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A Hybrid Approach to Face Detection And Feature Extraction

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Abstract: *This paper presents a hybrid approach to face classification and detection. The remarkable advancement in technology has enhanced the use of more accurate and precise methods to identify and recognize things. Face detection and identification is a new field because face is undeniably related to its owner except in case of identical twins. This paper presents a combination of three well known algorithms Viola- Jones face detection framework, Neural Networks method to detect faces in static images. Face recognition is a kind of biometric detection using the physiological measure to identify and detect face. It allows the user to passively identify the person and its features using biometric. The proposed work emphasizes on the face detection and identification using Viola-Jones algorithm which is a real time face detection system. Neural Networks will be used as a classifier between faces and non-faces.*

Keywords: *Face detection and identification; Viola-Jones algorithm; feature vectors; Integral images; Adaboost.*

I. Introduction

Face detection has been considered as the most complicated and challenging dilemma in the field of computer visualization, due to the many intra-class changes caused by the variations in facial look, illumination, and expression. These changes make the face distribution process to be extremely complex and nonlinear in all space dimensions which is linear to the given image space dimension. Moreover, in day to day life the implementation of biometric and other real life methods make the device constrain to create variations which make the distribution of human faces in feature space more widespread and complicated in space dimension than that of frontal faces. Consequently, the problem related to robust face detection becomes more complex.

Terrific advancement in the field of face detection methods has been made from decades and it has emerged as a new area of study for new researchers these days. Numerous face detection techniques emphasis only on detecting frontal faces with good luminance conditions.

This paper deals with the study of the methods used in first two steps of the proposed algorithm, i.e. classification between face and non-face and then face detection. Many methods can be used for face detection like neural network, Adaboost algorithm and other methods proposed by Viola- Jones [7]. Various methods proposed by Viola- Jones for face detection are described in section II in the further sections the paper.

The main purpose of the face detection is to identify human faces in images. Some possible applications for automatic face detection are:

A. supervision and security applications,
B. video-conference applications,
C. animation of facial expressions,
D. remote camera control applications,

The existing methods face the problems described below:

a) Too high computational (time-, space-) complexity and/or
b) Too low effectiveness.

Presently it is necessary to stress on the fact that automatic face detection as well as most other automatic object-detection methods is a very pompous task, especially because of significant sample variations, which can't be easily analytically described with parameters. The face detector performs very well using a Viola Jones based method. It is not too fast, but gives accurate result.

II. Literature review

The problem of face detection refers to determining whether or not there are any faces in a given image [01]. There have been various approaches proposed for face detection, which could be generally classified into four categories [02]: template matching based methods, feature-based methods, knowledge-based methods, and learning based methods. Template matching based method means the final decision comes from the similarity

measurement between input image and the template. It is scale dependent, rotation-dependent and computational expensive. Feature-based methods use low-level features such as intensity [3], color [4], edge, shape[5], and texture to locate facial features, and find out the face location. Knowledge based methods [6] detected an isosceles triangle (for frontal view) or a right triangle (for side view). Learning based methods use various training samples to make the classifier to be capable of judging face from non-face.

According to survey of Yang, the face detection technique can be categorized into four types and are explained below.

Knowledge-based methods:- In this method the rules are coded by humans to represent the facial feature distinctly for e.g. Symmetry between eyes, position of nose and mouth underneath the nose.

1) **Feature invariant methods:-** In this method those features which are difficult to pose, condition of lightening or rotation are considered. Colors of skin, edges and shapes fall into their class.
2) **Template matching methods:-** In this method the correlation between a given test image and pre-selected facial templates is calculated.
3) **Appearance-based methods:-** In this approach an advanced machine learning method is used to extract the discriminative features from a pre-labeled training set to find out facial features.

III. Related work

Recently, a lot of research is being done in the vision community to accurate face detector in real work application, in particular, the seminal work by viola and Jones [7]. The Viola and Jones face detector has become the defacto standard to built successful face detection in real time, however, it produces a high false positive (detecting a face when there is none) and false negative rate (not detecting a face that's present) when directly applied to the input image. To handle this problem, various improvements have been proposed, such as using skin color filters (whether pre- filtering or post-filtering) to provide complementary information in color images. Though many experimental results have demonstrated the feasibility of combining SCF with VJFD to reduce false positive, both methods suffer from high false negative rate as some face regions may be ignored by detector, when directly applied to the input image with complexes background[08][09][17]. This can significantly decrease the accuracy of any face application domains, attributed to the fact that, when a face region is missed, the next stages of the system cannot retrieve the missed face. Therefore, false negative determine the eventual success or failure of the subsequent stages. The methods and frameworks related to the proposed work are discussed below.

