Enhanced Face Detection Using Skin Color Model: A Review

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Abstract—Face detection is the elementary component of any face processing structure. It is emerging as dynamic investigation and delves into the area of image processing. Biometrics use face detection often as a part of a facial recognition system. In this paper, a method has been proposed to detect multiple faces in a crowded image which will comprises of different poses and illumination conditions using color based skin model for skin detection and also extract facial feature like nose, lips and eyes. In the preprocessing step skin color is detected using hybrid color space and Gaussian distribution model then enhance the image. Filters and Morphological operators will be used to fill the holes that will be created after the segmentation process. Then edge detection method will be used to detect the edges of the face using ellipse model and then masking is done and the faces are detected. The aim is to develop an algorithm to detect faces from an image so that it will improve the true detection rate and decreases the rate of false and miss detection.

Keywords—face detection, skin color model, edge detection, feature extraction;

I. INTRODUCTION

Recent years has seen tremendous amount of research being carried out in the field of biometrics. The idea of using physical attributes – face, fingers and their fingerprints, iris, hands, voice and several other metrics of human body has a lot of importance to verify human identity. Fig. 1 shows the percentage of different categories of biometrics. Any peculiarity of humans which is distinctive and adequately stable can serve as a distinctive measure for identify, verify, recognize or classify them. Face is one of such traits of human beings that undoubtedly distinguishes among individuals. Therefore face is the most common trait that is used in human interaction system to identify people.

Face recognition has attracted a lot of attention for its various commercial, security and law enforcement applications such as authenticated access control (secure banking, device unlocking, voter verification, employee access etc.), surveillance (comparing detected faces to known criminals and tracking them), HCI.

The foremost task of any face recognition system is face detection, which involves detection of faces in the image. The ability to detect faces in complex backgrounds is something people do effortlessly and without much conscious thought, yet this problem which delves into image processing and pattern recognition, is a confounding challenge till now for scientists and engineers. Many methods have been proposed [1]-[3] till now, however, there is scope for improvements in terms of speed, robustness, reliability, and flexibility.

Face Detection is challenging due to:
1. Textual differences among the faces
2. Pose
3. Facial expressions
4. Orientation
5. Facial size
6. Illumination conditions
7. Cluttering
8. Occlusion
9. Gender
10. Different skin tones and changes in background
11. RST (Rotation, Scaling and Transformation)
12. Scene changes can also be detrimental to face detection since a background can be simple as well as complex.

![Fig. 1: Various biometrics categories](image-url)
Faces are not uniform in size and vary with the subject’s distance from the camera [5]. Owing to these challenges, researchers are striving to improve face detection by proposing new and more robust algorithms.

Taken a picture from a digital camera, we would like to know that weather is there any person in the photo, who is he/she and where his/her face situated. For this, we generally separate the face recognition system into three steps: Face detection, Feature Extraction and Face Recognition.

![Fig. 2: Example of face detection[4]](image)

The main task of face detection is to determine (1) whether human faces appear in a given image, and (2) where these faces are located at. The expected outputs of this step are patches containing each face in the input image as shown in Fig.2.

Methods of face detection

A. Using a skin color model
RGB color and intensity values are normalized in the image. Then the pixels are matched with the skin color model and marked. Regions that are not representing face are removed and face appearance is confirmed by verifying common features of a human face.

B. Feature-based methods
Geometric relationships between eyes, nose and mouth are taken for use. To avoid geometric confusion, one face should be present and also require good quality of image and thus the computation is expensive. Eg- Haar Classifier, Adaboost, Viola Jones.

C. Appearance-based methods
This method applies statistical learning method and training set of data is used to construct a face or non-face classifier Eg-Neural Network Techniques.

D. Template Matching
In this method we have a training set of data with us. Now the input images are matched with these data to find the similarity.

Up to now, much work has been done on detecting and locating faces in color images and the methods like template based [6], neural network-based [7], feature-based [8], machine learning-based [9] have been well studied by many researchers. Among many face detection algorithms, the method based on skin color model has been widely used for its convenient use, simple performance and high detection speed [10,11]. It is unreliable to make face detection only using skin color features when there are a large number of objects similar to skin color. So we need to utilize the other features of human face to further verify. So it is desirable to use feature extraction process to get more accuracy while detecting faces.

Color Spaces Used for Skin Color Classification

Skin color is a powerful fundamental feature of human faces among face detection algorithms which are based on skin color information and the speed of processing color is faster than other facial feature. So skin color detection is firstly performed on the input color image to reduce the computational complexity.

