Face detection over the internet

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Abstract

We improve the recognition rate of face detection by implementing a new mouth detection program. It is shown that this greatly improve the success rate in segmentation stage, the critical stage in face detection. A web-based face detection scheme is made available using MATLAB web server and HTTP web server for public testing purpose.

Keywords: Face detection. Image recognition. Internet application.

1. Introduction

Given an image, a face detection program processes the image and locates the face automatically. In real life practice, face detection programs have been deployed for robot development and suspect detection. The eyes on a robot are usually a pair of small cameras which rapidly captures images. With these images, face detection program can analyze them and locate or recognize a person immediately. Face detection programs are also applied in many airports and railroad stations to detect suspects. Computer systems at railroad stations obtain images from the cameras and process them to detect and compare these faces to the suspect faces stored in the computer database.

Because of its practical application, face detection has been an intensive research area and has been discussed in many research documents. In face detection research, the most widely used face detection techniques are face structure detection and skin color segmentation detection. Face structure detection is based on the structure of face and face features to determine if there is a face in an image or not. The advantage of this technique is the speed because it processes images in grayscale format only [GD]. The second technique, skin color segmentation detection, is based on the color difference between human skin and the background. This technique looks for both face structures and skin color areas to distinguish faces from the background [HAJ]. Since this technique involves in both checking face structures and color image processing, it consumes more time and can only process on color images.

Within this color-based image processing technique, there exists two different methods, Hue Saturation Value (HSV) and YCbCr, which can both be used to accomplish color image face detection. Both HSV and YCbCr are types of color space representation for decoupling the chrominance information from the luminance information [KJ]. This project utilized YCbCr segmentation method to detect face regions and proposes an extended image processing application—face swapping. The project also integrates MATLAB application with a HTTP web server, so users can easily try out this project through the Internet with a browser.

2. Face Detection overview

The face detection process has four stages in sequence as follows: *skin color samples, segmentation, elimination,* and *face determination*. We will briefly describe each one of these four stages below.

(i)Skin color samples: Select a set of sample images to generate skin mean values for use with input images in the segmentation stage

(ii)Segmentation: Distinguish human skin from background area based on values generated by the samples process (i). Threshold values are determined and then used to brighten the area where human face skin may appear and subsequently filter out those non-human-skin areas.

(iii)Elimination: Analyze each white area one by one from the binary image obtained from the

segmention stage and eliminate the areas that are not likely to be a face. Elimination based on hole-number in face region and elimination based on geometry are the two principal guidelines used in this elimination phase. In the hole-number based elimination, the number of black holes in a white region must be more then 1 in order to be considered as a possibleface. This is based on the observation that a normal face should have two eyes and any possible orifices. In the geometry based elimination , the height-width ratio (height/width) of a white region should be 0.8 or higher. Human faces usually have a certain general shape that needs to be taken into consideration to be considered as a face.

(iv)Face determination: Cross-correlation and mouth detection are used to enhance the accuracy of face detection.
The technique of cross-correlation is to compute a 2-dimensional correlation coefficient between two images or matrices. It is actually computing the similarity of two images. A MATLAB cross-correlation function ***corr2*** can be used for this purpose[MW].

3. Mouth detection

After detail observation on face features, mouth is the most recognizable feature of all. A mouth usually contains more red and blue components than the surrounding face skin. That is, lips contain higher Cb and Cr value. Also, a mouth usually appears close to the center of the bottom half part of a face. If a skin-color-like area is found to have high Cb and Cr value appears close to the center of the bottom half part, we can determine this area is a face.

In mouth detection, we look for the red and blue components and the location of the mouth in relation to the surrounding skin. The reason being is the lip contains higher Cb and Cr value and the mouth is close to the center of the bottom half of the face. Mouth detection helps filter out non-face areas as well as help recognize faces that could not be detected otherwise by the cross-correlation method alone
The first step of mouth detection is to apply a function to a RGB color image and separate Cb and Cr components from the luminance information.

 = rgb2ycbcr()

The resultant image is represented in a 3 dimensional image (***m*** x ***n*** x 3).
(***m***, ***n***, 1) is the luminance component image,

(***m***, ***n***, 2) is the Cr component image,  and

(***m***, ***n***, 3) is the Cb component image, 
Since the mouth usually have higher Cb and Cr value, Cb component image and Cr component image above are added together to reveal the highest Cb, Cr area.

 =  /2 +  /2

Dilation function can then be applied on the resultant image to emphasize high value pixels.

The mouth area is usually brighter and has higher pixel values.

The pixels which have values higher than the image pixel mean value plus three times standard deviation will be determined to be as a possible mouth area.

Figure 3.1 shows how the mouth is detected from a given image. Since mouth will only show up on the bottom half of the face, only the bottom part of the result image will be considered. The final test is to see if the center of the white area in Figure 3.1 is within a distance of 1/4 of diagonal from the center of this result binary image. In this test image, it satisfies the criteria to be a mouth. This mouth detection scheme can be superimposed on top of traditional face detection scheme to ensure a more accurate face detection process.

(a) (b)

Figure 3.1: Mouth detection result

4. Experiment

Numerous experiments are run to test the validity of our mouth-based face detection methodology. The picture in figure 4.1 is used as the input image to detect possible faces. In the first approach, the system does not detect all faces successful by using the cross-correlation threshold value as 0.6. Figure 4.1 shows that only the face on the left hand side is detected. Since 0.6 is often not sufficient to accurately distinguish human hands from faces, we use that a hand was mistaken as the faceThe addition of the mouth detection scheme allows us to use a higher cross-correlation value, 0.8, for a stricter classification of face from non-facial regions. As shown in Figure 4.2, it successfully detects the both faces in the picture.

Figure 4.1 Only one face recognized with cross-correlation scheme

Figure 4.2: Both faces recognized with mouth-detection scheme

Experiments are conducted by employing both cross-correlation and mouth detection schemes to test on 64 randomly selected images. 53 out of these 64 images were detected with faces. As a result, the rate of successful face detection is around 82%. This is much better than the traditional scheme using only cross-correlation method to detect faces.

5. Conclusion

Existing face detection schemes have a high false-positive rate. A mouth detection scheme is proposed to improve the face detection accuracy. The analytical and experimental results using the proposed approach validate our approach can improve face detection of images. Future research calls for extension of this scheme to face tracking on moving objects in streaming video.

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