IMAGE SEGMENTATION ALGORITHM BASED ON COLOR FEATURES: CASE STUDY WITH GIANT PANDA

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Abstract- Color which is one of the basic features of the image is widely used in image processing. The choice of color space is a primary issue for the color image segmentation based on color features. In this paper, giant pandas are chosen as the research objects. In order to achieve good segmentation results, different color spaces and the corresponding algorithms are chosen for image segmentation according to the color characteristics of different background of panda images. There are three kinds of color spaces introduced in detail and its advantages and disadvantages for the giant panda image segmentation are also summarized in this paper.

Index terms*:* color features, giant panda, image segmentation.

I. INTRODUCTION

Giant pandas are specialty wild animals of china. They have been praised as rare and precious animals. They are also the symbol of auspicious friendship and the messengers of peace and friendship. In ancient times, pandas are regarded as tributes, and now as national treasure, pandas have even been hailed as the modern world's animal stars and the global wildlife conservation signs and banners. David, a French priest, found giant pandas in 1869, since then westerners have come to capture and kill them by different means such as investigation, exploration and mission. As a result, the giant pandas have become endangered [1]. At present, the competent department of the state has introduced a variety of in situ and ex situ conservation measures. Although the situation has improved, the protection of giant pandas is still not optimistic. As giant pandas are white except that their eyes, ears, fore-and-hind limbs and shoulders are black, using the method based on color features to segment giant panda images can achieve good results and it can also provide technical support for better real-time monitoring and protection of giant pandas.

II. COLOR IMAGE SEGMENTATION

a. Image Segmentation

As for an image, we need not to pay attention to the whole image. And the different regions which have some special properties compared to the surrounding image information are more meaningful to us. These properties may be very notable so the people’s eyes can easily distinguish. But they also maybe too subtle to be discovered. Image segmentation aims to divide the target images into many regions that have some independent and special characteristics according to specified limitations and purposes. It is a technology to extract the targets, which persons are interested in and taken to further study and process, from original images. Image segmentation can not only save the information that most represents the whole image, but also can largely reduce the amount of data to be processed for the follow-up image understanding and image analysis.

b. Color Image Segmentation

Feature extraction is an important research field for digital image processing and machine vision. Feature extraction is to find those points who belong to the image characteristics in image and remove redundant information. The purpose is to divide the points of images into different subsets according to certain rules, then extract the subsets people is interested in [2]. Feature extraction of image is one of the main methods to understand and analyze target image. Studying the nature and essential attributes or characteristics of images and quantizing the corresponding measured parameters to realize the image recognition [3]. Image features include shape, color, contrast

and a variety of human characteristics and so on. In general, the features which are simple, independent, reliable and easy to be distinguished is good [4].

Vision is one of the main ways to get information from outside. Color is a response of human brain to external light stimulation and a mapping produced by the human eyes for a specific wavelength of light [5]. According to the theory of visual psychology, when human observes an image, the visual system tries to seize the representative color characteristics and ignores the minor color details. The color which occupies a large part of the image and plays an important role in the expression of the color image content is called the main color [6]. Color features are one of the three basic features of image and it is a characteristic for surface property of target image. Color features are the most widely used visual features in image retrieval recognition and have play an important role in the field of pattern recognition and computer vision [7]. And taking the main color as the color feature to segment images can achieve better effects.

Image segmentation is the basic premise and step of image retrieval, image recognition and image understanding. According to different strategies, image segmentation can be divided into two types: gray image segmentation and color image segmentation. Based on the mentioned reason in the above paragraph, color image segmentation is more attractive than gray image segmentation during the past few years [8]. The two main problems of color image segmentation are choosing the appropriate color space and using the appropriate algorithm [9]. Selecting the appropriate color space and method according to different occasions can get the segmentation results which are in line with people's subjective visual perception. There are not any universal and effective methods in the field of image segmentation at present and most methods are only effective for specific applications. Since there are large differences between the quality of actual images and the effects of different color image segmentation methods have varied, the study of color image segmentation methods is of great significance [10].

