Global Transitions Proceedings 2 (2021) 330–335

Contents lists available at ScienceDirect

Global Transitions Proceedings

journal homepage: http://www.keaipublishing.com/en/journals/global-transitions-proceedings/

Facial recognition using Haar cascade and LBP classifiers

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ARTICLE INFO

Keywords:
Facial recognition
Haar cascade
Local binary pattern (LBP);Open CV
Radio-frequency identification(RFID)
Support-vector machine(SVM)

ABSTRACT

Facial Recognition is the biometric technique used in face detection. The task for validating or recognizing a face from the multi-media photographs is done using facial recognition technique. With the evolution of advanced society the requirement for face identification has been really important. Detection and identification of faces has been grown worldwide. It owes the demand for security such as authorization, national safety and other vital circumstances. There are number of algorithms for facial detection. This paper aspires to present the comparison of two face recognition techniques Haar Cascade and Local Binary Pattern edified for the classification. As a result the accuracy of Haar Cascade is more than the Local Binary Pattern but the execution time in Haar Cascade is more than Local Binary Pattern.

Introduction

Biometric Recognition is he statistical data analysis of people's unique behavioral and physical characteristics which is mainly used for security and identification which includes fingerprints, facial features, retina, iris, voice, gaits palm print etc. Among these methods face detection is considered to be most precise and safe. Facial recognition is an activity of discovering a peep's face by estimating and evaluating motifs on the exclusive facial markers of the face. Biometric software is used for this purpose.

There are number of strategies for recognizing person's face. Some of them are adaptive regional blend matching method and generalized matching face detection method. The values of the nodal points on the person's face plays crucial task in face recognition system.

Many researches had been done on LBP and Haar cascading techniques [1]. But either they are using only one algorithm or they are detecting a single face in the image. In the current work two algorithmsare used to detect the faces in the image containing many faces to calculate the accuracy then the acquired accuracy will becompared by plotting the curve and bar graph to find the efficient algorithm.

There are two types of image positive image and negative image. Positive images are those images which contain the face in that and negative images are the images which contains non-face image [3]. Classifier is a device which decides whether the taken image is negative or positive. It is trained on hundreds of thousands of face and non-face images to learn to classify a new image as face or non-face image correctly. OpenCV provides two pre-trained classifiers Haar Classifier and LBP Classifier. Both of these classifiers process images in gray-scales as it doesn't need color information to decide if image has a face or not [4].

Haar Cascading

Haar Cascading is the machine learning method where a classifier is drilled from a great deal of positive and negative photos. The algorithm is put forwarded by Paul Viola and Michael Jones [5, 6]. Haar feature-based cascade classifiers are the classifiers implemented for object detection. This classifier chases machine learning procedure in which a cascade operation is inculcated from the photos to discover items in additional photos. Face detection and facial expressions in an image are also successfully detected. The exercise is finished by offering positive and negative pictures to the classifier. Then the characteristics are drawn out from the picture. Each characteristic is an individual value, which is acquired by subtracting sum of pixels in white rectangle from summation of pixels in black rectangle.In which it detects the faces of different individual in different environments. The Haar-like feature of any size can be calculated in constant time because of integral images [2].

Local Binary Patterns

Local Binary Pattern is a kind of visual course used for categorization on computer vision. LBP is the distinct case of the Texture Spectrum imitation put forwarded in 1990.

LBP was first illustrated in 1994. It has since been found to be a strong factor for texture categorization. By utilizing LBP operator, individual photo is examined as a structure of micro-patterns. Then the histogram of LBP is enumerated throughout the face, which encrypts just the circumstances of micro-patterns. The figure of documentation is assembled by splitting face picture toward m minor non over lapping sections such as R0, R1,…,Rm .The original LBP labels the pixels by threshold the 3×3 neighborhood in relation to the central pixel value. In

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https://doi.org/10.1016/j.gltp.2021.08.044
Received 27 May 2021; Accepted 28 July 2021
Available online 12 August 2021

a particular numerical scale the common features, such as edges, lines, point, can be represented by a value [3]. Therefore, it is possible to recognize objects in an image using a set of values extracted a priori.

