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Face detection in video based on AdaBoost algorithm and skin model

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Abstract

A real-time method is proposed to detect faces in videos. First it uses frame difference method to extract the motion area. Next the clustering character of skin is used to get the general face area. AdaBoost algorithm is applied to make concrete detection of human face. Finally an improved CamShift algorithm method is used to keep the tracking and improving algorithm speed. The experiments demonstrate the robustness and high speed of the proposed algorithm.

Keywords detecting, skin model, Adaboost algorithm, CamShift algorithm, face tracking

1 Introduction

Face detection is the first step of facial expression recognition, which is used to determine whether there are any faces in an arbitrary image and, if there is, return the face location and extent of each face [1]. Face detection is originated from face recognition, but its application has been spread far beyond the scope of face recognition system. Face detection has become popular in recent years among researchers as a separate subject, mainly due to its value in security control, intelligent human-machine interface, visual surveillance, content-based retrieval and other application areas. It's been widely applied in capturing and tracking faces in dynamic image on a real-time basis.

Human face is a complex natural structure, and there are three characteristics which make the face detection much more difficult:

1) The variability of face pattern, such as the differences of pattern appearance, expression, color, etc.

2) There may be glasses, beard and other appendages on the face.

3) Face is vulnerable to light effects [2].

Although many face detection methods are already effective in a certain scope, there is no general algorithm which is widely applicable.

This paper presents a method of detecting human face in videos. Firstly it uses frame difference method to remove background image and extract the motion area. Secondly it uses the clustering character of skin in YCbCr color space to get the general face area. Thirdly AdaBoost algorithm is used to make concrete detection of human face. At last an improved CamShift tracking method is applied to keep the tracking in order to reduce the scope of detection and improve algorithm speed. Experimental results indicate that the method is fast and reliable and could meet the requirement of real-time system.

Fig. 1 shows the process of face detection using the proposed method.

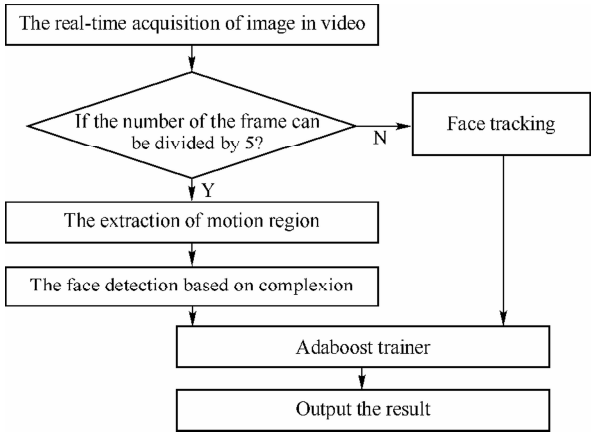

Fig. 1 The process of the proposed method

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2 Face detection

2.1 The extraction of motion region

In practical applications, the background in a video scene always has a big impact on face detection. Therefore we need to remove the background of a video scene. Firstly, this paper applies frame difference method to remove background. The method includes adjacent frame difference method and background frame difference method. The adjacent frame difference method subtracts two time continuous frames to determine whether there is any moving object. But for the slow moving object, it makes motion profiles fuzzy and will cause motion segmentation failure. The background frame difference method subtracts current frame and background image, and through combining background updates algorithm it can obtain more accurate information. As a result it is always used in occasions of higher real-time. Study of this paper is a part of face expression recognition in E-learning system and students' motion is slow. Taking all these into consideration, we choose background frame difference method in the paper.

The formula of background frame difference method is as Eqs. (1) and (2). Where c is the current frame; b is the background frame; d is the difference image; R_c, G_c, B_c are the red, green and blue component of the current frame; R_b, G_b, B_b are the red, green and blue components of the background frame; i and j are the x-coordinate and y-coordinate of an image respectively.

$$\gamma(i,j)=\sqrt{(R_c-R_b)^2+(G_c-G_b)+(B_c-B_b)^2}(i,j) \quad (1)$$

$$d(i,j)=\begin{cases}c(i,j); & \text{if } (\gamma(i,j)>\theta)\\ 0; & \text{others}\end{cases} \quad (2)$$

In Eq. (2), if $\gamma(i,j)>\theta$, the difference image's pixel value at point (i, j) is equal to the current frame's pixel value, else its value is zero. Fig. 2 is the background image of the experiment.

Fig. 2 The background frame

Fig. 3 is the current frame, where there is an object moving into the background. Fig. 4 shows the background difference image obtained by background frame difference method.

Fig. 3 The current frame

Fig. 4 The difference image

2.2 The selection of color space

Skin color is an important visual characteristic of face which shows a certain degree of clustering in the color space [3]. However, skin colors differ from people to people due to races, sex and regions. And skin color differences are mainly reflected in brightness. In RGB color space [7], vector [r, g, b] reflects not only the color information but also brightness information. Since skin clustering feature is not obvious, it does not fit the skin model establishment. The three components of HSI space are Hue, Saturation and Intensity. Advantage of this format is that it takes chrominance and saturation which could reflect the nature of color apart. The space has been widely adopted in face detection based on skin color. In YC_bC_r space, Y presents brightness information; C_r presents red component; C_b is blue component of color. The color space also has the advantage of separating brightness.

The YC_bC_r color space is chosen in this article as the detection space, and the advantage of that is the luminance component Y has less impact on the chrominance