There are different colour spaces that can be used for skin modelling namely RGB, normalised RGB, hue, saturation and value (HSV), hue, saturation and intensity (HSI), hue, saturation and lightness (HSL), tint, saturation and luminance (TSL) and YCbCr. RGB colour space is not considered efficient for colour segmentation owing to high channel correlations, considerable perceptual uniformity and mixing of luminance and chrominance data. If ambient light is ignored while representing matte surfaces with normalised RGB values, the change in surface orientation with respect to light source has no effect on the values. This is the most desirable feature of normalised RGB and the distortions in an image caused by shadows and lights can be reduced by this colour space.

HSV, HSI and HSL colour spaces are popular for skin modelling and segmentation. They are used in because of their intuitive components and distinguished chrominance and luminance properties. YCbCr colour space has been defined in reaction to escalating demands for digital algorithms to handle video information, and has since become a widely used model in a digital video. It belongs to the family of television broadcast color spaces.

This family also indulge other color spaces such as YUV and YIQ. YCbCr is a digital color system, while YUV and YIQ are used as analog spaces for the respective PAL and NTSC systems. These color spaces detach RGB (Red-Green-Blue) into...
luminance and chrominance information and are useful in compression applications however the specification of colors is somewhat unintuitive.

**Edge Detection**

This is a collective name for a set of arithmetical methods whose aim is to identify points in a digital image where the image intensity changes sharply or more formally, has discontinuities. The point where image vividness vary sharply are structured into set of curve line sequences and known as an edge.

Edge detection is the foremost step in deriving edge representation. So far, many different types of edge operators have been applied.

![Fig. 3: Example of edge detection][4]

The Sobel operator was the most common filter among the techniques mentioned above. A variety of first and second derivatives (Laplacian) of Gaussians have also been used in the other methods. For instance, a Laplacian of large scale was used to obtain a line drawing and steerable and multiscale orientation filters. In an edge detection-based approach to face detection, edges need to be labeled and matched to a face model in order to verify correct detections. Fig.3 shows edge of the respective image using edge operators

**II. RELATED WORK**

Significant amount of research has been carried out on face detection in the past few years. A multi-level ellipse detector along with a support vector machine verifier is proposed to precisely detect human faces and eyes. This method can be used for face recognition; however, it is not suitable for small faces, low quality images or non frontally oriented faces. Faces smaller than 10% of the image height increase the processing time and reduce the face detection rate significantly. Three dimensional (3D) face detection based on a 3D point distribution model is proposed. This algorithm does not need any prior knowledge of face orientation or pose, however, it requires a larger training set for better accuracy since a lower number of training samples decrease the true acceptance rate. Abin proposed a real-time multiple face detection and tracking algorithm that uses skin colour, edge and shape information. However, the false detection rate is extremely high (27.6%) on the Compaq skin database. Viola and Jones have proposed a robust real-time face detection framework, which is built using the AdaBoost classifier. This method combines the classifiers in cascade to remove the background region of the image and allows promising face-like regions to be processed. The AM-CC face detection algorithm based on AdaBoost is proposed in and has a 10% higher detection rate than the traditional AdaBoost algorithm. However, the authors have only used single facial test images. A significant amount of work is carried out further to propose a facial expression recognition method using Haar-like feature based Adaboost cascades for face detection. At each stage of the AdaBoost algorithm, all the features need training on the entire re weighted training data[12].

Another type of work has been done which is based on skin color segmentation and feature extraction. Gaussian model is used extracting the skin color in CbCr color space and with the means of likelihood ratio method a binary mask is created. Best ellipse searching is used to detect the outline of the face. Caltech database has been taken from which 165 images has been selected to assess the performance of the proposed method and it is found 95% accurate. But the method fails to detect the face or partially detects the face due to improper illuminations [13]. In next research a comparison is done between feature based method and skin color based method for face detection. Viola Jones is used for haar detection for facial feature like nose, eye and mouth is calculated. The competence achieved by feature based is method for face is 89.42% while that of skin color method is 84.61%. The experimental result shows that the efficiency of haar is more than that of skin color as skin color model is highly affected by lightening factor, color of individual etc. But the speed of skin color model is faster than that of haar[14]. Also EM algorithms have used for face detection of image segmentation in YUV color space. This method uses clustering method for skin color and improves the velocity performance of face. For complicated backgrounds, especially contains the similar color of skin in the background, it will come out an obvious division error[15].