The general flow of image processing is shown in figure 1. The preprocessing includes gray-scale transformation, histogram equalization, filtering, denoising, etc and the image segmentation methods include threshold-based segmentation method, region-based segmentation method, edge-based segmentation method and other methods based on specific theories. The classification methods mainly include statistical pattern recognition, artificial neural network and support vector machine (SVM) and genetic algorithm, etc. In this paper, three segmentation algorithms based on color are proposed for giant panda images. Through the analysis and comparison of experimental results, the applicable situations and disadvantages of these algorithms are pointed out.

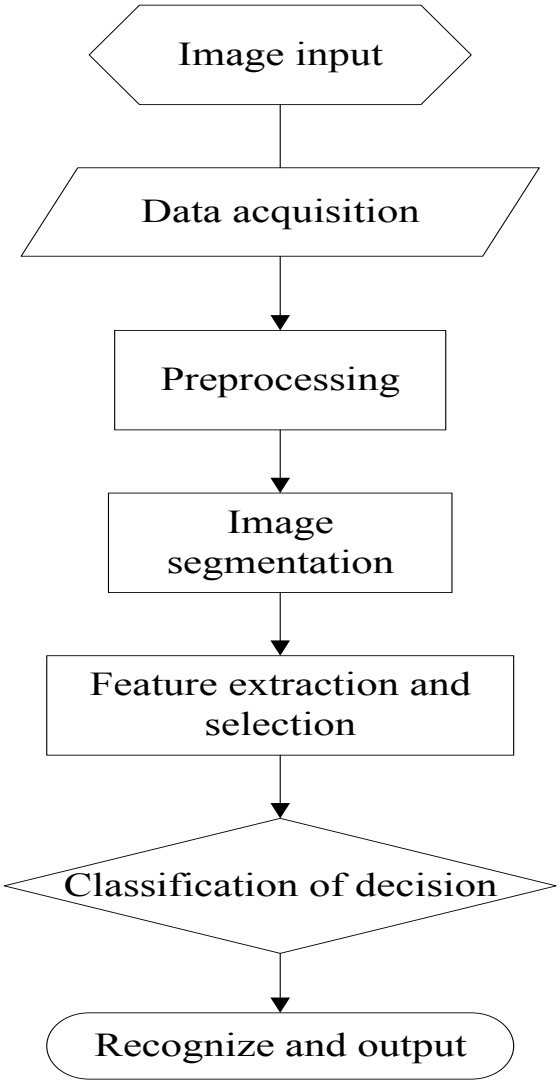


Figure 1. the flow of image processing

III. SEGMENTATION ALGORITHM

a. Segmentation Algorithm Based on Gray Model

Black is the reference color of grayscale and different saturation of black is used to display images. In nature, most of the images have rich and colorful colors. In order to enhance and segment images more effectively, color processing technology is widely used in digital image processing. Most images are using the RGB color model. RGB color model is also called computer graph color model, it converted the colors of images into information which can be expressed by computers. It is a widely used color space and all present color spaces can be converted to RGB color space [11]. In RGB color space, the three components R, G, B should be processed respectively in the image segmentation. Although color images provide more

abundant information than the gray images and the visual perception of human eyes experience richer to color images than to gray images, gray images are widely used in industry and the corresponding image processing methods have also been very mature. In many cases, color images need be converted into gray images and the gray image is a special kind of color images.

For a color image of the giant panda, its most notable feature is the black-and-white body. Since the gray space is made up of pure black, pure white and various kinds of gray levels between the two, converting color images of panda into gray images can get a good description of the color features. A segmentation algorithm based on gray space is used in this study [12] and the specific implementations are listed as follows: First of all, convert the RGB images into gray images. Then extract the pixels distributed in the interval [0, 30] and [155, 255] through morphological opening and closing operation to achieve the purpose of image segmentation [13].

b. Segmentation Algorithm Based on HSI Color Space

The HSI color model is proposed by an American scientist H.A.Munseu in 1915. It reflects the way that the human visual system percepts color. There are three basic characteristics used to perceive color among which hue and saturation are used for color description and intensity is used for describing the brightness of the light. This model has the following three characteristics: Firstly, the I component has nothing to do with the image color information; Secondly, the H and S components are closely linked with the way people feel the color; Thirdly, with linear scalability, the perceived color difference is proportional to the Euclidean distance of the corresponding sample value of the color components [14]. These characteristics can make the model eliminate the influence of intensity component from carried color information (hue and saturation) in color images. Thus the HIS model is very suitable for image processing methods which perceive color characteristics via human visual system.

