IMPROVEMENT OF HAAR FEATURE BASED FACE DETECTION IN OPENCV INCORPORATING HUMAN SKIN COLOR

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ABSTRACT

Face detection from a digital image or video stream is used often for various purposes. But sometimes a system detects an object or area as a face where there is no face at all. This paper presents a technique to reduce such wrong detection rate introducing human skin color (HSC) characteristic. The general property of human skin in RGB color space is that it possesses R>G>B (i.e., red values are higher than green value and green value is higher than blue). In this study, such HSC property has been incorporated with the popular Haar Feature Based Face Detection (HFFD) in OpenCV, to reduce wrong detection of faces. Proposed HFFD with HSC (HFFD-HSC) has been tested and compared with standard HFFD rigorously on large number images with single and multiple faces. Experimental results identified the effectiveness of HSC incorporation in HFFD to improve its performance reducing wrong detection of faces.

Keywords: Haar feature based face detection; OpenCV; skin color analysis; RGB;

INTRODUCTION

Face detection is a very important and challenging matter in the field of image processing. It is also a crucial step of face recognition. Face recognition has distinct advantages over other biometrics systems (e.g., finger print, palm print etc.) because of its non-contact process. Face images can be captured from a distance without touching the person who is being identified and the identification does not require interacting with the person. In addition, face recognition serves the crime deterrent purpose because face images that have been recorded and archived can later help to identify a person.

Face detection is one of the tasks that can be done easily by human vision but very complex for a machine. Several studies are available on face detection which discusses different techniques like feature-based face detection, example-based face detection, geometric based face detection, neural network-based face detection and many more [1-3]. Now a day's almost every smart phone uses face detection for automatic focusing on the face area when capturing a photo.

The main goal of any face detection system is to achieve a very high detection rate along with low computational cost. A face detection method detects facial features and ignores anything else, such as building, trees and also bodies. However, many face detection methods fail to detect correct faces from images. David, Kriegman, and Ahuja presented a survey of face detection and presented the trends of researches in face detection [4]. In the survey authors categorized and evaluated different face detection algorithms. Some limitations of those algorithms were also discussed in a brief. A common problem of the existing methods is that they treat non facial area as a facial area. The popular Haar like feature-based face detection [9, 12] also suffers from the same problem.

LITERATURE REVIEW

This paper presents a technique to improve feature-based face detection introducing human skin color (HSC) characteristic. A number studies are available on human skin color based face detections. The methods analyzed different color spaces (e.g., RGB, YCbCr, HIS, TSL, HSV) and their main focus was to generate a rule with the help of these color spaces which can determine whether

a color is similar to human skin color or not. Different studies have also shown different techniques to model human skin color. In this study, HSC property has been incorporated with the popular Haar Feature Based Face Detection (HFFD) in OpenCV, and found to improve its performance.

The rest of the paper is organized as follows. Section II explains HAAR feature based face detection method. Section III presents the proposed face detection technique incorporating of human skin color analysis in HAAR. Section IV presents experimental results to identify the proficiency of the proposed method. Section V concludes the paper with a brief summary.

Haar Feature Based Face Detection in OpenCV

OpenCV is a very popular tool for object detection. Any types of objects including human faces can be detected by it. Currently OpenCV is using Haar feature based cascaded classifier for face detection [10]. At first the classifier is trained with a lot of positive images (the images containing particular object like car or face we are interested to detect) scaled to same size say 20x20 resolution. And then the classifier is trained with some negative images (arbitrary images that does not contain that particular object like car or face) of same size. After completion of the training process the classifier capture frequently happening features or pattern throughout the whole training images. Then the classifier can be applied to the region of interest to detect that particular object. In the detecting process the classifier finds those features throughout the region of interest and returns the coordinates of that particular object in the input region. Otherwise, it does not return any coordinate. OpenCV contains many pre-trained classifiers for detecting face, eye, upper body, smile, nose etc. Following subsections briefly explains HAAR feature selection and detecting process of cascade classifier those are used by OpenCV for face detection.

HAAR Feature Selection

HAAR features are very popular for face detection. Figure 1 shows such features whose are pixel based rectangular patterns. Human face can be represented with these rectangular features. A rectangular feature is like a rectangular area that represents a part of an object. Figure 2 shows only three features representing eye area, nose area and mouth area of a human face.

