FACIAL PARTS DETECTION USING VIOLA JONES ALGORITHM

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***Abstract*—This paper presents to detect the faces in an image and locates the facial features in an image. The detection of the facial parts such as eyes, nose, mouth and face is an important task in this process. This system is used to recognize and detect the parts of the human facial factors in an image. The study involves the algorithm of Viola-Jones Cascade Object Detector which gives various combination of filters and methods to detect these facial expressions.**

Keywords— Face detection; Viola-Jones algorithm; Skin detection; Facial features; Face extraction; Skin color; Pattern reorganization

I. INTRODUCTION

The main motive is to build a system which detects and recognize the textures of human parts of body in an image or a video. The estimation parameters of the parts in human body are tracked with the various parameters of facial features. Face Detection through the computer is a challenging task as it requires to recognize and identify it with different size, shape, textures and varying intensities of colors on it. This can be further applied to real world applications of face recognitions in online exams, identifying persons gender/age, and much more. The logic of the face detection with computers is to detect and vary between the facial and non-facial structures and returns the facial parts present in the human body.

Face Detection:

The Face Detection task is easily done in the perspective of human visual task but when it comes in the view of computer it is little bit difficult. An image is given in which the faces are detected leaving the illumination, pose variation and lighting factors. The faces of the people have been detected as shown in Fig. 1.

Fig. 1. Face Detection

In image preprocessing unit, data prepare for next module. The normalization and illumination has been done on the image on this module which is based on the face expression and pattern here. The specified information which is effective from the detection of eye and noise is performed using face feature extraction module. This is very useful in differentiating the faces and the non-faces part with respect to several photometric and the geometric variations. Finally these images can be used to detect the facial parts such as eyes, nose, mouth and upper body based on the extracted features.

II. RELATED WORK

The problem related to facial expression recognition may vary between several factors such as illumination, pose invariant and rotation, etc. There are many researches based on the detection of face and people tracking and counting the number of peoples in either an image or video such as [1] and [2]. But detecting facial parts in several images is a challenging task as the accuracy won't be good for every images. The company named 'Omran' [8] is a sensing company has released a smile measurement software which detects the smile of a several persons at the same time with the percentage of 0-100. It uses 3D face mapping technology and its detection rate will be greater than 90%. Also, the facial expressions given by the human beings have been recorded and analyzed using [4].

The algorithm such as PCA, LDA has been used for the recognition of face which gives a good results [6] and [7]. The FGNET face database have been used [3] and the results have a detection rate of 88.5% and false alarm rate of 12.04% whereas Sony T300 performs the detection rate of 72.7% and false alarm rate of 0.5%. The emotional recognition on the face has been achieved [9] with a best result of 94% on a Raspberry Pi II and the faces that are invariant to the orientation and pose have been detected [10] with the Gabor wavelet methods.

III. VIOLA-JONES FACE DETECTION

The Viola-Jones face detection method is the first framework based on object detection that provides good detection rates in real-time is given by Paul Viola & Michael Jones in the year of 2001. This algorithm has been implemented in a software 'Matlab' using the method vision.CascadeObjectDetector.

The Viola - Jones contains of 3 techniques for the facial parts detection:

1. The Haar like features for the feature extraction is of a rectangular type which is determined by an integral image.

978-1-5090-4559-4/17/$31.00©2017IEEE

2. Ada boost is a machine-learning method for detecting the face. The term 'boosted' determines the classifiers that are complex in itself at each stage, which are built of basic classifiers using any one of the four boosting techniques.

3. Cascade classifier used to combine many of the features efficiently. The term 'cascade' in a classifier determines the several filters on a resultant classifier.

