# An Analysis on Face Detection Techniques

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*Abstract*— In this paper we present an extensive and critical survey of face detection algorithm. Face detection is very crucial step in face recognition system. Face detection is the technology which is utilized by computer system in order to detect faces in given digital image. Face detection has several applications like content-based image retrieval, facial motion capture and so on. There are wide verities techniques like Viola Jone, Hausdorff distance, CNN and etc. have been proposed for face detection and paper we presented talk on different algorithm and its efficiency.

***Keywords:*** Facial Motion, Viola Jones, CNN, Hausdorff Distance

## I. INTRODUCTION

Face detection is a process of Identifying faces from a given scene. Many face detection techniques have been proposed. For human it's not difficult to identify the face because their brain has been collecting data since childhood. But for machines on other hand its too difficult task, because machine like computer system work on instruction given by us, it requires clear and specific instruction as what to do. Differentiating a face from a given image is a challenging task due to visual variations in images, magnified facial expressions and large area to find face in so on. Facial identification challenging is task we need to train the machine for detecting the face form given image. In this paper we talked about different image detection techniques by giving survey on some important and recent techniques.

### *A. Face detection categories*

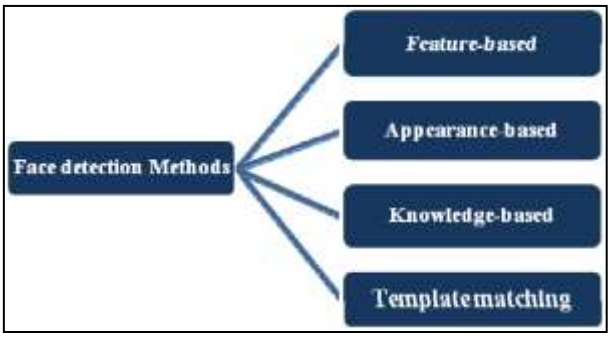
Face detection divided into four categories according to Yan, Kriegman, and Ahuja presented a classification for face detection methods, these are:

### *B.* Knowledge-Based:-

This method is based on human knowledge which will consist of some set of rules. These rules consists information a face must consist of nose, mouth and eyes within certain distances and positions with each other. The main problem in this method is building appropriate set of rules. Alone this method is insufficient and unable to find many faces in single image.

### *C. Feature-Based:*

This method works by extracting structural features of the face. This method is used to differentiate between facial and non-facial regions, but mainly used as classifier. This method provides efficient results even for identifying face in photo with multiple faces.




### *D. Template Matching:-*

Template matching method uses a predefined face as template to detect faces by comparing the face template with input image. Using edge detection method a face model can be build by edges. This approach is simple to implement but inadequate for face detection.

### *E. Appearance-Based:-*

Performance of appearance based model is better as compared to remaining model. This Appearance based model works on a set of delegate training face images to find out face models. Relevant characteristic of face model are build with help of statistical analysis and machine learning. This method also used in feature extraction for face recognition

## II. ALGORITHMS

### *A. Viola Jones*

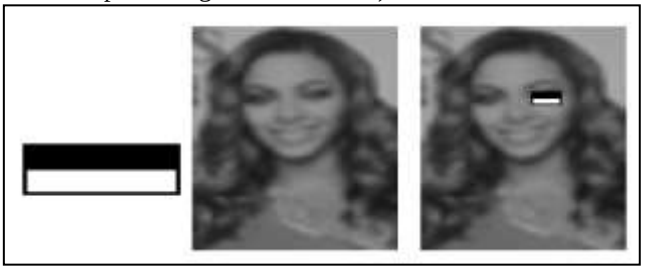
Developed by Paul Viola and Michael Jones back in 2001, this algorithm can be used for detection of object from a given image very quickly and accurately. This algorithm is implemented in OpenCV and it has 4 stages:

- Haar feature Selection
- Creating integral image
- AdaBoost training
- Cascading classifiers

#### *1) Haar feature Selection:*

Haar feature selection is used for edge detection, this can be effectively used in face detection.

For example, in a small image of Beyonce, this Haar-feature would be able to detect her eye (an area that is dark on top and brighter underneath).

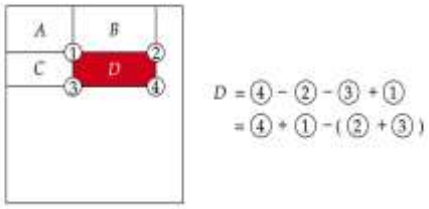


#### *2) Integral Image*

An Integral image is calculated as, where the value for location ($x$, y) on the integral image equals to sum of the pixels above

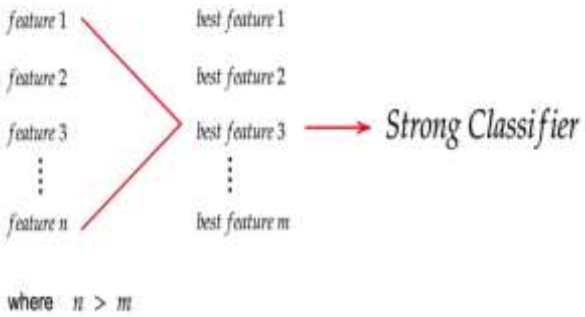
 

and to the left (inclusive) of the (*x*, *y*) location on the original image. Integrated image is intermediate representation of an image. This imetrmediate is important for fast calculation of rectangular region.

