negative images are the two different categories of images. Pictures with a face in them are considered positive images, while pictures without a face are considered negative images.

A classifier is a machine that determines if a picture is positive or negative. It has been trained on millions of photographs with and without face to reliably identify a new image as either a face or a non-face image in order to learn how to classify. Open-CV provides the assistance of classifiers which are pre trained : the LBP Classifier and the Haar Classifier.
These algorithmic classifiers process photos in grayscale since they don't need color information to identify whether or not a picture contains a face.

CHAPTER 2

HAAR CLASSFIER

A classification algorithm which is generated from a large number of positive and negative pictures using the machine learning technique known as Haar Cascading,
In their paper two renowned erstwhile software developers suggested an efficient object identification technique: Detection of Object,faces, etc using a classifier which is based on an algorithm known as the Haar based Classification algorithm.

Using a machine learning method called Haar Cascading, a classifier is created from a huge number of positive and negative images.
An early 21st century study proposed an effective method for object identification: object recognition utilizing cascade classifiers based on Haar features.
Cascade classifiers are a type of classifier used for detection of objects that rely on Haar features. By using a cascade operation from the photos, this classifier learns from more pictures by using machine learning.

Facial expressions and face detection in an image are also successfully recognized.The process comes to an end when the classifier receives both positive and negative images.
In this instance, Haar Cascade will be employed for face detection. Many positive (photos with faces) and negative (pictures without faces) images are needed for the procedure to successfully train the classifier.

The process of extracting its features comes next. This is done by using the Haar features that are visible in the pictures. They are exactly like our convolutional kernel.
One value is obtained for each feature by subtraction of the total count of pixels under the white rectangle and the sum of the count of the pixels under the rectangle which is black.

Furthermore effectively identified are facial expressions and face detection in an image.The classifier receives both positive based images and negative based images, at which point the procedure is concluded. The face detection method used in this case is Haar Cascade.

The process to effectively train the classifier requires a huge number of positive based (snaps which contain a face) and negative (snaps which do not contain a face) images. After that, follows the feature extraction procedure. The Haar features that can be seen in the images are used to do this. Our convolutional kernel is just like them.

The value of the total count of pixels under the rectangle which is white and the total number of pixels under the black rectangle are subtracted to yield one value for each feature.apply each quality to every

training image in order to achieve this.
It establishes the best cutoff point for every characteristic, enabling the positive or negative classification of the faces.

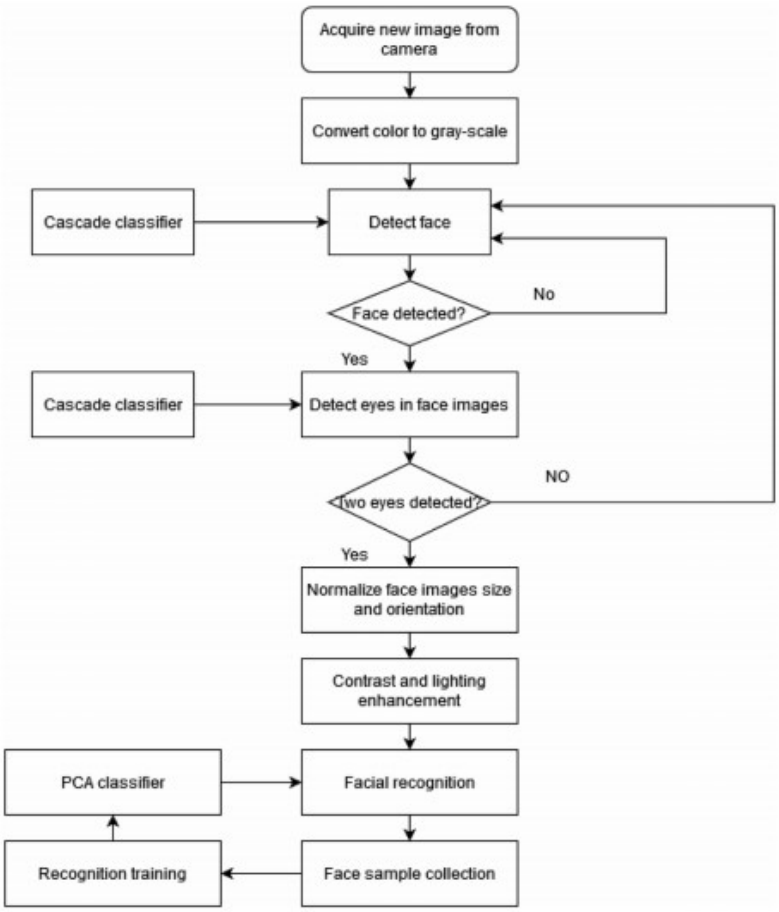

Fig. 2. Haar Cascade flowchart.