Literature survey

Mayur Surve *et al.* in 2020, [7] have developed a model which catches the live images from Camera. Then it applies different algorithms for face detection and face recognition. They also created the GUI on single click which catches the images, form the dataset and inculcate the dataset. They used the Haar cascade algorithm to recognize the face in the image.

Palanivel N *et al.* in 2019, [8] has approach a module that signs the existence of people by detecting their facial nature and creating the attendance data itself. Face Recognition's reliability charge is bestrewed with the aspects similar to changing the glowing, posture changes, expression changes, and occlusion. They used K-means clustering algorithmic rule for analyzing the face characteristics. Biometric nature of the face features has been withdrawn. The K-mean clustering approach is used in gathering the face characteristics. Then, SVM method is used in detection of the photos characteristics. It may fulfill high identification showing with lesser characteristics number.

Jenif D Souza W S *et al.*in 2019, [9] has proposed a system where image processing techniques is used for facial recognition. The refined photo is utilized to compare with the staved catalogue. The commenced procedure was being effectuated with 4 modules such as Image Capturing, Cleavage of group photo and Face Detection, Face comparison and Recognition.

AZM Ehtesham Chowdhury *et al.* in 2019, [10] have proposed a rare camera prototype to analyze the attendance much effectively. For developing a model with additional vigorous and steady. A different algorithm was also put forwarded to exercise the technique perfectly. This technique will make use of a modus to analyze student's attendance. This is based on face recognition and detection. Precision in average was the basic interest for selecting the most valid modus.

Nandhini R, Duraimurugan N *et al.* in 2019, [12] has built a technique which is capable to detect and acknowledge student faces quickly and accurately in photos or videos which is then detained via a camera. Many algorithms and technologies have been implemented for tweaking the execution of recognizing the face using Deep Learning [21-23].

M. Kasiselvanathan *et al.* in 2018, [15] has built a technique named automatic attendance management system by face detection technique. The system used to recognize the facial dimensions in order to detect the face. An effective face recognition system has been implemented by upgrading the quality of the system. Eigen Faces algorithm has been used in this system. The technique is not only recognizing the faces, also the space of the facial nature based on changing rules.

Omar Abdul Rhman Salim *et al.* in 2018, [16] had proposed a technique of implementing a fully implanted student attendance process by face detection. The technique is depending on Raspberry Pi which runs Raspbian Operating System. The Camera and a 5-inch screen is connected to the Raspberry Pi. The image captured from the camera will be transferred to the Raspberry Pi. Which is intern programmed to handle face recognition by developing the LBPs. If the face in the input image i.e., image taken matches with the trained dataset image, the door will be opened and the attendance will be taken positively and it will be stored.

Xiang-Yu *et al.* in 2017, [17] they have forecasted an identification method of face procedure, that supports the quick justification study so as to defeat the problem of not acquiring accurate guide to recognition of squat face underneath limitless situation. To withdraw the characteristic from primal database Haar-feature classifier has been used. Additionally to that the procedure is utilized to the procedure for withdraw the characteristic. The existing probes technologies show that private recognition may be attained by make use of facial detection.

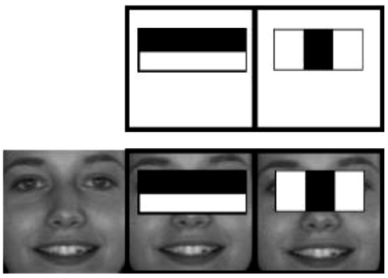

Fig. 1. Haar like feature.

