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THE FACE EXTRACTION METHOD FOR MOBILE DEVICES

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Abstract. *The problem of automatic face recognition on images is considered. The method of face ellipse extraction from photo and methods for face special points extraction are proposed.*

Keywords: computer graphics; mobile guarding devices; recognition of images.

1. Introduction

The mobile devices that are detecting suspicious persons are used more and more often in the modern guarding systems. These devices use realistic extraction of face features from the photo or video image of people (or person) and their visualization in dynamics for potential intruders and offenders detection. The detection and extraction from the image face figure, the finding of face special points, such as eyes, brows, lips and so on is done for the further recognition of the face, for example, extra red color deleting, white noise deleting, or proceeding recognition of the person with the help of the special data bases or special signs [Yuille et al. 1989; Chai, Bouzerdoum 1999; Chai, Ngan 1999; Tomaz et al. 2004; Ahlberg 1999; Kakumanu et al. 2007; Vezhnevets et al. 2003; Yang et al. 2002; Vezhnevets 2002].

There are many methods are used for the solution of these problems, but it must be paid attention that many of them require significant costs of machine operations, and therefore need huge time for their working [Chai, Bouzerdoum 1999]. The others require big data base of images to create Bayesian or neuro-net [Chai, Ngan 1999]. These demands sometimes can be too heavy for the devices, especially mobile, where the speed of operation still remains important parameter [Chai, Bouzerdoum 1999].

Therefore the problem of face extraction and special points of the face detection without using additional data bases and with quick speed of working is stated and still remained to be important.

2. The problem formulation

The problem of face extraction is formulated the next way. The photo or image containing face image is coming on the device (or server). The program should recognize and extract the face ellipse, transfer it to the next image or data base and find the lips, brows and eyes as more realistic as possible for the next recognition.

This task is naturally divided into the next two subtasks:

1) face ellipse extraction;
2) special points of the face detection and output.

3. Existing solutions survey

There is the wide range of the solutions for the first of these tasks exists. Among them we may count the following: neuro-nets [Chai, Bouzerdoum 1999; Chai, Ngan 1999; Tomaz et al. 2004; Ahlberg 1999; Kakumanu et al. 2007], usage of data bases of face images for choosing appropriate criteria [Yuille et al. 1989], color face feature extraction [Kakumanu et al. 2007; Vezhnevets et al. 2003; Yang et al. 2002; Vezhnevets 2002] and others [Yilmaz, Shah 2002].

There are also two types of this task, that can be considered here: the first one is when it is known that the face on the picture is situated without inclination to the axis of the picture and the second one is when it is known nothing about the angle of the face inclination. The second type of the task naturally requires more time and resources for the solution. In the present paper the first variant of the task is considered because the quick solution is interested here.

The variant of the method, that uses color characteristics in format of YCrCb by color differentiation of the skin [Kakumanu et al. 2007; Vezhnevets et al. 2003] and allows to control the amount of machine operations for the face ellipse extraction with considerable preciseness of the result.

There are many methods for the second subtask are developing at the present time [Vezhnevets 2002; Yilmaz, Shah 2002]. They are using similar approaches for the solution as to the first subtask. Alas, even the best methods of this problem solution cannot give one hundred percent solution even for the good image quality. Moreover, most of these methods require many computational resources [Yilmaz, Shah 2002].

The method for eyes, brows and lips coordinates detection is proposed in the given article. This method does not use the huge amount of computational operations and additional data storages with considerable level of correctness for the solution.

4. Face ellipse extraction

It is considered that the photo with the face is presented and inputted in one of the well-known standard formats, which keep the image as the matrix of colors for the pixels of the picture, and these colors are stored in standard representation of the color model RGB.

For the ellipse of the face extraction it is proposed as in the most of existing methods to use the color characteristics of skin of a face. The color model YCrCb gives the best characteristics for recognition the skin.

Color model YCrCb is built from the standard RGB by the next formulae:

$$Y = 0.299\,R + 0.587G + 0.114B;$$

$$Cr = R - Y;$$

$$Cb = B - Y.$$

The criteria of the recognition of the pixel as the part of the skin is the next one [Kakumanu et al. 2007]:

$$\begin{aligned} &Y>80,\\ &85<Cb<135, \qquad (1)\\ &135<Cr<180, \end{aligned}$$

where the values of Y,Cr,Cb parameters are normalized the way that they are belong to the interval [0,255].