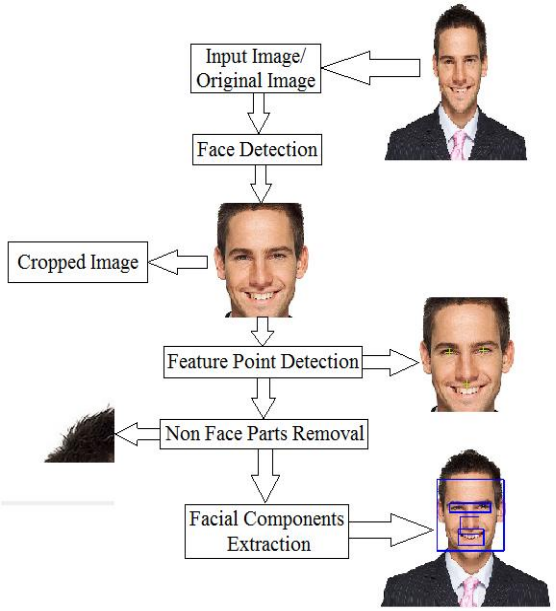

Fig. 2. Flowchart

A. Viola Jones Upper Body Detection

The upper body parts can be detected using this method in the still images based on the successful object detection framework on it that also contains the model for detecting the near and frontal upper bodies. This model has been used to detect the part of the upper body of the human and also it observes the face object detection.

The upper body detection in this model detects the upper body region, which consists of the head as well as the region of the shoulder combining with the face. These details of the head and the shoulder region has been encoded using the Haar features and the object detection. Since the object in the head and face uses more type of features, this model is more robust against the pose or the changes in the image, e.g. rotating head/blinking eyes with a tilt. To detect the upper body using the classification model we have 3 properties:

1. Create a detector object and their properties.
2. Input image given is read and detects upper body.
3. Show the detected upper bodies in a bounding box.

B. Viola-Jones Face objects Detection algorithm

In the early stage the face detection in the images was a challenging task. As it has many variations of lighting conditions, poses and various factors on it. But later it was implemented in all of the recent technological products like camera to detect a face object wherever we move the camera with a region of the box.

The face objects detection algorithm here consists of variations like illumination, poses and even rotated faces on it. This is detected by getting several window classifiers on the Viola Jones algorithm.

C. Viola-Jones Eye Detection Algorithm

The region of the eye is darker related to other parts of the face, so finding the regions of the eye is based on segmenting a small region of the image which is specified as a darker region. The center part of the eye region is darker than the other region based on this model the eyebrow region has been removed.

After the region of the selected eye region is done using the histogram analysis, as the region of eye exhibits two peaks whereas the region of eyebrow shows only one peak. The 2 major axis has the alignment of which is the final constraint here, so that the two eye regions corresponds to the same line.

D. Iris Pupil Detection Recognition System

The iris present in our eye has many properties based on the biometric recognition. Pupil is the center part of the darker region pixels in an eye circled by the iris (colored part of the eye). The light may enter through the pupil and then it passes through the lens, and at last it is focused onto the retina.

There may be some information lose surrounding the pupil since the boundary region of the pupil is not always a circular part and there may be a small error in the detection of this boundary. When the head or the eye is also rotated, there occurs some problem in the segmentation of iris part.

E. Viola-Jones Nose Detection Algorithm

The nose has different properties on it to detect easily,

a) Dark White Dark Pixels: When an image is taken and it is convolved with these Dark White Dark Pixels the nostril region will be identified. This is based on the two regions of holes on the nose, which represents the dark pixels and the center region of the nose describes the white pixels.

b) Similarity of region on both the sides: The nostrils has the region of black areas on both the left and right side of the nose which is very same. These properties have been considered as a similarity on both the sides of the region.

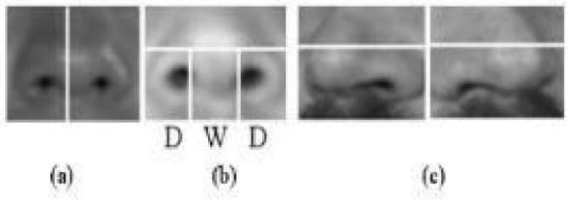

Fig. 3. Reflection of light on the nose

F. Viola-Jones Mouth Detection Algorithm

The weak classifiers may be classified in these mouth detection algorithm in which the detection and extraction of the features from the mouth region is based on a typical decision stump that uses the features of Haar to encode the details of the mouth.

