Geometrical Feature Extraction of Human Hand

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Abstract— **Feature extraction is one of the significant parts of image processing. In the literature, several research efforts have been proposed different feature extraction methods using edge detection, corner detection, etc. One of the key limitations of the existing approaches is the absence of an appropriate feature extraction method. In this paper, we therefore introduce a method of hand feature extraction using several geometrical dimensions. Using this method we extract features of human hand. In our proposed method of extraction, we calculate height, width, area, and centroid of the hand image, in order to extract the hand feature. Our extraction method can be easily used for further image processing to detect human body parts other than hand. In this research, our aim is to provide an efficient method of hand feature extraction.**

Keywords-feature extraction; hand feature; geometrical dimension; image processing

I. INTRODUCTION

Feature extraction is an important part of image processing, which is mainly used for separating/grouping image parts based on the some special characteristics. It can also be referred as streaming, which means separating something from images. In the field of image processing, the feature extraction method can be used to detect several human body parts, such as hand, eye, face, fingerprint, feet, leg, etc.

Most researchers use human face, fingerprints as well as ear for identification. We think hand is much preferable than face as human face has a lot of color variations (retina, lip, etc.) and causes a great difficulty during feature detection. During lifetime human can change their face through cosmetic surgery or face may change due to age. Face shape may also change due to different expressions. Fingerprint detection can be used only when we can have a fingerprint, but during a crime, criminals never leave their fingerprints. Ear can also be a tough human body part to detect as it may be hidden using a mask or may have a occlusion (e.g. hair) over ear.

Based on the existing literature, we can say hand is being the most important part of human body, as human depends on it for any type of work. Hands are the main structures for physically manipulating the environment. For example, when a criminal intend to commit a crime, he normally uses his hand; when a professor teaches he also uses his hand to write something. As a whole, as a human we use our hand in every aspect of our life. We can apply feature extraction method for detecting hand features from any image. The difference of hand feature detection with the detection of the other parts of the human body is that hand feature extraction can be done from a continuous stream of incidence.

In the literature, feature extractions have different meaning depending on the fields. Our hand feature extraction is one of the important fields of multimedia, which has been introduced in twentieth century and gradually increasing in every field. A number of research efforts have been highlighted different feature extraction methods in the literature. However, one of the key limitations of the existing approaches is the absence of an appropriate feature extraction method. In this paper, therefore, our goal is to introduce a new feature extraction method.

The paper makes the following contributions. First, we have proposed a method of hand feature extraction using several geometrical dimensions. For simpler process, first we have used a single image from a video clip for extraction. Then, we have converted the image into binary to implement our geometrical process on it. Here, we have calculated the height, width, area, and centroid of the hand image, in order to extract the hand feature. In this paper, we have claimed that our extraction method can be easily used for further image processing to detect human body parts other than hand.

The rest of the paper is organized as follows. In Section 2 we discuss a few backgrounds followed by some existing related work, which motivate us to develop a new feature extraction method. Section 3 discusses our proposed method of the feature extraction. Our proposed feature extraction method is applied for detecting hand features in Section 4. We present a few discussions and results by using our method in Section 5. Section 6 concludes the paper and outlines future work.

II. Background And Related Work

A. Feature Extraction in Image Processing

We have used feature extraction and color segmentation process in our feature extraction method. All these methods are used for different types of human identification.

The term 'feature' refers to remote sensing of the scene objects with similar characteristics. The term 'feature extraction' can thus be taken to encompass a very broad range of techniques and processes, ranging from simple ordinal/interval measurements derived from individual bands to the generation, update and maintenance of discrete feature objects.

There exist different types of feature extraction methods. According to some researchers, ordinal or internal measurement derived directly from the DN values of imaginary is known as feature extraction. According to supervised classification pixels that satisfies a certain criteria is assigned to that class of pixel. In this case the extraction is based on pixels. Sub pixel classifier is a kind of supervised classification. This has an advantage of detecting up to 20% of any pixel. On the other hand unsupervised classification is more computer-automated. Image Segmentation is one form of unsupervised image classification, or feature extraction. However, it has several advantages over the classic multispectral image classification techniques, the key discriminators being the ability to apply it to panchromatic data and also to high resolution data.