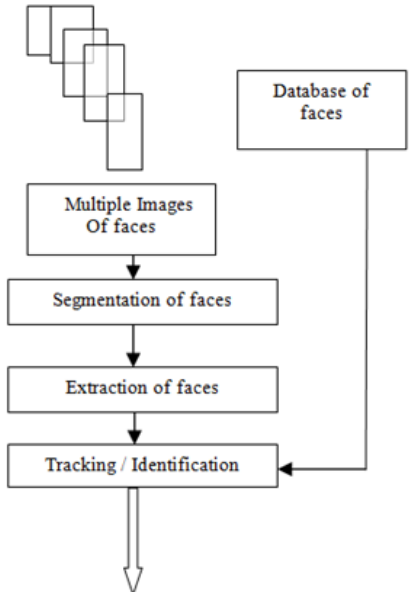

Fig 1: Machine face recognition algorithm

A. Viola–Jones object detection framework

The first object detection framework to provide competitive object detection rates in real-time was given by Paul Viola and Michael Jones in the year 2001. Although it can be taught to find out a variety of object classes, it was inspired chiefly by the crisis of face detection. This algorithm as cvHaarDetectObjects().

In Viola-Jones system a simple characteristic is used, with relation to the attribute sets. Viola and Jones make note that the choice of features instead of a statistical pixel based system is important due to the benefit of

ad-hoc domain encoding. It is particularly important in case of face detection. Facial appearance can be used to signify both the statistically close facial information and sparsely related background data in a sample image.

Viola-Jones detector is a better, binary classifier build of several weak detectors. Each weak detector is particularly simple binary classifier.

During the learning stage, many weak detectors are trained to achieve the desired hit rate / miss rate using Adaboost .To detect objects, the original image is segmented into smaller rectangular subparts, each of which is submitted to the cascade as shown in fig 2.

If a rectangular image patch passes through all of the cascade stages, then it is classified as "positive" The process is repeated at different scales.

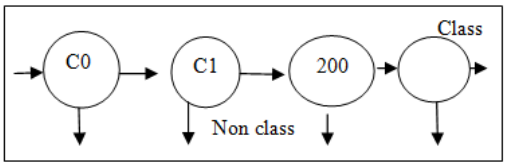

Fig 2: Cascade based classifier

The basic, weak classifier is based on a very simple visual feature (those kind of features are often referred to as "Haar like features".

Paul Viola and Michael Jones opened an approach for object detection which minimizes computation time while achieving high detection accuracy earlier.

The first contribution is related to computing a dense set of image features with the aid of integral image. To obtain ideal scale invariance, mostly all object detection systems must operate on multiple image scales. In integral image, by removing the requirement to compute a multi-scale image pyramid reduces the initial image processing required for object detection significantly.

The second contribution is pertaining to feature selection based on AdaBoost which is forceful and efficient technique for feature selection.

The third contribution is a strategy for synthezing a cascade of classifiers which thoroughly reduce computation complexity while enhancing detection accuracy. In the beginning stages the cascade is planned to decline a majority of the image to focus later execution on prominent regions.

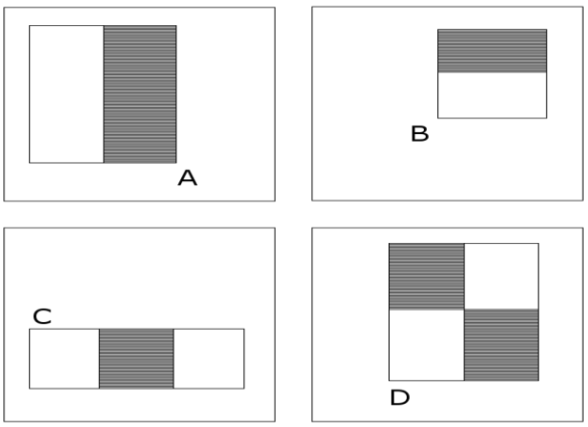

Fig 3: Edge based processing

B. Edge-Based Feature Maps

Edge-based feature maps are the very bases of our image representation algorithm. The feature maps represent the distribution of four-direction edges extracted from a 64×64- pixel input image. The input image is first subjected to pixel by-pixel spatial filtering operations using kernels of 5 × 5- pixel size to detect edges in four directions, i.e. horizontal, +45 degree, vertical, or -45 degree. The threshold for edge detection is determined taking the local variance of luminance data into account. Namely, the median of the 40 values of neighboring pixel intensity differences in a 5 × 5- pixel kernel is adopted as the threshold. This is quite important to retain all essential features in an input image in the feature maps. The edge information is very well extracted from both bright and dark images.

