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Machine Vision Based Yak Body Size Measuring Points

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Abstract. In livestock breeding, it is a research hotspot to conduct non-contact measuring and acquire the body size parameters of animals without stirring stress. And traditional animal body size manual measurement methods involve heavy workload and safety risks. This paper aims to acquire the color image of yak by shooting the traditional body size measurement position of yaks in Sanjiangyuan area. Then, a classification processing based foreground extraction method is used to extract the yak from the image; after the profile curve of the yak is extracted, the temple point and ischium end of the yak are obtained by means of calculating the distance between the image border and the central point. Finally, the body height and body dip length points of the yak are acquired. This paper specially extracts the yak in a yak image shot in Sanjiangyuan area, Qinghai Province, marks points and displays them. The experiment suggests that the dark yak body size point marking algorithm studied by this paper is quite effective to point marking of two-dimensional yak images.

1. Introduction

Yaks are one of the rare mammals living in Qinghai-Tibet Plateau, China. They belong to Bovinae, Bovidae, Ruminantia, Artiodactyla, Eutheria, Mammalia. Yaks are grass-eating, big-sized and fierce. They are known as “boat of grassland” on the roof of the world. The animals are important living guarantee and income source of Tibetan people, and also an indispensable livestock species for animal husbandry in Qinghai-Tibet Plateau. Our country is the world largest yak breeder, accounting for nearly 92%[1] of the total yak population in the world. Qinghai Province, in particular, owns 4.9 million yaks, taking up 38% of the national total yak population as the largest yak breeding base in China[2].

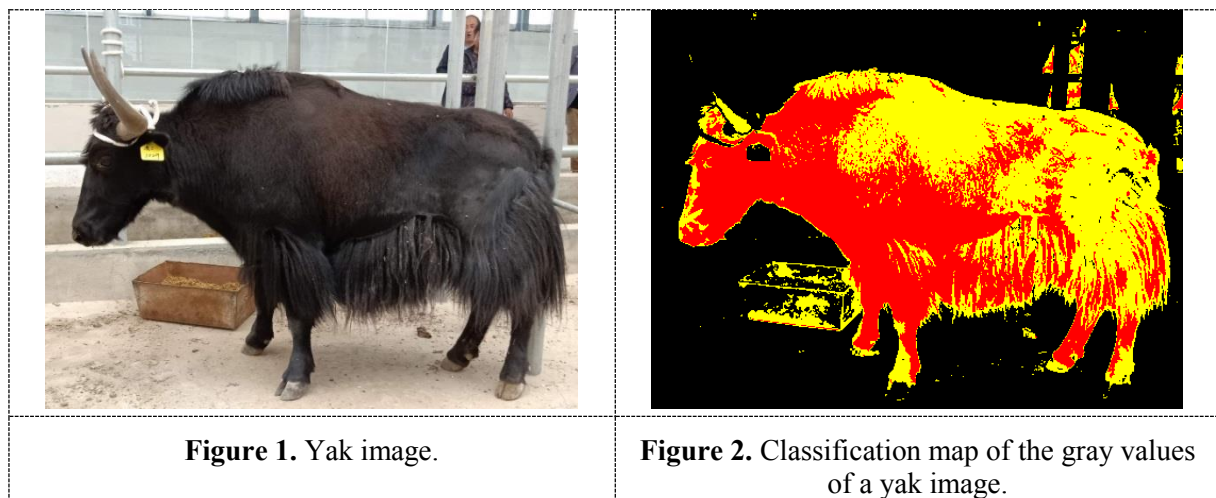
Research on yaks is of vital importance considering the animal's special status in Qinghai-Tibet Plateau. For research on yaks, yak body weight measurement is a key point. With the development of information perception technology and targeted breeding, the method of acquiring yak's body size data is progressing toward non-contact and high precision[3]. For yak body weight measurement, once the body size data is obtained, the weight can be calculated with a formula based on the data. In order to obtain the body size data in a two-dimensional image, the special body parts of the yak shall be recognized. This paper firstly processes a two-dimensional yak image roughly to recognize the yak in the image. Then, by recognizing the processed image, the four points necessary to measuring the height and dip length of yak body are marked. If we obtain the punctuation of the calf's body height and body length, we can estimate the body height and body length of the calf by other methods, and



