Face Detection and Recognition Using Machine Learning

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***Abstract*— Face recognition has been a rapidly growing and intriguing region progressively applications. A huge number of face recognition calculation have been produced in a long time ago. In this paper, for face detection we are using HOG (Histogram of oriented Gradient) based face detector which gives more accurate results rather than other machine learning algorithms like Haar Cascade. In recognition process we are using CLAHE (Contrast Limited Adaptive Histogram equalization) for preprocessing than we are using HOG which is a standard technique for features extraction. HOG features are extracted for the test image and also for the training images. And finally for classification we are using SVM (support vector machine). SVM will classify the HOG features. Preprocessing technique is use to remove the noise, contrast enhancement, and illumination equalization. The result of this paper show the liability and productiveness in better face recognition performance.**

Keywords: Face detection, Face recognition, Feature extraction, Pre-processing, Classification, Machine learning, HOG, SVM, Haar Cascade, CLAHE.

I. INTRODUCTION

IMAGE face recognition is an important area of research in computer vision. It is easy for humans to detect and recognize face in images, but not for machines. There are several techniques in machine learning to detect and recognize a face. Human face consists of multidimensional structure and required a quality computing technique for recognition. To identify a faces in images, there are several things to look as a pattern, such as height, color of the faces, width of other parts of the face like lips, nose, eyes, etc. Clearly, there is a pattern, different faces have different dimensions, and similar faces have similar dimensions. We have to convert a particular face into numbers. Because machine learning algorithms only accept numbers. C Rahmad, R A Asmara, D R H Putra, I Dharma, H Darmono and I Muhiqqin [1] has compared The Haar Cascade and HOG base face detection and found more accuracy in HOG base face detection. Improving in the Face recognition performance is always the challenge ever since the first algorithm was developed. In 1991, Alex Pentlandand Matthew Turk [2] applied Principal Component Analysis (PCA). Which is known as the eigenface method and it is an approach for all face recognition algorithm progressing nowadays. Navneet Dalal et al. [3] made a modification by introducing Histogram of Oriented Gradient (HOG) features instead of Eigen faces which are in the PCA algorithms. In 2016 Dadi HS andPillutla GM [4] has compared between HOG and PCA based face recognition technique and found 8.75% improvement in HOG than PCA, because HOG features have the advantage oforientation binning, scale gradient, relatively course spatial binning and high quality local contrast normalization. But Still, it is in need of some better kind of preprocessing step and contrast enhancement for better face recognition performance. In this paper, we are proposing the method to overcome this problem. We are applying CLAHE in the preprocessing step for noise removal, and contrast enhancement, and illumination equalization. SVM classifier is then used to classify the HOG features extracted from the input image. In maximum classifier input dimension is fixed but the number of key points extracted from different images are not same. That means dimension of input is not same. The result of SVM is obtained by classifying all key points in the image. So according to the analysis of SVM result computer will identify the person.

II. RELATED WORK

C Rahmad, R A Asmara, D R H Putra, I Dharma, H Darmono and I Muhiqqin [1] found around 5% more accuracy in Hog than haar cascade algorithm. And Haar cascade has higher rate of false-positive detection in images.

Face recognition method is mainly deal with images which contains large dimensions. This make recognition very difficult. To overcome this problem dimension reduction was introduced. PCA is the most extensively used algorithm for dimension reduction and also for subspace projection. PCA is an unsupervised machine learning algorithm and it take the whole dataset consisting of d-dimensional samples and ignores all the class labels. It calculate the scatter matrix, covariance matrix and compute eigenvectors and corresponding eigenvalues.

Dadi HS and Pillutla GM [4] and Albiol A, Monzo D, Martin A, Sastre J, Albiol [6] found more accuracy in HOG features based face recognition rather than holistic methods, such as PCA[2] or LDA.

Anila S, Devarajan N. [7] proposed a method of preprocessing by combining some preprocessing algorithms like histogram equalization, gabber filter.

Bora DJ, Gupta AK.[8] in 2016 proposed a new technique AERSCIEA for satellite color images. Which is a binary search based CLAHE and got far better result than CLAHE.

