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*Research Article*

# Implementation of Viola-Jones Algorithm Based Approach for Human Face Detection

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***Abstract***

*This paper proposes an approach to find a human face in an image with high accuracy rate in the better way. Face detection and recognition is an eminent issue in image processing. Human identity is crucial for identity, search, monitoring system and security purpose. Face detection is easy for human beings but it's an arduous task for the computer system. The computer application in face detection is increasing day by day. In this paper, we are using Viola-Jones approach to detect a human face from the different images. Using some threshold value with this approach, we can also detect the children's faces, Asian origin people faces as well as old age people's faces.*

***Keywords:*** *Face Detection, PCA, ANN and Viola-Jones Algorithm.*

## 1. Introduction

The human face detection is one of the most common and long-standing problems in computer vision (Chunhua, *et al*, 2008). The face detection is the key step of the automatic face recognition system (Kirti, *et al*, 2017). Face detection determines the presence and location of the face in an image, by distinguishing a face from all other patterns present in the scene. Given an arbitrary image, the goal of face detection is to determine whether or not there are any face(s) in the image and if the face(s) are present then it returns the number of faces in the output and extent of each face (Yiming, *et al*, 2017).

In this approach, we can easily see that in the image of the animals with human faces, it detects only human faces. With the right pose, it also detects the Asian origin peoples or old human faces in best possible manner.

This work aims to design a system that would be capable to address these problems through the use of an algorithm that may recognize human faces in real time (M. Dwisnanto, *et al*, 2017).

## 2. Related work

The approach suggested by Paul Viola *et al.* (Paul Viola, *et al,* 2001*)* is usually called Viola-Jones algorithm. Its original motivation was face detection, but it can be trained to detect different object classes. It combines four key concepts. Qiao Qiang *et al.* (Qiao, *et al,* 2005) elaborated a face detection method in colour images using multi-resolution sub-images fusion combined with support vector machine (SVM). The long distance of the faces in a group photo is not detected properly and that was a drawback of this method. Zhao Fei *et al.* (Zhao, *et al,* 2009) approach is based on the external face of the rectangular knowledge rules, can be used to determine whether the human face is in skin colour area (Chongshan, *et al,* 2017), then use the positive human face structural characteristics to remove the non-human face to further determine human face.

There are so many methods and algorithms available to locate human face from the image with the complex background. Viola-Jones algorithm, PCA, and ANN are major three of them which are comparably better than others. Following is the comparison of the three methods:

### *2.1 Viola-Jones Approach*

The Viola Jones Object Detection framework was proposed by Paul Viola and Michael Jones in 2001 which was the first framework to give competitive object detection rates. It is a framework which is used for detecting objects in real time but mainly applied to face detection application because its training rate is very high and the result is more accurate in comparison to others. Due to its high detection rate (true-positive rate) and fast processing at least two frames per second must be processed that is to distinguish a face from non-faces.

The main four steps of this algorithm are as follows:

1) Haar features: Simple rectangular features, called Haar features. This Digital image feature is used to

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locate human faces, pedestrians, objects and facial expressions in an image (Phillip, *et al*, 2006). All human faces have similar properties like eyes, mouth, and bridge of a nose. These properties are compared using Haar feature and mainly used for face detection.

2) Integral Image: Integral Image concept for rapid feature detection. Rectangle features can be computed very fast using an intermediate representation of the image which is called the integral image. The integral image computes a pixel value, in a quick and effective way at each pixel (x,y).
3) AdaBoost: The AdaBoost algorithm was introduced by Yoav Freund and Robert Schapire (Yoav, *et al*, 1999). It is a machine learning algorithm used to improve their performance and detect weak feature selector (Wenxiang, *et al*, 2016).
4) Cascading Classifiers: The process of combining the classifiers which quickly discards the background windows so that more computation can be performed on face-like regions (Van-toi, et al, 2012). It can keep high detection rate and low false positive rate (Jiayao, *et al,* 2016).

*2.2. PCA Approach*

Principal component analysis (PCA) is a statistical procedure. The main purpose of principal component analysis is the analysis of data to identify patterns and finding patterns to reduce the mentions of the data set with minimal loss of information.

This approach transforms faces into a small set of essential characteristics, eigenface, which are the main components of the initial set of learning images (training set) (Divya, *et al*, 2016).

Recognition is done by projecting a new image in the eigenface subspace, after which the person is classified by comparing its position in eigenface space with the position of known individuals.

*2.3 ANN Approach*

Neural Network inspired by human brain composed of simple artificial neurons also known perceptions are connected to each other in multiple layers (K.K., *et al*, 1998). There is a long history of using a neural network for the task of face detection (Michel, *et al,* 2016), (Mohammad, *et al,* 2015).

