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Face detection based on skin color extraction scheme

Zhang Ning, Geng Xutao

Department of Electronics and Communication Engineering, North China Electric Power University, Baoding 071003, China.

zhang_ning_new@163.com

Abstract. Quickly and accurately detecting a face in a picture is critical to subsequent face recognition applications. However, the complexity of actual images has a great influence on face detection. Face detection based on skin color extraction scheme can eliminate a large number of non-face background and determine the face area. Then, use the AdaBoost algorithm to detect the face accurately, so as to improve the speed and accuracy of the face detection system.

1. Introduction

Skin color is one of the special features of the human body, which does not depend on the details of the face. It can be applied to changes in expression, rotation of the face, etc., and the processor can distinguish the skin color from most backgrounds. Therefore, skin color features can be used as a feature in face detection. Skin color features are mainly described by skin color models. Face detection based on skin color is generally divided into three major steps: color space selection, skin color segmentation and face region detection. After selecting the skin color model, the first step is to detect the skin color. After detecting the skin color pixels, it is necessary to segment the possible face regions according to their characteristics and correlations in the color space. Meanwhile, geometric features of the regions are used for face verification to exclude other background objects with similar skin color. Usually, in order to eliminate the influence of light on the skin color, the image is processed before skin color segmentation. Before the skin color is extracted, the face image is reasonably processed, including brightness balance, noise filtering, sharpening, and so on.

2. clustering characteristics of skin color in YCbCr color space

In the YCbCr color space, Cb and Cr represent the blue and red components respectively, which can separate the brightness and the chromaticity. The skin color is concentrated in a small range in the color space. The YCbCr space can fully express the human face color and can largely eliminate the influence of brightness, so it reduces the dimension of color space and reduce the computational complexity. The color space of YCbCr is widely used in the field of color display of televisions. "Brightness" is established by RGB input signals by superimposing specific parts of RGB signals together. "Chroma" defines two aspects of color - hue and saturation, represented by Cr and Cb respectively. Among them, Cr reflects the difference between the red part of the input signal and the brightness value of the RGB signal. Cb reflects the difference between the blue part of the RGB input signal and the brightness value of the RGB signal. It has the advantage of separating the luminance components and can be directly obtained by linear transformation of the RGB color space, so it can be directly applied to color cluster analysis of objects. In this space, the skin color of the human body is good, as shown in Figure 1:



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Figure 1. Clustering properties of skin color in the YCbCr color space

Skin color has good application advantages. Image segmentation based on skin color is basically not affected by image size or image quality and is insensitive to posture and facial expressions. Even if occlusion occurs, the remaining areas that are not occluded will be effectively detected. Based on this feature of skin chromaticity, it is possible to effectively exclude a face that is very similar to a human face in a grayscale image but is not a human face at all in a color image. Thereby, the accuracy of face detection can be improved, the false detection rate can be reduced, and the face detection system can be more suitable for face detection in a complex background. The feature of chromaticity is used to detect the skin position of human face, and the facial area is segmented to exclude most of the complex background area, so as to improve the face detection. It can separate human face quickly and well by taking advantage of the significant difference between skin color and environment color.

