International Journal of Computational Intelligence Research
ISSN 0973-1873 Volume 13, Number 5 (2017), pp. 707-717

http://www.ripublication.com

Performance Analysis of Face Detection by using Viola-Jones algorithm

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Abstract

In digital image processing, face detection is one of the most important applications. The Viola-Jones algorithm is used to detect the face in an image. This algorithm is used to identifying and locating the human face irrespective of its size, situation and surroundings. The face detection is a technique that detects the human face and ignoring the anything else, like trees, bodies and buildings. In this paper, Viola-Jones algorithm is practically implemented by using MATLAM R2013a for detecting the human face in images. This algorithm is used to find out an automatic human face and it also calculates the accuracy of the system.

Keywords: Viola-Jones, face detection, Haar feature, Adaboost.

I. INTRODUCTION

From last few years, the face detection has received important consideration. In few areas the face detection gain extraordinary position due to various reasons such as verification of identities, large range of commercial and law enforcement available for feasible technologies. Face detection is one of many applications in digital image

processing. It is concerned with the automatic identification of an individual in a digital image. Face detection is used to identifying and locating the human face irrespective of its size, position and situations. Face detection is an easy task for human brain but it is a very difficult task for computer system [1]. To detect the face easily and accurately computer system needs some training factors so that the computer system can easily identify whether it is face or non-face. For detecting the face some thresholds values are sets based on these value a system can detect the human face. If the image specifies the desired threshold value then the image is a face otherwise it is a non-face.

Face detection algorithms are divided into two parts: (i) feature based (ii) learning based. The feature based algorithms are based on the statement that the face is detected based on some simple features, independent of light, face variation and posture. The learning based algorithm usage an amount of training models, benefit from statistical models and machine learning algorithms [2].

Various complexities are linked with face detection algorithm that can be:

i. Quality of image

Face detection system is required a good quality images. A good quality images are collected under predictable circumstances. An image quality is necessary to extract the features from an image. When the calculations of features are not good then the robustness of the system will be lost.

ii. Variations in illumination

Due to the lighting changes same faces images will be shown differently. The presence of an object can be changed due to variations in illumination.

iii. Facial expression

The person's facial expressions are effected by the presences of faces.

iv. Visual angle

For different angles the face images directly vary about the camera optical axis.

There are many algorithms through which the face detection process is carried out but in this paper, viola-jones algorithm is used for detecting the face from images which is one of the most popular algorithms among all the face detection algorithms.Face detection components detects or separates out human faces from the non-face objects present in an image. The image may be captured either in a controlled environment or in an uncontrolled environment [3] [5].

This paper is organized as: In section II the proposed face detection models is illustrated, in section III the viola-jones face detection algorithm is described, in section IV the viola jones face detection framework is explained, in V section the

experimental results is shown and in VI section the performance evolution of the proposed algorithm is shown with the help of table.

II. PROPOSED FACE DETECTION MODEL

The proposed algorithm is used to examine the sub-window that is able to detect the faces from a given input image. The standard image processing approach would be to rescale the input image to different sizes and then run the fixed size detector through these images. This approach turns out to be rather time consuming due to the calculation of the different size images.Contrary to the standard approach the proposed algorithm rescale the detector instead of the input image and run the detector many times through the image each time with a different size. At first one might suspect both approaches to be equally time consuming, but proposed model have devised a scale invariant detector that requires the same number of calculations whatever the size. This detector is constructed using a so-called integral image and some simple rectangular features reminiscent of Haar wavelets.

