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Biometric Verification Using Face Recognition

[1] Nethra. R [2] Bhavya. K N [3] Anil Kumar. M [4] Gagana. P [5] Mr.Manikandan
Department of Computer Science and Engineering
Sri Sairam College of Engineering, Bangalore

Abstract: **-- Real time challenges are eternal for verification & recognition of a person."An image is worth more than ten thousand words!!"Automatic detection/ recognition of people is a challenging problem which has received much attention in the recent years. Face recognition concept is one of the successful & important application of image analysis. It's a holistic approach towards technology & has potential applications in various fields.**

This paper provides an overview of real time applications of face recognition concept. We have proposed an efficient algorithm by generating a code based on MATLAB platform. The basic techniques which we have used are categorized into 2 parts i.e. Feature based including skin color model, geometry based model; and template matching. We have also discussed about various color space models. We have segmented the various parts of the face using mapping and then made use of Viola Jones method & Artificial Neural Networks which includes Gabor filter in order to compare the test image with the images in our database to find the similarities and hence recognize the person.

Keywords:- **Face recognition, Viola Jones, Gabor filter, Artificial Neural Networks Template Matching.**

I. INTRODUCTION

"You may delay, but time will not" as said by Benjamin Franklin, time is very precious. Every time a lecture, section or laboratory starts, the lecturer or the teaching assistant delays the lecture to record attendance of the students. This is a lengthy process and takes a lot of time and effort. Especially if it is a lecture with a huge number of students. It also causes a lot of disturbance and interruption when an exam is being held. Moreover the attendance sheet is subjected to damage and loss while being passed on between different students or the teaching staff. Apart from wastage of time while taking attendance there are few other problems such as false attendance popularly known as "proxy", lack of dedicated time for teaching, resulting in incompletion of syllabus, maintaining records of attendance, mispronunciation of names. To find a solution of these we use the Advanced Digital Image Processing and its real time application using MATLAB.

The main advantage of biometric systems over the normal automated system is that they really do what they are supposed to do, which is authenticating the user, in a way initiating the human capabilities; and using real human physical characteristics, which are unique for all and impossible to change. In addition, some researches proposed that biometrics are not subjected to theft, loss or passing to anyone else like what is done with cards or passwords. While some other objects point out that they are not a secret and could be falsified or stolen from computer systems.

In today's era of fast growing biometric systems, several approaches of face detection have been proposed. In this algorithm a method for face detection in color images has been implemented. Detecting of faces in color faces has become important for a face detection system, as the color being one of the timely and most useful components to extract skin regions. There are numerous color models that constitute an image viz. RGB, YCbCR, HSV color models. As a primary color model, we worked on RGB by specifying the general range for Red (R), Green (G) and Blue (B) color intensities.

II. DIGITAL IMAGE PROCESSING

It is an area characterized by the need for extensive experimental work to establish the viability of proposed solution to a given problem. Digital image processing encompasses processes whose inputs d outputs are images and in addition, includes processes that extract attributes from images.

Image processing includes:-

1. Image display and printing

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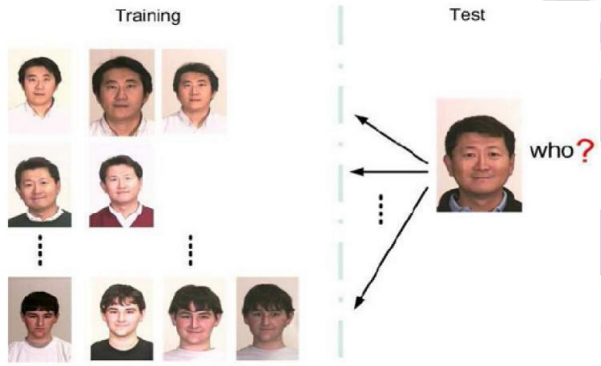
2. Image editing and manipulation
3. Image enhancement
4. Feature detection
5. Image compression

In this thesis, we are working with face detection system which can detect static images. Human activity is a major concern in a wide variety of applications such as video surveillance, human computer interface and face recognition. Detecting faces is the first and the most important step in these applications. Face detection can be viewed as a two-class (face vs non-face) classification problem. This skin patches are detected after applying lighting compensation technique. The facial features are subjected to verify feature maps for the eyes, mouth and face boundary. This approach is very much sensitive to illumination, color variations, hence we moved towards template matching.



