ISSN : 0974 - 7435 Volume 7 Issue 11

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 7(11), 2013 [435-439]

Study on movement of the fish body related water pollution based on image processing

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ABSTRACT

The contour extraction method of fish body movement is discussed based on the principle of digital image processing. At first, the image is transformed into HSV space model, and extract value image to analysis and pretreatment. The dynamic threshold method is used to eliminate the interference from nontarget object. Hole filling is used to eliminate tiny holes in fish body. Morphological operation is adopted to solve the narrow breakage phenomenon, also can ensure the final image is in the same size. Experimental results show that this method can extract the contour of fish very well, and then get the growth status and movement characteristics of aquatic biology, which is effective for biological water quality monitoring and satisfies practical requirement.

KEYWORDS

Fish;
Image processing;
Contour extraction;
Water quality monitoring.

INTRODUCTION

With the rapid development of industry, available water resources is declining, water pollution incidents occurs frequently, in recent years, people pay more and more attention to the environmental water quality monitoring, in order to protect water resources better and timely. Because the traditional chemical monitoring method can not reflect the water quality and the measuring comprehensive is poorer, so biological monitoring methods comes into being. The key to biological monitoring is how to get the growth status and movement characteristics of aquatic biology accurately, and then judging the water quality[1-7]. As we all known, edge is the most basic characteristics of image, it includes the useful information for identification, so, the growth status and movement characteristics of aquatic biology can be got by extracting the edge of aquatic biology. Fish is the typical representative of aquatic organisms, also can reflect the aquatic biological characteristics very well, so it is suitable for water quality monitoring. At present, the commonly used biological monitoring method is to use fish as the research object. As the research object is fish, which is vulnerable to the interference from nontarget object under water, it needs to make full use of the characteristics of image to process to achieve purpose. In addition, generally, edge is extracted in RGB model, illumination has effect on the gray scale of image, the change of illumination intensity also has great effect on the accuracy of the extraction, what's more,

FULL PAPER

even in the same lighting conditions, the shape and size of object will affect the RGB gray value.

In order to solve the above problem, this paper based on the principle of digital image processing, putting forward a fish contour feature extraction method, which can be used for biological water quality monitoring.

METHOD AND ANALYSIS

The properties of the original image

It can be seen from the captured image that, as shown in Figure 1, the color of the fish to be detected and background region have bright contrast,it can be distinguished with the naked eye intuitively. But as the stone brightness is strong, if extract the edge contour of the image directly, the bottom stone will be identified as the target, which will greatly affect the experimental results. So in order to achieve the ideal result, the image must be analyzed and pretreated.

Figure 1 : Original image

Extracting of color channels

Choosing an appropriate color space has important significance for image segmentation. This paper based on the HSV color space, it is a kind of subjective color model, and it is different from RGB model. HSV color space does not decomposed a particular color into three primary colors,but describe its three color properties. These three properties are: Hue, Saturation and Value. Among them, the hue indicates the basic pure color, the saturation represents the ratio of the color mixed with white light, value represents the the ratio of the color mixed with black light. It is worth noting that the color model is more close to people's experience and color perception than RGB model, at the same time, it eliminate the effect illumination intensity in RGB model.

The conversion formula of HSV space and RGB space is:

$$V=\frac{1}{3}(R+G+B)$$

$$S=1-\frac{3}{(R+G+B)}[\min(R,G,B)]$$

$$H=\arccos\left\{\frac{[(R-B)+(R-B)/2]}{[(R-G)\times 2+(R-B)(G-B)]^{\frac{1}{2}}}\right\}/360 \quad (1)$$

HSV model divides the color information of color image into three channels, and generates three corresponding gray images, Fig.2 (a) shows the hue channel, Fig.2 (b) shows saturation channel, Fig.2 (c) shows value channel.

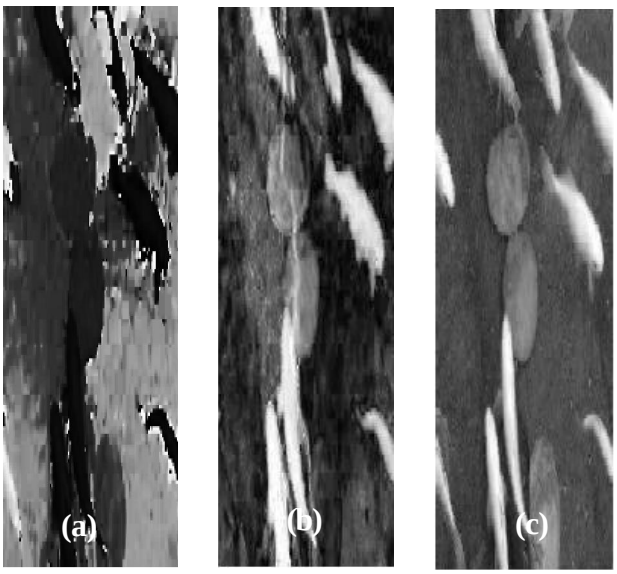

Figure 2 : Color channel image

It can be seen from H, S, V image that the value image can well reflect the characteristics of the image, therefore, this paper will analysis the value image for further process.