C.B. Yuvaraj *et al.* in 2017, [20] had developed a proposal to keep the attendance with the help of image processing method. This paper was conventional to perceive the face employed Haar feature assisted the Viola-Jones approach. It will find the face of an individual student in the image. It gives the solutions with modularized coaching schedule for database files. Haar cascade is very beneficial for face features. The commute had to been made by maintaining the cameras numbers properly.

Sujay Patole *et al.* in 2017, [23] had implemented a device which combines techniques as justification examination. It is based on feature extraction and also for face-detection voila-jones. Faces are identified using PCA. Initially the database holds pictures of human which are used in identifying the person in the image taken. Good result is obtained and it will recognize the changes over the period of time in the faces.

Methodology

Face detection

In the field of technology Face detection is treated as the demanding and practically applied approach. The identification of each face present in an image is the major task of the face detection [11, 13, 14]. Here the implementation is done using OpenCV.

i. Loading the input images.
ii. Converting the input images into gray scale images.
iii. Applying the Haar cascade and LBP classifier.
iv. Comparing both classifier based on the accuracy and time.
  a Importing the required libraries
  b Taking the images which are captured by the camera.
  c To process the image through the classifiers it is converted into gray scale image.
  d Image will be loaded using OpenCV
  e By default, image will be loaded into BGR color space

Haar cascade classifier

i Loading the input image using built in function *cv2.imread(img_path)*, here the passing the image path as an input parameter
ii Converting it to gray scale mode and then displaying it
iii Loading the haar cascade classifier

Fig. 1 represents the Haar like feature. It consists of edge feature and line feature. In the gray-scale image the white bar represents the pixels that are closer to the light source [1].

Haar value calculation:

$$\text{Pixel value} = (\text{Sum of the Dark pixels/Number of Dark pixels}) - (\text{Sum of the Light pixels/Number of Light pixels}) \quad (1)$$

Haar Classifier is an object detection algorithm. In order to detect the object and to identify what it is; the features will be extracted from the image. Using Equation (1) haar pixel value can be calculated [18-20].