Giant pandas are distributed in forests or wildlife nature reserves and there are mainly grass and trees in their living environment. As the background of photographed giant panda images is mainly green, using the H and S components can distinguish the information of color images well. A segmentation algorithm combining H and I components based on HSI color space is used in this study [15] and the specific implementations are listed as follows: Firstly, convert the image into double precision floating point type. Then convert the RGB color space into HSI color space and use the discriminate formula (1) to deal with the target image.

$$(R,G,B)=\begin{cases}(255,255,255), if\ (H<0.2\ \&\ I>0.6)\\(255,255,255), if\ (H>0.6\ \&\ I<0.2)\\(0,0,0), else\end{cases} \quad (1)$$

c. Segmentation Algorithm Based on YCbCr Color Space

YCbCr is part of the ITU-R BT.601 proposal in the course of the development of the world organization for digital video standards. It is usually used for the continuous processing of film and digital camera system. In this color space, Y is the brightness of the color; Cb and Cr respectively represent the chromaticity of blue and red. In the family of YUV, YCbCr is the most widely used member in the computer system and JPEG and MPEG both adopt this format.

The YCbCr color space is widely used in face detection. Although the distribution of face images with different sex, different age and different color of skin is different, the differences mainly exist in the luminance rather than the chrominance and the color of skin present a clustering feature within a certain range. It was found that the color of skin in the YCbCr space is mainly concentrated around the Cb equals 150 by statistical experiments [16]. Studies have shown that the YCbCr color space also has a very good clustering effect for the giant panda skin and using the Cb and Cr components can cluster color information of giant panda images well. A segmentation algorithm, which combines Cb and Cr components based on YCbCr color space, is used in this study and the specific implementations are listed as follows: Firstly, convert the image into double precision floating point type. Then convert the RGB color space into YCbCr color space and use the discriminate formula (2) to deal with the target image.

$$(R,G,B)=\begin{cases}(255,255,255),\ if\ Cb\in(0.5,0.51)\ and\ Cr\in(0.5,0.51)\\(0,0,0), if\ Cb\notin(0.5,0.51)\ or\ Cr\notin(0.5,0.51)\end{cases} \quad (2)$$

IV. EXPERIMENT RESULTS AND ANALYSIS

Three kinds of typical giant panda images are tested in this research, and three algorithms mentioned above are used in the experiments to segment the same image. The original images are shown in figure 2.

NO.1 Giant panda image

NO.2 Giant panda image

NO.3 Giant panda image

Figure 2. the original giant panda images

Use the three mentioned algorithms to segment the above images respectively and the segmentation results are shown in the following figures.

The segmentation results by three algorithms of the NO.1 giant panda image are shown in figure 3.