Global threshold segmentation

The advantage of image thresholding segmentation is simple to realize, with small amount of calculation,

and the performance is stable, the gray values or other characteristics for different classes of objects vary greatly, threshold segmentation can segment them very effectively, so it is a commonly used and the simplest method for image segmentation, also it is a necessary process to image analysis and feature extraction. The main problem to the method is how to get the thresholding value. According to the approach that obtain the best segmentation thresholding, thresholding segmentation can be divided into global threshold segmentation and dynamic threshold segmentation. Global threshold segmentation uses a threshold value to the whole image, it is suitable for segmenting images that target and background have uniform gray but there are some differences in both. Dynamic threshold segmentation is also be called as local threshold segmentation, it divides the image into many small piece, and each small piece choose a threshold value respectively, this method is suitable for segmenting images that the background is not uniform. In this paper, dynamic threshold is used to segment fish image. The basic principle of this method is that by setting different characteristics threshold, the image is divided into several types of pixels. In this paper, firstly, the image is expressed as $f(x, y)$, then get the characteristics value according to certain criteria, so the image will be segmented into two parts, it can be expressed as follows:

$$g(x,y)=\begin{cases} b_0 & f(x,y)\le T \\ b_1 & f(x,y)>T \end{cases} \quad (2)$$

where $g(x, y)$ is binary image.

In order to get the suitable threshold value to segment image, the method that this paper adopted is to compute the best segmentation threshold by iteration, the idea is as follows:

(1) To compute the minimum and maximum gray value of image, Z_l and Z_k, then calculate the initial threshold value $T_0 = (Z_l + Z_K)/2$ 0

(2) According to T_k, image will be segmented into two parts (objective and background), compute the average gray value of these two parts, we describe them as Z_0 and Z_B.

$$Z_0 = \frac{\sum_{z(i,j)<T_K} z(i,j)\times N(i,j)}{\sum_{z(i,j)<T} N(i,j)}$$

$$Z_B = \frac{\sum_{z(i,j)>T_K} z(i,j)\times N(i,j)}{\sum_{z(i,j)>T} N(i,j)} \quad (3)$$

Where $Z(i, j)$ is the gray value of (i, j) in image, $N(i, j)$ is the weight coefficient of , takes the probability of gray value.

(3) To compute the new threshold.

$$T_{k+1} = \frac{Z_0 + Z_B}{2} \quad (4)$$

(4) If , end compute, or , it turns to the second step.

(5) After the fourth step, is the best threshold.

Image threshold segmentation is one of the most commonly used, but also the most simple method of image segmentation, it is a necessary process to image analysis and feature extraction.

The result of Fig.2(c) after threshold segmentation is shown in Fig.3. Compared it with Fig.2 (c), we can know that Fig.3 has eliminated the interference from the rock under water, put the fish out successfully.

Hole filling

We can know from the image after global threshold image segmentation, the target object interior appeared small hole, as the fish in the bottom of Fig.3, its interior has the appearance of the holes. In order to eliminate such holes, filling operation can be used. This paper used a method based on the set expansion, complement and intersection algorithm. The A represents a set, it's element is 8 connected boundary, each boundary surround a background region (i.e. a hole), when given to a point in each hole, the purpose is to fill all holes. Fig.4 shows the results after fill operation.

Morphological operation

We can see from Fig.4 that although the holes in fish body has been filled very well, but there are some

FULL PAPER

Figure 3 : Image after threshold segmentation

Figure 4 : Image after hole filling

narrow gaps existed in fish body, if extract the contour directly, the contour line will be not continue. In order to avoid the phenomenon, morphological operation must be adopted. First, do expansion operation to the image. The expansion will make the objects in binary image" growth " or " rough ", so it can eliminating the narrow gaps existed in fish body. But as expansion operation will expand the part of the image, while the corrosion will reduce the part of the image, in order to ensure the final image is in the same size, the the corrosion operation must be adopted to the image. So, it not only eliminates the narrow gaps, but also and the part of fish body back to the original size. Fig.5 shows the result of morphological operation.

Extract contour

After the above image preprocessing, the image is suitable to be used to extract the contour of the object, this paper based on the morphological algorithm to extract contour. If represents the boundary of set A,so first use B doing the corrosion to A, then compute the difference between A and the result of corrosion, after these, can be computed.

$$\beta(A) = A - (A \Theta B) \quad (5)$$

Where B is structural unit, the size of the unit this paper used is . Figure 6 is the result of contour line of Figure 5.

Figure 5 : Image after morphological operation

Figure 6 : Contour line

CONCLUSION

Aiming at the biological water quality monitoring, this paper proposes a method for extracting fish contour features, the biggest feature of this method is to make full use of the image color space, and has achieved a good results. It can be seen from the experimental results that the extraction of contour feature is accurate, which give consideration to both the overall contour and detail information, so this method has very strong use value in the monitoring of water quality, and is very suitable for biological monitoring system.

ACKNOWLEDGMENT

This work is supported by The Project of National Natural Science Fund (Grant No.51076130), the Project of Social Development Scientific development of Shaanxi Province (Grant No.2010K11-02-11),

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