Face Detection System Based on Viola - Jones Algorithm

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Abstract: *Locating facial feature in images is an important stage for applications such as eye tracking, recognition of face, face expression recognition and face tracking and lip reading. In this paper, we present a method for detecting face from the live image. The face is detected from whole image using viola jones algorithm. Than haar feature based Adaboost algorithm are used to extract the facial region from the image. We use cascading of stage to make the process faster.*

Keywords: Adaboost, Face detection, Eye tracking, Face recognition

1. Introduction

Face detection is one of the most complex and challenging problem in the field of computer vision, due to the large variations caused by the changes in facial appearance, lighting, and facial expression. So face distribution to be highly nonlinear and complex in any space which is linear to the original image space. In the real time applications like surveillance and biometric, the camera limitations and pose variations make the distribution of human faces in feature space more complicated than that of frontal faces. It further complicates the problem of robust face detection.

There are many techniques has been researched for years and much progress has been proposed in literature most of the detection method most of the detection methods concentrated on detecting frontal faces with enough lightning condition. Yang's categorized this method into four types in his survey: knowledge based, feature invariant, template matching and appearance-based.

1) Knowledge based methods modeled facial feature using human coding, such as two symmetric, mouth, nose etc.
2) The feature which are invariant to pose and lighting condition are find using feature invariant method.
3) The correlation between a test image and pre image fall into template matching category.
4) This appearance based method include machine learning techniques to extract discriminative feature from a pre-labeled set.

Paul **Viola** and Michael **Jones** presented a fast and robust method for face detection which is 15 times quicker than any technique at the time of release with 95% accuracy at around 17 fps. The paper is organized as in section A. we gives brief discussion of detecting algorithm, in section B. Results, in section C. conclusion.

A. Detection Algorithm
Viola and jones's algorithm is used as the basis of our design. As we know there is some similarities in all human faces, we used this concept as a haar feature to detect face in image. Algorithm looks for specific haar feature of a face ,if these feature found algorithm pass the candidate to the next stage .Here the candidate is not whole image but just a rectangular part of this imageknown as **sub window** have a size of 24*24 pixel. With this window algorithm check whole image.

1. Haar Features
As we know there some kind of similarities in human face. We use this concept for making haar feature .They are composed of two or three rectangles. These features are applied on face candidate to find out whether face is present or not. Each haar feature has a value and this can be calculated by taking the area of each rectangle and than adding the result. Using the integral image concept we can easily find out the area of rectangle.
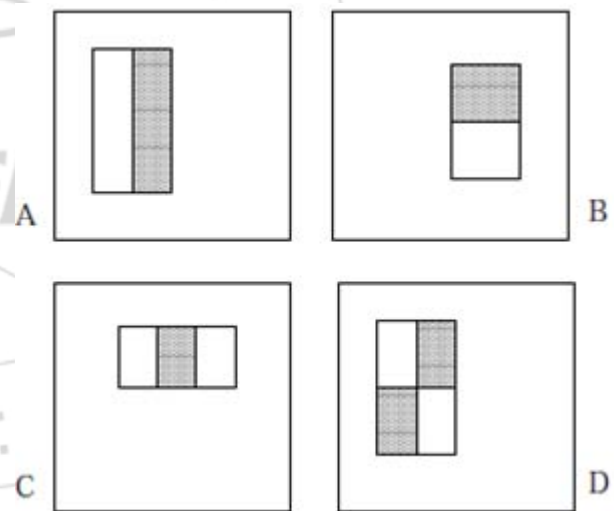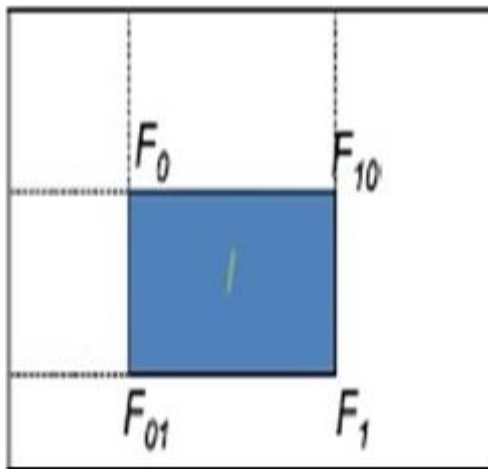