In the case of face detection, neural network system examines each and every window to determine whether it consists of face or not. It reduces the computational task as it doesn't require to train with non-face images (XU Yan, *et al,* 2009).

## 3. Methodology

Figure 1 reveals the block diagram which is used in a system for face detection. As can be seen, there are five blocks which define the whole system from face detection to making of the face database. All five blocks are sequentially described below with its functionality.

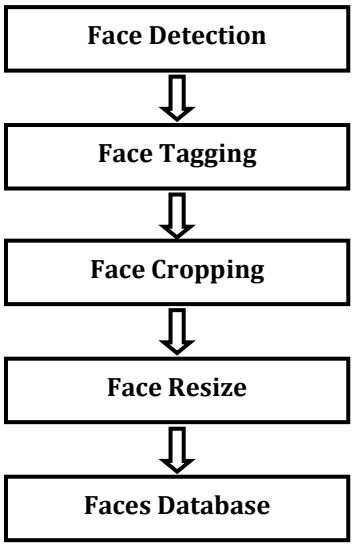


**Fig.1** The block diagram of the system

*3.1 Face Detection Block*

The first block converts an image from colour to the gray scale for image normalization process, after that it illustrates the face detection by the using Haar feature-based cascade classifiers is an effective object detection method. This approach is based on machine learning where a cascade function is trained from a lot of images (Shuo, *et al,* 2017). The Viola-Jones Algorithm is based on Haar features that are basically black and white rectangles. The algorithm generates the sum of pixel intensities in rectangles in an image depending upon the threshold values (Ma. Christina*, et al,* 2014).

*3.2 Face Tagging Block*

After detection of the human faces that can be of an old age people faces, the Asian origin people's faces as well as the child face, detected face is shown inside a rectangular box that is called a boundary box (Narayan, *et al*, 2017). There outside of boundary box, it shows a 'Face' in the text format and tags the human face.

*3.3 Face Cropping Block*

In this block, when the human face is detected by the Viola-Jones algorithm, the image is cropped to the region of the face (Michel, *et al,* 2013).

*3.4 Face Resize Block*

Every image can be of different dimension, size, and pixels. The face position can also be not in a particular manner and the face size also can be different. So the cropped faces are resized before making a database. It gives the normalized face results that are used in the face database.

*3.5 Face Database Block*

The last block of the system is a database making block. The face that already has been cropped and resized in the last block is saved in an appropriate place for the security purpose or some future work. That database can be helpful for the security reasons, some kind of attendance, or may be a checking for the presence of any particular person in an area.

## 4. System Flowchart

The step followed by the system in implementing the process blocks discussed in Fig.1, are presented in detail in the flowchart shown in Fig.2.

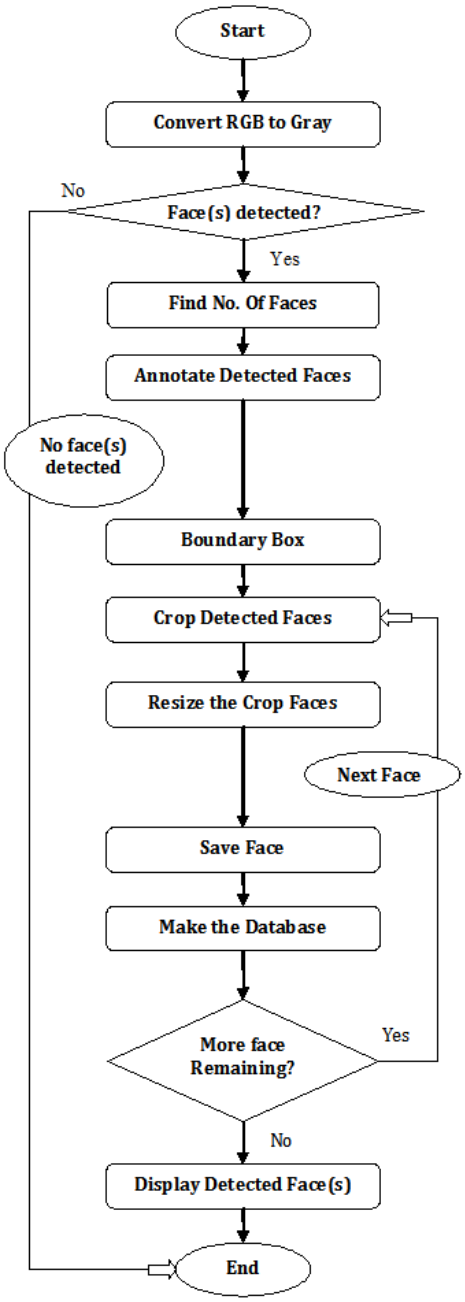


**Fig.2** Flowchart of the system

The system begins the face detection process by reading an image. First, an image is converted from RGB to gray scale image under normalization process. Face is detected by the use of the Viola-Jones algorithm which takes some time for the process that may be about 1 second.