So, the problem of face ellipse detection can be formulated as the detection of the ellipse that contains all the points from the connected region of points, that satisfies criteria (1) and the shape of it is close by the form to an ellipse.

It is not known where the face is situated on the picture at the beginning of the program work. The greatest 8-connected group of points (pixels), that satisfies (1) is needed to be found to get the first candidate of face ellipse. If it wouldn't be the face then we go to the next greatest such region and so on.

The detection of this region can be performed by the famous sequential scanning algorithm of 8-connected region finding [Konushin 2011, Sampada 2011].

During the first round (scanning) of this algorithm it is worth to add into the standard routine the operations for the mass center of the region finding (i.e. the coordinates of the each points of the region as added and the counter of points into the regions is incremented for each point, that satisfies (1)), and during the second round (scanning) the received mass center coordinates are added for each of the region, where the connection equivalence is found.

We receive the resulting array of points after this algorithm, containing the sums of the coordinate. We can get the mass center of the regions by dividing these results for each of the coordinates Ox and Oy by the results of counts. The regions can be ranged by size by ranging the counters values. Thus we can get the coordinates of the mass center for the greatest seeking region, which is a candidate for face ellipse.

Therefore, the resulting point is the possible candidate to be the face center, and so the center of the seeking ellipse. Moreover, we can calculate the approximate width (W) and the height (H) of the face ellipse by the formulae:

$$W = \sqrt{N/2}\,, \qquad (2)$$
$$H = \sqrt{2N}\,,$$

where N is the number of points in the region, previously counted in the algorithm.

The further algorithm of face ellipse extraction is based on the classical energy algorithm [Vezhnevets et al.].

The first approach values for the height and width of the ellipse is already defined. So we can draw the first approach to the ellipse.

The first round of the method of face ellipse extraction is the correction of the face center coordinates.

The circumference of the ellipse is divided into the big enough number of the equal parts (arcs) (experimentally it was chosen as equal to 20). The number of pixels satisfying (1) and the total number of points for each of these parts pixels are counted by simple checking point by point. The ratio of received two numbers is calculated. If it is greater than 9/10 then the mass center of ellipse is moved into the direction of this arc on the 1/20 of the distance to the center of this arc from the center of the ellipse, with respect to the lowest 4 arcs where the move made on the 1/40 of the distance (i.e. two times less). All the parameters listed above are experimentally chosen number.

The second round is the correction of the width and height parameters.

The inner part of the ellipse and the border is divided into the four parts as shown on the Fig. 1.

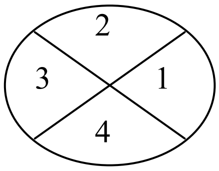

Fig. 1. Ellipse division

If on the border and into the middle of the parts 1 and 3 more than 80% of the points are satisfying condition (1) then the width of the ellipse is increased into 8/7 times. If visa versa, this ratio is less than 80%, then the width is decreased into the 25/24 times.

Analogically, when on the border and into the middle of the parts 2 and 4 more than 80% of the points are satisfying condition (1) then the height of the ellipse is increased into 8/7. If, on contrary, this ratio is less than 80%, then the height is decreased into the 25/24 times. The mentioned parameters are received experimentally by applying different photo to algorithm and choosing the parameters that gain good results the quickest way.

These rounds of correction are one by one repeated until the parameters of two succeeding cycles do not change.

As for as for the given task it is required to finish the work even if the face ellipse is not fit to the expected result, it is the good idea to set the maximum number of iterations to the fixed number. The experiments have showed that this number can be set to 100 with sufficient quality of received result.

5. The special points of face detection

The next task is to find the special points of face detection. This task is one of the most popular tasks in the image recognition science.

Really, the next step for the face identification before, for example, comparing it to the existing data base of the faces of potential crimes, the special points of the face should be found for the next algorithms of person recognition.

The different methods for the solution of this problem are developed, based on the various color- and geometric-based principles and also with using previously created data base of the faces, neuro-nets structures etc [Yuille et al. 1989; Vezhnevets et al…].

