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Sparse Reconstructed Bovine Sign Measurement Method Based on SFM

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***Abstract*—[Objective] In order to improve the efficiency of measurement and reduce the labor force, a non-contact measurement method for cattle breeding in modern animal husbandry was developed. [Method] A sparse reconstruction method based on a few two-dimensional images is proposed, which includes four parts: extracting feature points using SIFT algorithm; matching the extracted feature points; calculating the three-dimensional coordinates of feature points; and finally sparse reconstruction based on SFM algorithm. [Conclusion] The bovine model reconstructed by this method can effectively solve the error problem in most manual measurements. It has relatively good applicability and robustness, high measurement accuracy, and high measurement efficiency, which also meets the requirements of evaluation of trait indicators. It can be widely used in the field of bovine physical measurement.**

***Keywords*— SIFT feature points; SFM; Sparse reconstruction; Three-dimensional measurement**

I. INTRODUCTION

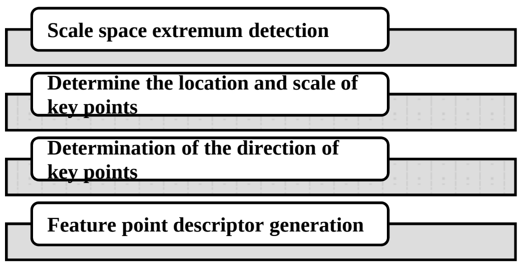
Cattle farming is already expanding, the traditional artificial breeding and traditional contact measurement methods can no longer meet the requirements of the development of modern cattle breeding. If cattle breeding industry is to be developed in a modern and scientific direction, it must be supported by advanced technology and excellent performance equipment. Sparse reconstruction method based on SFM algorithm is used in this paper. 3D vision measurement is mainly non-contact measurement of cattle, and the image sensor is based on ordinary camera, which is preprocessed through image processing. Then the 3d information of the target can be recovered from the processed 2d image, and the high measurement accuracy can be achieved. The method of 3D measurement can be protected not only by subjective factors, but also without direct contact with the measured object. In this way, compared with manual measurement, it is not only high in efficiency and accuracy, but also more convenient and fast [1].

At present, the measurement of cow traits is mostly based on the study of two-dimensional images. In 2009, yan zhen, qian dong et al. studied the 3d image synchronous acquisition system of cow body size evaluation[2].The two dimensional images of the front, side and rear of the cow are taken as the data by the camera, and the two dimensional images are processed to measure the cattle traits. In 2009, wang zhongli's research on key technologies in cow body size assessment based on machine vision [3] only studied and discussed the 3d measurement technology, but did not specifically realize the 3d modeling and measurement of cows, and there was no specific implementation data.

This paper proposes a reconstruction of the three-dimensional model of cattle based on SFM algorithm. The measurement of bovine body traits can be based on the reconstructed three-dimensional model. Compared with the two-dimensional image measurement method, this method has higher accuracy and is more convenient to observe bovine body shape traits, providing a new method for the measurement of bovine body shape traits[4].

II. SIFT FEATURE POINT EXTRACTION AND MATCHING

Scale invariant feature transform (SIFT) is an algorithm used to extract and describe image features [5].The SIFT algorithm has practical significance for dealing with the feature point matching problem in the case of rotation, translation, scale transformation and illumination transformation between two images, and it can not only solve the problem of viewing angle change, but also have stable feature matching for affine change problem. ability. The generation of SIFT feature vectors of an image [6] is mainly composed of four parts:



For the first part, the detection of extreme value in the scale space is based on the differential gaussian DOG extreme value. If it is determined that the detected point is in the middle layer of the DOG scale space and the extreme point of the upper and lower adjacent layer is the maximum or minimum value, it is called the feature point. And then identify the position of the feature points and scale, at the same time get rid of low contrast and the edge of the unstable points. In order to calculate the gradient and direction parameters of each feature point need over its use peculiar to each of the feature points in the neighborhood pixels of this layer gradient direction characteristics. All subsequent operations on the image data are transformed relative to the direction, scale and position of the key points. In the neighborhood around each key point, the local gradient of the image is measured on the selected scale to generate its feature vector descriptor. In this way, the extracted SIFT feature points not only maintain the stability of noise, but also have invariance to brightness change, scale scaling and rotation [7].

SIFT feature matching [8] uses the Euclidean distance of the feature vector to match and determine a suitable threshold. That is, the ratio of the minimum distance value of feature points to the sub-minimum value in the two images. If the value is less than this threshold, the point with the minimum distance is taken as the corresponding matching point. If the threshold value is reduced, fewer matching point pairs with strong matching can be obtained. In this paper, the threshold value is 0.6, and 35 pairs of matching pairs are obtained, as shown in figure 1:

(a) feature point extraction results

(b) matching results

FIGURE I. SCHEMATIC DIAGRAM OF IMAGE MATCHING

III. THREE DIMENSIONAL POINT SOLUTION IN SPACE

The image is matched to 35 pairs of feature points to get the unit should be matrix H:

$$H = \begin{bmatrix} 0.8736 & 0.1888 & 120.4539 \\ -0.0071 & 0.9346 & 18.6630 \\ -0.0002 & 0.0004 & 1.0000 \end{bmatrix}$$