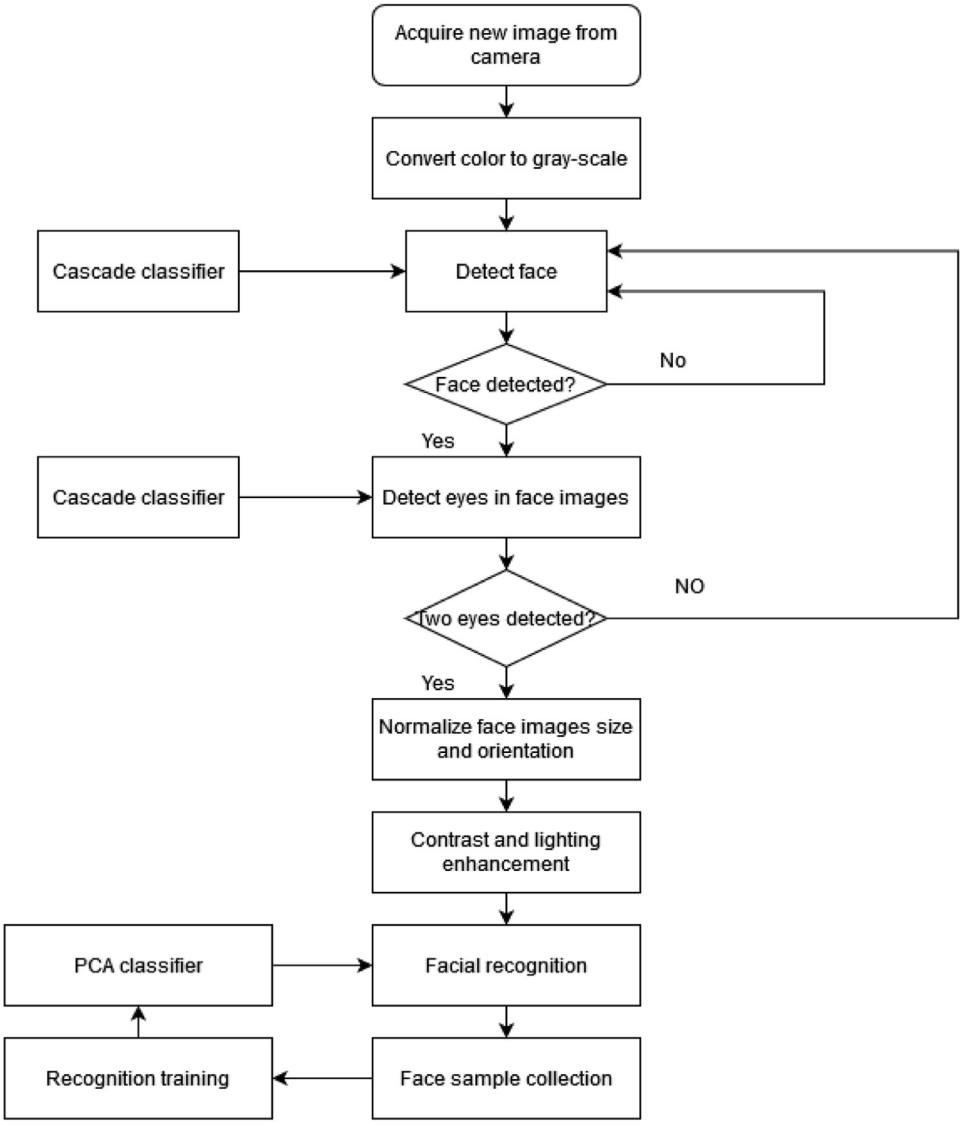

Fig. 2. Haar Cascade flowchart.

Fig. 2 represents the flowchart of the Haar cascade classifier. Once the camera acquires the image it converts the image into gray-scale. The cascade classifier detects the face, if the face is detected then the classifier once again checks for the both eyes in the detected face and if two eyes are detected it normalizes the face images size and orientation. Then the image is processed for face recognition where the image is compared with the face sample collection [24-25].

Importance of Haar Cascade classifier is that the Perception precision is more and the Positive rate is less.

LBP classifier

i Loading the input image using built in function *cv2.imread(img_path)*, here the passing the image path as an input parameter
ii Converting it to gray-scale mode and then displaying it
iii Loading the LBP classifier

The LBP for each pixel is calculated. For each pixel p, the 8 neighbor of the center pixel are compared with the pixel p and the neighbors are assigned a value 1 if x is greater than or equals to p.

Equation (2) is defined as the formula for the calculation of LBP Classifier, such that it is given as

$$\mathrm{LBP}(\mathrm{xc}, \mathrm{yc}) = \sum_{(p=0)}^{(p-1)} 2\mathrm{ps}(\mathrm{ip} - \mathrm{ic}) \quad (2)$$

Where,

(x_c,y_c) is the centre pixel i_c is the brightness i_p is the brightness of adjacent pixels s(.) is a sign function defined as: s(x)=1 if x≥0 and s(x)=0 otherwise

Fig. 3 represents the LBP Classifier flowchart. Once the camera acquires the image the face in image is divided into several blocks. Then the Histogram is calculated for each block. Block local binary patterns histogram are concatenated into a single vector. If there are more faces in the image then the above process is repeated or else face recognition are represented by LBP [9, 26].

Importance of LBP Classifier is that the Estimation is simple and fast. Thus the training time required is less. The classifier is vigorous to occlusion [20-25].

Accuracy calculation

- True positive (TP): It is an actual object of interest that is correctly identified. The correctly classified faces can be calculated as [5]:

  True positives rate (TPR) = TP/(TP+FP)

- False-positives (FP): It is a non-object of interest which is falselyidentified as the true object.

Table 1
Haar Cascade classifier.