Examples of haar features

2. Integral Image
The integral image is defined as the summation of the pixel values of the original image. The value atany location (x, y) of the integral image is the sum of the image" s pixels above and to the left of location (x, y). "Fig. 3" illustrates the integral image generation.
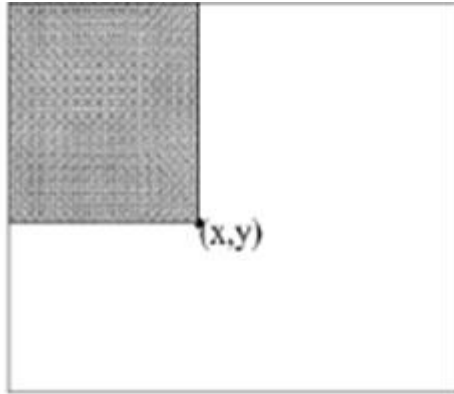
Integral image

$$\sum_{x' \le x, y' \le y} ii(x, y) = i(x', y')$$

Fast Calculation in Integral Image

Fig. presents the calculation process: in order to calculate the intensity sum of green region .Just four values of F have to be considered. As a consequence, the intensity sum of any rectangular-shaped area can be calculated by considering as few as four values of F. This allows for an extremely fast calculation of a convolution with one of the rectangular haar feature describe above.

The integral image F can be calculated in pre-processing stage prior to detection in a recursive manner in just one pass over the original image I as in equation 2 and 3 below.

$$R(x, y) = R(x, y-1) + I(x, y) \quad (2)$$
$$F(x, y) = F(x-1, y) + R(x, y) \quad (3)$$

Where R and F are initialized by $R(x, -1) = 0$ and $F(-1, y) = 0$.

The sum of intensities of a rectangular are ranging from (x, y) to (x1, y1) can be calculated by considering the values of F at the four cover point of theregion instead of summing up the intensities of all pixels inside:

$$\sum_{a=x}^{x1} \sum_{b=y}^{y1} I(a, b) = F(x1, y1) - F(x, y1) - F(x1, y) - F(x, y)$$
(4)

3. Haar Feature Classifier

A Haar feature classifier uses the rectangle integral to calculate the value of a feature. The Haar feature classifier multiplies the weight of each rectangle by its area and the results are added together. Several Haar feature classifiers compose a stage. A stage comparator sums all the Haar feature classifier results in a stage and compares this summation with a stage threshold. The threshold is also a constant obtained from the Ada Boost algorithm. Each stage does not have a set number of Haar features. For example, Viola and Jones" data set used 2 features in the first stage and 10 in the second. All together they used a total .of 38 stages and 6060 features [6].

4. Cascade

It is possible to eliminate the false candidate quickly using stage cascading. The cascade eliminates candidate if it not passed the first stage. If it passed than send it to next stage which is more complicated than previous one. If a candidate passed all the stage, this means a face is detected
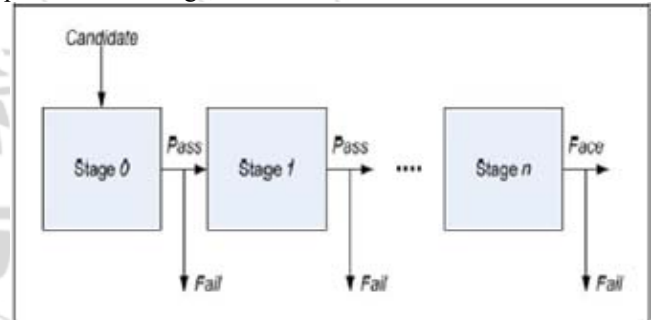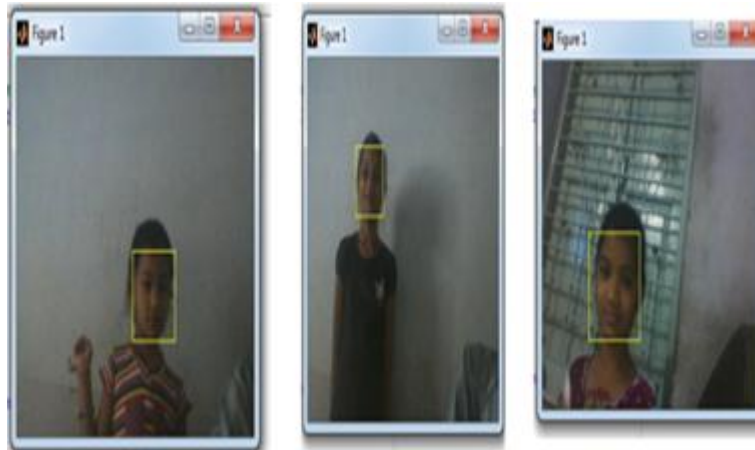

Figure 4. Cascade of stages. Candidate must pass all stages in the cascade to be concluded as a face.

B. Results

On the static data base of CMU PIE with 106 images we have 87% efficiency of face detection.Output on live image with various background and lightning condition are as shown in fig

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2. Result of Face Detection

a) Conclusion

We have presented an approach for object detection which minimizes computation time while achieving high detection accuracy. The approach was used to construct a face detection system which is approximately 15 faster than any previous approach.

This paper brings together new algorithms, representations, and insights which are quite generic and may well have broader application in computer vision and image processing.

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