FIG. 2.1) THE HAAR CASCADE CLASSIFIER FLOWCHART

It goes without saying that there will be mistakes or incorrect categorization.The characteristics that best distinguish between face and non-facial photos are those with the lowest mistake rate, or smallest selection bias.
At first, every image has the same weight. The weights of photos that are incorrectly classified are raised after every categorization. Next, the identical procedure is carried out once more, and new weights and error rates are computed. Until the desired accuracy, error rate, or feature count is reached, the process is repeated.

The final classifier is weighted and formed by adding these subpar classifiers together. Its inability to classify the image on its own is why it is called weak; nevertheless, when combined with other classifiers, it becomes a powerful classifier.
An image's non-face region comprises the majority of the image. Cascade of Classifiers is used in this because it is a better method for determining whether a window is not a face region because it is a simple methodology.

The features are divided into different stages of the classifier and applied one at a time rather than applying all of the features on a single window. There will be far less features in the initial stages.

A window should be discarded when it fails the first test. The characteristics that are still present on it are ignored. In case it passes, proceed with the process by applying the second set of features. The window that goes through every phase is a facial region.

2.1)THE USE OF HAAR CASCADES

This technique has a wide range of applications in numerous industries. Below is a list of some of the most significant applications:

1)Facial Recognition:; Other electronic devices and security protocols can employ Haar cascades to verify the identity of the user for secure login, in a manner similar to how the iPhone X uses facial recognition.

2)Robotics : By utilizing object recognition, robotic devices are able to "see" their environment and carry out tasks. This can be applied, for example, to manufacturing task automation.

3)Autonomous Vehicles:: In order to make better decisions and boost safety, autonomous vehicles need to be aware of their surroundings. Haar cascades can assist in identifying items like pedestrians, traffic lights, and walkways.

4) Image Search and Object identification;: Building on the notion of facial identification, any kind of object may be found through the application of computer vision algorithms like Haar cascades.

5) Agriculture: In the field of agriculture, food shortages caused by pests can be minimized by using

6) Plant Safety: Haar classifiers to detect if dangerous insects are flying onto plants.

7)Industrial Use: Many of the jobs that people could previously only perform may now be automated by using Haar classifiers to enable machines to pick up and distinguish specific objects.

As seen above, there is no question that The fields of machine learning and education will be greatly impacted by Haar cascades and associated computer vision technology Haar cascades can be used almost anywhere due to their adaptability.
Ensure that, when using Haar cascades, you optimize against false negatives. To create your own Haar cascade model, using Open-CV.

CHAPTER 3

Local Binary Patterns (LBP)

A particular kind of visual course used in computer vision classification is known as local binary patterns. This method describes the patterns or texture of a picture.
Take a look at a fingerprint, which may mimic the unique qualities of a variety of textures, including rough, patterned, and smooth surfaces. LBP is the particular example of the imitation of Texture Spectrum. The first example of labor law case law dates back to 1994. Its importance as a determining factor in the texture classification has been found since then.
Using the LBP operator, a single photo is examined as a structure of micro-patterns. Next, the LBP histogram is superimposed over the face, thereby encrypting only the circumstances pertaining to micro-patterns. The facial photo is divided into smaller, non-overlapping sections to create the figure of documentation.

By comparing the values of the central pixel to the 3 × 3 neighborhood, the original LBP identifies the pixels. A value can be used to represent common features in a certain numerical scale, such as edges, lines, and points. Consequently, object recognition in an image can be achieved with a priori extracted set of values.