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Benitez-Garcia G, Olivares-Mercado J, Aguilar-Torres G, Sanchez-Perez G, Perez-Meana H.[10] applied CLAHE on PCA basd face recognition.

Guo G and Li SZ, Chan K.[11] represented the face recognition technique using linear support vector machines with the help of binary tree classification strategy. The experimental results show that the SVMs are a better learning algorithm compare to the nearest center approach for face recognition.

III. Face Detection

We have observed from paper [1] that HOG based face detector has higher accuracy level than Haar Cascade algorithm. That is why we have chosen HOG based face detection algorithm for face detection. HOG i.e. Histogram oriented gradient is an unfamiliar way of detecting faces. The HOG face detector uses a rotating detection window which rotates around the image. A HOG algorithm is a feature descriptor usually used for object detection. HOG are widely known for their use in pedestrian detection. A HOG depends on the property of objects within an image to have the distribution of intensity gradients or edge directions. The gradients are calculated from block of the image. This descriptor is then shown to the trained SVM, which classifies whether it consists a face or not. HOG-SVM algorithm consume more time than Haar Cascade Algorithm but gives higher accuracy.

IV. Methodology for Face Recognition

The following figure represents the steps involved in the proposed approach in a sequence manner:

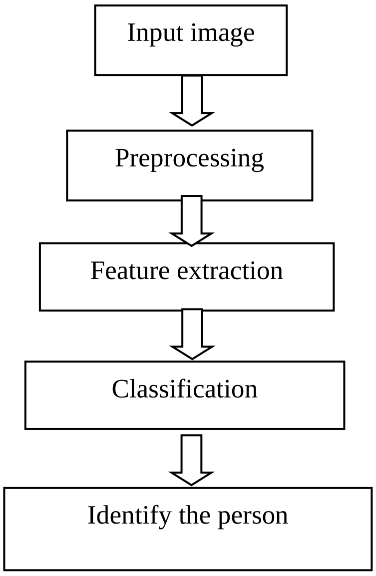


Fig.1. Block diagram of the propose method.

A. *Preprocessing*

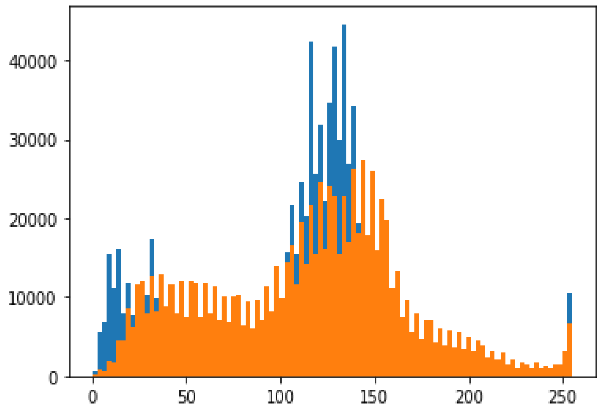
Preprocessing is playing an important role in image processing field. Histogram equalization is image processing technique for adjusting the image's intensity. This enhances the contrast in an image. It could be explained by using a histogram. An equalized histogram is that where the image uses all gray levels in equal quantity. So, that intensities are finely distributed on the histogram. CLAHE is an advanced form of AHE. Pisano et al. [4] (1998) have implemented an algorithm to detect speculations in dense mammograms which are known as CLAHE. AHE had a drawback of over amplifying noise. CLAHE limits the amplification by clipping the histogram at a predetermined value. Adaptive histogram equalization causes noise to be amplified in near-constant regions. CLAHE limits the contrast amplification to reduce amplified noise. It does so by distributing that part of the histogram that exceeds the clip limit equally across all histograms. CLAHE is a variant of AHE designed to reduce the contrast in uniform areas of the image to reduce over enhancement, thereby minimizing the noise ratio. In this method, the image is divided into non overlapping regions called the contextual region. For each region a histogram is computed, and the maximum height of each contextual region histogram is computed. The height measure is the clip limit to enhance the contrast. The clip limit is the threshold value and the histograms are redistributed without exceeding the limit. This procedure increases the contrast, but results in intensity in homogeneity.

