

Intelligent Farming Control System based on Computer Vision

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Abstract—This paper presents an intelligent, stable, low cost farming control system to solve automatic farming issues. It promotes the development of intelligent farming by detecting animal feed and animal waste and applying different treatments in different conditions. RFID, Auto-transport units, temperature and humidity detectors are added to extend the system's functions.

I. INTRODUCTION

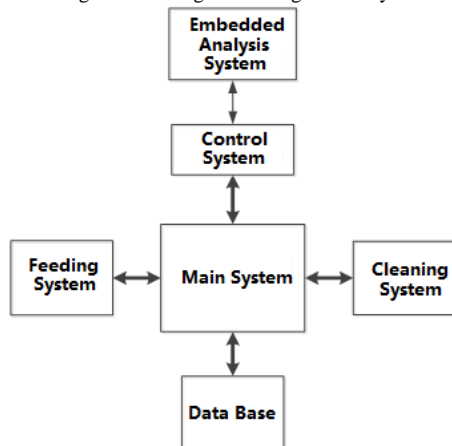
As the popularization of cameras and network, computer vision is needed to solve many problems. Applying computer vision to intelligent farming is a new break through.

However, intelligent farming has not been broadly used due to the low market demand and the high system cost. Nowadays, most farms still use manpower to feed and clean, even the controlling and managing cost is high. Also it is easy to make mistakes when managing manually.

In order to optimize the benefit and lower the cost, manpower cannot satisfy the needs. Moreover, modern farming surveillance system can only provide video records, but not control the farm. In other words, intelligent farming system is urgently needed to overcome these problems such as high managing cost, low efficiency, resources wasted and bad management.

The intelligent faming control system detects the available animal feed and the amount of animal waste. Then from the detection results, the system automatically controls the cleaning and feeding system to accomplish certain tasks.

Figure 1: Intelligent farming control system



II. INTELLIGENT FARMING CONTROL SYSTEM

Machine farming is an application of 'Intelligent information technology application of farming', which is proposed by Ministry of Science and Technology (MOST) in 1990 under '863' project. It is actually a tool for farming management and decision [1]. It learns special agriculture knowledges manually and provides decisions in different circumstances.

Digital farming is developed based on the traditional machine farming. Its main features are collecting, transmitting and processing data. It makes farming digital and automatic [2].

With the development of Internet of things and Cloud computing, intelligent farming is developed. Intelligent farming is a mixture of automatic production, intelligent management and optimum controlling. Even this concept is still new, automatic devices are still popular in our life.

In traditional stock farming, cameras form a surveillance system and RFID is used for the animal identity control. However, these systems are far from enough. The new intelligent farming control system firstly detects the available animal feed and animal waste contamination area, and then the sub-systems are controlled to managing the farm. The intelligent system includes: surveillance system, embedded analysis system, feeding system and cleaning system. These sub-systems all have three processes: detecting, controlling and informing.

Detecting system includes animal feed and animal waste detection. The detections modules are embedded into the cameras so that real-time detection can be achieved.

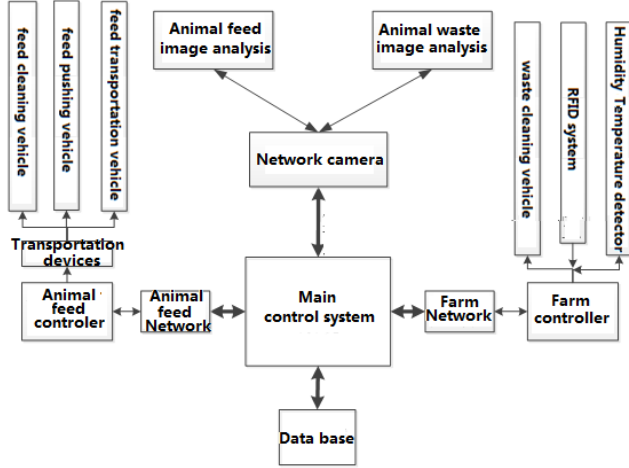
Controlling system includes animal feed transporting vehicles, animal feed pushing vehicles, sewage cleaning machines. They can transport and push the animal feed, and cleaning the animal waste once they receive an instruction from the central control system.