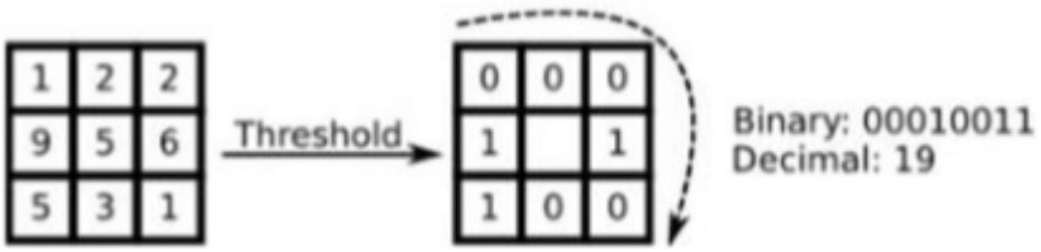

FIG. 3.1) WORKING OF LBP ON A 3X3 MATRIX WITH A THRESHOLD

This method is applied to characterize an image's texture or patterns. As we considered earlier the example of a fingerprint, for instance, which may capture the distinctive characteristics of various textures, such as smooth, patterned, and rough surfaces.

Examining a grayscale image pixel by pixel to gain an understanding of LBP. We analyze each pixel's neighbourhood, which is made up of the pixel and the pixels around it. We compare a pixel's intensity value with that of its neighbors to get the LBP code for that pixel. We award a value of 1 to nearby pixels whose intensity is equal to or greater than the central pixel's intensity, and a value of 0 to neighboring pixels whose

intensity is lower.

We traverse the neighborhood in either a clockwise or counterclockwise direction, beginning at a reference pixel. We assign a 1 or 0 at each step based on the comparison between the intensity of the current neighbor and the intensity of the central pixel. After comparing each neighbor to the last one, we are left with a series of 1s and 0s. The central pixel's LBP code is represented by this sequence. It depicts the neighborhood's textural pattern.

We create an entire LBP representation of the image by going through this process again for each pixel in the picture. The texture properties of the image can then be described and examined using this representation. using this LBP method to the identification of facial characteristics.

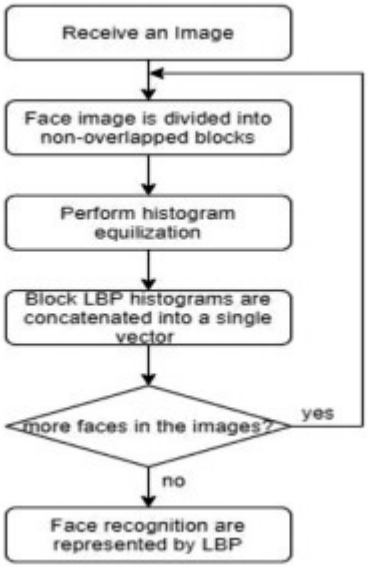

FIG. 3.2) THE LBP CLASSIFIER BASED FLOWCHART

3.1)STEPS FOR A LOCAL BINARY PATTERN CLASSIFIER ALGORITHM

STEP 1:

We traverse the neighborhood in either a **clockwise or counterclockwise direction**, beginning at a reference pixel. We assign a 1 or 0 at each step based on the comparison between the intensity of the current neighbor and the intensity of the central pixel.

After comparing each neighbor to the last one, we are left with a series of 1s and 0s. The central pixel's LBP code is represented by this sequence. It depicts the neighborhood's textural pattern.

STEP 2:

We produce a full LBP representation of the image by going through this method again for each pixel in the picture. Subsequently, we may define and examine the texture attributes of the picture using this representation. To identify facial features, we apply this LBP approach in this instance.

STEP 3:
Creating a Function to Take and Store Pictures in Step Three
Here you should provide a function that can identify faces in real-time camera captures. and then resize and place in the "Faces" folder. utilizing the procedures listed here.

STEP 4:
The final step is to execute the capture_images() function, which will activate the camera, take pictures, convert them to grayscale, and save the pictures so that we may extract more facial features and train the model later. To facilitate easy access, all of the photos are kept in the local data set folder called **"Faces."**

3.2) IMPORTANCE OF LOCAL BINARY PATTERN CLASSIFIER:

1)The estimate of LBP Algorithm is easier to use.

