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A review of research on pig behavior recognition based on image processing

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Abstract

Image recognition-based behavior recognition is an active research field in computer vision. With the modernization of animal husbandry in China, innovative technologies such as machine vision and artificial intelligence are gradually applied to pig monitoring, which can realize real-time abnormal behavior of pigs, and pig behavior analysis. Pig behavioral identification, detection of image sequences containing pigs, framing, target classification, anomaly detection, and behavioral analysis and identification of pigs. Based on the individual behavior recognition of pigs, this paper introduces the research and development status of pig her identification in recent years and the challenges faced by the current research direction, and makes a brief summary.

Keywords

Image processing, behavior recognition, artificial intelligence, pig herd.

1. Introduction

As the world's largest pig breeding country, China's 2018 pig production has reached 694 million heads, and the Chinese pig industry has a scale of about 1.4 trillion yuan, contributing more than 2% to China's GDP. At present, China's animal husbandry is at a critical moment of modernization. Artificial technologies such as artificial intelligence, big data, Internet of Things, and traceability management will be deeply integrated with traditional animal husbandry and widely used. This process is precisely the traditional Chinese pigs. The only way for the aquaculture industry to advance rapidly in scale and standardization. However, before the subclinical and clinical manifestations of many livestock diseases, they are usually accompanied by changes in the animals' own behaviors. Therefore, daily behavior monitoring of pigs is particularly important, which can improve and make up for the deficiency of biosecurity measures and help prevent the spread of severe infectious diseases in pigs and zoonoses. Although there have been great changes in the scale of cultivation and the way of farming, there are still many problems because the pig industry in China is still in the development stage. First, the expansion of farming scale has led to an increase in stocking density. Intensive feeding methods have also caused changes in pig habits, and related pig infectious diseases will become more easily transmitted [1]. Secondly, the daily observation of pigs is more difficult to achieve. Traditional manual observations have serious shortcomings, and accuracy and real-time performance are poor, which is time-consuming and labor-intensive. The resulting frequent epidemics have led to a more and more significant decline in meat quality provided by farms, which has hindered

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the development of China's aquaculture industry. Therefore, it is very important to find and identify the abnormal situation of pigs in time, and it is also an important prerequisite for improving the economic benefits of breeding and avoiding losses. In view of this, many scholars have developed an automated early warning system that monitors pig behavior changes and provides feedback through sensors. However, since most sensors need to be attached to the body surface of the pig, the pigs collide with each other and the pig moves easily, and the contact sensor is easy to cause the stress response of the pig, which affects the measurement accuracy. The sensor installed in the field is The staff is required to routinely intervene in the readings. In summary, the contactless computer vision system is more suitable for behavioral monitoring of commercial pig breeding.

In recent years, many domestic and foreign scholars have applied computer vision technology to pig behavior recognition analysis and research, and are committed to increasing animal welfare and breeding income. This paper summarizes the existing visual algorithms from the aspects of pig target extraction and individual identification, pig behavior recognition, etc., and analyzes the existing problems in the existing identification methods, in order to provide reference for relevant research scholars, and promote the in-depth application and promotion of visual technology in animal husbandry.

2. Target extraction and individual identification

2.1 Pig target segmentation and extraction

The primary task of behavior recognition is to segment and extract foreground objects within a video sequence frame. At present, the commonly used pig extraction algorithm can be divided into static single frame extraction and dynamic multi-frame extraction. The static single-frame pig extraction is to split the video sequence into single-frame images, and extract the pigs through feature analysis in the single-frame two-dimensional image, which is characterized by accurate extraction but slower speed; dynamic multi-frame pig extraction refers to In the video sequence, the adjacent inter-frame processing algorithm is used to extract the pig target, which is characterized by faster extraction, but it is difficult to extract the target when the pig is in slow motion or at rest.