Contrast: It is the difference in luminance and color that makes an object determinable.

$$Contrast = \frac{Imax - Imin}{Imax + Imin}$$

Where Imax is the highest and Imin is the lowest luminance. In a digital image, 'luminance' is a value that goes from 0 (black) to a maximum value depending on color depth. In case of typical 8-bit images i,e. grayscale, the value is 28 -1 = 255, since this is the number of combinations, one can be achieve with 8 bits sequences, assuming 0-1 values for each.

To perform CLAHE we need to take the input image I, number of bins n, minimum intensity min, maximum intensity max, window size ht_w, wd_w and clip limit clip as input parameters and return an output image with new intensities after CLAHE. The following plot shows the input and output intensities of our input image.



1 Fig.2. Blue plot indicating input image intensities and Orange are indicating CLAHE intensities. re

based linguistics which used in image. It is generally used in computer vision for the purpose of detecting the objects.

Gradient computation: Calculation of gradient values is the first step in computation. The first method is to apply 1-dimensional derivative masks both vertical and horizontal directions.

Orientation binning: 2nd step is Orientation binning in extracting the HOG features. Based on the number of values contained in the gradient computation, each pixel within the

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cell casts a weighted vote for a histogram channel which is based on the orientation. The cells can be either outspread or rectangular shape and channels are spread over 0 to 3600 or 0 to 1800 and it depends on whether the gradient is marked or not.

Descriptor blocks: The power of the gradient must be normalized locally in order to account the changes in contrast and illumination. This requires bunching of cells into larger and spatially attached blocks. The Histogram of Oriented Gradients descriptor is obtained by sequence the components of the cell histograms which are normalized from all the block regions. These blocks overlap typically, means that every cell contributes to the final descriptors at least more than once.

Block normalization: Dalal and Triggs [3] explored four different methods for block normalization. Let us assume 'v' be the non-normalized vector. And 'v' is containing all histograms in a given block, k v be its k-norm for k=1,2 and e be some small constant. Then the normalization factor can be anyone of the following:

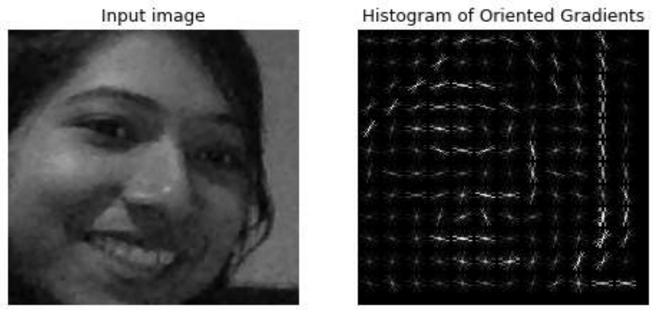
L2-norm: $f = \frac{v}{\sqrt{\|v\|_2{}^2 + e^2}}$

L2-hys: L2-norm followed by clipping and renormalizing, as in

L1-norm: $f = \frac{v}{\|v\|_1 \ + e}$

L1-sqrt: $f = \frac{v}{\sqrt{\|v\|_1 + e}}$

All four methods showed very significant improvement over the non normalise data.



(a) (b)

Fig.3. (a) Sample image from training dataset. (b) HOG features of the image

C. Classification

Support vector machine is a supervised learning algorithm. It is a two-class classifier, while it has been extended to be multiclass. It is also used for regression.

Support vectors: Support Vectors are the data points that are closest to the Hyperplane and control the position and direction of the Hyperplane. Using these support Vectors we are able to maximize the margin of the classifier and deleting these support vectors will change the position of the Hyperplane. These are actually the points that help us to build the SVM. Support Vectors are equidistant from the Hyperplane. They are called support vectors because the if their position shifts, the Hyperplane shifts as well. This means that the Hyperplane depends only on the support vectors, and not on any other observations.

