Face Detection using RGB Ratio Model

Gayatri A. Patil
Department of Electronics and Telecommunication Engineering,
R. C. Patel Institute of Technology,
Shirpur, Maharashtra,
India.

Shailaja A. Patil
Department of Electronics and Telecommunication Engineering,
R. C. Patel Institute of Technology,
Shirpur, Maharashtra,
India.

ABSTRACT
In this paper, we proposed face detection algorithm based on RGB Ratio model. Face detection is used to find faces in images. This algorithm has a simple procedure which is divided into two steps, first to segment image using RGB Ratio Model and secondly, to classify this regions into face or non-face skin regions. It uses RGB ratio model in combination with fuzzy classifier to quickly locate faces in images. RGB ratio color model is used for skin color segmentation. Basically, this color model is used to remove non-skin like pixels from an image. Each skin region is actually represents a human face or not, checked by using human face features based on knowledge of geometrical properties of human face. The experiment result shows that the algorithm gives satisfactory output.

Keywords
Skin Color Segmentation, RGB ratio Model, Fuzzy Logic

1. INTRODUCTION
Face detection is technology to find faces in images and videos. Face detection is used in many applications such as face recognition, surveillance system, and facial expression analysis. Face detection is very simple technique for human being. However, there are many challenges present in face detection, as the human face has a illumination, high degree of variability in appearance, occlusion, rotation of head in different places, distance from the image device facial expression and many more [10].

Early efforts in face detection have dated back as early as the beginning of the 1970s, where simple heuristic and anthropometric techniques were used. These techniques are largely rigid due to various assumptions such as plain background, frontal face such as a typical passport photograph scenario [15]. Face detection techniques can be divided into four categories namely, template matching-based approaches, feature-based approaches, skin color model-based approaches and statistical model-based approaches.

Many methods have been implemented to resolve each variation. For instant, template-matching methods [4] are used for face detection by comparision of an input image to a standard face pattern. The feature invariant approaches are used for feature detection of eyes, mouth, ears, nose, etc. and appearance-based methods are used for face detection with edge detection [7] and neural networks [6]. Many several face detection algorithms that are use neural networks, and support vector machine [8]. For color images, various literatures have studied that is used to separate the skin region from non-skin [1] [4].

2. IMPLEMENTATION OF FACE DETECTION METHOD
The proposed face detection algorithm is divided into different steps as shown in fig. 1.

For rejecting non-skin pixels from an image firstly, we use skin color segmentation. After classifying images into skin and non-skin pixel, here we use fuzzy logic concept [14]. Rejection of non- skin pixels is to be done using several steps such as removal of noise, bounding box properties, height to width ratio, eyes detection and morphological operations for removing small regions from face.

2.1 Skin Color Segmentation
The skin color segmentation process removes all non-skin pixels and keeping the skin-pixels. since a primary method of detecting faces is generally feature of skin color [5] [12]. The color distribution is concentrated in the small region of chromatic color space and thus skin color detection is normally used to find the face detection rather than the the facial features[6].

For better result of skin pixels detection is RGB ratio model is used. RGB ratio model will be formulated by examine and observation from histogram and scatter plot as well as from the Kovac et al [16]. Skin color distribution modelling is a third step after the choice of color model has been made and data transformation in skin color detection algorithm development. A pixel is marked as a skin pixel if their color value satisfies the following threshold conditions.

Rule 1: R > 95 and G > 40 and B > 20 and

Rule 2: Max(R, G, B) - Min(R, G, B) >15 and

Rule 3: R - G >15 and

Rule 4: R > G and R > B

If a pixels whose intensities falls in the above range marked it as ‘1’ and other pixels are marked as ‘0’.

Hence, the output of above step is binary image. But this image consists of arm; face and part of brownish hair are also marked with ‘1’. This non-face part is removed in the later process.

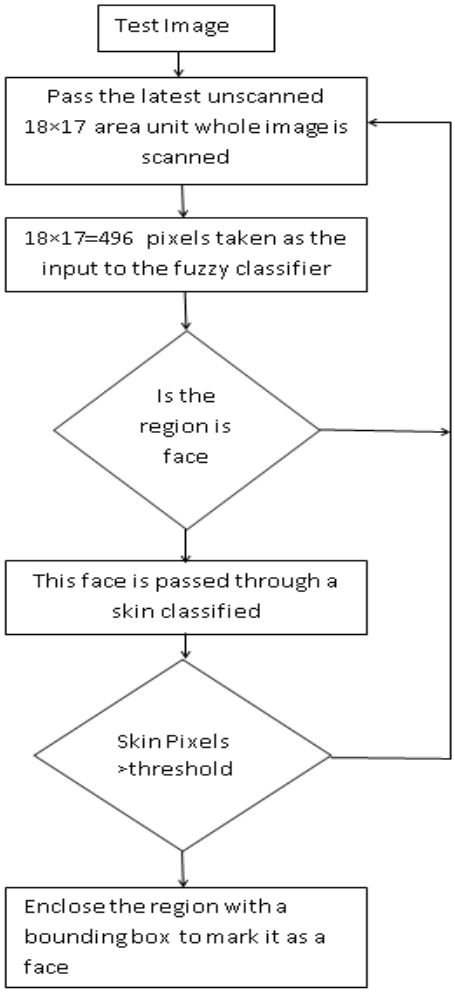

Fig.1 The Flowchart of Face Detection Algorithm.