No.of faces in an image	Execution Time (sec)	No.of faces detected	Accuracy (%)
5	0.141	5	100
10	0.055	9	90
15	0.11	12	80
20	0.369	19	95

Table 2
LBP classifier.

No.of faces in an image	Execution Time (sec)	No.of faces detected	Accuracy (%)
5	0.049	5	100
10	0.017	8	80
15	0.034	11	73.33
20	0.109	17	85

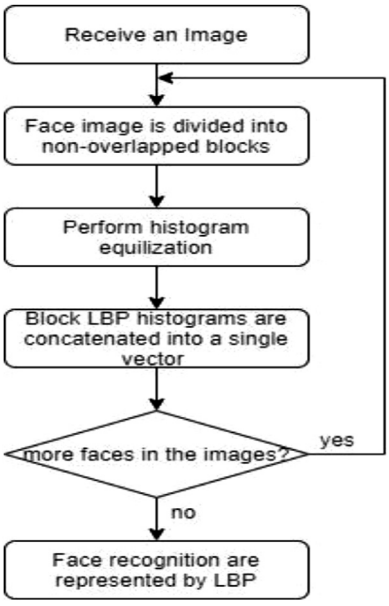

Fig. 3. LBP Classifier flowchart.

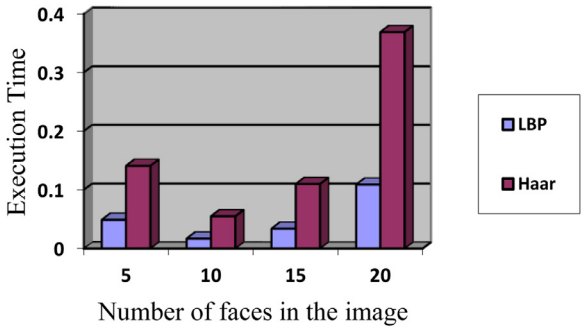

Fig. 4. Comparison between Haar Cascade and LBP Classifiers based on execution time.

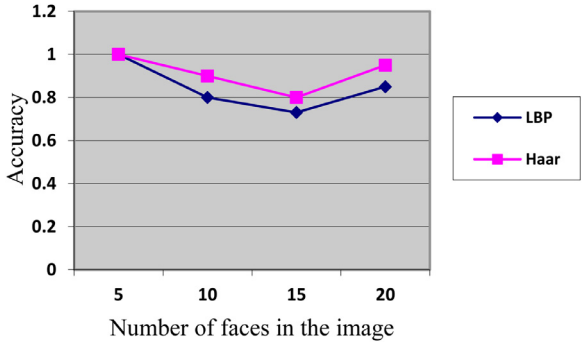

Fig. 5. Comparison between Haar Cascade and LBP Classifiers based on accuracy.

- False-negatives (FN): It is an actual object of interest falsely identified as negative. False negatives rate

(FNR)=FN/(FN+TP)

$$\text{Accuracy} = (TP + TN)/(TP + TN + FP + FN) \quad (3)$$

Where,
TP: True Positive FP: False Positive
TN: True Negative FN: False Negative
By using Equation (3) Accuracy is obtained for the Haar cascade is 96.24% and for LBP classifier 94.74%.

Results

The execution is performed on both Haar cascade and LBP classifier by using number of images. As a result, Haar cascade has more accuracy than the LBP classifier but time taken by the LBP classifier is less than the Haar cascade classifier compared to other researches. Haar cascade classifier detects more number of faces than the LBP classifier in an image.

Table 1 and Table 2 contains the execution time, number of faces detected and accuracy of both classifiers. Time is in the form of seconds and accuracy is in the form of percentage.

Table 3 gives the comparison of proposed model with already existing model, where referred two models has less accuracy rate than the proposed model. Here the dataset is number of faces detected and accuracy rate is in the form of percentage.