Figure 3 shows the original image. As discussed above, the system determines through a set of processes whether a person's face is present in the image and shows the face inside a boundary box as shown in Fig.4. It also provides the number of faces present in the image. In the case that no faces are found from the image, the system will give a pop-up message that no face is found in this image please upload another one.

Faces are cropped when it detects all faces that are present in the image. Cropped face will be resized as per given size (height and width). Fig.5 shows the output of the face tagging block of the system which is the cropped faces that were present in the image with its modified size (same height and width).

All resized faces are saved in a particular user defined place or folder. Finally, it makes a database of all human faces. The face detection is the first step before face recognition process.

## 5. Result and Discussion

In (Md. Iqbal, *et al*, 2013) Md. Iqbal Quraishi *et al.* proposed a novel effective approach towards human face detection showing an accuracy rate of 91.67% which is highly encouraging. Sang-Jean Lee *et al.* (Sang, *et al*, 1999) achieved a recognition rate of 81%, in a uniform background and 76% in complex background. Also a false detection rate of 7% and 17% is obtained in uniform and complex background respectively.

This paper proposes to apply the Viola-Jones algorithm with some specific threshold values. Fig.3 shows the image read by a program which is not stored in the database.

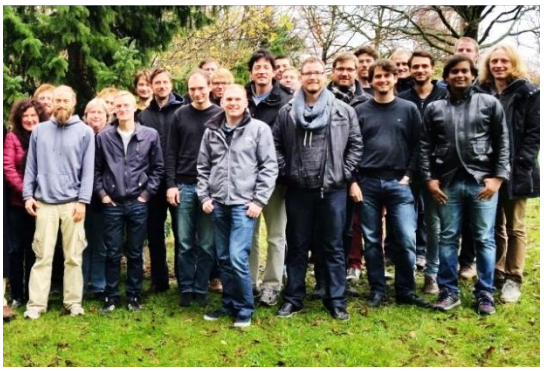

**Fig.3** Original image

Original image is converted to the gray scale image and detects the multiple faces which are present in the image. The successfully detected faces are bounded in a rectangle. The output of image after detection of faces is shown in Fig.4.

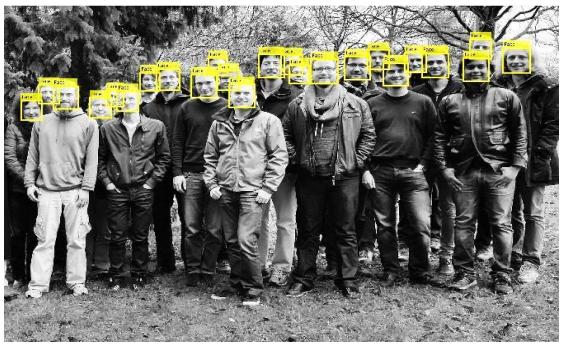

**Fig.4** Image after face detection

After detection of faces, the faces are cropped and then stored in the database. Fig.5 shows the result obtained after cropping of faces. All faces are of same in size (width and height). Faces of same size are helpful in recognition of faces rapidly and efficiently.

**Fig.5** Cropped faces

Sometimes it is hard to detect faces which are not clearly/partially visible in the image. Some of such faces are also detected with the help of proposed algorithm. These results are shown in Fig.6.

**Fig.6** Some intricate results of Fig. 5

Position of face (more than 60 degree) and facial expressions pose challenges in face detection and hence the detection rate is reduced. Face distance, face size and large number of faces present in the image do not affect the detection rate.

**Table 1** Results of multiple faces

| Image / Type | Total no. of image | Total no. of faces | Total detected faces | Detection Rate |
|---|---|---|---|---|
| Young People | 73 | 1463 | 1445 | 98.76% |
| Children's faces | 58 | 765 | 738 | 96.47% |
| Old Age Peoples | 32 | 482 | 457 | 94.81% |
| Total | 263 | 2710 | 2640 | 97.41% |

We used more than 200 images for the experimentation and we got 98.76% accuracy for young age people's face, 96.47% accuracy for children's faces and 94.81% accuracy for old age people's face. Finally Table 1 shows that the overall detection rate is 97.41%.

Its computation time depends on the device processor, image size, and image resolution. The high-resolution image gives the high detection rate but large computational time is required. The average computational time is 2.89456 seconds approximately that is varied by the image feature and specification.

## Conclusions

In this paper, we conclude that the Viola-Jones algorithm with some specific threshold value gives the result with fast detection rate and high accuracy. In this approach computational time is increased when the image size is large and resolution is high. The average detection rate is 97.41% as found in this work. Large number of faces present in the image does not affect the computational time as well as detection rate.

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