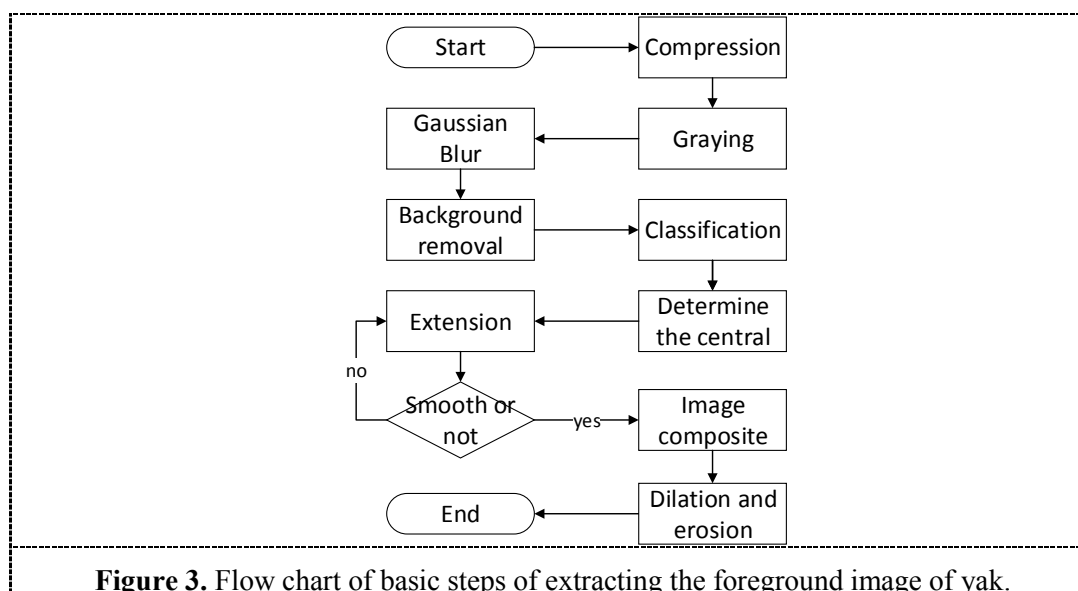
then estimate the body size and weight of the calf. The method of research in this paper has a good paving effect on the body size data and body weight of yak obtained through non-contact.

2. Image Recognition

Lots of experiments suggest: in gray level image, the dark yak has the lowest gray value; and the pixel points with a gray value of over 150 in the image are almost not the pixel points of the dark yak. For the yak image in Figure 1, Figure 2 uses different colors to mark the gray values of the image using a gray value of 50 as the unit. The gray value marked by red is $[0, 50]$; the value marked by yellow is $[51, 100]$; the value marked by blue is $[101, 150]$; the value marked by white is $[151, 200]$; the value marked by black is $[201, 255]$.



It is easy to see that the red parts basically depict the body shape of the yak. Based on that, the foreground of the dark yak is extracted from the color image. The specific steps are shown in Figure 3.



2.1. Gaussian Blur

In image processing, all points on an image can be indicated as the numerical matrix of a pixel. The so-called “blur” can be understood in a way that each pixel takes the average value of its surrounding pixels. In value, this is a kind of “smoothing”. In graphics, the effect of “blur” is achieved, with the “middle points” losing details. Due to the continuity of an image, nearer points have closer ties while

more separated points have more aloof ties[4]. To achieve Gaussian Blur algorithm, Gaussian convolution kernel shall be generated first. Then the Gaussian convolution kernel is convoluted to achieve blur processing of an image.