In the informing system, all the information such as videos, temperature and humidity data, RFID data are reported to the central control system.

The intelligent farming control system has these three sub-systems, which operate independently. Also all the

information can be gathered in the central control system. It is effective, easy to control and stable.

Figure 2: Structure of Intelligent farming control system



III. COMPUTER VISION IN INTELLIGENT FARMING

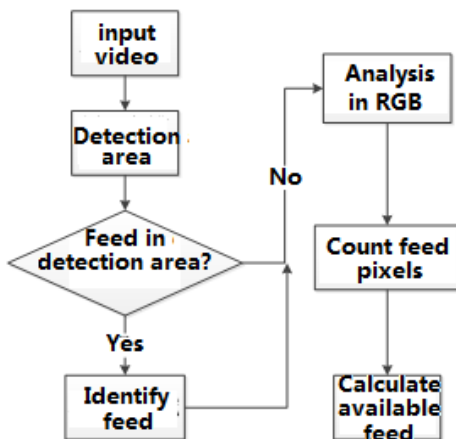
Currently most farms check the available feed and contamination area manually. The staffs in the farm check the animal feed regularly and carry the feed to the stock farm. They also have to push the animal feed when one side of the feed is eaten up. The same method is applied for cleaning the animal waste. The staffs check the amount of animal waste and use the cleaning machine to clean manually.

The animal feed and the animal waste can be detected automatically by using the intelligent farming control system. Also, machines can be operated automatically so that less staffs are needed to do the everyday work.

A. Animal feed detection

There are many algorithms [3][4] to detect the animal feed. Most detection algorithms use edge features, color features and shape features to detect the location of the animal feed.

Figure 3: Animal feed detection



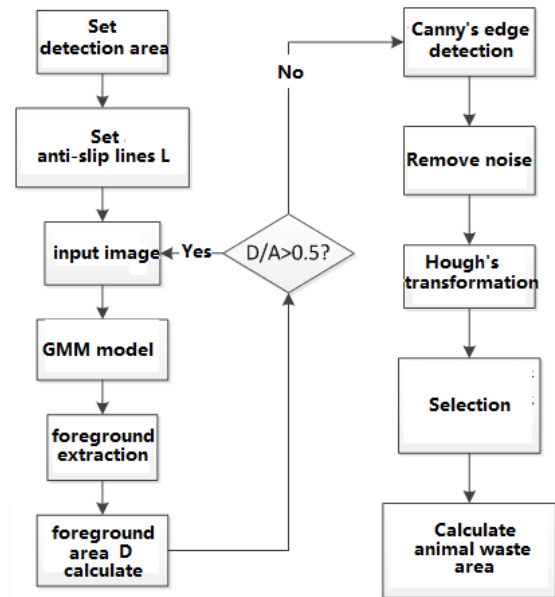
When an image is captured, it is detected that whether the animals are eating. If any animal is eating in the image, the area in the image is regarded as the detection area. Then for

the detection area, color detector classifies the animal feed due to the different color of the animal feed from the ground. Also, edge detector detects the animal feed. Then the detection results are combined and the available animal feed in the detection area is estimated. Finally, the estimation is fed back to the central control system.

A. Animal waste detection

The animal waste is detected by detecting the anti-slip lines in the stock farm. If any of the anti-slip lines is not detected, it means the line is covered by animal waste. The percentage of the lines, which are not detected, is calculated to estimate the amount of animal waste. The detection results are then fed back to the central control system.

Figure 4: Animal waste detection



IV. AUTOMATIC TRANSPORTATION DEVICES

Automatic transportation devices are the hands of the system. These devices are broadly used in the farm. Once a feeding or a cleaning demand is arisen, the central control system will send an instruction to the transportation devices to feed or clean.