2)The time needed for training the data is lesser in comparison to other algorithms.

3)The LBP classifier works hard to obstruct the flow of the algorithm.

CHAPTER 4

Methodology, Results and Analysis

In the proposed automated attendance management system, the "FACIAL RECOGNITION BASED ATTENDANCE SYSTEM" is based on the LBPH algorithm for facial identification and the Haar cascade for face detection.

The simplest and fastest way to create a GUI application is to develop the Graphical User Interface (GUI) for this system using the Tkinter Python Module. Among the functions provided by this system is the ability to take pictures of students and store them in a database, train the camera and database to recognize those images, and begin tracking students as they enter the classroom.

This system uses the camera to identify students as they enter the room, pre-processing their faces before sending them on for additional processing.

Considering that the distance needed to recognize an object is 36 inches. Students recognize faces with a 76.8% accuracy rate and a 27.9% false-positive rate. Even if a human has grown facial hair or is wearing glasses, the algorithm can still identify them.

The face recognition accuracy of both the current and proposed models for unknown individuals is lesser than 60%. The primary cause of this was the face detection algorithm's identification of background objects as human faces. For the suggested and current models, respectively, its false positive rate is 15% and 30.8%. Only the false positive rate for an unidentified person was impacted by the threshold value.

Fifty is the preferred filter value. Nonetheless, under the suggested system, only an individual is regarded as unknown and their picture is preserved as such if their confidence level is higher than 50 and 95.

4.1)METHODOLOGY

A)Face recognition

Face detection is considered a thorough and practical approach in the field of technology. Finding every face in a picture that can be seen is the main objective of face detection. The implementation in this scenario makes advantage of Open-CV.

Following are the steps involved in the Face Recognition process:

i. Adding the image data import.
Ii. The process of converting the input pictures into grayscale images.
Iii. Applying the Haar cascade and LBP classifier
iv. Assessing both classifiers' accuracy and processing time

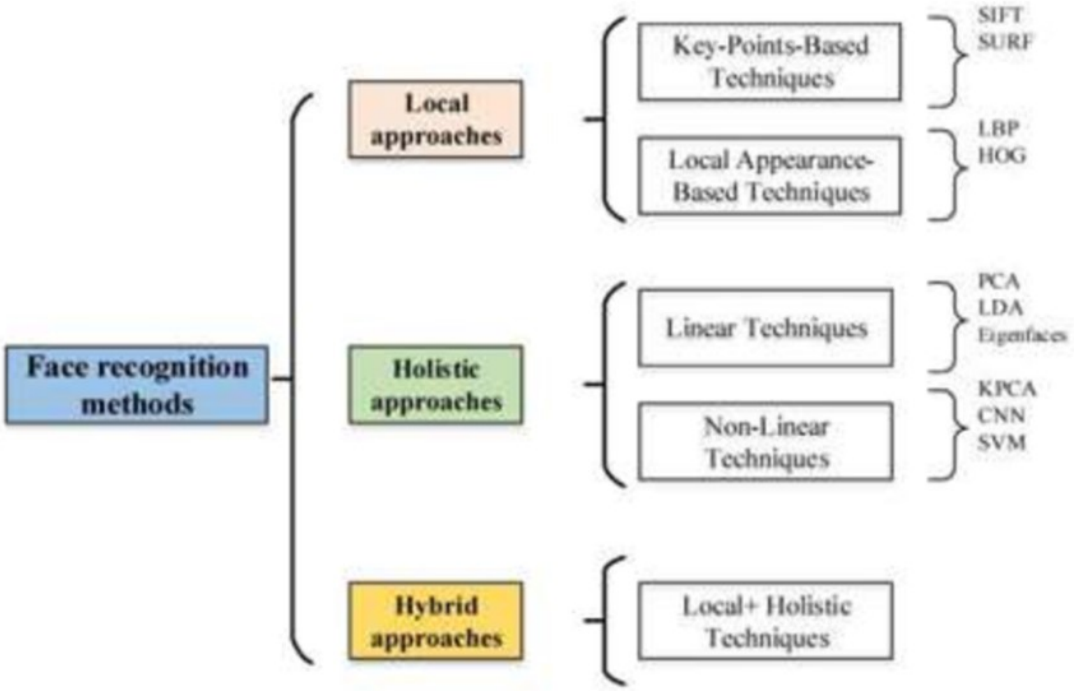

FIG 4.1)DIFFERENT TYPES OF FACE RECOGNITION METHODS

This is completed using the following steps:

a)Acquiring the required library materials
b) Securing the images captured by the camera.
c) To prepare the picture for the classifiers to process, it is converted into a grayscale image.
d) To import the image, Open-CV will be utilized.
e) The picture will load into the BGR color space by default.