2.2. Background Removal

In background removal processing, a threshold value for background removal shall be determined first, and then the surrounding pixels of an image shall be traversed to determine whether a pixel belongs to the background[5] through tolerance. If so, the pixel is removed; if not, the pixel is reserved. The background removal codes are shown in Table 1.

Table 1. Background removal

Delete Background(img, point)
Into the queue(point);
while (queue. count > 0)
Out queue(temp_ point);
for (i=0 to 4)
Calculate the next coordinate point;
if (Ineligible)
continue;
if (<= allowance)
Into the queue(next_ point);
Mark the current point;

2.3. Classification Processing and Extension

After the image background is removed, the gray values of the image can be classified. Meanwhile, the central position of the yak can be calculated. Then, the Flood fill algorithm is used to constantly iterate this image until the image is smooth [6].

In the process of gray values classification, the already removed background shall be excluded first, and then the gray values of the remaining pixels are classified by [0,50], [51,60], [61,70], [71, 80], [81, 90], [91,100], [101,110], [111,120], [121,130], [131,140], [141,150], [151,255]. The average value of the horizontal and vertical coordinates of [0, 50] is calculated to determine the central point of the yak. If the number of pixels with a gray value between [0, 50] is too small, the average value of the horizontal and vertical coordinates of [0, 100] should be calculated to determine the central point of the yak. The gray values of the red parts are [0, 50]; the gray values of the yellow parts are [51,100]; the gray values of the blue parts are [101,150]; the gray values of the white parts are [151,200]; the black parts are background zones; the pink part is the central point of the processed image.

After the central point is determined, extension is conducted from the central point to determine the body in whole of the yak. The extension codes are listed in Table 2.

2.4. Image Erosion and Dilation

Erosion and dilation are primary morphological algorithms for gray level images. Erosion is achieved based on the concept of filled structural elements. It uses a certain structural element to detect an image so as to find an area in the image that can hold the structural element. Dilation is dual operation of erosion. It can be defined as erosion algorithm to the complementary set of an image[7].

After classification processing is used to extract the foreground of the yak, the extracted yak image may be unsmooth somewhat. In such case, the image can be dilated before being eroded to make the yak image smooth.

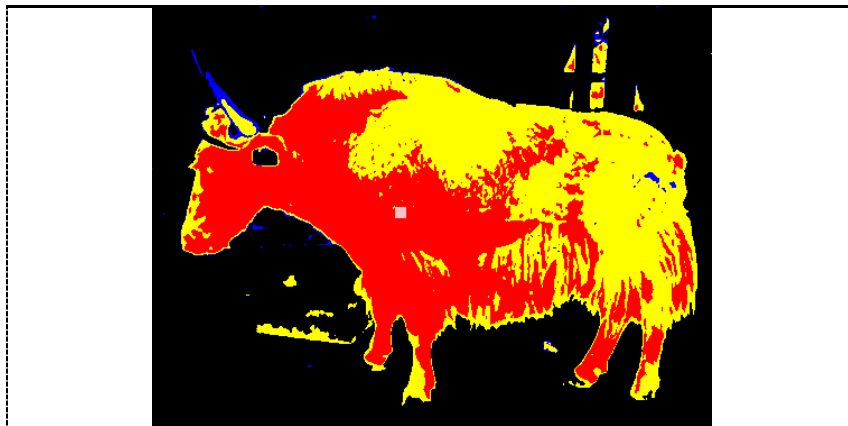


Figure 4. Using the classified image and the central.

2.5. Summary of identifying yak foreground images

After a large number of experimental tests, when the yak foreground image is identified by the above method, the image can be processed at the threshold of 20 in the initial state, and then the threshold value is adjusted according to the result of recognizing the yak image, and the accurate image of the yak is finally recognized. The final image of the yak that is finally extracted is shown in Figure 5. After identifying the foreground image of the yak in the picture, the measurement points of the yak can be identified based on the result. **Table 2.** Extension

```

Diffuse Water Filling (img,mid_point)
    Into the queue(mid_point);
    Set the pixel to white;
    while (queue.count > 0)
        Out queue(temp_point);
        for (i=0 to 4)
            if (Ineligible)
                continue;
            if (Meet the criteria)
                Into the queue(next_point);
                Mark the current point;
                Set the pixel to white;
        if(!cheak())
            Continue to expand;

```



Figure 5. Finally extracted yak foreground image.

