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Eye Detection Using Area Analysis of Connected Components Which Uses the Concept of RGB Color Based Model and Morphological Operation

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ABSTRACT
Among various facial features, eye is a very important tool for many applications like iris detection, eye gaze tracking, biometric identification, security system, surveillance, drowsiness detection, video conferencing, face detection and face recognition [1] [2] [4] [9] [11] [14] [16]. In this paper, we propose a novel eye detection using RGB color model and morphological image processing [3] [15]. Eye has some unique characteristics than other features like they are much darker and sharper than other facial features. In our proposed method we have used normalized frontal view face images. Here we extract eye region using RGB color model. The problem associated with this color model is that, apart from eye feature it will also detect some other facial parts. So to correctly detect the eye region we will make some morphological operation like dilation and erosion. After that we calculate the area of each of these candidate eye region and mark two regions with maximum area as the eye region.
Keywords: Eye detection, RGB color model, morphological operation, dilation, and erosion.

I. INTRODUCTION

In recent year, people are more concerned with the security aspect of various systems. Examples of such systems are ATM, surveillance, biometric identification, and human computer interaction system. Now, we can make a more secure system with the help of advanced image processing or rather computer vision techniques. In a computer vision system we make the computer able to do what a human being can do easily with the help of advanced image processing techniques or some other techniques [3] [4]. Example of such system is biometric identification, where we need to identify a person or some specific feature like eye, nose, mouth, fingerprints etc.

Though it is very easy for a human being to easily identify such biometric feature, but for a computer it is a great challenge. In spite of these challenges, computer vision has been able to duplicate the abilities of human vision by electronically perceiving and understanding an image. Among various images, human face image is a very important tool in many applications such as face detection, facial expression detection, gender detection, face recognition etc. Not only face, we can also use various facial features like eye, nose, and mouth in some other applications. In our paper we are considering eye feature because it is the most widely used facial feature and has some unique properties, which make it more useful than the other facial features. Eye detection [8] [10] [12] [13] can also be used as the preprocessing technique of many applications like face detection, face recognition, surveillance, drowsiness detection system and facial expression detection system.

Detection of eye can be made by different techniques like template matching based techniques [6] [7], Hough transform based techniques [3] [5]. In template matching based technique we compare the input image against some previously stored template (eye template) and compute their correlation. Though it seems very easy but it may fail with the variation in scale, illumination. To solve these problems we use deformable template [7].

Another very popular way for eye detection is Hough transform method, where we use the shape feature or the iris. Binary valley or edge maps can describe the shape feature of iris. The efficiency of this technique is dependent on the threshold values used for binary conversion of the valleys.

II. PROPOSED METHOD

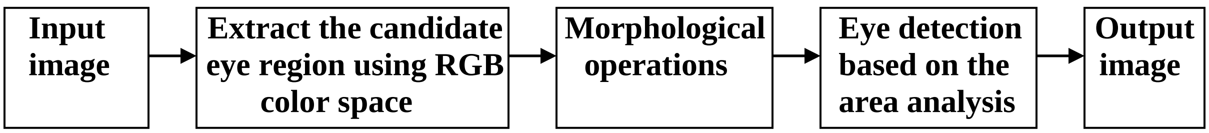


Figure 1: Block diagram of our proposed eye detection algorithm.

1. Extract the candidate eye region using RGB color space

In this paper we have used normalized RGB color model to locate the eye region. The following formula is used:

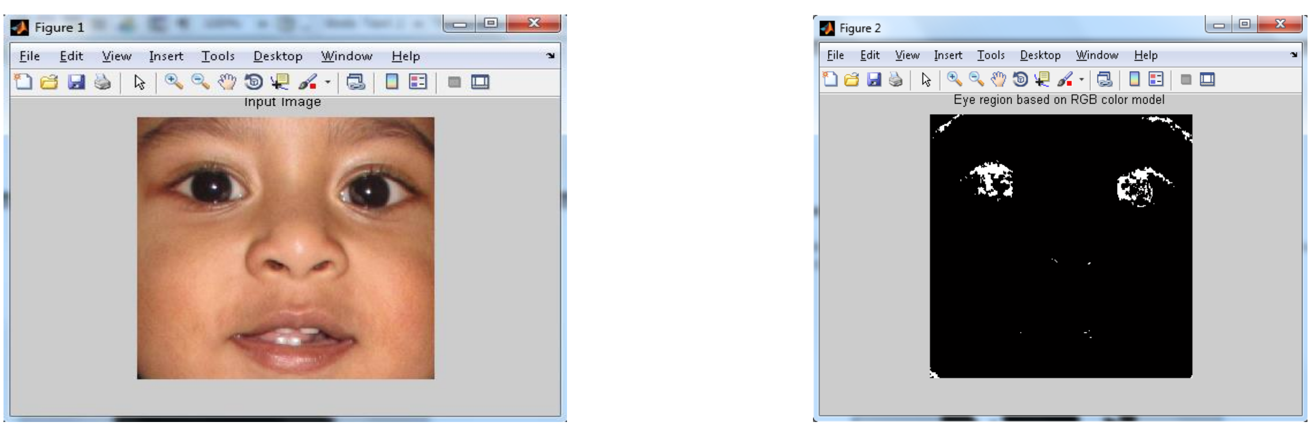
$$\mathbf{96.0 < Norm_R < 120.0,\ 75.0 < Norm_G < 86.0}$$

where,

$$\mathbf{Norm_R = (R / (R + G + B)) * 255.0,}$$

$$\mathbf{Norm_R = (G / (R + G + B)) * 255.0}$$

By using these threshold functions we can detect all the low intensity regions. Hence, apart from the eyes, some other lower intensity images will also be detected like hair. So, to solve this problem we have considered only cropped images. These cropped images are also called as normalized images. Thus we can reduce the number of candidate eye regions and get a better solution.



(a) (b)

(a) **(b)**

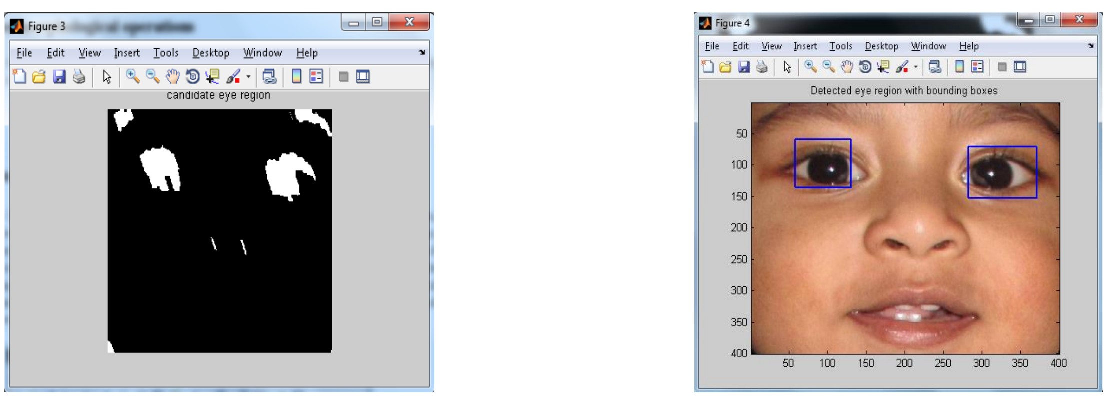
Figure 2: (a) Input image, (b) Candidate eye region based on RGB color model

2. Do some morphological operations

In this step we will perform some morphological operations such as dilation and erosion to find out the connected components that may be considered as candidate eye regions.

3. Eye detection based on the area analysis of each component

Though we have used cropped images to reduce the domain of candidate eye regions, there may be some false detected eye regions. To eliminate those false detected regions, we have used an area analysis based technique, where we calculate the area of each of these components and two regions with maximum area value. In case if the components corresponding to each eye region has different area value, we consider the maximum and second maximum value area region. After that we will make boundary region around each of these eye regions.



(a) **(b)**

Figure 3: (a) Candidate eye region after morphological operation, (b) Detected eye region based on area analysis of each component.

III. EXPERIMENTAL RESULT

In the following diagrams we will show the output of three different phases. Here we have considered three input images, which have shown in the first row (Figure 4a, 4b and 4c), images in the second row (Figure 4d, 4e and 4f) show the output after RGB color based segmentation, which are the candidate eye region. Images in the third row (Figure 4g, 4h and 4i) show the results after some morphological operations like dilation and erosion. Images in the last row (Figure 4j, 4k and 4l) show the output image, where the first two connected components with maximum area can be treated as the final eye regions and are surrounded with a boundary box.