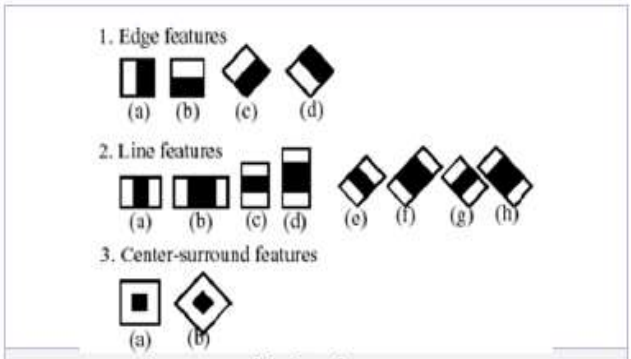

Figure 1: Haar features used for face detection

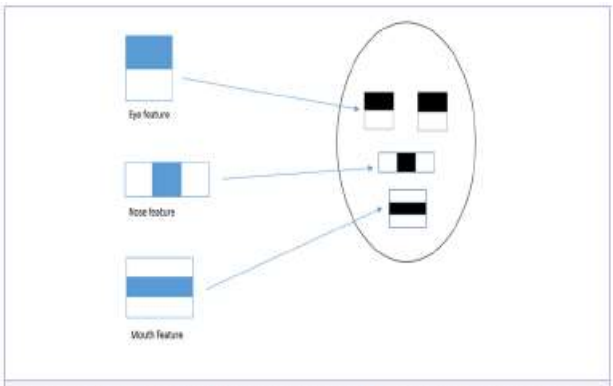

Figure 2: Three rectangular features used for detecting human face

The task of classifier is to find HAAR features throughout the input image. As the face size varies with image size, classifies uses a window that can be scaled at any size and can be moved to the any position. This scaling is achieved by the detector itself rather than scaling images. And this window is moved left to right and upper to down throughout the whole images. The classifier searches the features across this window. These features are also scaled to any multiply. For an example, for 24x24 resolution window the land for edge feature 1(b) (shown in Figure 1) scaled with 2x2 pixels, the classifier will find this 2x2 pixels feature throughout the whole window. Then this features size will be increased to 4x4 pixels and again classifier will find this 4x4 pixels feature to the whole window. This process is done for several scales. Thus, the combination of the features, scaling and positions become very large (more than 160,000); thus, incurs a very high computational cost. To overcome this situation, Ad boost is used to select some important features those explain a face very well from the large number of features. Such selection discards a large amount of unnecessary computation during the training

process. The first two important features selected by AdaBoost are shown in Figure 3.

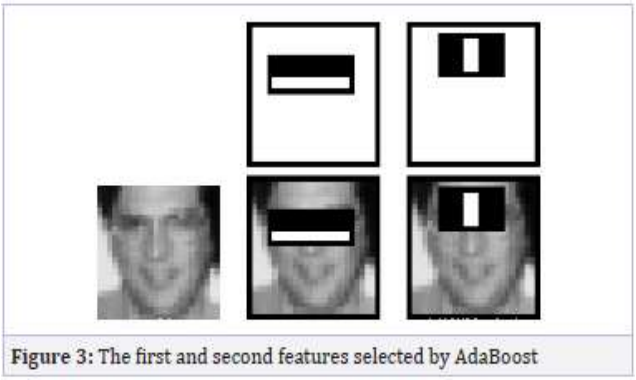

Figure 3: The first and second features selected by AdaBoost

Finally, to detect a rectangular feature (*F*) from an image, the sum of the pixels which lie within the shaded rectangles (Ps) were subtracted from the sum of pixels in the white rectangles (*Pw*).

$$F\ PPW\ s = - \quad (1)$$

Figure 4 shows this rectangular feature selection. If rectangular feature value is positive or above some threshold value, it was considered as a facial feature. Otherwise, it is not considered as a facial feature.

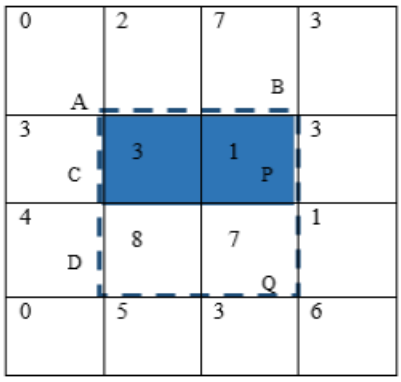

Figure 4: Rectangular feature selection from human face

CONCLUSIONS

This paper shows a discussion on technique to reduce wrong detections by HFFD incorporating human skin color characteristic measure. The proposed method improved performance decreasing wrong detection rate. Experimental results on large number of images of put face database [11] and some complex images revealed that human skin incorporation is an effective technique to improve performance of HFFD.

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