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Development process of animal image recognition technology and its application in modern cow and pig industry

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Abstract. The construction of digital farms had emerged since 2018. It used computer image processing and pattern recognition technology to study cow and pig recognition through interdisciplinary research. This paper introduced specific cases about using image recognition technology to build modern cow and pig farms. Then reviewed the research on animal image recognition technology and had the following research directions: iris recognition, retinal recognition, nose pattern recognition and face recognition. In the end this article proposed how to “DIY” classification for pigs.

1. Introduction

The development of animal identification systems began in the late 1960s. Research institutes in the United Kingdom, Germany, the Netherlands and the United States have developed prototypes of animal identification systems. In April 1976, at the seminar on "Certification System and Application of Cattle" held in the Netherlands, research institutes in the United Kingdom, Germany, the Netherlands and the United States demonstrated the first results of animal identification systems[1]. Traditional animal identification methods, such as ear tags and tattoos, are easy to lose, stolen[2], cause animal infections[3][4], not to mention animal welfare issues[5].

Research on real-time identification of animal individuals is currently a challenging research frontier in modern agriculture.

2. Application of animal Image recognition technology in modern aquaculture

2.1 Cow recognition application

Creating new digital farms through machine vision technology, obtaining data, analyzing data to formulate production plans, increase production and promote more effective and environmentally friendly land use. Some developed countries have taken a practical step in the construction of digital farms. The analysis system of Rich Feed and Seed Company, a feed manufacturer in eastern Ontario, Canada, uses face recognition technology to reduce the nutritional differences of dairy cows and will make dairy cows a "live database" to make management decisions. The mobile app ida developed by Connecterra uses a wearable sensor to learn the behavioral patterns of dairy cows, which can enable dairy farmers to notice problems caused by dairy cows as early as possible and increase the user's farm dairy output by 30%. Cainthus is an American technology company dedicated to digital agriculture. Cainthus has developed face recognition software for farms that can remember the face of cattle within 6 seconds and monitor the activity of the entire herd without the need for wearable tracking devices. The company is creating algorithms to allow software to show early signs of lameness in cattle or remind farmers when they are fighting for the best feed.

2.2 Pig recognition application

The application of animal recognition in China emerged in 2018, mainly using pig face image recognition technology. In December 2018, Sichuan Tequ Group company and Dekon Group company cooperated with Alibaba group company to carry out "AI pig raising". One of the projects is to cooperate with pig raising scientists to develop algorithms that can judge whether a sow is pregnant through image and video data. To increase the litter size on the farm. In the theoretical verification stage of this algorithm, AI can allow sows to produce 3 more piglets per year, and the death rate of piglets is reduced by about 3%.

The AI pig project of Jilin Jingqishen Organic Agriculture Co., Ltd. and JD Academy of Agriculture and Animal Husbandry, a subsidiary of JD Digits company. In the traditional mode, pigs in the same pen have very different body weights. Pig face image recognition technology can count the weight, growth and health of each pig, knowing how much feed each pig needs, accurate to grams. The weight difference when pigs are slaughtered can be reduced to within 5%, the feed consumption can be reduced by 8% -10%, and the slaughter time can be shortened by 5-8 days on average.

In summary, the image recognition technology of pigs can help farmers build identity files for each pig, track them in real time, lay the foundation for refined farming, reduce feed use, and find them in time when they are sick and pregnant.

3. Development process of animal image recognition technology

Each animal is provided with a unique identity that is associated with the animal for life through biometrics. The identification process does not require the use of syringes or ear tags. There are several major research directions of animal recognition technology, namely iris recognition, retina recognition, nose pattern recognition, and face recognition.

3.1 Iris recognition

The iris of domestic animals contains some recognizable features, just like human irises. Based on the scale-invariant feature transform (SIFT) algorithm to extract iris features[6], and by using modern parallel processing technology[7], the feature extraction time can be greatly reduced. The local features of an image are usually related to changes in image attributes, such as intensity, color, and texture[8]. The advantage of using local features in iris recognition is that they are calculated at multiple points in the image; therefore, they are not affected by image scaling and rotation. In addition, they do not require further iris image preprocessing or iris image segmentation operations[9]. In 2014, Lu Yue et al. proposed a cow recognition system based on two-dimensional complex wavelet transform (2D CWT) algorithm to extract cow iris features. Through a non-contact device used to collect iris images, the overall accuracy of the recognition system in the recognition mode is 98.33%[10].

3.2 Retina recognition

Animal retinas have similar characteristics to human retina scans. Retinal recognition can be applied to animals such as cattle and sheep, and remains basically unchanged in the eyes of normally developing animals from birth to maturity [11]. In 2008, Allen A. et al. used 869 cows to obtain 1738 retina pictures from both eyes for individual identification of cattle. The maximum recognition rate was 98.3% [12].