The bar graph in Fig. 4 shows the comparison between the Haar cascade and LBP classifier based on the execution time. The X-axis implies the total number of faces in the image and the Y-axis implies execution time taken by the classifiers.

The line graph in Fig. 5 shows the comparison between Haar Cascade and LBP Classifiers based on the accuracy. The X-axis implies the total number of faces in the image and the Y-axis implies accuracy.

In Fig. 6 and Fig. 7 total number of faces is 15. When the image is processed using Haar cascade classifier 12 faces are detected as shown in the Fig. 6. When the same image is processed through LBP classifier only 11 faces are detected which represented using Fig. 7.

In Fig. 8 and Fig. 9 total number of faces is 20. When the image is processed using Haar cascade classifier 19 faces are detected as shown in

Table 3
Comparison of proposed with existing feature.

Dataset		State-of-the-Art		Rate [%]
Referred Model				
Number of Faces detected	Haidi *et al.* [5]	Paul K.C *et al.* [1]	81.82	78.40
Proposed Model	**85.00**			

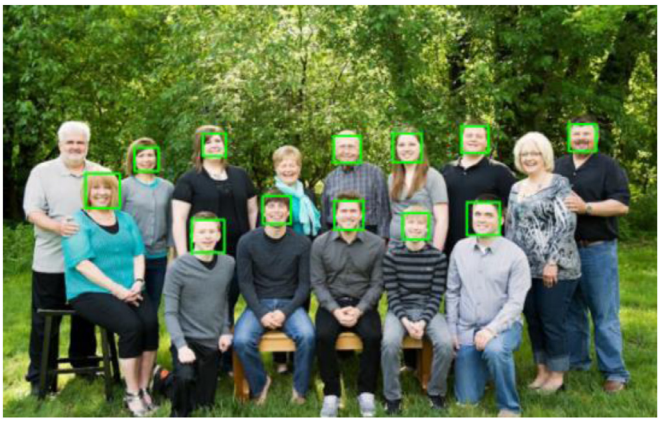

Fig. 6. Faces detected using Haar Cascade classifier.

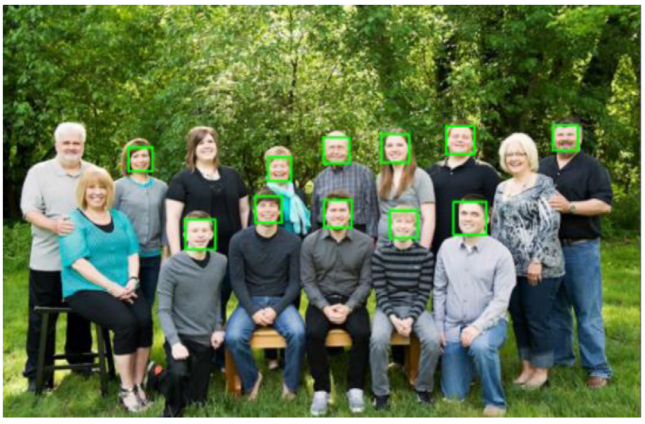

Fig. 7. Faces detected using LBP classifier.

the Fig. 8. When the same image is processed through LBP Classifier only 17 faces are detected which represented using Fig. 9. So the conclusion is that the Haar Cascade Classifier is more accurate than the LBP Classifier.

Conclusion and future work

In identification methods face recognition is one amongst them. It is one of the major applications compared to other different identification ways like the fingerprint, iris scanner and RFID. The clear image and correct pose may increase the face recognition accuracy. The current work is based on the face recognition system, where the two algorithms Haar Cascade and Local Binary Pattern Classifiers are compared. In which the conclusion is that the Haar cascade classifier is more accurate than the LBP classifier. This will help the people to choose the best algorithm for their work. The disadvantage of the classifiers is that it doesn't detect the face of the children. This can be the future implementation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Fig. 8. Faces detected using Haar Cascade classifier.

Fig. 9. Faces detected using LBP classifier.

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