Research and application of early warning system for abnormal temperature of breeding pigs based on deep learning

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Abstract. Based on deep learning, the early warning system for abnormal temperature of pigs can identify suspicious diseased pigs in advance, avoid group death and reduce the loss of a large number of diseases. It includes multi-domain cross-fusion, combining artificial intelligence machine vision image processing technology (CV), Internet of Things information technology (LOT), software engineering technology (STT), and traditional breeding technology (TFT). The CV technology is used for the identification and tracking of individual pigs. The LOT technology is used for the real-time capture and monitoring of the body temperature of the individual pigs. The STT technology is used to send and receive network messages and implement an early warning system. Combining CV technology, LOT technology, STT technology and TFT technology, a solution for automatic monitoring and real-time warning of the temperature measurement area of breeding pigs is proposed and implemented. The paper summarizes the technology used and details the design and implementation process of the system.

1. Introduction

Pig production is one of the most complex biological systems in the production of domesticated animals. It has been produced cyclically throughout its life, continuously breeding offspring, and providing commercial pigs [1]. For the breeding of breeding pigs, it is a very technical job. In addition to experts, most people still have the impression of raising pigs in rural pig sheds. For the breeding of large-scale pigs, the labor costs required have increased dramatically. On the basis of agricultural informationization, the system of this paper innovatively adds a deep learning algorithm to the infrared thermometer to track and visualize the body temperature of each breeding pig. It makes up for the gap in real-time and accurate body temperature monitoring, can timely isolate and isolate suspected dangers, avoid immune spread, and can improve production efficiency and improve pig quality by reducing direct contact. It is the key technology needed by the market under the current social situation.

In the 21st century, the animal husbandry industry has fully entered the information age. The application of computer technology in the breeding of animal husbandry can greatly promote the development of animal husbandry, performance improvement and variety improvement [2]. At present, the development trend of foreign factory in the aquaculture industry is: more sophisticated farming techniques based on animal individual or small group difference information to achieve fine regulation.
and management [3]. This paper adopts deep learning-based monitoring system for pig body temperature abnormality. Real-time non-contact monitoring of boar body temperature is carried out in combination with multi-field cross-fusion applications such as breeding pig breeding, image processing and internet of things. It mainly uses the rapid development of computer vision technology in artificial intelligence to automatically monitor the temperature measurement area of the breeding pigs. The non-contact infrared sensor is used to measure the temperature of the pig’s buttocks, and the rectal temperature is calculated according to the linear relationship between the body surface and the body temperature. The system is capable of fine-grained tracking of boar body temperature to a second-order density. The system will organically combine deep learning counting, Internet of Things technology, and software engineering technology. The innovative application to the temperature measurement stage of breeding pigs can effectively improve efficiency, save costs and reduce the mortality rate of breeding pigs.

The overall goal of the pig body temperature warning system is to research and develop a system that can monitor the body temperature of pig farms in real time and provide early warning to individuals with abnormal body temperature. The requirements for the system are analyzed as follows:

A. **Object detection algorithm module**

The system will monitor the hips of pig farms in real time during use. In order to achieve the goal, we need to select and design a deep learning algorithm for target monitoring.

B. **Infrared linkage thermometer module**

The system needs to use computer vision and through the target detection algorithm to track the infrared thermometer in real time to the hips of the current breeding pig. Therefore, it is necessary to carry out a linkage design between the camera and the infrared thermometer.

C. **App system software module**

In order to improve the interactive experience of the system, the whole system involves the visualization of the real-time temperature data of each pig in the farm and the interactive visual interface when pushing the abnormal data information for the farmer. The system is finally open for use in the form of APP software. Need to design and develop a related app.

2. System design

The system design is divided into three parts, namely the target detection algorithm design, the infrared linkage thermometer design, the App platform early warning system design, and the system function structure diagram is as follows.

![System structure](image-url)

**Figure 1. System structure**

2.1. **Algorithm design**

Target detection is an important branch of image processing and computer vision, and it has great significance both in theory and in practice [4]. The target detection algorithm is divided into two key subtasks: target classification and target positioning. The target classification task is responsible for
determining whether an object of the interest category appears in the input image or the selected image area, and outputting a series of scored labels indicates the possibility that the object of the interest category appears in the input image or the selected image area. The target positioning task is responsible for determining the position and range of the object of interest in the input image or the selected image area, outputting the bounding box of the object, or the center of the object, or the closed boundary of the object, etc., usually using a rectangular bounding box, i.e., Bounding Box To indicate the location information of the object. At present, the target detection algorithms based on artificial intelligence are roughly divided into two categories: a two-step target detection algorithm. This type of detection algorithm divides the detection problem into two stages, and the first stage first generates candidate areas. It contains the approximate location information of the target, and then the second stage is to classify and refine the candidate area. Typical examples of such algorithms are R-CNN, Fast R-CNN, Faster R-CNN, etc. It is characterized by slow speed and high detection accuracy. One-step target detection algorithm, this kind of detection algorithm does not need to extract the stage of candidate frame, and can directly generate the class probability and position coordinate value of the object through one stage. The typical algorithm is YOLO [5], SSD. The characteristics of this type of target detection algorithm are Fast speed and low detection accuracy. In the production of this system, it is considered that the body temperature of the breeding pigs is monitored in real time. This requires that the real-time detection speed must be met when selecting the target detection algorithm. The paper selects the SSD (SSD: Single Shot MultiBox Detector [6]) in the one-step detector to detect the temperature of the breeding pig. The area (hip) can not only achieve real-time speed detection of the pig's buttocks, but also achieve the system's effective detection of the detection accuracy of the pig's body temperature. The network model of SSD is shown in Figure 2.