The basic matrix F obtained by calculation is:

$$F = \begin{bmatrix} -0.000 & 0.0000 & -0.0173 \\ 0.0000 & 0.0000 & -0.0102 \\ -0.0171 & 0.0085 & 1.0000 \end{bmatrix}$$

In two images of the same object, the position of its matching point is constrained by the polar geometry, which can be represented by the fundamental matrix [9]. As shown in figure 2:

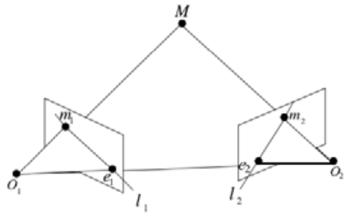


FIGURE II. POLAR GEOMETRIC REPRESENTATIONS OF THE TWO FIGURES

Let's say that the three-dimensional coordinates of some point M in space is $X = (x, y, z)^T$, and set the two images of the same scene from different perspectives as I and I'. The projection matching point pairs of the spatial point M in I and I' are m_1 , m_2 , that is, m_1 and m_2 are the corresponding points of the spatial point M. Usually 6~8 points are selected to calculate the space transformation matrix considering the accuracy and speed. Due to the interference of the collected two-dimensional images, the data is always noisy. The least square method can be used to obtain the three-dimensional coordinates of the spatial points. The solution in the least squares sense is that the two feature points on different planes match the midpoint of the line segment of the shortest distance of the line. The matched feature points are calculated according to the principle of spatial point three-dimensional reconstruction to obtain a three-dimensional point set of matching feature points. Get a three-dimensional model as shown in Figure 3:

FIGURE III. 3 3D MODEL OF CATTLE

IV. CATTLE SIGNS MEASUREMENT

This article only takes the calculation of the height of the cow as an example:

Height: vertical distance from the highest point of plain to the ground. As shown in figure 4:

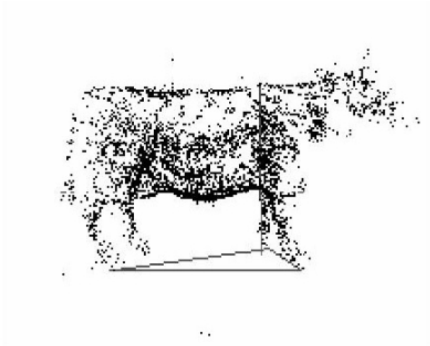


FIGURE IV. BODY HEIGHT OF CATTLE

Assuming that the three intersections are $m_1(x_1, y_1, z_1)$, $m_2(x_2, y_2, z_2)$ and $m_3(x_3, y_3, z_3)$, respectively, Then the only determined normal vector is as shown in equation (1):

$$n = m_1m_2 \times m_1m_3 \tag{1}$$

The expression of the plane equation is shown in equation (2):

$$m_1m \cdot n = 0 \tag{2}$$

Represent the vector n with (A,B,C), then the plane equation is transformed into $A(x - x_1) + B(yy_1) + C(z - z_1) = 0$. Expressed in the general formula as: $Ax + By + Cz + D = 0$, where $D = -(Ax_1 + By_1 + Cz_1)$, The distance from the point to the plane can be obtained by equation (3):

$$d = |Ax_0 + By_0 + Cz_0 + D| \Big/ \sqrt{A^2 + B^2 + C^2} \tag{3}$$

V. EXPERIMENTAL RESULTS

Based on type (3)to get the cow body height is 128.83 cm, this article also used the traditional measuring method to get the cow body body height data, In addition, in order to verify the detection accuracy of the characteristic indexes of bovine body size with the sparse reconstruction method based on SFM, the measuring position must be consistent with the measuring point of bovine body size. In order to reduce the error and facilitate the analysis of the algorithm and the stability test, the body height measurement was actually measured 5 times, and the average value was taken as the actual measurement value of the bovine sign, which was 128 cm. The data results obtained by two different measurement methods were compared and analyzed, as shown in table 1.

TABLE I. COMPARISON OF MEASURED AND ACTUAL BOVINE BODY SIZE

	Actual measurement	Measured value	REL1 /%
Body height	128cm	128.83cm	0.64

Note: REL1/% : relative error between measured and measured body height;

By actual measured values in table 1 and the error analysis of measurement value of detection data, its body measurements by sparse reconstruction calculation algorithm of cattle body's height of actual measured value and the detection error of the measured value is 0.64%.According to the relative error between the measured value and the measured value of living organism ruler is within the tolerance range of error within 5%, the measured value of this test reaches the expected accuracy, and the error value is less than the standard error. This measurement method is feasible and can replace manual measurement.

VI. CONCLUSION

According to the analysis results of the test data. The algorithm based on image sparse reconstruction, obtain ideal cow body model reconstruction results, and to the cow shape body high properties were measured. The experimental results show that using this method to measure the body height the indicators are relatively high precision. The measurement results are reasonable, the measured results are reasonable, which fully shows that the application prospect of this method is considerable. This measurement method can be used to replace manual measurement .It provides an efficient measurement method for most of modern cattle breeding. Therefore, this method can be used for data collection, measurement and analysis of bovine body shape traits.

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