Experimental results show that the region of the mouth may be detected based on the location of the eyes, nose and also lips that we will detect using these algorithms. This application can be used in a wide range of features and it is effective, for the complex background based on the mouth detection.

IV. PROPOSED METHOD

In terms of speed and reliability for face detection from an image we use the ratio between the sum of black rectangle and sum of white rectangle and with this I am using some better features except those which are used in the previous algorithm. These features are better in identifying black and skewed faces. They also work for tilde faces in some images.

A. Face Detection

In this paper, Matlab is used to implement the haar cascade classifier. It is originally developed by two persons namely, Paula Voila & Michael Jones. The Haar Cascade classifier is the main part of the face detection. The presence of the features in any of the input image is determined by the Haar features. The result of each feature has been obtained by dividing the sum of black pixels by the sum of white pixels as shown in the figure 3. For rapid detection of a face, the rectangle features like Haar features have been used. The Haar like features is as shown in the Fig. 4.

$$P(x) = \text{Sum black rectangle} / \text{Sum White rectangle} \quad (1)$$

Fig. 4. Haar Features

The Haar features have been allowed to convolve and scan through the images from the top left corner and it ends the detection of face processing at the right bottom corner as in Fig. 5. In order to detect the faces of the person on the image, several times of scanning has been done using the Haar like features.

Here the concept of integral image is used in order to compute the rectangle like features. Sum of the pixels in any rectangle is determined using the four values present at each corner of any given rectangle. In an integral image, the value at every pixel is given by the sum of the left and to the above pixel of the image. All the pixel values have been added in rectangle D as shown in Fig. 5.

G1=A,

G2=A+B,

G3=A+C,

G4=A+B+C+D

G1+ G4 - G2- G3=A+A+B+C+D-A-B-A-C=D

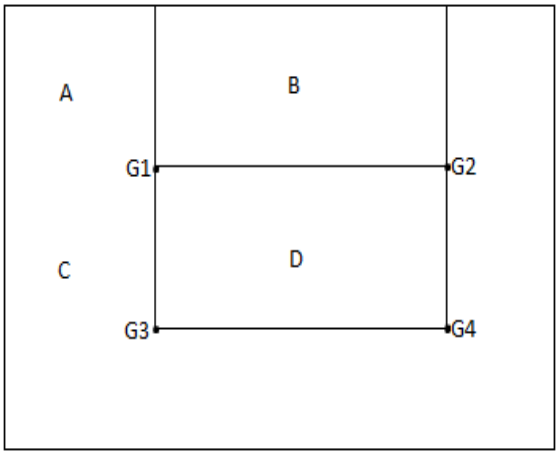

Fig. 5. Calculation of Integral Image

The base size of the window has been initially considered as a 24x24 for determining or evaluating the features in the image given. The various parameters like position, type and scale of the Haar features if considered, then the calculation of 1,60,000 features should be done which is impossible practically.

The best features among these 1,60,000 features have been found using Adaboost technique which is an algorithm for machine learning. This may be considered as weak classifiers. Ada boost determines a strong classifier which may be the linear combination of these weak classifiers as shown in (2).

$$F(x) = \alpha 1F1(x) + \alpha 2F(x) + \ldots\ldots \quad (2)$$

The Haar like features method can be used in face detection as shown in Fig. 6. In this cascade method, if the image of the human is a face, then it will pass the case, otherwise it will be considered as a non-face region.