Human identification can be of two different types. The first one is behavioral and the second one is physiological. In the first type is done depending on voice scale, walking style, talking style, typing etc. The second one that is the physiological part identification is the most common type of identification used in present world which is done depending on measurement and comparison of a specific part of different human body. So as a part of identification feature extraction of human body parts are very important. Different researchers have done their research on different parts of human body. Some worked with face, some with ear, some with eye, fingerprint etc.

B. Related Work

Despite considerable interest and research in feature extraction, in this section, we briefly highlight several existing feature extraction methods that have influenced our work.

N. Tanibata et al. have used a method [1] in which to detect a hand they first used skin color detection and then elbow detection to detect the hand. For some human being it is tough to detect the elbow, especially for over weighted persons. Elbow detection is tough when hand is kept straight down.

L. dung et al. [2] have also showed a method, where they detected the center position of hand then they used line detection system to detect the finger print position. Thus they can detect a hand. . According to me it is not necessary that we can have an image of hand with the finger print side. It may be the opposite side. So it is tough to detect the hand in that case.

Some authors also used template matching to detect fingertips and palms in some methods [3, 4, 5]. However, in systems using these methods, the distance from camera to hand is fixed and good hand segmentation results are also required.

Even though in the literature [1, 2, 3, 4, 5], a few feature extraction methods have been proposed, to the best of our knowledge, no single approach can efficiently detects hand features from any image of human body.

III. Our Proposed method of Feature Extraction

In this section, we have presented a very easy and simple geometrical method for feature extraction. Our method is completed through skin color segmentation, and binary image conversion through image matrix. Fig. 1 shows our proposed methodology of feature extraction.

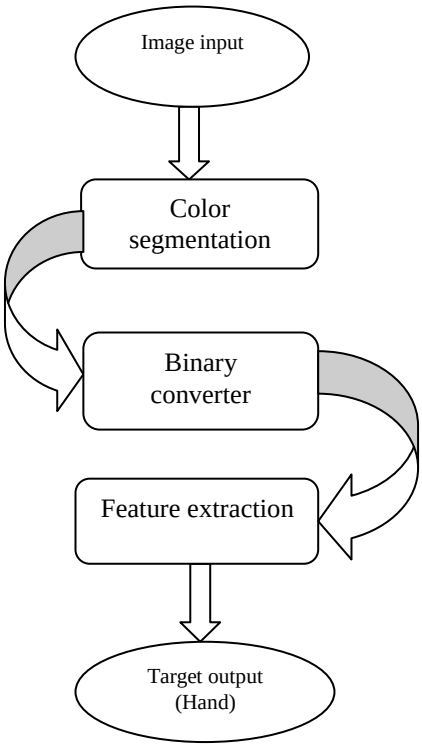

Figure 1. Proposed method for hand feature extraction

A. Skin Color Segmentation

Color is a very important part of image processing especially when we are working with any human body part. The skin detection is the most common and first approach for detecting meaningful skin color [6]. Skin color detection helps us to come out from the exhaustive work when we are trying to detect any body parts. There are many color models to work with.

From different type of color models, in HSV color model, Hue (H) is not reliable for the discrimination task when the saturation is low, Also in YC_bC_r color model, the distribution

of skin areas is consistent across different races in the C_b and C_r color spaces, though RGB color model is lighting sensitive[7]. The result of the experiment mainly depends on the color model selection and the process of pixel selection. We have used RGB color model without any complex selection as it is the most commonly used one. Fig. 2 and 3 show us the result of skin color segmentation.

Figure 2. Original RGB image

Figure 3. Skin pixel detection

B. *Binary Image Conversion*

The result of skin color segmentation gives us skin pixel contained area of the image. The image output is a 3 dimensional matrix. To work further, that is to extract the feature of those regions, to determine wither it is a hand or a face it will be very complex to work with a 3 dimensional image. For easy further processing we converted it to a 2 dimensional image means binary image. Binary image contains '1' and '0' to represent the image. Skin color pixels are represented by '1' and the remaining part by'0'. Finally after processing this binary image will give us the area that contains the features of a hand. Fig. 4 shows a binary image which is converted from the skin pixel image. The binary image matrix which is calculated from the binary image is shown in Fig. 5.