Facial Feature Detection

- It is possible that some of the detected skin tone regions will include some non-face regions whose color is similar to the skin tone.
- The face feature detection module rejects face candidate regions that do not contain any facial features such as eyes, nose and face boundary.
- This module can detect multiple eye and mouth candidates.
- A triangle is constructed from two eye candidates and one mouth candidate and the smallest enclosing ellipse of the triangle is constructed to approximate the face boundary.
- A face score is computed for eyes, mouth and ellipse, and if it exceed threshold it is then considered as a face.

Face Detection Approaches

The attempt to automate human recognition initiated the research in the field of face detection. The existence of variable illumination, complex background and d pose variation adds constraints to an efficient and robust face detection system. In this section, we review existing face detection techniques over a single intensity or color images. Image detection methods here are classified into 2 types:-

1. ***Feature based method***
   A. Skin color based
   B. Geometry based
   C. Appearance based
   D. Edge based

2. ***Template matching***
   A. Artificial neural networks and Gabor filter

Skin color based

Human skin color has been used and proven to be an effective feature in many applications from face detection to and tracking. Although different people have different skin color, several studies have shown that the major difference lies largely between their intensity rather than their chrominance. The skin pixel detection in RGB space is difficult as it is not perceptually uniform and the color components are very sensitive to the intensity.

Geometry based

Most of the face detection approaches utilize size and shape to find the face candidate and then verify these candidates using local, detailed features such as eye brows, nose, mouth and hair. A typical approach begins with the detection of skin like pixels, as mentioned above. Next, skin like pixels are grouped together connected component analysis or clustering algorithms. If a connected region has an elliptical or an oval shape, it becomes a face candidate.
The symmetry of face patterns has also been applied to face localization. A face triangle is drawn utilizing the eyes and mouth indicating a face candidate.

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Appearance based

Gray values are the most important parameter for the face detection. Face detection performance is effected by light intensity and occlusions. Contrasted to the template matching methods where the template are predefined by experts, the templates in appearance based methods are from the examples in the image. Appearance based methods rely on techniques from statistical analysis and machine learning to find the relevant characteristics of face and non-face images.

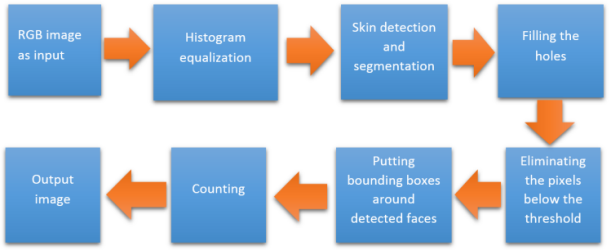
Edge based

The edge information is extracted and used to detect face. These methods can handle large variations of the face images but require processing for illumination normalization. Edge detection is the foremost step in deriving edge representation. So far, many different types of edge operators have been applied. The Sobel operator was the most common filter among the techniques. A variety of first and second derivatives (Laplacian) of Gaussians have also been used in the other methods.

Template matching

Input image is compared with predefined face template, pose and shape. In template matching, a standard face pattern (usually frontal) is manually predefined or parameterized by function. Given an input image, the correlation values with the standard pattern are computed for the face contour, eye, nose and mouth independently. The existence of face is determined based on the correlation values. This approach has the advantage of being simple to implement. However, it has proven to be inadequate for face detection since it cannot effectively deal with the variation in scale, pose and shape. Multi resolution, multi scale, sub-templates and deformable templates have subsequently been proposed to achieve scale and shape invariance.