3. Formatting the Text

In accordance with the traditional measuring standard for yak body size parameters, the body dip length refers to the distance between the shoulder tip to the ischium end, as is shown by Section TX-C in Figure 6. The body dip length can be measured by a measuring stick. If the body weight needs to be estimated by body size indicators, a tape can be used as the measuring tool. Body height refers to the vertical distance between the temple to the ground, as is shown by Section T-G in Figure 6. Body height can be measured with a measuring stick[8]. Therefore, once the ischium end, shoulder tip and temple point of the yak are correctly marked, the body dip length and body height of the yak can be acquired accurately[9-11].

After the two-value yak foreground image is obtained, the edge of the yak need to be extracted first, and then the central point of the yak is calculated. After the orientation of the yak is obtained based on interaction with the user, the image can be divided into 4 parts, and the four points – TX, C, T and G should be determined as is shown in Figure 6. The body height and body dip length of the yak can be obtained finally.

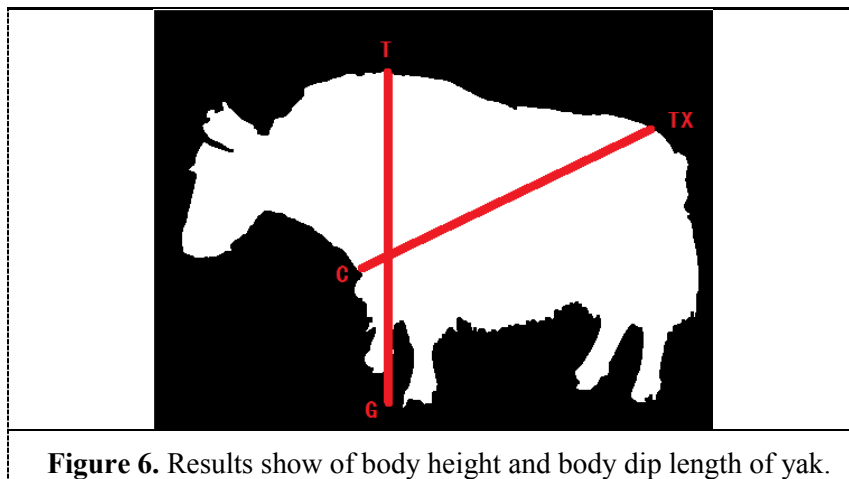


Figure 6. Results show of body height and body dip length of yak.

3.1. Image Border Extraction

Image border refers to the set of pixels related to dramatic gray value change[12]. It effectively describes the outline and some details of an image. Detection of border, one of the important characteristics of image spatial domain, is significant to help people understand and apply images. In the course of image point marking, we first extract the border of the image in Figure 5, and calculate the central point of the yak.