Figure 4. Converted binary image

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	1	0	0
0	0	0	0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	0	0	0	0	0

Figure 5. Binary image matrix

IV. HAND FEATURE EXTRACTION

In this section, we have applied our proposed method of feature extraction (which is presented in Section 3) to detect hand features.

Hand state in time t, **s**(t), by means of a vector,

$$\mathbf{s}(t)=(\mathbf{p}(t),\mathbf{w}(t),\alpha(t)),$$

where **p= (p_x, p_y)** is the hand position in the 2D image, **w**=(w, h), is the size of the hand in pixels, and α is the hand's angle in the 2D image plane.

From the literature, we found that there are 24 states of hand. These all states are occurred due to the different hand positions, different sizes, and different angles. So we have analyzed all that states of hand. After taking the images of all the states using the following operations on them such as skin pixel segmentation, converting to binary image we have calculated the height, area, and centroid of the image for each of the hand states.

In the following, we have calculated the height, width, area, and centroid of the hand image. These are actually the features of any image. From these, we can analyze any image features.

Height = Σ (the number of skin pixels in each column).

Width = Σ(the number of skin pixels in each row)

Average height = Round (total number of white pixels (H)/total no. of columns).

Average width = Round (total number of white pixels (H)/total no. of rows).

Area can be calculated as the total number of white pixels (i.e., binary value '1') means H.

To calculate centroid we can use the following formula,

$$X_c = \Sigma\, x_i/\text{Area}$$

$$Y_c = \Sigma\, y_i/\text{Area}$$

Centroid = [Round (Σ(x-values represent white pixels)/area), Round (Σ(y-values represent white pixels)/area)].

Given the two points (x1, y1) and (x2, y2), the distance between these points is given by the formula,

$$d = \sqrt{((x_2 - x_1)^2 + (y_2 - y_1)^2)}$$

Distance of centroid from origin (0,0) = Round ($\sqrt{(X^2+Y^2)}$).

I. Discussion and Result

In this section, we have presented some discussions regarding our feature extraction methods. We also have analyzed our method with some results.

Hands are of nearly a square shaped, but cannot be said square as feature. In fact hands show different shapes in different situations and positions. If we normally calculate a hand's height it is nearly equal to face height. Area of a hand is also sometimes equal to the area of a face.

The first step for skin area distinction from an image we have selected the average width and average height ratio. So for the first step we have fixed a ratio threshold value which is 0.5. Using this threshold value firstly we can determine either the skin part is a face or a hand. In the next step to distinguish between a face and a hand we can use some small parts like eyes, lip etc. These parts are not of skin pixel. So we can detect a hand when the binary matrix does contain any discrete area that has an eccentricity of 0.89905 or less. For determining height to width ratio of each skin region, we used region properties based Bounding Box MATLAB function.

The following resulting image (see Fig. 6) and table (see Table I) show our research results.

Finally we can say that, with the combination of all the above steps, we are successful to detect the hand features from any image.

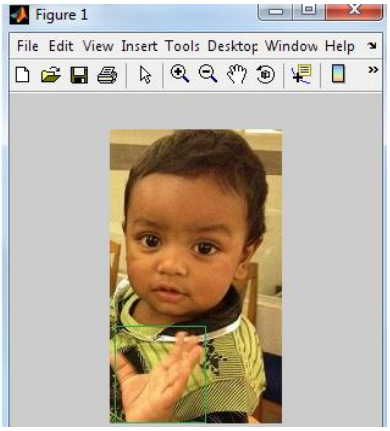

Figure 6. Experimental result output

TABLE I. Comparison of Existing and Our Proposed Methods

Method	No. of image	Fault rate
Existing	20	11.23%
Our method	20	7.44%

II. Conclusion

The objective of this paper is to develop an appropriate method to detect a hand more accurately than existing ones. Towards this goal, we have proposed a new feature extraction method for detecting hand features. Here we have used first skin pixel segmentation process for human body part detection, and then we have used some geometrical measurements such as height, width, area, and centroid, etc. for feature detection. We have also shown here the accuracy rate of our proposed method. We can conclude that our proposed feature extraction method is not only easy but also much acceptable than other methods described by other authors.

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