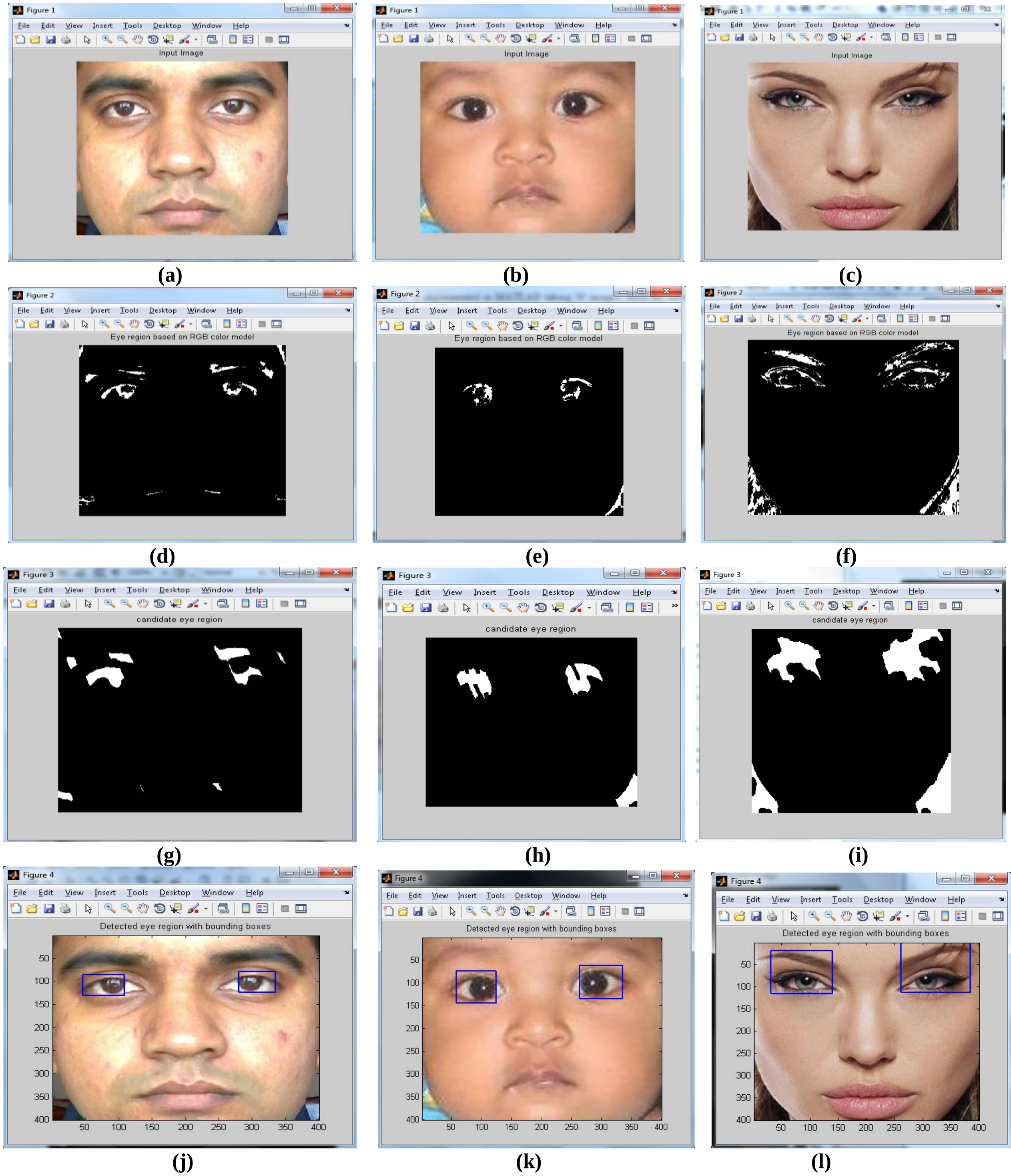


Figure 4: (a) (b) (c) Input image, (d) (e) (f) Candidate eye region based on RGB color model, (g) (h) (i) Candidate eye region after morphological operation, (j) (k) (l) Detected eye region based on area analysis of each component.

IV. CONCLUSION

The process of eye detection can be made using various techniques. In our algorithm we have used RGB color based model and analyze the area of each connected components. Instead of considering the area we can also consider the aspect ratio or the intensity valley to determine the eye region.

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