3.3 Nose pattern recognition

Although the recognition accuracy of the livestock iris and retina recognition algorithm is very high, due to the limited number of samples of the livestock iris database, the algorithm may be difficult to achieve high accuracy in the actual production. In addition, these two identification algorithms have high requirements on the collection equipment, and the identification of livestock cannot be completed in real time.

Since 1921, the nose pattern of animals has been studied [13]. An animal's nose pattern can be considered as an accurate, time-invariant biometric identifier. A sufficient identification of animals can be similar to the accuracy achieved by human fingerprints[14]. Awad A.I. et al. Applied the scale-invariant feature transform (SIFT) algorithm, and combined with the random sample consistency (RANSAC) algorithm, a total of 15 cattle were collected, and 108 nose images of cattle reached 93.3% recognition accuracy[15].

3.4 Face recognition

There have been many studies on face recognition, however research on animals has just started. Research on pig face recognition was first introduced in 2013. Japanese scholar Wada Naoki et al. proposed the use of PDA algorithm to recognize pig faces. The 16 training samples obtained a recognition rate of 97.9%[16].

Compared with animal iris and retinal recognition, animal nose pattern recognition, face recognition have lower requirements for collection equipment and real-time recognition, which is the future development trend. Furthermore, these three types of recognition algorithm research also have the difficulty of identifying samples and lacking a standard database. In addition, existing research on animal individual recognition is often based on high-quality images, and in actual production, the existing recognition algorithms for low-quality images may not be achieved high recognition rate.

4. DIY pig classification

Fig. 1. Pig face

Fig. 2. Pig nose

The deep learning algorithm is to let the algorithm help humans to do some large-scale data recognition, sorting, regular summary and other things that humans spend time comparing. In recent years, deep learning have been successfully used in face recognition, speech recognition, natural language processing, medical images and other fields, both in terms of accuracy and speed are superior to traditional algorithms.

The difficulty in constructing a deep learning algorithm for image classification is to set appropriate parameters for the algorithm model. Even if the appropriate algorithm parameters are found for the smaller data set used to train the algorithm, it may not be available in the actual production of large data sets good result.

AutoML refers to try not to set the hyperparameters by humans, but to use a learning mechanism to adjust these hyperparameters. These learning mechanisms include traditional Bayesian optimization, evolutionary algorithms, and deep learning.

The core idea of automl is to create an algorithm that can mine regular things from the data without writing code for a certain problem. All we need to do is to "feed" the data to the platform, and then it will build its own logic on the data.

Recorded videos of multiple pregnant pigs at two farms in Fangshan District, Beijing, and extracted images from the videos to extract face and nose images (Fig. 1,2).

A pig classifier is constructed through machine learning algorithms. 90% of the face and nose images are used to train the algorithm, and the remaining 10% are used for testing. Using Customvision AutoML platform built by Microsoft, "feed" the images to this platform, the face image recognition rate reached 97.3% and the nose image recognition rate reached 95.8%.

Customvision AutoML platform is currently available for free after registration. Small pig farms can use this platform to build their own pig classifier.

5. Discussion

In the long run, the prices of domestic and international meat products in developing countries such as China have been seriously upside down for a long time, and breeding enterprises will face huge competition pressure from international meat companies.

The reason for the high price of livestock products in China is the high cost of breeding. The reasons for the high cost of breeding are as follows: at present, Chinese animal husbandry and breeding outlets are scattered, small in scale, high in feed cost, and low in production technology.

In addition, as Chinese environmental protection efforts are increased, labor costs have also increased. Taking the pig industry as an example, the cost of raising pig farms in the United States is 0.6 dollar per catty. Not only is the size of the American pig farms large, but also the application of automation and mechanization is relatively high. Large-scale farming is beneficial to breeding, epidemic prevention, artificial insemination, and feeding management To be more professional, improve breeding efficiency and reduce costs. An American pig farm can manage 3,000 pigs per person, while China can only manage 500 pigs per person.

PSY (the number of pigs slaughtered per sow), the most important indicator for measuring breeding efficiency, is currently 16-18 in China, and 25-26 in the United States.

Ear tags are currently widely used in Chinese animal husbandry for individual identification. With the research on animal identification, the construction of digital farm has achieved certain results. Taking pig breeding as an example, the identification model established by analyzing reliable data has good adaptability and high accuracy, which improves efficiency and increases production in practical applications.

The development of animal identification technology to build a digital farm can help developing countries improve production capacity and create happy lives for their people.

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