3.2. Recognition of Temple Point (Point T)

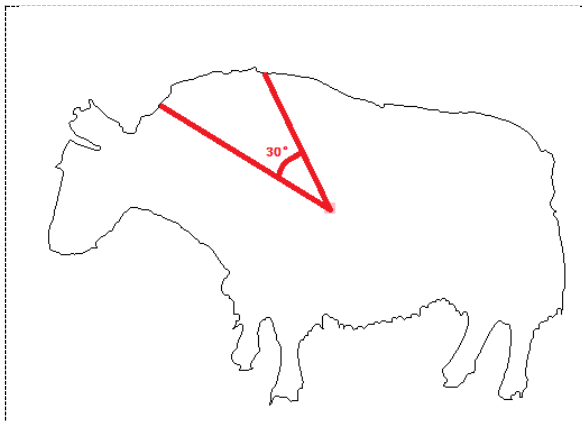
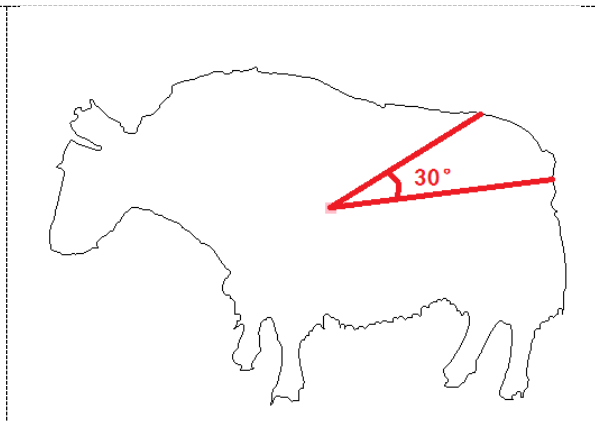
After the central point is determined, once we get the orientation of the yak, we can determine the zone where Point T is located lies on the upper left or the upper right. Lots of experiments suggest Point T is located at the highest point of the profile curve between 30° and 60° of the central point as is shown in Figure 7.

3.3. Recognition of the Lowest Point (Point G)

After the central point is determined, we can determine Point G is located in the area in the left or right below the central point based on the orientation information. Then, we only need to traverse the image part to determine the lowest point.

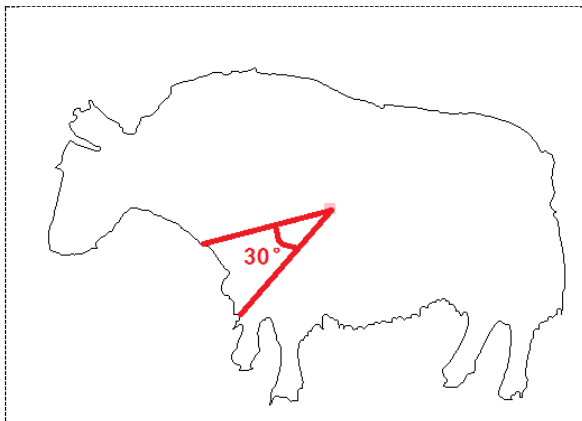
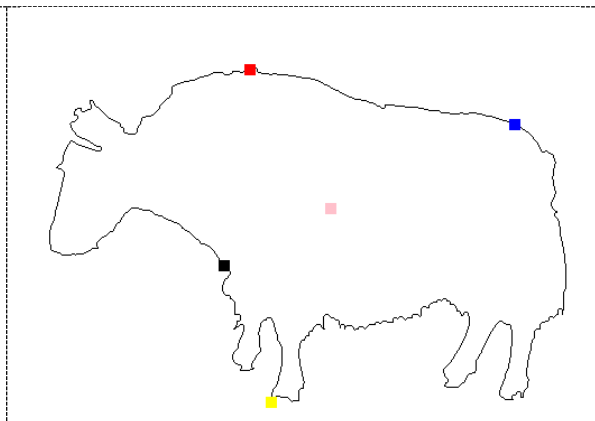
3.4. Recognition of Ischium Point (Point TX)

After the central point is determined, once we have the orientation information of the yak, we can determine the zone where the ischium point of yak is located lies in the left or right below the central point. Lots of experiments suggest that Point TX is located at the farthest point from the central point on the yak profile curve between 10° and 40° [15], as is shown in Figure 8.

**Figure 7.** Zone where the temple point lies**Figure 8.** Determination of ischium point

3.5. Recognition of Shoulder Tip (Point C)

After the central point is determined, once we have the orientation information of the yak, we can determine the zone where the shoulder tip of yak is located lies in the left or right below the central point. Lots of experiments suggest that the shoulder tip is located on the border between 50° and 80° with the central point, shortest from the central point, as is shown in Figure 9.