Block diagram representation



HSV Color Space

Hue (H) is a measure of the spectral composition of a color and represented as an angle, which varies from 0 to 360. Saturation (S) refers to the purity of colors and intensity of pixel is defined by the Value (V) which ranges from 0 to 1. HSV model is related to human color perception. Conversion from RGB to HSV color system is done using the following equations:-

$$H_1 = \cos^{-1}\frac{0.5[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}$$

$$H = H_1 \quad if \quad B \le G \quad H = 360^0 - H_1 \quad if \quad B > G$$

$$S = \frac{Max(R,G,B)-Min(R,G,B)}{Max(R,G,B)}$$

$$V = \frac{Max(R,G,B)}{255}$$

Condition in the HSV color space for skin regions:-
0<H<360
H>=0 && H<=50
S>=0.1 && S<=0.9

Face detection steps

The following steps are followed in order to find the regions where face may be found:-

1. Normalize the test image.
2. Take two template images from database and normalize them.
3. Apply 2-D convolution between test image and template images.
4. Find the regional maxima in both convolved images where the maximum found is set to 1 and all other regions are set to 0.
5. Combine the regional maxima of both the images into one image which will give the position where the face features may be found.

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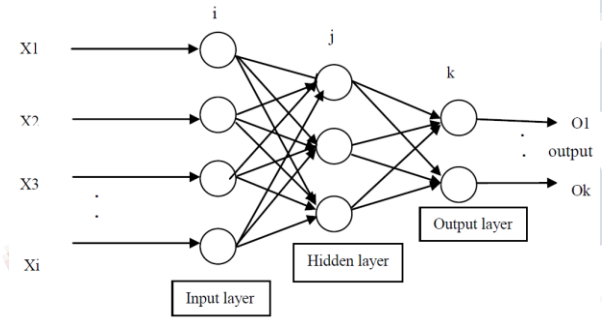
III. ALGORITHM

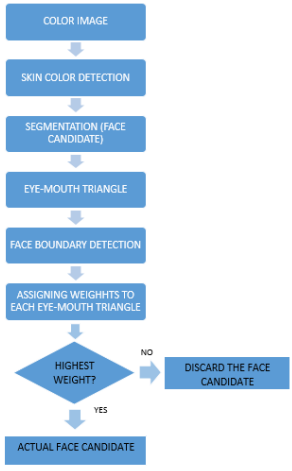
We are using Artificial Neural Networks for training our system for face and non-face data feature where our ANN has three layers, one input layer, one hidden layer and one output layer. The size of the hidden layer is fixed to 100 and the input layer is from -1 to +1. For calculation purpose, the hyperbolic tangent sigmoidal transfer function is used and is described as:-

$$A = \frac{2}{1 + e^{-2n}} - 1$$

Where, n is the number of inputs to the ANN.
For checking the performance of the network, we have used the mean squared error with regularization performance function that measures the measures the network performance as the sum two factors, mean squared error and the mean squared weight, and the bias value. The scaled conjugate gradient back propagation function as been adapted for training the whole network.



Flow Chart Representation



Viola Jones Approach

The basic principle of the Viola Jones algorithm is to scan a sub window capable of detecting faces across a given input image. The standard image processing approach would be to rescale the input image to different sizes and then run the fixed size detector through these images. This approach turns out to be rather time consuming due to the calculation of the different size images. Contrary to the standard approach, Viola Jones rescale the detector instead of the input image and run the detector many times through the image – each time with a different size. At first, one might suspect both approaches to be equally time consuming, but Viola Jones have devised a scale invariant detector that requires the same number of calculations whatever the size. This detector is constructed using a so called integral image and some simple rectangular features reminiscent of Haar wavelets.

IV. CONCLUSION

The algorithms mentioned above are in the hierarchical order of their complexity and accuracy. Skin color based algorithms like RGB, YCbCR and HSV methods could yield the output for simple images. However, they failed for the images which have complex background and poor or non-uniform illumination. Moving to the improved methods, we worked on geometrical features where eye and mouth parts were extracted using a method in which face triangle is drawn. This approach overcame the dependency of face area and complex background. However, it failed again in terms of poor illumination and in different orientations. Hence a better method would be the one which is independent of color variation and illumination. This directed us to work on template matching algorithms like Gabor filter and ANNs. For a class room environment constructing a database is not a problem. Since the classroom contains a pre-defined number of students. These databases are used to match with the test image, an image taken by the camera, in a real-time scenario. So far this is the best algorithm among the above mentioned and best suits for our problem statement.

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