As for as the main characteristic for the proposed solution is the resource economy and time economy, the principle for the described solution was chosen as the combination of the color and geometric-based ways [Vezhnevets et al…].

The main special points of a face are eyes and lips ends. The main geometric properties for these points, that help to identify them are the following [Ahlberg 1999; Sanjay Kr. Singh et al. 2003]:

– the left eye, the right eye and the center of the lips form the equilateral triangle;

– the left eye and the right eye are symmetric concerning the main axis of the face;

– the line that unites both eyes divides the main axis of the face ellipse into the ratio close to 1:2.

For the eye seeking the color characteristics are critical. The color of the eyes is significally differs from the color of the skin. Therefore, by controlling the color change on the line perpendicular to main axis of face ellipse and divide that axis into the ratio 1:2, we can find the eyes coordinates.

Thus, the algorithm of face special points detection can be described as follows:

1) The main axis of the face ellipse is drawn;

2) This axis is divided into the ratio 1:2 and from this point the perpendicular to the axis is built;

3) The change of the colors along the built line is calculated (it is not important into which color system, but it is convenient to use the color model YCrCb, into which we are already perform the calculations);

4) The places where the picks of the changes are found and checked as the eyes coordinates (it can be done by the method explained in [Vezhnevets et al…]);

5) The center of the lips coordinates can be found by building equilateral triangle with two vertexes as the eyes coordinates;

6) The nose coordinates can be found by moving along the main axis in the region of the center of the built triangle and seeking again the changes of the color;

7) The whole lips and mouse points can be extracted by moving from the center of the lips into the both sides checking where the change of the red color is not significant. Thus the end points of the lips can be found.

The described above method allows to find the special points of the face with relatively small amount of operations and without usage of additional memory of computer and external data base.

6. The results of experiments analysis

The program realization for the checking of the correctness of the described methods were created and tested. The testing was done on the PC (IBM Pentium IV, Athlon 2.33 MH). The software for implementation was programmed on PHP 3.0 language as the server application, that receives photo images with face and extracts the resulting face with special points on to the screen for checking the correctness of the results.

For the tests the data base with face images was downloaded from the Internet.

The results of the program work can be seen on the Fig. 2.

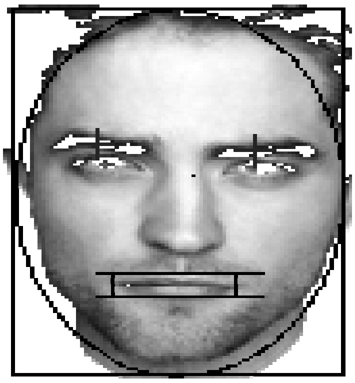

Fig. 2. Face with the special points

The speed of operating for the program turned out to be satisfactory – the processing of each image was not exceeded one second, that is the good speed for the application of this kind.

The quality and correctness of the application work depend from the quality of inputted photos, particularly in some cases of close color characteristics of the background and the skin and for the non-standard turn of the face the mistakes of face extraction were valuable. Yet on the most part of the images the results were satisfying.

7. Conclusions

The method of the face features extraction from the photo image, containing face without inclination to the image axis direction is presented in the given paper. In this method the face ellipse is found with the help of the iterated but quick algorithm. Later with the help of the color and geometric methods the special points of the face are found. This method can be used for the mobile guard system of person detection and was realized into the software.

The advantages of this method are big speed of processing and small usage of the computing memory and other computer resources.

The results of operation of realized method for the set of test photos show good quality and high speed of processing for the described proposals.

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В.А. Бородін. Метод розпізнавання обличчя в мобільних пристроях

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Розглянуто задачу автоматичного розпізнавання обличчя по зображенню. Запропоновано метод розпізнавання еліпсу обличчя на фотографії та методи формування реалістичного зображення, що відображає міміку та рух обличчя.

Ключові слова: комп’ютерна графіка; мобільні пристрої охорони; розпізнавання зображень.

В.А. Бородин. Метод распознавания лица в мобильных устройствах

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Рассмотрена задача автоматического распознавания лица по изображению. Предложен метод распознавания эллипса лица на фотографии и методы формирования реалистического изображения для отображения мимики и движения лица.

Ключевые слова: компьютерная графика; мобильные устройства охраны; распознавание изображений.

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