The purpose of foreground detection and image segmentation is for object extraction. The foreground detection is to extract the changed region (target) from the video, and the image segmentation is often to extract the region of interest (target) by using a single frame image. The effective detection of the moving foreground target is post-processing to the target classification, target behavior understanding and analysis. It is important. Typical foreground detection algorithms mainly include optical flow method, interframe difference method and background subtraction method. Nasirahmadi et al [2] and Wu Yan [3] use the background subtraction method to extract the pig region, and after binarization, extract the pig. aims. Considering the effects of illumination and shadow, it is easy to make the background subtraction error. Lind et al [4] defined the background as the reference frame and updated it once in 5 frames. The frame difference image was binarized by automatic threshold detection to extract the pig foreground. Ott et al [5] used the adaptive histogram equalization algorithm to process images and the background subtraction method to obtain moving pigs. Sun Longqing et al [6] proposed an improved Graph Cut algorithm to segment live pig images based on the interactive marker watershed algorithm. The traditional Graph Cut algorithm has poor segmentation accuracy, is susceptible to illumination and noise, and improves time-consuming problems.

For the foreground detection of the multi-rabbit video in the group, the background image is difficult to obtain directly. The scene is much more complicated than the single pig video. How to achieve fast and robust foreground detection is still a research difficulty. In the report on the prospective detection of individual pigs in the overlooking group, Tu et al [7] proposed a foreground detection based on cyclic reliability propagation algorithm for the video sequence of overlooking group pig with complex background, which can overcome the influence of light mutation, dynamic background, immobility of foreground target and other complex scenes.

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Liu Bo et al [8] used threshold segmentation and mathematical morphology processing to extract side-view single pigs for the automatic registration and fusion of infrared and visible images of graduate students [9,10]. Kashiha et al [11] used the image segmentation method to extract the target for the single pig in the drinking water area in order to estimate the total amount of pig drinking water through the pig stay time.

2.2 Individual identification

To identify the behavior of individual pigs in a group of pigs, pig identification becomes even more important. The ear tag RFID (radio frequency identification) [12] is the main way to identify the individual pigs in the current group. In recent years, domestic and foreign experts have begun to study the identification methods of pigs based on machine vision, but these methods are mainly identified by printing patterns, numbers and other marks on animals, which is still in the preliminary exploration stage. Navarro-Jover et al [13] painted different colors on pigs and constructed a color space [B /(R+G+B) , (GR) , (BG)], where R, G, and B respectively represent red (Red), Green (Blue) and Blue (Blue) colors are color-coded for individual pig identification purposes; Ahrendt et al [13] established a real-time computer vision system for tracking group pigs, which he painted on the back of the pig Marked on it, it was achieved that 3 pigs were tracked for 8 minutes without losing. Kashiha et al [14] used pattern recognition to identify individual pigs by applying differently shaped markers to the back of the pig. Yang Qiumei et al [15] made A, B, C, and D marks on the back of the pig, intercepted the pig back image with the smallest circumscribed rectangle as the training set and test set for deep learning, and applied migration learning to fine-tuning in the trained GoogLenet. The individual recognition rate is 95%. However, when the scale of breeding is large, manual marking is no longer applicable. Guo Yizheng et al [16] established an individual pig training sample set that consists of individual eigenvectors with color, texture and shape features. The hybrid kernel function support vector machine classifier based on Sigmoid kernel function and RBF kernel function is used to realize pig identification and individual identification of pigs. The rate is 92.88%. On this basis, Zhao Wei [17] divided the grid with the shoulder and hip as the characteristic area, and extracted the Gabor histogram of the grid texture of the pig epidermis to establish the sample library; the same method was used to construct the classifier, and the experiment confirmed the average. The recognition rate reached 86.51% [6]; Tan Huilei [18] extracted color information entropy, shape parameters and Tamura texture feature eigenvectors for hip and back, respectively, and calculated feature similarity to identify individual pigs. The accuracy of recognition method was 86.7. %. Chen Jiali [19] used non-contact intelligent monitoring technology to identify individual pigs. Firstly, Grab Cut interactive target extraction algorithm is used to segment the color image, and other image processing techniques are used to extract the complete target. Then, multiple features with large discrimination and fast calculation rate are extracted and combined to form 31-dimensional feature data. The vector is then used to reduce the dimensionality of the feature data by local linear embedding. Finally, the hybrid kernel function support vector machine is used to identify the identity of the individual pigs in the test frame, and the error cost coefficient and kernel of the support vector machine are optimized by the particle swarm optimization algorithm. The parameters are optimized to improve their recognition rate. Zhang Sunan [20] collected the image information of pigs in the farm, and then achieved the target positioning of the pig through the Gaussian model and the mean shift method, and determined the daily eating behavior, the number of excretions, the rest time, etc. Make a judgment on the health situation.