B) Local Binary Pattern Categorization

The steps for catgorization are as follows:

I. The input picture is loaded using the built-in method cv2.imread(img_path); the image path is utilized as an input parameter here.

II. Presenting it once it has been converted to grayscale.

III. Next, the LBP classifier is loaded.

For each pixel, the LBP is calculated. For every pixel p, there is a comparison between the eight neighbors of the central pixel, p. The neighbors are assigned a value of 1 or 0 depending on whether x is greater than or equal to p.

Referred to as the equation that computes LBP so that

$LBP(xc, yc) = \Sigma(p-1)(p=0)\ 2ps(ip - ic)$

The **center pixel is represented by (xc,yc)**, the **brightness by (ic)**, and the **brightness of the neighboring pixels by (ip)**. **S(.) is a sign function with the definitions of s(x)=0 and s(x)=1 if x⩾0.**

At the moment of image capture, the camera divides the face into many blocks.

Next, each block's histogram is computed. A single vector is created by concatenating the block local binary patterns histogram. The procedure described above is repeated if there are other faces in the image; otherwise, LBP is used to represent face recognition.

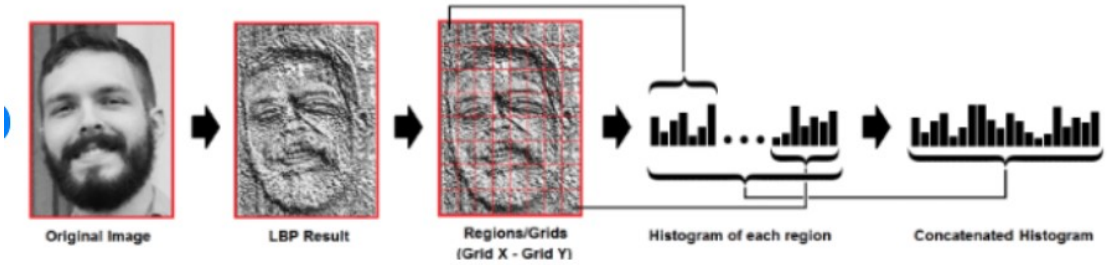

FIG 4.2)WORKING OF LBPH ALGORITHM USING HISTOGRAMS

4.2) COMPUTATION OF ACCURACY

· **True Positive (TP):** The object of interest has been accurately recognized and is an actual one. The faces that have been accurately classified can be computed as follows:

TP divided by (TP+FP) yields the True Positive Rate (TPR).

· **False-Positives (FP)**: When an object of no interest is mistakenly detected as the real object, this is known as a false-positive.

· **False-Negatives (FN)**: These are real objects of interest that have been mistakenly classified as negative.
FNR, or false negative rate, is calculated as FN divided by FN+TP.

For every variable, TP denotes True Positive, FP stands for False Positive, TN for True Negative, and FN for False Negative, and the formula for **accuracy is (TP + TN)/(TP + TN + FP + FN).**

These formulae yield an accuracy of 96.24% for the Haar Cascade Classifier and 94.74% for the Local Binary Pattern Classifier

CHAPTER 5

Conclusion

The limited size of the data set is the issue with this "FACIAL RECOGNITION BASED ATTENDANCE SYSTEM". Better datasets could be created in the future, which might theoretically produce results that are more accurate.

Through the creation of fresh training cases, we can enhance haar cascade classifiers, increasing the accuracy with which unknown individuals are recognized.