C. Feature Vectors

64-dimension feature vectors are generated from feature maps by taking the spatial distribution histograms of edge flags. In this work, three types of feature vectors, two general-purpose vectors and a face-

specific vector generated from the same set of feature maps were employed to perform multiple-clue face detection algorithm [1].

Fig. 3 illustrates the feature vector generation procedure in the projected principal-edge distribution (PPED) [9]. This provides a general purpose vector. In the horizontal edge map, for example, edge flags in every four rows are accumulated and the spatial distribution of edge flags along the vertical axis is represented by a histogram.

D. Integral Image

Accuracy and speed are the two important parameters for a good face detection algorithm .But there is always a conflict between these two. So a new image representation known as integral image is used.

Integral images are easily understandable and are built by just taking the sum of the luminance values above and to the left of a pixel in the given image. Viola and Jones exploit the fact that the integral image is obtained by double integrating the sample image; it is done initially along the rows then preceded by columns.

An integral image is used to increase the speed that is used in feature extraction because any rectangle in an image can be found from those integral images, in only four indexes to the integral image.

IV. Proposed work

In the proposed work we combine two common approaches, one based on neural network for classification between face and non-face and other based on face detection using Viola and Jones algorithm.

The selection of the type of neural network as a classifier between face and non-face and the selection of Viola-Jones methods for face detection is yet to be worked upon on and will be published in the final implementation paper as a part of this study work.

The basic methodology of the algorithm is as follows:

Firstly the neural network needs to be trained for a defined set of test images of faces. The types of neural network selected for training can be a self-organizing map (SOM) using an unsupervised learning technique can be used to classify to identify if the subject in the input image is "present" or "not present" in the image database, multilayer feed forward network, Multi-Layer Feed-Forward Backpropagation Network . One of these neural networks can be used in our proposed work for classification between face and non-face using one of the training algorithms like Scale Gradient Conjugate(SCG), traincgf(Fletcher-Powell conjugate gradient back-propagation) in any version of MATLAB using neural network toolbox.

After the training of the neural network the input image can be passed into it and if the outcome is a face then it can be passed through the next step of processing for face detection.

Viola-Jones face detection framework can be used for detection of the human face. Any one of the three methods of viola-Jones i.e. Integral image, Ada-boost and Cascade classifier can be used in our proposed work [7].

For example the basic operation of a cascade classifier can be operated as follows:
Find an image in all regions, which contain possible candidates for an eye, then on the basis of geometric face characteristics try to join two candidates into an eye pair and finally, confirm or refuse the face candidate using complexion information.
The method was projected over a set of quite different images, i.e. the training set.
The Goal of method was to reach maximum classification accuracy on the images, which meet the following demands and constraints, respectively (beside already mentioned two):
• Plain background,
• Uniform ambient illumination,
• Fair-complexion faces, which must be present in the image in their entirety (frontal position) and
• Faces move round for at most 30 degrees.
The method's effectiveness was tested over an independent image set, i.e. the testing set.
The basic principle of operation is shown on Fig. 2.
The method requires some thresholds, which plays a crucial role for proper processing. It is set quite loosely (tolerantly), but it becomes effective as a sequence. All thresholds were defined using the training set.
After the detection of face in our proposed work this proposed work can be extended to facial feature detection and extraction.
Table below shows the summary of facial feature extraction approaches carried out by different authors.

Table1. Summary Of Facial Feature Extraction Techniques

Author	**Approach**	**No. Of Feature**	**Video/Still-Frontal/ Rotated**
T. Kanade, 1997	Geometry Based	eyes, mouth and nose	still-frontal
A. Yuille, D. Cohen, and P. Hallinan, 1989	Template Based	eyes, Mouth, nose and eyebrow	still-frontal
C. Chang, T.S. Huang, and C. Novak, 1994	Skin color based	Eyes and/or mouth	still and video frontal initially in a near frontal position and therefore both eyes are visible

V. Conclusion And Future Work

In this study work we have proposed an approach for face detection using neural networks and Viola-Jones face detection method. After the implementation of this combined approach the work can be further extended for feature localization and extraction. This approach will be implemented initially on static frontal images. Histogram equalization can also be applied for adjusting the contrasts in images in future work accompanied by noise removal.

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