3. Pig behavior analysis

Whether the behavior of feeding pigs, drinking water and excretion is normal is an important basis for judging their health status. Moderate diet and drinking water can ensure healthy growth of pigs, and excessive excretion is a disease manifestation, such as viral diarrhea and infectious gastroenteritis.

Xie Wei [21] used the trained decision tree SVM classifier to mark new images, paired time and posture to realize pig eating and drinking behavior recognition, and the average precision was over

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90%; Kang Feilong [22] and others rotated the rectangular frame Mark the side view of the pig body, extract the center of gravity coordinate, rotation angle, foreground target area, distance from the center of mass to the abdomen, and the height and aspect ratio of the rotating frame. It realizes the recognition of pig walking and lying posture; Chen Zicheng [23] describes the video frame with the behavior description method based on the space-time interest point and the word bag model, and then uses the SVM classifier to establish the pig behavior model. The classification and detection of food and other behaviors showed a comprehensive accuracy rate of 92.31%. Some scholars have proposed methods for identifying diet and excretion behavior based on the location of pigs. Wu Qiong [24] established a moving pig detection model based on adaptive background difference method to detect pig excretion behavior; Pu Xuefeng et al [25] proposed an improved moving target detection algorithm to detect whether pigs are located in the discharge area to identify excretion behavior; Li Zhendu [26] By tracking the moving target pigs in real time, identifying whether they are in the discharge area and judging the excretion behavior according to the detention time; Yang Wei [27] et al. used the mixed Gaussian model background modeling method to model the background of the captive porcupine breeding environment and mark the scene. The contours of porcupines and other moving objects, the key points of the image local features ORB are introduced as classification attributes, which improves the recognition accuracy of porcupines to 93.23%. Kashiha et al. realized the automatic monitoring of the pig's residence time in the drinking water area, and then used it to estimate the total drinking water of the pigs in the pigpen [11]; Yang Qiumei et al [15] selected the pre-trained GoogLenet model and the calibration was good. The image data in the drinking water area containing the head, tail and floor labels is repeatedly trained to adjust the parameters, and the image is accurately judged by the trained network, and the recognition rate is 92.11%; Tan Huilei [18] sets the area near the drinking fountain as the region of interest. The contour feature of the pig's head shape was extracted when drinking water, and the polygon similarity matching contour was calculated to realize the drinking water behavior recognition. The recognition rate reached 91.07%.

4. Challenges

In the identification and separation of adhesion pigs, in actual cases, individual adhesion of pigs is inevitable, and the higher the stocking density, the more serious the problem of individual adhesion of pigs. Therefore, the separation and identification of individual pigs in the future will be a research difficulty. .

With the scale of breeding, there are many types of farmed pigs, such as Songliao Black Pig, Chenghua Pig and Ningxiang Flower Pig, which are black in color, have different textures and are similar in color to the background of the circle. Pig body target extraction method and even tracking and behavior recognition algorithm.

For the individual identification of pigs, the difference between pigs is small and difficult to identify. The traditional method of manual labeling has high complexity and high accuracy of marking requirements. The individual identification of a large number of similar pigs in the same circle is still as the focus of video identification of pig individuals, how to accurately identify individuals according to their own characteristics is an important problem at present.

At present, most diet and excretion behavior recognition algorithms are implemented according to specific pig pens, resulting in poor portability of the algorithm and not having the universal applicability of multiple pig houses. Behavior recognition algorithms all acquire a single perspective. Due to limited information, it is difficult to solve multi-behavior recognition.

5. Conclusion

Although the herd behavior recognition is still in its infancy, with the transformation of China's animal husbandry, large-scale, intelligent and refined farming will gradually replace the traditional form of free-range, artificial intelligence, big data, Internet of Things, traceability. Innovative technologies such as management will be deeply integrated with traditional animal husbandry and

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widely used. Machine vision technology is a non-contact, low-cost and high-return monitoring method. With the advancement of society, automation will be popularized in commercial animal husbandry, and real-time monitoring of pig abnormalities can be well monitored, from individual identification to behavior analysis, abandoning traditional manual inspections, etc., saving a lot of labor costs. It is conducive to promoting the large-scale development of modern aquaculture industry and the establishment of a scientific modernization management system. It is an inevitable trend to apply machine vision technology to the modern pig industry, and it is very important to improve the automation and intelligence level of China's large-scale aquaculture industry.

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