Face Detection Using Open CV in Real Time

Drakshayani Desai[1], Dr. Ramakrishna Seemakurti[2]
[1] *Research scholar, ECE Dept., JJTU, Rajasthan, India, 333001, Associate Professor, SVIT, Secunderabad-500 003*
[2] *Dean, Ph.D., SVIT, Secunderabd, India, 500003, Approved Research Guide, JJTU, Jhunjhunu-333001, Rajasthan, India*

***Abstract*- Face detection is a fundamental part of any face processing system which is the task of localizing faces in a given image. The aim of this paper is to highlight on various methods and algorithms for face detection. This paper mainly focus on three different algorithms i.e. Haar cascade, Adaboost algorithm and template matching.**

This paper mainly focused on the methodology for face detection robustly in real time environment. Here the use of Harr like classifier and Adaboost algorithm to track faces on Open CV which is open source and developed by Intel in 1998.

***Index Terms*- Face Detection, Adaboost Algorithm, Harr Like Features, Computer Vision, Open CV.**

I. INTRODUCTION

Face detection has been regarded as the most complex and challenging problem in the field of computer vision, due to the large intra-class variations caused by the changes in facial appearance, lighting, and expression. Such variations result in the face distribution to be highly nonlinear and complex in any space which is linear to the original image space. Moreover, in the applications of real life surveillance and biometric, the camera limitations and pose variations make the distribution of human faces in feature space more dispersed and complicated than that of frontal faces. Locating and tracking human faces is a essential for face recognition and facial expressions analysis, although it is often assumed that a normalized face image is available.

II.RESEARCH PROBLEM

In order to detect a human face in an image, the system needs to capture an image using a digital camera and a frame-grabber in order to process the image. Then search for the important features in the image and then use these features to define the location of the face. For detecting the face in a captured image there are various algorithms and methods including skin colour based, Haar like features, Adaboost and cascade classifier. Skin colour is an important feature of human faces. Using skin-colour as a feature for tracking a face has several advantages because colour processing is much faster than processing other facial features [10].

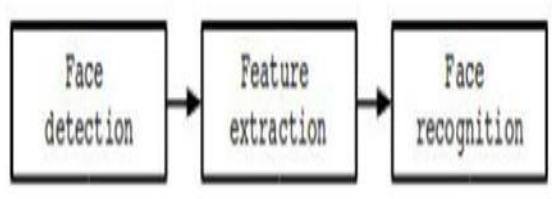

Fig 1. A block diagram of face detection system

The input of a face recognition system is may be an digital image from camera or video stream. The output is an identification or verification of the subject that appear in an image or video. Some approaches [3] define a face recognition system as a three step process (Figure 1). From this point of view, the Face

Detection and Feature Extraction phases could run simultaneously.

III.RELATED WORK

Face detection is defined as detecting the face in an image. This procedure has many applications like face tracking, pose estimation and image compression. The next step is feature extraction-which involves obtaining relevant facial features from the database. These features could be certain face regions, variations, angles and measures, which can be human relevant (e.g. eyes spacing, mouth circles around eye) or not. This phase has other

applications like facial feature tracking and emotion recognition. Finally, the system does recognition of the face. In an identification task, the system would report an identity from a database. This phase involves various comparison methods, a classification algorithm and an accuracy measure. This phase uses methods common to many other areas which also do some classification process - sound engineering, data mining. These phases can be merged, or new ones could be added. Therefore, we could find many different engineering technologies to a face recognition system. Face detection and recognition could be performed in tandem, or proceed to an expression analysis before normalizing the face. In some cases, face images stored in the data bases are already normalize. There is a standard image input format, so there is no need for a detection step for example criminal data base. Criminal report will be stored by law enforcement agency. If there is new person and the police has his or her passport photograph, face detection is not necessary. However, the conventional input image of computer vision systems is not that suitable. They can include many items or faces. In these cases face detection is mandatory. It's also unavoidable if we want to develop an automated face detection and recognition system. For example, video surveillance systems try to include face detection, tracking and recognizing the image captured camera. So, it's reasonable to assume face detection as part of the more plentiful face recognition.

Next is feature extracting faces from scenes. From the features extracted face recognition will be effectively done.

Face detection is a two class problem where we have to decide if there is a face or not in a picture. This approach can be seen as a simplified face recognition problem. Face recognition has to classify a given face, and there are as many classes as candidates. Consequently, many face detection methods are very similar to face recognition algorithms. Or put another way, techniques used in face detection are often used in face recognition.

Face detection methods are divided into four categories. These categories may overlap, so an algorithm could belong to two or more categories. This classification can be made as follows:

Knowledge-based method also known as Ruled-based methods that encode our knowledge of human faces which are Feature-invariant methods. Algorithms that try to find invariant features of a face despite of it's angle or position.

Template matching methods. Template matching algorithms compare input images with stored patterns of faces or features with images of database.