III. VIOLA-JONES FACE DETECTION ALGORITHM

The viola-jones algorithm is used to detect the human face from an image. The system takes some face images or non-face images as an input. After taking the input images the training phase will be start in which the system detect the face. In training phase two types of sets are included that is positive image set or negative image set. In positive image set all the images are face images and in the negative image set all the images are non-faces images. In training phase, all the features are collected that is related to the face images and all these features are stored in a file. After the training phase the next phase is testing phase. In the testing phase all the stored features are applied on an input image and classified whether it is face or not. If the image passes all the threshold then it is classified as face otherwise the image is classified as non-face [4] [13]. The viola jones algorithm has four stages. These are: (i) Haar feature selection (ii) An integral image (iii) Adaboost training (iv) Cascading classifiers.

i. Haar feature selection

All human faces share some similar properties. These regularities may be matched using Haar Features [12]. A few properties common to human faces are:

1. The eye region is darker than the upper-cheeks.
2. The nose bridge region is brighter than the eyes.

Composition of properties forming match able facial features:

- Location and size: eyes, mouth, bridge of nose
- Value: oriented gradients of pixel intensities

The four features matched by this algorithm are then required in the image of a face. Rectangle features:

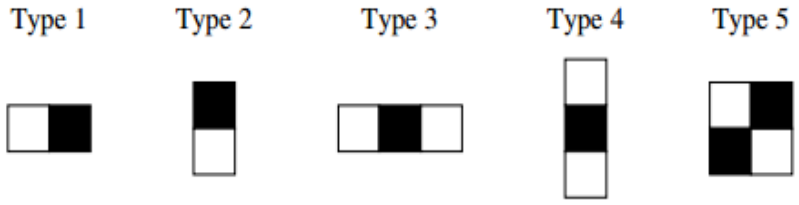

Figure 1: Different type of features

- Value = Σ (pixels in black area) - Σ (pixels in white area)
- Various types of features like two, three and four-rectangles, Viola & Jones used two-rectangle features.
- Difference in brightness between the white and black rectangles over a specific area.
- Each feature is related to a special location in the sub-window [14].

ii. An integral image

In the subsequent step of the Viola-Jones face detection algorithm is rotate the input image into an integral image. This is completed by creation of every pixel equivalent to the total addition of all pixels above and to the left of the pixel. This is established in Figure 2.

1	1	1
1	1	1
1	1	1

1	2	3
2	4	6
3	6	9

Figure 2: The Integral Image

This makes the computation of the addition to the entire pixels within any specified rectangle using only four values [6] [7]. In the integral image, these values are the pixels that correspond with the corners of the rectangle in the input image. This is established in figure 3.

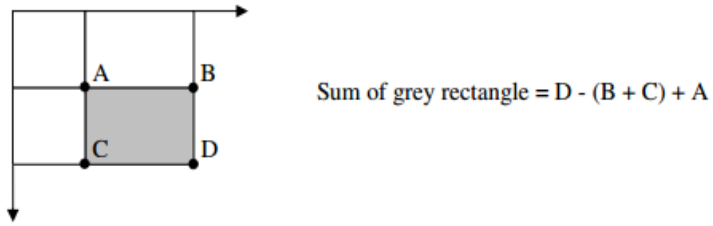

Figure 3: Sum Calculations

iii. Adaboost training

Viola Jones algorithm use a 24x24 window as the base window size to begin evaluating all the features in any given image. If we think about all feasible parameters of the Haar features like situation, degree and type, then we need to calculate about 160,000+ features in any given window. By using this algorithm, we need to evaluate huge sets of features for every 24x24 sub-window in any new image. The basic idea is to eliminate a lot of features which are redundant and not useful. To select only those features that is very useful for us, which are done by Adaboost. Adaboost eliminate all the redundant features [11].

Adaboost is a machine learning algorithm which helps in judgment only the most excellent features between the entire those 160,000+ features. After these features are establish a weighted arrangement of all these features in used in evaluating and deciding any given window has face or not. These features are also called as weak classifiers.

A major component of the modified Adaboost algorithm is the determination of the most excellent feature and threshold. There seem to be no smart solution to this problem and Viola-Jones suggest a simple brute force method. This means that the determination of every latest weak classifier involves evaluating each feature on all the training examples in order to find the best performing feature. This is estimated to be the most time consuming part of the training method [7].

iv. Cascading classifiers

The cascaded classifier is collection of stages that contains a strong classifier. The work of every phase is to verify whether a particular sub-window is definitely not a face or may be a face. When a sub-window is classify to be a non-face by a given phase it is discarded. A sub-window classified as a may be face is passed on to the next stage in the cascade. It follows that the additional stages a given sub-window passes, the higher chance that the sub-window really contains a face [15].