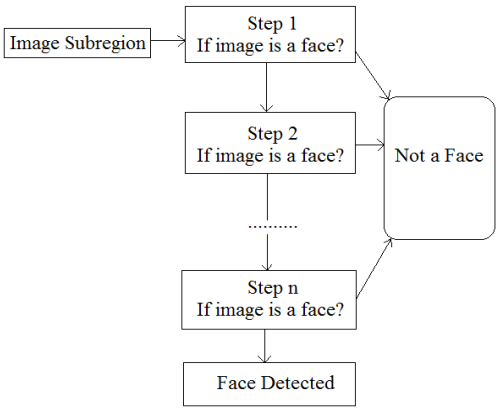

Fig. 6. Cascade Classifier

V. EXPERIMENTAL RESULTS

The experiment has been evaluated on several face image Databases, containing a different collection of photos. A Face database named Bao database contains the image of several faces at various lighting conditions and in various poses which we detected using the algorithm gives an accuracy of 92%. And other databases such as AR-Face database, Yale Face database contains a straight faces which is not very complex or variant to detect the faces on it. So we take the faces with varying parameters in this database and we have done a recognition and trained our classifier. So it is a proper database to test our full algorithm. In our algorithm we can detect the various facial parts of a human and some non-facial regions are removed using thresholding techniques. These experimental results of facial features are as shown in the Fig. 7.

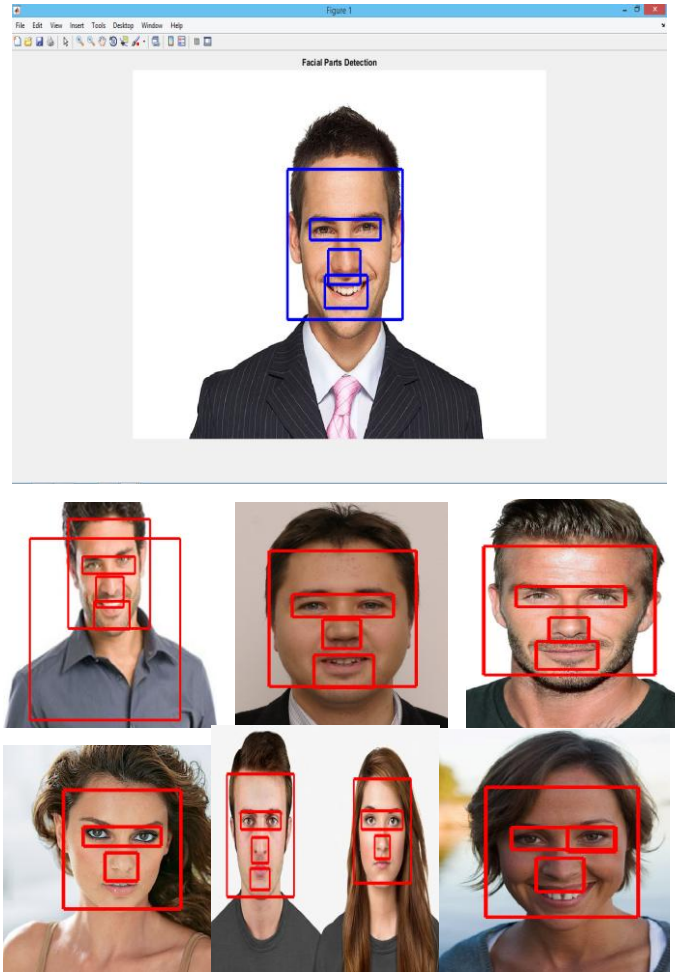

Fig. 7. Experimental Results

When the image detects some non-textured facial features the Merge Threshold value is increased and tested. The Merge Threshold here is based on the intensity of regions and its default value is 4. The Merge Threshold value is also based on the image sizes and their intensity variations in an image.

VI. CONCLUSION AND FUTURE SCOPE

In this paper the face, eyes, nose and mouth of a human is detected in a random set of samples and further tested. These are descripted as for checking the distance of the eyes and matching the pupil that helped in detecting the left and right eye pairs of the human, the nose with the darker region at the 2 sides and the lighter region at the center, mouth and the face with several points on it.

The algorithm, already defines the distance between the two eyes when any image is given as an input and then it processes the algorithm and matches the eyes distance and pupil distance and therefore the eyes will be detected.

It has the same process of matching the functions in detecting the serial eyes, nose, mouth and face.

The next contribution given in this study is to build a fully automated correct facial requirements of a human in detecting their body parts with complex type of regions in the image. This experimental part was done in the Matlab environment which gives a various set of examples that has been widely used. This work has been initiated as a part of the project on various Action Detection algorithms of a human. In the future this will be an essential part in detecting the actions of a human in Content-Based Video Retrieval System and also used in the presence of a video stream.

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