A. Feeding devices

The feeding devices are devices that can accomplish a series of feeding tasks. The devices include feed transportation vehicle, feed pushing vehicle, feed cleaning vehicle, conveyor belt and controller.

The central system controls all feeding devices together. The feed transportation vehicle transports the animal feed to the ground, the feed pushing vehicle pushes the animal feed to the conveyor belt, then the conveyor belt is controlled by a controller to move the animal feed. Finally, the excess animal feed is removed by the feed cleaning vehicle. Once the tasks

are finished, data will be sent to the central control system and the feeding devices will wait for further instructions.

B. Cleaning devices

The cleaning devices are plough-like machines that communicate with the central control system through WIFI. When a cleaning process is needed, the cleaning devices will receive an instruction from the central control system. The cleaning devices will then clean up all the animal waste on the ground and return to their original positions. Also cameras can be installed on the cleaning devices to analysis images.

V. COLLECTING DATA

Collecting the data is important for farming management. Data include lighting condition, ventilation, temperature, humidity and videos are collected and sent to the central control system. Then the data can be shown as an output to the supervisors. Also the data are saved as the historical records.

A. RFID

RFID includes Reader, Writer, antenna, labels and RFID data collect supporter. RFID is useful in tracking the animals. For example, RFID is used in pork tracking system by SpiesslMaryr E[5]. In intelligent farming, it can be used for animal number control, reducing cost of losing animals. Each animal in the stock farm has a RFID label. A reader and a data collect supporter are installed on the door. Any animal leaving or entering the stock farm will be reported. The RFID has many advantages, such as long distance detection, multi-targets detection and repeatedly reading data.

B. Data base

The data base can store the historical data such as temperature, humidity, and lighting condition. It can also store operation events such as cleaning processes and feeding processes. So that relative supervisors can analysis the historical data and make better operation strategy to run the farm.

VI. DEMONSTRATION

After an image is captured, detection area is selected to detect the animal feed. The detected animal feed is marked as green to inform the staffs. An example is shown in figure 5.

Figure 5: Animal feed control system

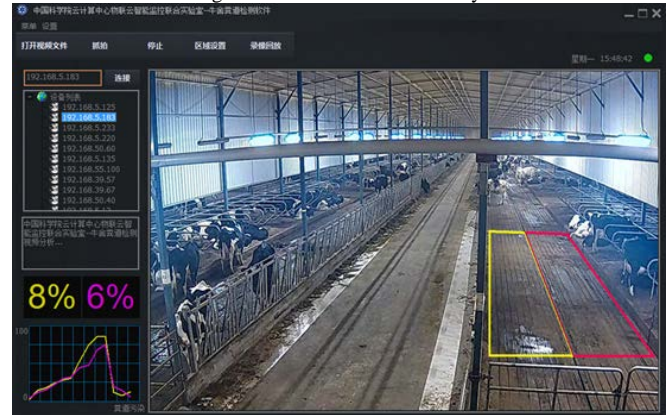


The contour of each detection area is shown in the image and the percentage of available animal feed is shown in the output window. The percentage changes from time to time to plot a curve.

From the detection results, the system makes decisions and sent instructions to the feeding devices. Once the animal feed reduces to 15%, the feed cleaning vehicle starts cleaning. After that, the other devices transport new feed to the detection area. Then the percentage of available animal feed reaches maximum level again. When half of the animal feed is eaten, the feed pushing vehicle pushes the feed toward the animals.

For the animal waste control system, the system calculates the total length of the anti-slip lines in the detection area from the gray scale image. Then the length percentage of the covered anti-slip lines is calculated and shown in the output window. A curve is plotted from the percentage. An example is shown in figure 6.

Figure 6: Animal waste control system



When the percentage reaches 75%, the control system sent an instruction to the animal waste cleaning devices to clean the animal waste until the percentage reduces to 15%.

VII. ACKNOWLEDGMENT

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