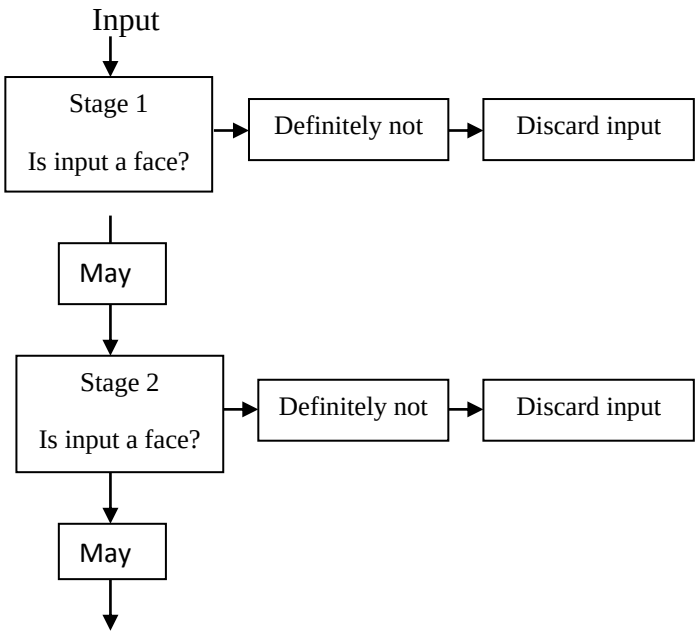

Figure 4: The cascade classifier

VIOLA-JONES FACE DETECTION FRAMEWORK

The viola-jones face detection framework is the primary face detection structure to give competitive face detection charges in real-time planned in 2001. It was forced mainly by the difficulty of face detection, while it can be trained to identify a multiplicity of object classes. This algorithm is implemented in Open CV as cvHaarDetectObjects (). Viola Jones detector become well-known due to its open source implementation in the Open CV library. In order to locate an object of an unidentified size is normally adopted to work this field that possesses a high competence and accuracy to locate the face region in an image [8].

i. Viola-jones face detection algorithm

Face detection techniques can be divided into two main groups that are feature based approaches and image based approaches. Image based approaches make use of linear subspace scheme, neural networks and statistical approaches for face detection. Feature based approaches can be subdivided into low level analysis, feature analysis and active shape model. Face detection is restricted by trained scanning window classifiers. Viola-Jones Face Detection Algorithm is the first real-time face detection system [9].

ii. Viola- Jones upper body detection

Correct upper body detection improves the strength and reduces the difficult task of detecting upper bodies from images. The Viola-Jones algorithm is uses the cascade object detector to detect people's upper body. This model detects the upper-body

area, which is distinct as the head and shoulders area. This model uses Haar features to encode the fine points of the head and shoulder area.

iii. Viola-jones face detection algorithm

Eyes are detected based on the assumption that they are darker than additional part of the face, finding eye analogue segments searching small patches in the input image that are roughly as large as an eye and are darker than their neighborhoods. To throw away regions equivalent to eyebrows, the model uses the information that the middle part of an eye region is darker than other parts. Then a straightforward histogram examination of the region is complete for selecting eye regions [10].

iv. Viola-jones mouth detection algorithm

This model is collected from weak classifiers, based on a result stump, which uses Haar features to encode mouth facts. Investigational outcomes prove that the algorithm is face image partition based on physical estimation of position of eyes, nose and mouth on face and can locate away the mouth region quickly [15].

EXPERIMENTAL RESULTS

The proposed face detection approach is based on the viola-Jones and segmented algorithm that is implemented by using MATLAB vision cascade detector and results are shown below: In figure 5 images is added by clicking on the insert image button, after insertion of an image the image is resized. Figure 6 is shown loading the image by clicking on insert button and then resized it. In figure 7faces is detected by using yellow square box. In figure 8 the binary converted image is shown and finally figure 9 shows the segmented face.