**Figure 9.** Determination of shoulder tip.**Figure 10.** Recognition of measuring points of yak.

The yak image is finally marked as is shown in Figure 10. The red point is temple point (Point T); the yellow one is the lowest point (Point G); the blue one is ischium point (Point TX); the black one is shoulder tip (Point C); the pink one is the central point.

4. Advantages and Disadvantages of This Algorithm

This algorithm firstly adopts Flood fill and classification ideas to recognize the two-dimensional yak image. After the central point is determined, the measuring points are obtained by calculating the distances between them and the central point. Tests have shown an extremely good effect of this algorithm to recognize the measuring points of yak images. However, affected by various external factors, the actual detection may have the following disadvantages:

- When recognizing the image, we need to manually determine whether the yak head turns left or right.
- If the image is not accurately recognized, the accuracy of points marking may be affected.

5. Conclusion

This algorithm firstly uses the gray values classification method followed by background removal, Gaussian Blur, the average value and Flood fill to determine the location of the yak in the image. Then, the central point is extended to locate the yak in the image. After that, based on the central point and the orientation of the yak, we determine the measuring points by using the distances between the image border and the central point. The algorithm identifies the measurement points of 20 yak pictures in Yushu area. The experimental results show that the accuracy of the algorithm for the identification of yak in Yushu area is 95%. Experiments prove that this algorithm is effective in recognizing the body size measuring points for images of black yaks in Yushu area.

6. Acknowledgements

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7. References

- [1] Wang Q. Management measures for breeding of pure wild yak during domestication. Chinese animal husbandry and veterinary Abstracts, 2015, 4(31):18.
- [2] Yang S B J, Bao S K, Zhao S N. Effect of warm season plus feeding on Yak in pastoral area of North Bank of Qinghai Lake. Heilongjiang animal science and veterinary medicine, 2014, 8:124.
- [3] Zhang W Z, Peng Y J, Zhu C X. Implementation and improvement of global Poisson matting. Journal of system simulation, 2006, 18(s1):92-93.
- [4] Wu X J. rovement of Gaussian Blur Algorithm and Image Processing Application Computer CD Software and Application, 2013(19): 129-129.
- [5] Lv R, Song X X, Li Q et al. Facial Image Processing Based on Gaussian Blur Algorithm. Shandong Industrial Technology, 2017(13): 261-261.
- [6] Chen J X, Jia Y M. A Real-Time Color Target Recognition Method Based on Flood Fill. Computer Simulation, 2012, 29(3): 4-9.
- [7] Gao X, Hu Y, Du W et al. Application of Erosion and Dilation Algorithm in Image Denoising. Journal of Beijing Institute of Graphic Communication, 2014(4): 63-65.
- [8] Wu J B, He S M, Jian S L et al. Analysis on Body Weight and Body Size Measuring of Sanjiang Yaks. China Cattle Science, 2017, 43(1): 14-17.
- [9] Blum, H., 1967. A transformation for extracting new descriptors of shape. Models Percept. Speech Visual Form 19, 362–380.
- [10] Blum, H., 1973. Biological shape and visual science (part I). J. Theor. Biol. 38 (2), 205–287.
- [11] Dunbrack, R.L. In situ measurement of fish body length using perspective-based remote stereo-video. Fish. Res. 82(1–3), 327–331 (2006).
- [12] Zhao C H. Modern Image Processing Technology and Matlab Realization. Beijing: Posts and Telecom Press, 2001: 152-157.
- [13] Mo C L. Improvements and Application Research on Digital Image Border Measuring Method. Hangzhou: Zhejiang Sci-Tech University, 2010:1-8.
- [14] Bai M Y, Xue H, Jiang X H. Inflection Point Based Sheep Measuring Points Extraction and Body Size Calculation [J]. Journal of Inner Mongolia Agricultural University, 2017, 38(6): 73-78.
- [15] Jiang J, Yue W, Cao M Z. Research on Sheep Body Size Measuring Method Based on Machine Vision. Journal of Inner Mongolia University of Science and Technology, 2015, 34(4): 322-327.