In another method regions of face are detected by detecting the eye regions. After this eye pairs are obtained by finding and verifying probable eye regions. The distance between the eyes is used to find a possible face candidate. Next, the face is divided into different regions and facial features are extracted from the corresponding regions. But the
system fails when both eyes are occluded. It is because of the fact that the entire system depends on the extracted eye centres. Thus presence of glasses causes errors in the system. Also performance degrades in extreme lighting conditions [16].

Recently a method based on skin color likelihood via boosting algorithm which emphasizes on skin color information. A Stochastic model is adopted to compute the similarity between a skin region and a skin color. Both Haar like features and lbp are utilized to build a cascaded classifier. This is implemented based on skin color emphasis to localize the face region from the color image. It shows good tolerance to face pose variations and complex background[17].

III. PROPOSED METHOD

The proposed face detection algorithm will implement using MATLAB.

The multistep process shown in Fig.4 is explained as follows

- **Start**
- **Take Database**
- **Skin detection**
- **Enhancement and Morphological Operations**
- **Filtering**
- **Binarization & Masking**
- **Edge Detection**
- **Faces Detected**
- **Stop**

![General block diagram of proposed method](image)

A. **Database**

Select an image from a database which consists of various colored images having different poses, illumination conditions, occlusions or select an image from own photo gallery.

B. **Skin Color Detection**

Because the pixel-level manipulation accounts for the most processing time in image process, a crucial issue in skin detection is to consider the process complexity. To reduce processing time significantly, we need relatively coarse but highly time-saving skin detection. We choose skin detection based on skin-color information because skin-color provides computationally effective yet, robust information against rotations, scaling and partial occlusions. We can model the skin color using hybrid color model that is a mixture of any two color model or can use any color model. Now to classify the skin pixel from non skin pixel we can use guassian model. The final goal of skin color detection is to build a decision rule that will discriminate between skin and non-skin pixels. This is usually accomplished by introducing a metric, which measures distance (in general sense) of the pixel color to skin tone. The type of this metric is defined by the skin color modelling method.

C. **Enhancement and Morphological Operations**

Image enhancement signifies a cluster of pre-processing methods that try to deliver the participated images in such a manner that the consequential improved images show off some predefined characteristics. These quality may incorporate the dynamic variety of the intensity value of the image, the shape of image histogram. They make certain at least some point of robustness to illumination conditions. This is accomplished with the help of filters like spatial or frequency domain filters. Now the enhanced image is subjected to morphological operations, a collection of techniques for digital image based on relative ordering of pixels values, not on their numerical values. For example we can use erosion, dilation, open, close operators.

D. **Filtering**

It is a process that cleans up appearances and allow for selective highlighting of specific information. There are two types of filters smoothing filters and sharpening filters. Smoothing filters are used for blurring and noise reduction like guassian low pass filter. And sharpening filters are used to highlight fine detail in an image or to enhance the detail that has been blurred either in error or as a natural effect of a particular method of image acquisition.
E. Binarization

Image binarization helps to classify all the pixels above a value. Pixels above the value considered as white and all other as black. This value is threshold. The problem then is how to select correct threshold. Adaptive image binarization is consider for the purpose of selecting optimal threshold for each image area.

F. Edge Detection

An edge is a set connected pixel that lie on the boundry between two regions. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundries of objects in a scene. There are different types of edge detection techniques like sobel operator, Roberts cross operator, prewitt’s operator, laplacian of guassian and canny edge detection. Thus, we get the faces detected in the image as shown in Fig.6.

Fig.6: Outcome of face detection[11]

IV. EXPECTED OUTCOME

The expected outcome is to achieve high true detection rate and reducing false and miss detections. Detection rate and the number of false positives are important factors in estimating face detection systems. The ratio between the number of faces correctly detected by the system and the actual number of faces in the image is known as Detection rate.

V. CONCLUSION

Biometrics use face detection often as a part of a facial recognition. In the past, research has started with the aim of teaching the machine to identify human faces and expressions. There are huge reasons to haul out information from images. We see that there are various methods and algorithms have been developed for face detection that can detect the faces to some extent but somehow fail to overcome the challenges of face detection. So we try to develop an algorithm that will overcome these challenges by enhancing the previous work done so that the detection rate increases as much as possible.

REFERENCES