3. Test Results and Discussions

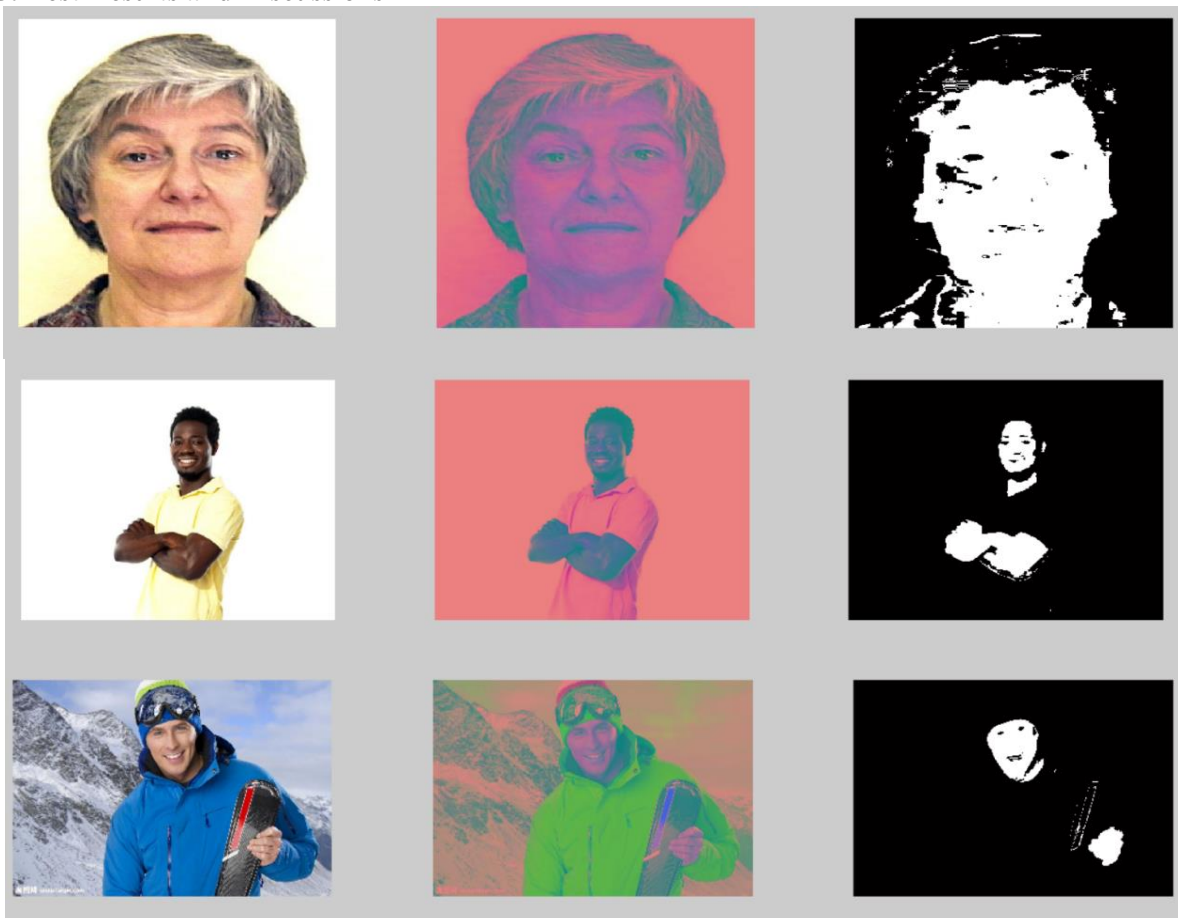


Figure 2. Face skin area test detected by chromaticity

As can be seen from the simulation of face skin area detected by chromaticity, Figure 2 shows that the face becomes more obvious and the background is weakened. Segmenting the skin color as part of the preprocessing of AdaBoost face detection is not simply to separate the skin color, but to remove the background non-face area as much as possible, while preserving face areas as much as possible, to provide candidate face areas for subsequent AdaBoost detection. The skin color region detected by the skin color detection method is used as the detection window of the cascade classifier, to reduce the search space for detection greatly. The size of the classifier detection window is adjusted by the size of the segmentation window to reduce the detection time. This is helpful for improving the detection rate, reducing the false detection rate and the missed detection rate, and reducing the detection time.

Through the simulation of face skin area detected by chromaticity, it can be seen that the skin color extraction in the YCbCr space will produce a false face, which is the position that is extracted but not the face, mainly because there may be areas such as hands, arms, legs and neck that are exposed except face, and even backgrounds with close color of skin may become interference factors. Eliminating these false faces is mainly achieved by image morphological processing and filtering denoising.

Morphological processing mainly includes image dilation, corrosion, opening, closing, and hole filling operations. Dilation and corrosion are inverse operations. Dilation expands the image area, while corrosion shrinks it. Binary morphology operations such as dilation and corrosion are used as the output of the previous steps to better prepare the candidate face area. For binary images, Dilation can expand the boundary by fusing the background points of the object to fill the holes in the object. Erosion can be used to eliminate small, meaningless objects. Corrosion and dilation are used at the same time, to process the same element of the image. The open operations generally smooth the contour of the object, disconnecting narrow gaps and eliminating small protrusions. The closed operation can also make the outline smoother, but contrary to the open operation, it usually eliminates narrow gaps and long narrow gaps, eliminates small holes, and fills the breaks in the outline. The above analysis shows that the morphological corrosion operation can shrink the image area and also can eliminate particle noise, and open calculation can make the image contour become smoother. In this paper, closed operation and open operation are used to process binary image. It can filter out the skin-like areas which can't be human face due to noise or other reasons, reduce the judgment of the candidate area and improve the detection speed.