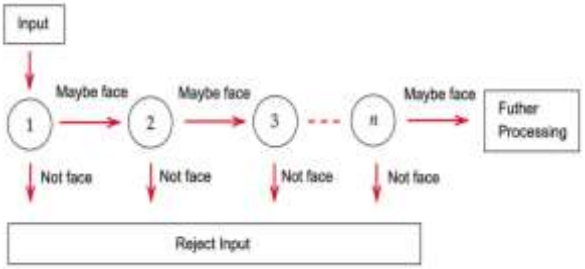

*3) AdaBoost*

Adaptive Boosting algorithm used for best selecting best subset of features from all[1] available features and this adaptive boosting algorithm is machine learning algorithm. The output of this algorithm is called as strong classifier and this strong classifier is made up of linear combinations of weak classifiers (best features).




*4) The Cascade Classifier*

A Cascade Classifier is a multi-stage classifier that can perform detection quickly and accurately. Each stage consists of a strong classifier produced by the AdaBoost Algorithm. From one stage to another, the number of weak classifiers in a strong classifier increases. An input is evaluated on a sequential (stage by stage) basis. If a classifier for a specific stage outputs a negative result, the input is discarded immediately. In case the output is positive, the input is forwarded onto the next stage.




Viola-Jones algorithm works best for detecting frontal faces, it able to detect frontal the best rather than faces tilted or turned faces and it also sensitive for lighting condition.

*B. Hausdorff*

Hausdorff algorithm uses Hausdorff distance which make it efficient and this model works on gray-scale images. Hausdorff distance is utilized as c comparability measure between image in which the object is to be detected and sample image.

Hausdorff algorithm has two stages:

– Coarse detection
– Refinement.

*1) Hausdorff distance*

It basically is distance between two distinct point sets. For two finite point sets A and B the Hausdorff distance is given by

$$H(A, B) = \max(h(A, B), h(B, A)),$$
where $h(A, B) = \max \min(a-b)$

where a belongs to A and b belongs to B, here h(A, B) is called the directed Hausdorff distance from set A to B with some underlying norm (.) on the points of A and B.

*2) Coarse Detection:*

Here before applying any method on incoming image, we need to determine area of interest (AOI) with present height/width. This AOI is re-sampled to a fixed size.

*3) Segmentation:*

By applying sobel operator calculate edge intensity image on re-sampled image, which is resulting in binary edge points.

*4) Localisation:*

Binary representation A is obtained by segmentation step, a localisation of the face in the image can be calculated.

*5) Refinement:*

In refinement a second AOI is defined which covers the expected area of face, from original image this is area is resampled. Here segmentation and localization are same with respect to coarse detection the only deference is here more detailed eye region is used.

Following image summarizes the two step process:

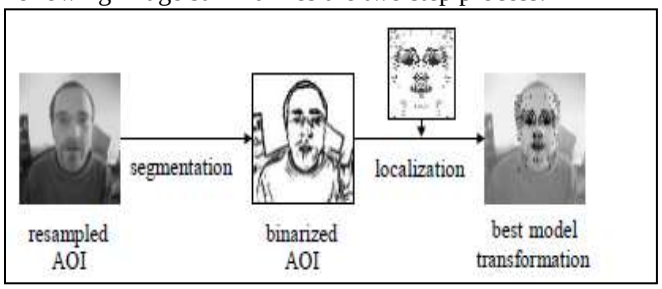



Fig. 2: Coarse Detection

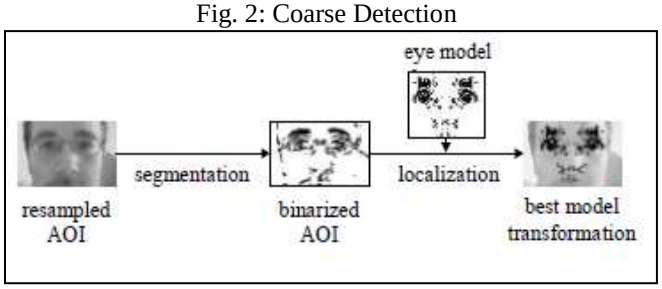



Fig. 3: Refinement

Hausdorff distance based algorithm best suits for fixed (constant) images rather than moving object and can also use for detecting faces that has intensive towards brightness.

### C. Convolution neural network cascade

This is new method proposed for face detection, the computational speed of this method is high it can perform at speed of 14 Fps on single core processor and at 100 Fps on a GPU.CNN cascade requires high computational processing because of complex computation . Previous algorithm uses the hand crafted features but CNN learns the features itself. For computing CNN cascade requires large set of training data, this is implemented on multi core in parallel.

## III. Conclusion

We have tried to survey all the important and influential algorithms in most simple and understandable way. We have categorized each algorithm and provided their pros and cons. A characteristic of each algorithm is also given. We have provided the most abstract survey/review of each algorithm so as to enable one to get an idea about that algorithm.

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