Appearance-based methods. In this method Face edges are found by calculating the Ecludian distance between the facial features such as nose, eyes and chin.

Face Detection in Computer Vision Area

In computer vision area face detection technology involves two terms facial feature extraction and face localization are explained as follows;

Face Detection

Given a test image, the goal of face detection is to determine whether or not there are any faces in the image and if present, return the image location and extent of each image. This is done by extracting the facial features.

Face Localization: It's objective is to determine the image position of a single face; this is a simplified detection problem with the assumption that an input image contains only a single face. As our main purpose of face detection is finding a work area for eye detection, nose detection and mouth. For doing so we need a fast face detection method which is independent of the structural components of face such as beard, moustache and facial mask etc. Although simple methods could be chosen without making detailed research about previous work on face detection. Human vision system can easily detect and recognize faces in images. The performance of the human vision system is so high that it can detect not only a single face but multiple faces in the same scene having different pose, facial expression, lightening conditions, scales, orientation etc. Also faces do not have to be complete that is; a partial view of a face is enough for humans to detect them in images. Unfortunately in today's computer vision technology no system can achieve that performance compared to human face recognition by human being. Their operations depend on controlled training set images. Using computer software database is created which includes a well-trained facial images of a person.

There are about 150 different techniques for face detection in images although they share some common methods for face detection. A detailed survey about various face detection methods is given in Yang's survey [4] and classified into four categories. Knowledge-Based Methods, Template Matching Methods, feature based methods. Which are explained below:

3.1 Knowledge-Based Methods

These rule-based methods. The Knowledge-Based Methods encrypt human knowledge of what constitutes a typical face. In Knowledge-Based Methods the software capture the relationships between the facial features. These methods are designed mainly for face localization.

In this approach, methods use simple rules to describe features of a face such as; a face often appears in an image with two eyes that are symmetric to each other, a nose acts as a bridge between the two eyes and a mouth below the nose region. The relationships between features can be represented by their relative distances and positions with respect to each other.

Problem with this approach is that; it is difficult to translate human knowledge into well-defined rules for computer software. If these rules are strict then they may fail to detect faces that do not pass all the rules. But on the other hand if the rules are too general than there may lead to false face detections.

One popular work about this approach was performed by [10] Paul Viola & Micheal Jones. They used a hierarchical knowledge-based method to detect faces. Their systems consists of three levels of rules. At the highest level, all possible face candidates are found by scanning a window over the input image and applying a set of rules known as Harr features at each facial location. The rules at higher level are general descriptions of what a face looks like while the rules at lower levels rely on details of facial features. A multiresolution hierarchy of images is created by averaging and subsampling.

3.2 Template Matching Methods.

Template matching method finds the similarity between the input images and the template images (training images stored in database). Template matching method can use the correlation between the input images and stored standard patterns in the whole face features, to determine the presence of a specific face features [16]. This method can be used for both face detection and face localisation. In this method, a standard face (such as frontal) can be used. Rest with different pose and illumination of the same image is stored as a training image. Using these training images computer is well trained to detect the face in a given image. The advantages of this method are that it is very simple to implement the algorithm, and it is easily to determine the face locations such as nose, eyes, mouth etc based on the correlation values. It can be applied on the various variations of the images such as pose, scale, and shape. Sub-templates, Multi resolutions, and Multi-scales have been proposed to achieve the shape and the scale invariance and localization method based on the shape template of a frontal view face [13]. A Sobel or Gabor filter is used to extract the edges.

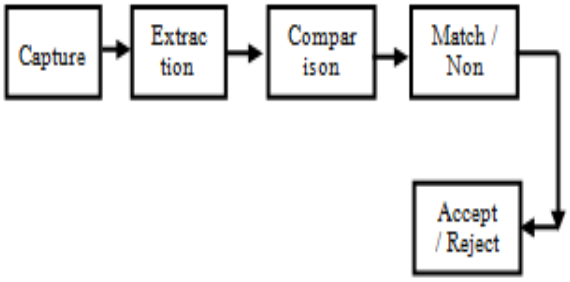

Figure.2 below shows the block diagram of template matching

IV.ALGORITHMS OF FACE DETECTION

An error rate higher than would be expected from a random classifier will be useful, since they will have negative coefficients in the final linear combination of classifiers.

Adaboost generates and calls a new weak classifier in each of a series of rounds for each specific feature.For each call, a distribution of weights is updated that indicates the importance of examples in the data set for the classification. On each round, the weights of each incorrectly classified example are increased, and the weights of each correctly classified example are decreased, so the new classifier focuses on the examples which have so far considered for correct classification.