2.2 Rejection of Non-Face Skin Regions

The input image is classified into skin and non-skin regions after that skin regions are gone through steps as shown in fig. 1 to find out most probable human face region using human face feature method and region properties of human face, then these stages of this step remove non human face like regions by using their properties which are fixed according to the human face. At finally, when binary image is totally passed from this step, image contains only highly probable faces like regions. We retrieve the locations of these faces from a filtered or passed binary image from this step. We plot rectangular around these highly probable faces in original image. This steps are describes one by one as follows.

2.3 Removal of noise

For removing high frequency noise, we implement a low pass filter by a 5×5 mask. First, segmented image is divided into 5 × 5 blocks, and calculate the number of white points in a block. When the number of white points is more than half number of total points, then every point of a 5×5 block is set to white. On the other hand, if the number of black points is greater than a half, this 5×5 block is converted to a complete black block. Fig. 3 (b) shows an example that we remove high frequency noise from Fig. 3 (a).

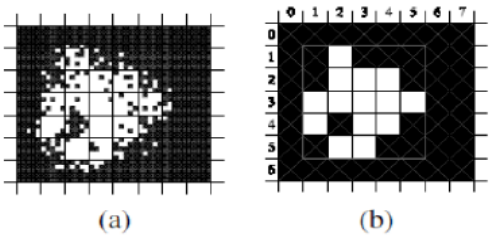

Fig. 2 a) An Example of Sij b) Removal of Noise by 5×5

2.4 Find out the skin-color blocks

After low pass filtering, there are several skin blocks. The human face can be in any possible skin blocks. In order to select this region, we store four vertices of rectangle for every region. By these four points, we create a rectangle around this region. Fig. 2 (b) shows an example that store (1, 1), (1, 5), (5, 1) and (5, 5) to describe the candidate region. Thus, we can get several skin-color blocks called blobs or candidate blocks to detect facial feature.

2.5 Height to Width Ratio Detection

After the step of face localization, we can get several regions which may be human face. Then, the feature of height to width ratio is performed for every candidate block. Because of this detection technique, we can reject the candidate blocks. Height to width ratio is a very fast and simple detection. Let the size of candidate block is $h \times w$. We define that if the height to width ratio is in between 1.5 and 0.8, it should be a face and this candidate block will be considered as a face [11]. If the height to width ratio is out of range then the candidate block is discarded Note that the range is determined by experiments.

2.6 Bounding Box Properties of Human Face

After passing from these above methods, the binary image is now passed from the stage, where it reject non-face skin region based on height to width ratio [7] [3]. Now compare height to width ratio with the threshold value of skin region, if it is less than threshold value, then the skin region will be discarded from class of probable human faces. Here we decided 0.2 and 1.9 threshold values for height to width ratio. For determining height to width ratio of each skin region, we used region properties based Bounding Box MATLAB function [11].

3. EXPERIMENTAL RESULTS

Our face detection method is implemented with MATLAB 8.0 version. We tested our programming on 149 single face images and 221 multi-face images that's taken from internet. Following table I. shows the results of face detection methods on single face images and multi-face images**.**

Table 1: Result of face detection approach for single face images and multi-face images

Database	Face Detection Rate (%)	False Acceptance Rate (%)
Single face Images	93.54	7.80
Multi-face Images	63.81	23.81

The Table I shows clearly that it maintain high face detection rate and low false acceptance rate. For single face images, detection rate is quite good, because there is no occlusion mostly.

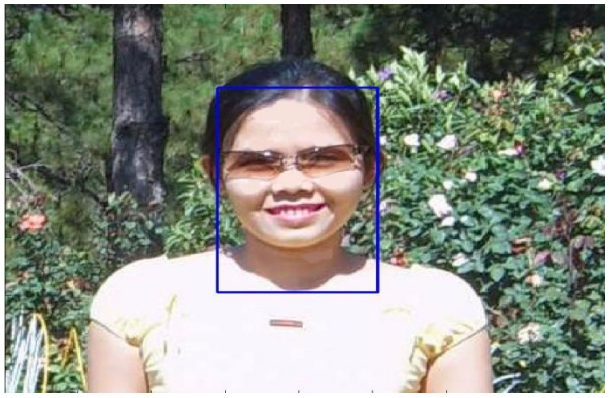

Fig. 3 Face Detection Result for Single Face Image

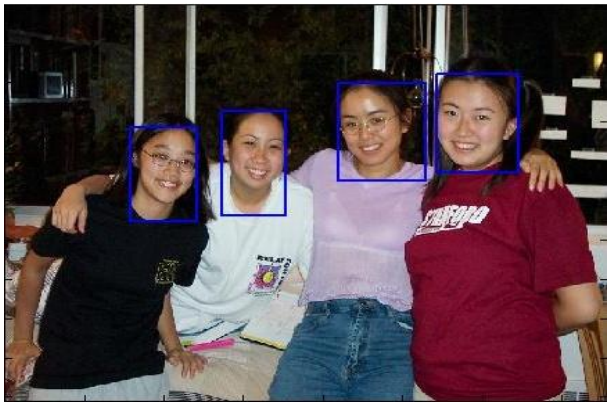

Fig.4 Face Detection Result for Multi-face Image

4. CONCLUSION

In this paper, we have implemented face detection algorithm using the skin color segmentation for that we have used RGB ratio Model. Experimental results show that the face detection rate is better for single face images due to the different challenges such as occlusion, lightning effect etc less occlusion. While the false acceptance rate is reduced this should be zero ideally for robust face detection. For multi-face images, the detection rate is poor for our algorithm, because in this database most of the faces are covered by other faces and head rotation of person. This is the main disadvantages of our face detection algorithm. These disadvantages are tried to remove using different robust techniques in future scope.

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