![Figure 2. Data processing model](image)

2.2. System working scene and infrared linkage thermometer design

The slide rails are installed in the farm for hardware devices such as cameras and infrared thermometers. The system which uses the breeding pig monitoring video data set to obtain the weight file after training the target detection algorithm on the computer, load the weight file into the test network, run the test network on the raspberry pie on the input real-time monitoring video data, and test the test of the pig in real time. Before the temperature zone (hip) and the position of the pig's temperature measurement area detected by the raspberry pie algorithm are sent to control the gimbal, the center position of the pan/tilt and video surveillance camera needs to be calibrated, and the camera must be tested every time. In the warm zone, there is only one breeding pig in the line of sight. Only the control pan/tilt after calibration can receive the position of the pig's temperature measurement area (hip) sent by the Raspberry Pi, and correctly adjust the infrared temperature sensor to measure the temperature of the pig's buttocks. Finally, the wireless network sensor is used to send the body temperature value of the corresponding breeding pig to a computer, mobile phone or other mobile terminal to display the real-time body temperature of each breeding pig. After the camera is stopped for monitoring the body temperature of the pig in a short time before each breeding fence, the video camera is moved by the slide rail to continue measuring the body temperature value of the next pig. Repeat this process until after measuring the body temperature values of all the pigs in a row of pigs, and then return to the repeated measurement to monitor the effect. System working scene and thermometer design is shown in Figure 3.
2.3. App platform design
The platform finally uses the android App platform for presentation, and the App uses the Hybrid App for research and development. The Hybrid App mainly uses JS_Native to call each other, and realizes the mechanism of “one development, multiple operations” from the development level.

The Hybrid App development model is an App development model based on the Native APP and Web App development models. It has a better user experience of the Native App development model and a cross-platform advantage of the Web APP development model, and is simple to update and maintain [7].

3. Experiment and system implementation
The dataset is sourced from a school farm pig house and provides up to 51 hours of breeding pig surveillance video. Through the processing of the video, a total of 38,000 pictures of the training set were obtained, and the test set was 30,000 pictures. In this paper, the computing device uses Inter Core i7 processor, memory 8G, 1T hard disk, N1080TI graphics card (6G alone), and the operating system is Windows 10. The hardware device uses the Raspberry Pi to perform PTZ linkage and upload and receive data. The software development platform is java1.6.0 and android SDK8.0. The system software and hardware use WIFI communication. The image data and temperature data acquired by the camera and temperature sensor are sent to the server through the Raspberry Pi, and the server processes the data to return the data representing the result. They are PTZ linkage data and temperature warning data. Will return to the Raspberry Pi and mobile client for related processing and complete business operations.

3.1. Target monitoring algorithm training experimental data and results

| Surveillance video | Total time 51 hours |
|-------------------|---------------------|
| data set          | Training set 38,000 pieces | Test set 30,000 pieces |
| Results of the SSD| mAP 84.5%            | FPS 22                |
4. Conclusion
Researchers at home and abroad are currently focusing on the study of wearable devices or invasive devices for intelligent pig raising. This type of equipment has extremely high measurement accuracy, but this type of system can greatly increase the installation cost and is also detrimental to the growth of animals. These devices also present risks such as loss and damage. The trend of the paper is to develop non-contact monitoring devices in combination with the rapid development of artificial intelligence and machine vision technology. Taking Alibaba's intelligent pig raising system as an example, they combined with a fixed camera and artificial intelligence system to monitor the temperature of domestic pigs, but it measures that the body surface temperature is not the actual body temperature of the pig, and there is still a large Errors, while each pig house requires multiple sets of equipment to monitor the herd, greatly increasing the cost of farming. Many other technology companies use earrings and invasive sensor devices to monitor the temperature of the pigs and then analyze the collected data using artificial intelligence algorithms. However, invasive equipment is inconvenient to wear for domestic pigs, and there is also a great risk of damage and the cost is too high. Based on agricultural informationization, the paper's system innovatively combines infrared thermal imager and deep learning algorithm to track and visualize the body temperature of each breeding pig. It makes up for the blank of real-time body temperature monitoring, can isolate the suspected danger in time, and avoid the spread of immunity. It is the key technology needed in the current social situation.

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