(1.1) Algorithm of Gray Space

(1.2) Gray image after segmentation

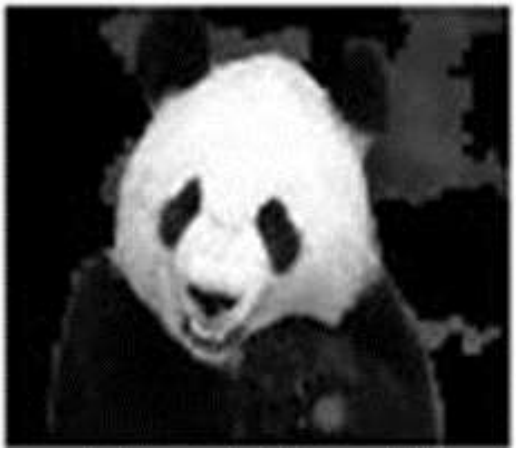
(1.3) Color image after segmentation

(2.1) Algorithm of HSI Space

(2.2) Gray image after segmentation

(2.3) Color image after segmentation

(3.1) Algorithm of HSI Space



(3.2) Gray image after segmentation

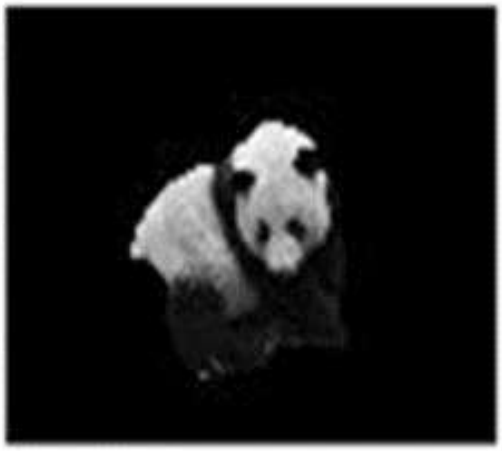
(3.3) Color image after segmentation

Figure 3. the segmentation results of NO.1 giant panda image

The segmentation results of the NO.1 giant panda image shows that for background of images that has little color information or colors that are significantly different from pure white and black, adopting the algorithm of gray space can obtain good segmentation effect.

The segmentation results by three algorithms of the NO.2 giant panda image are shown in figure 4.

(1.1) Algorithm of Gray Space



(1.2) Gray image after segmentation

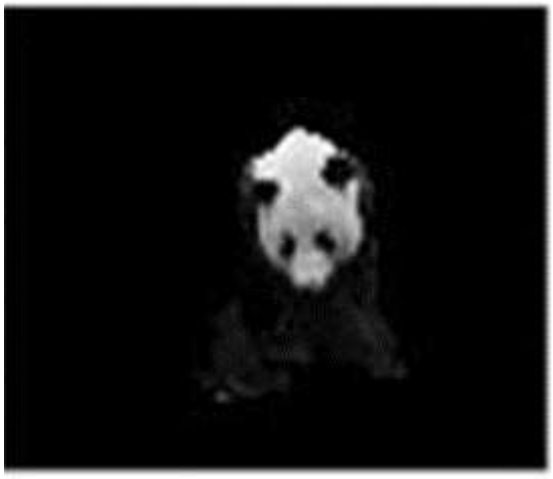
(1.3) Color image after segmentation

(2.1) Algorithm of HSI Space

(2.2) Gray image after segmentation

(2.3) Color image after segmentation

(3.1) Algorithm of HSI Space



(3.2) Gray image after segmentation

(3.3) Color image after segmentation

Figure 4. the segmentation results of NO.2 giant panda image

The segmentation results of the NO.2 giant panda image shows that for images that have a single background color which is significantly different from pure white and black, adopting the algorithm of HSI space can obtain good segmentation effect.

The segmentation results by three algorithms of the NO.3 giant panda image are shown in figure 5.

(1.1) Algorithm of Gray Space

(1.2) Gray image after segmentation

(1.3) Color image after segmentation

(2.1) Algorithm of HSI Space

(2.2) Gray image after segmentation

(2.3) Color image after segmentation

(3.1) Algorithm of HSI Space

(3.2) Gray image after segmentation

(3.3) Color image after segmentation

Figure 5. the segmentation results of NO.3 giant panda image

The segmentation results of the NO.3 giant panda image shows that for images that have simple background which is significantly different from the color characteristics of giant pandas' skin, adopting the algorithm of YCbCr space can obtain good segmentation effect.

The most important problem of color image segmentation based on color feature is to choose the appropriate color space. Through analyzing and summarizing the applicable occasions of the above algorithms, then combining with characteristics of each image in the sample library, selecting the suitable algorithm to segment the giant panda image can make the segmentation results best.

V. CONCLUSIONS

With the performance improvement of computer hardware and image acquisition device and the reducing of costs, Color image processing technology is paid more and more attention. In image process, feature extraction is a key step which affects the identification accuracy. Large-scale data set contains many irrelevant or useless features and they may lead to high dimensions of the feature space or will reduce the efficiency of learning [17]. Therefore, to reduce the dimensions of the features, it is very important to how to select image segmentation algorithms which attribute to extract suitable features.

However, the development of color image processing technology is not mature and most of the color image segmentation algorithms are still based on the ideas of gray image segmentation. Three algorithms of giant panda image segmentation based on color features are put forward in this paper. The algorithms used for segmenting images that meet certain conditions can obtain good effect. They can also provide technical support for monitoring and protecting giant pandas more effectively to an extent. However, the parameters of these algorithms are selected through large amounts of experiments and the adaptive ability of these algorithms is poor, so is their universality. Further research will be done to improve the accuracy and efficiency of image segmentation by exploring new features and developing new algorithms.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

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