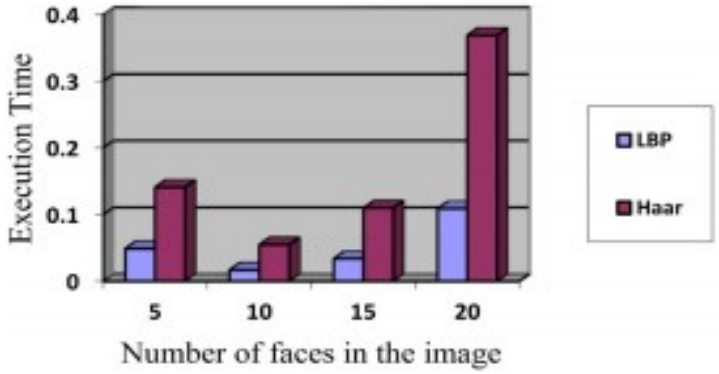

FIG. 5.1) Based on execution time, a comparison was made between the Haar Cascade and LBP classifiers.

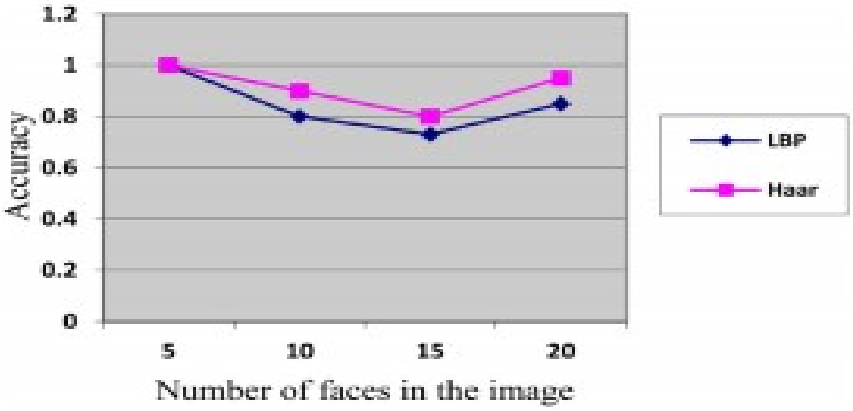

FIG. 5.2) Based on accuracy, a comparison was made between the Haar Cascade and LBP classifiers.

Using a large number of images, the implementation is done on both the LBP classifier and the Haar cascade. In comparison to other studies that have been made publicly available, The LBP classifier completes faster than the

Haar cascade classifier, but the former is more accurate. The Haar cascade classifier locates more faces in an image than the LBP classifier.

where, Seconds are used to represent time, and percentages are used to represent accuracy.

The accuracy rate of the two models that are referred to in the comparison between the proposed and existing models is lower than that of the suggested model.

Among the methods of identification is facial recognition. It is one of the primary uses when contrasted with other forms of identification like RFID, iris scanning, and fingerprint scanning. Proper posture and a clean photo could help increase facial recognition accuracy.

The results of this report's comparison and application of two algorithms—Haar Cascade and Local Binary Pattern Classifiers—over the "FACIAL RECOGNITION BASED ATTENDANCE SYSTEM" indicate that the LBP classifier is less accurate than the Haar cascade classifier.

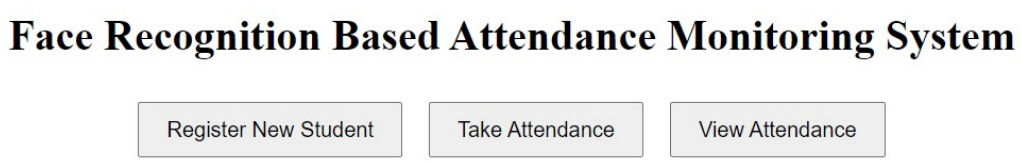

FIG 5.3) THE FRONTEND WEBPAGE OF “FACE RECOGNITION BASED ATTENDANCE MONITORING SYSTEM”

CONCLUSION

For face detection and recognition, we thus employ the Haar Cascade Classifier and the Local Binary Pattern Classifier, respectively, since the former finds more faces in an image while the latter uses a shorter processing time to recognize faces.

The primary limitation of this "HAAR CASCADE CLASSIFIER AND LOCAL BINARY CLASSIFIER-BASED ATTENDANCE SYSTEM" is that it is not suitable for use with younger learners.

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