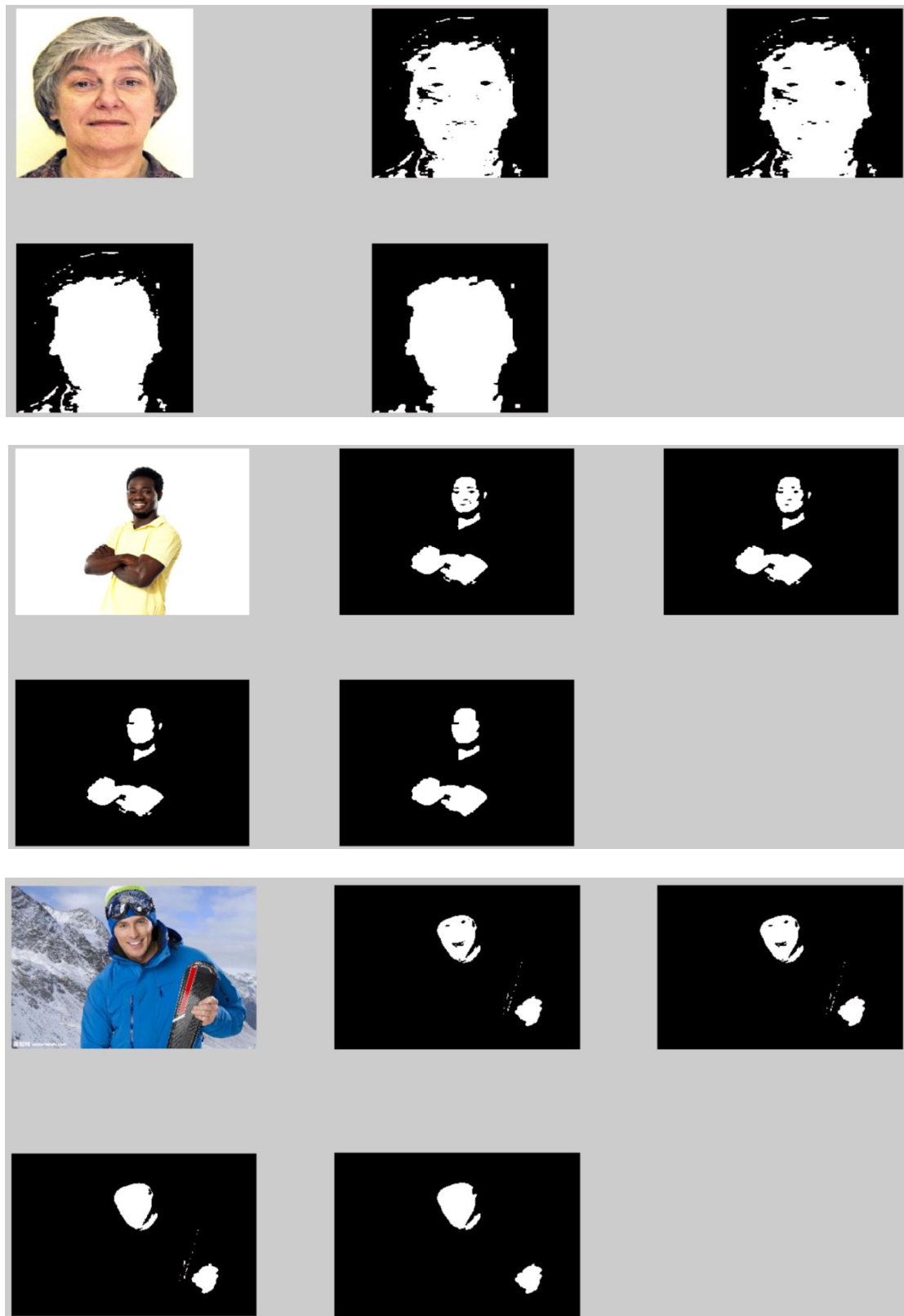


Figure 3. Test diagram processed by open operation, closed operation and hole filling

By following, some measures are taken to ensure a complete and clean face area, and then the edges of the face are detected by image dilation, erosion, opening operation, closing operation, reconstruction, filling, edge detection, and other operations.



Figure 4. Detection of face edges after processing

4. Conclusion

1) For color images of various backgrounds, when detecting the skin of a face part, the images with expressions changes, face rotation and other conditions can be detected. When the exposed part of the human body is not only the face area, the skin color feature extraction method may extract multiple face areas, and there may be misjudgment for some complex background similar to skin color. Therefore, after skin color extraction, the AdaBoost algorithm is added to accurately detect the face, so as to improve the speed and accuracy of the face detection system.

2) The face detection method of skin color extraction is not ideal for darker pictures, so the detection of face area is greatly affected.

Acknowledgments

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