Hyperplane: Hyperplane are the boundaries that help to classify the data points into two classes. The dimension of the Hyperplane depends upon the number of features i.e. if the number of features is two then the Hyperplane is a line. Similarly, if the number of input features are 3, then the Hyperplane will be two-dimensional plane. It becomes difficult to imagine when the number of features exceeds 3 or more than 3.

Optimal Hyperplane: Optimal hyperplane can be defined by maximizing the width of the margin. It is required to clarifying an optimization problem. So. When we are choosing optimal hyperplane we will choose one among set of hyperplane which is the highest distance from the closest data points. If optimal hyperplane is very close to the training data points then margin will be very small, and it will generalize well for training data, but when an unseen datum will come it will fail to generalize. Therefore, our main purpose is to maximize the margin so that the classifier is able to generalize well for unseen instances.

Margin: Distance between the Hyperplanes is called margin. If a Hyperplane is very close to a datum point, its margin will be small. The area of margin does not contain any data point.

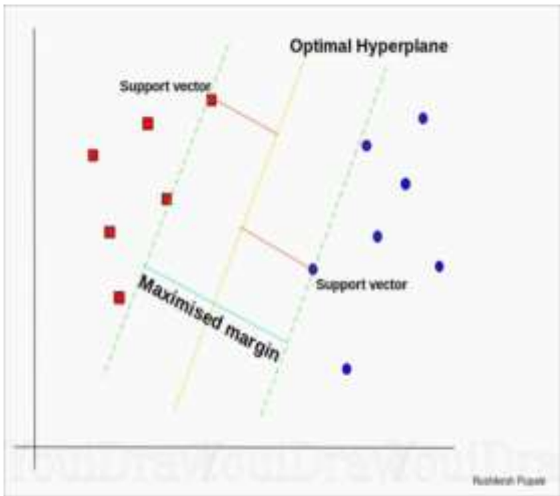


Fig.4. SVM diagram

Svm is one of the most robust and accurate Machine learning algorithm among other classification algorithms. A small change to the data does not greatly affect the Hyperplane and hence svm. So the svm model is stable.

V. EXPERIMENTAL RESULT

The proposed methodology is tested with different images. Some of the results are shown in below:

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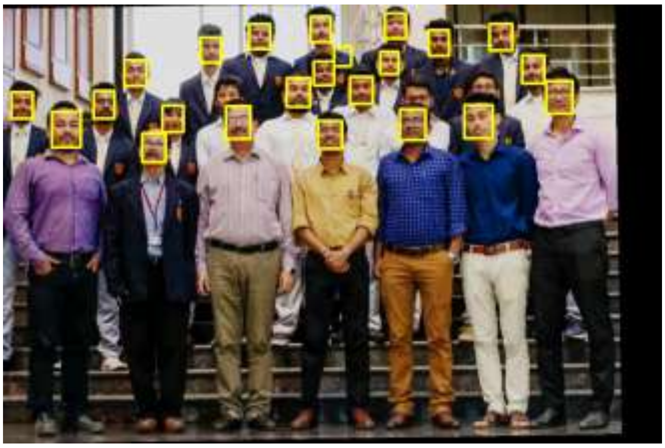

Fig.5. Face detection

In the above figure, we can see that it has detected 22 persons and one false-positive result is showing. It could not detect 3 persons. Because their faces are not fully appearing in the image. So, we can see that the accuracy level is much higher in this algorithm.

(a) (b)

Fig.6. (a) Hog-Svm based (b) CLAHE –Hog-Svm based

In the above figure.6, we have observed that 6(a) Hog-Svm based algorithm couldn't detect and recognize the face. But in 6(b) which is our proposed method it is detecting and recognizing the face.

VI. Conclusion

In this paper, CLAHE, HOG features and SVM classifier based face recognition algorithm is introduced. This proposed algorithm is compared with HOG features and SVM classifier based face recognition algorithm. Results show that the proposed algorithm is having an improved face recognition performance. It is a time-consuming algorithm but give more accuracy and productiveness rather than other machine learning algorithms.

Future research work

Face recognition is a futuristic and relatively unexplored field with extensive area of practical applications, including security and criminal cases. Although we can recognize the person from a video. This field has a lot of future building for development and performance in new areas.

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