4.1 Haar like feature:

Haar-like wavelets are binary rectangular representations of 2D waves. These are used for face detection. These are rectangular windows containing black and white regions. A common visual representation is by black (for value, minus one) and white (for value, plus one) rectangles. The figure below shows a cut through a binary wavelet between x = 0 to x = 1. The square above the 0-1-interval shows the corresponding Haar-like wavelet in common black-white representation. The rectangular masks used for visual object detection are rectangles window having black and white smaller rectangles. Those masks are designed in correlation to visual recognition tasks to be solved, and known as Haar-like wavelets. By convolution with a given image they produce Haar-like features.[11],[12].These are known as templates later these are sent for template matching.

Now a days Face detection is gaining the interest in research area. A webcam can be integrated into a television and detect any face that walks near by. The system then calculates the race, gender, and age range of the face. Once the information is collected, a series of advertisements can be played that is specific toward the detected race/gender/age. Face detection is also being researched in the area of energy conservation.

4.2 AdaBoost Algorithm:

Adaboost is an algorithm for constructing a"strong" classifier as linear combination of weak classifier. Adaboost, short for Adaptive Boosting, is a machine learning algorithm, formulated by Yoav Freund and Robert Schapire[14]. It is a meta-algorithm, and can be used in conjunction with many other learning algorithms to improve it,s performance. Adaboost is adaptive scheme in the sense that subsequent classifiers built are weak in favour of those instances misclassified by previous classifiers. Adaboost is sensitive to noisy data and low illumination. In some problems, however, it can be less susceptible to the over fitting problem than most learning algorithms due to different image sizes. The classifiers it uses can be weak (i.e., display a substantial error rate), but as long as their performance is slightly better than random (i.e. their error rate is smaller than 0.5 for binary classification), they will improve the final model.

V.EXPERIMENTAL RESULTS

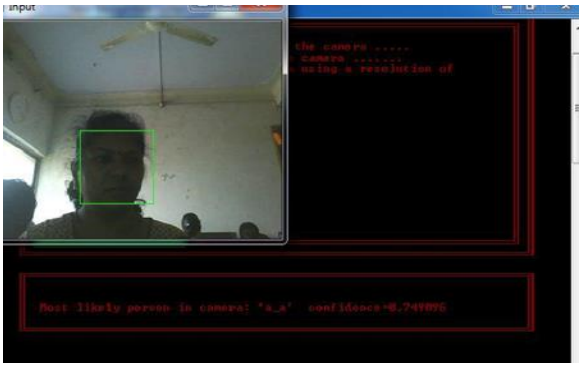

Fig 3. Face detection system

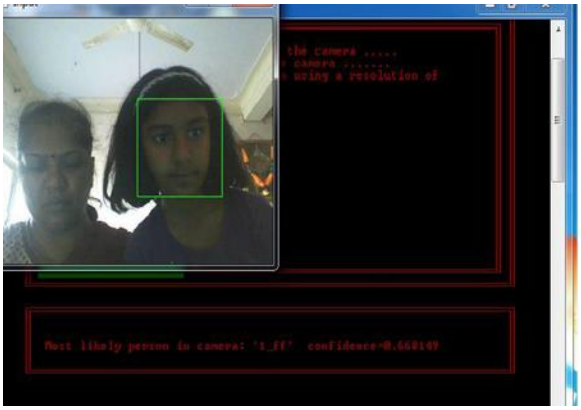

Fig 4. Performance criteria: Confidence

VI.APPLICATIONS

Face detection is used in biometrics because of its uniqueness and robustness. It is often a part of a facial recognition system. It is also used in video surveillance, human computer interface and image database management. Some recent digital cameras use face detection for autofocus. Face detection is also useful for selecting regions of interest in photo slideshows that use a pan-and-scale Ken Burns effect [17]

VII.DISCUSSION

Different methods and algorithms of face detection have been reviewed in this paper. The choice of a face detection method in any study should be based on the particular demands of the application. None of the current methods is the universal best for face detection as well as recognition because each has it,s own advantages and disadvantages. Haar-like features are digital image features used for object detection and recognition. They owe their name to their intuitive similarity with Haar wavelets and were

used in the first real-time face detector. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region i.e black and white region and calculates the difference between these sums[11],[12]. This difference is then used to categorize subsections of an image. The key advantage of a Haar-like feature over most other features is its calculation speed and accuracy

In order to be successful a face detection algorithm must possess two key features, accuracy and speed. There is generally a trade-off between the two parameters. Through the use of a new image representation, termed integral images, Viola and Jones describe a means for fast feature evaluation, and this proves to be an effective means to speed up the classification task of the system.

Adaboost, short for Adaptive Boosting, is a machine learning algorithm. Adaboost algorithms take training data and define weak classifier function for each sample of training data. It can be less susceptible to the over fitting problem than most learning algorithms. Bad feature of adaptive boosting is its sensitivity to noisy data..

The weak classifiers have the task to detect a face. They are performed in a cascade. A search window (sliding window) of 24×24 pixels contains more than 180,000 different rectangular sub-windows of different size. Future improvements can be made for reduction of huge data by adopting Principal Component Analysis.

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