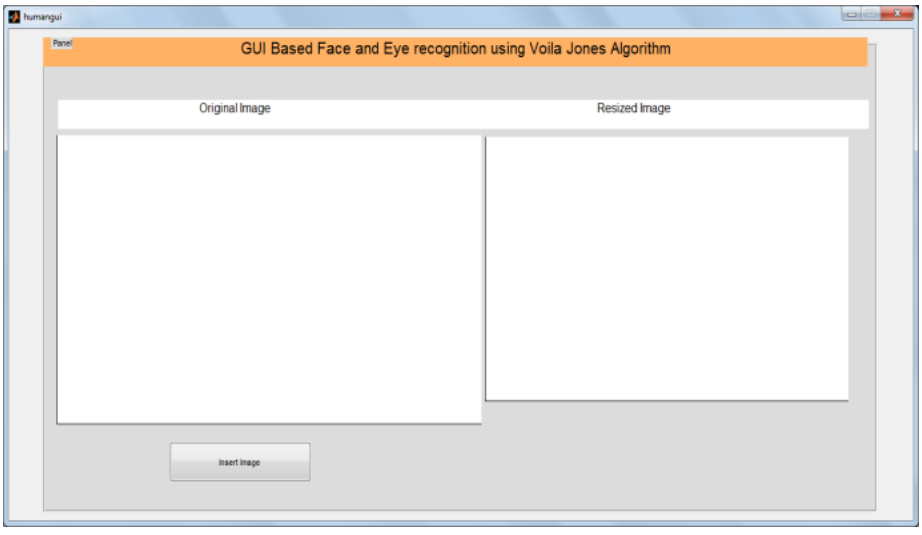

Figure 5: GUI Window created in Matlab

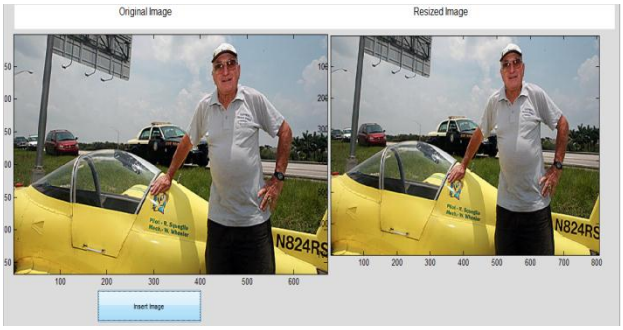

Figure 6: Load Image using Insert image Button

Figure 7: Detected Face by Yellow Square

Figure 8: Binary Converted Image

Figure 9: Segmented Face of an Image

EVALUATION

In order to conduct face detection experiment, a comprehensive database of human faces has been created. Experiment has been carried out on 10 images. The accuracy may vary with the number of detected faces in the image database. Accuracy is calculated as:

Face Detection= Detected Face/ Number of face

Table 1: Overall result table

Image Name	***Face Detection***	***Face Segmented***
1.jpg	*Yes*	*Yes*
2.jpg	*Yes*	*Yes*
3.jpg	*Yes*	*Yes*
4.jpg	*Yes*	*Yes*
5.jpg	*Yes*	*Yes*
6.jpg	*Yes*	*Yes*
7.jpg	*Yes*	*Yes*
8.jpg	*Yes*	*Yes*
9.jpg	*Yes*	*Yes*
10.jpg	*Yes*	*Yes*

CONCLUSION

In this work, we use the various techniques to detect and locate faces in images. Faces have been detected through skin segmentation in grey scaled images performed by a various Image Processing Techniques. The regions of face were found by analyzing the binary and gray scale variation in different regions of the face. Successively, face recognition was implemented through a global classification technique, which classifies the faces from the standard deviation of the difference between input faces and average faces. By applying the several techniques, we will implement in Matlab algorithms for face detection, will try to reach satisfactory results in comparison to the existing techniques with more correct results.

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