Study Progress of Intelligent Facility Feeding Technology for Broilers

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Abstract. Some progress has been made on the intelligent facility breeding of broilers in China and international. Contents and achievements of the research are concentrated in two aspects. One is the control of breeding environment, and the other is the recognition automatically of broiler state. The research achievements in these two aspects were summarized, and the application status and prospect of these research achievements were analyzed in this paper, which would provide reference for the development of intelligent broiler feeding.

1. Foreword
The Intelligent facility breeding of broiler is an intelligent breeding method based on the new information science and technology. It is on the premise of meeting the physiological and welfare needs of animals. It is based on the individual differences in groups. It is characterized by on-demand, fixed-point and regular feeding management. And it is the specific embodiment of fine agriculture in broiler production industry. More specifically, based on the mechanized and information-based equipment that can meet the needs of broiler growth, life and production management, the Internet of things technology is applied to acquire the digital information related to the physiological and production process of broiler population, including the physical and behavioral information. Moreover, through the algorithm of broiler growth model, healthy state of broiler can be predicted scientifically and responded in real-time. And by using closed-loop industrial control theory, the microclimate environment in the broiler house can be controlled intelligently. In addition, based on the acquired digital information, the whole process automatic production management and decision-making services can be implemented such as scientific feed supply, disease prevention and control.

2. Environment control of Intelligent facility breeding

2.1 Introduction
Intelligent broiler feeding environment is to install various environmental sensors such as ammonia, temperature, humidity, light in the broiler house. These sensors are connected into a network to monitor the environmental information. According to the existing research results and breeding experience, thresholds of some environmental parameters are set in the intelligent breeding system. When the collected environmental data exceeds the threshold value, intelligent breeding system can give an alarm. Computer alarm or mobile text message alarm can be chosen on the user interface. Furthermore, in order to improve the intelligence of environmental control and reduce the negligence caused by human, when the environment is abnormal, the intelligent breeding system can start the...
control equipment including heating, fan, wet curtain and other equipment. All of these make breeding management more intelligent and accurate.

2.2 *Research progress abroad*

In foreign countries, environmental parameters affecting broilers growth are collected, and some effective model about environment and broiler growth is established, and the environmental monitoring system is developed. British and Belgian researchers Tomas Norton, Alberto Peña Fernández, et al. studied Real-time modelling of indoor particulate matter concentration in broiler houses using broiler activity and ventilation rate[1]. A function model of discrete-time multi input and single output was established. In this model, activities of broilers and ventilation rate of broilers house were used as input to determine the dynamic model of particulate matter concentration at different time of each day in the broiler house. The model can predict the indoor particle concentration level in advance and was able to applied to the real-time particle concentration control system in the broiler house. Belgian researcher Ali Youssef et al. developed a towards real-time control of broiler activity in a ventilated broiler house[2]. In this study real-time modelling was used to predict the dynamic activity index of broilers in relation to variations in the inlet temperature and ventilation rate. Real-time models were defined to describe the dynamic response of broilers’ activity to changes of ambient temperature and air flow. A real-time calculation software system of broiler activity level was developed. The model will be applied to the intelligent decision-making function of the broilers house environment control system.

Research has been done on the breeding facilities to improve the welfare of broilers. Danish researcher Monica h. Bach et al. studied effects of environmental complexity on behavior in fast-growing broiler[3]. Their experiment set up five types of facilities to change the complexity of the environment of the broilers house: the elevated platform with/without ramps, vertical boards, straw bales, roughage, three facilities setting ways (two groups with differing increased distances between resources and one with reduced stocking density) to observe the behavior of 6, 13, 20, 27 and 34 day old broilers. The applicability reference model of different days old broilers to different types of complex facilities and their setting modes was proposed. These achievements should be used to improve the welfare of broilers.

2.3 *Domestic research progress*

Some researchers have monitored the effects of different environmental parameters on the physiology and behavior of broilers. These researches provide a theoretical basis for intelligent and fine regulation of chicken house environment. Some researchers have developed the environmental monitoring system of broiler house and carried out small-scale experiments. He Xiaofang of Nanjing Agricultural University et al. studied the regulatory mechanism of the influence of warm environment factors on broiler feeding, which provided a theoretical basis for the control of warm environment of broilers[4]. Yang Li, from Sichuan Academy of animal husbandry studied the distribution of environmental parameters in the closed environment-controlled broiler house, which provided a theoretical basis for the design and layout of breeding facilities[5]. Zheng Jiye of Shandong Academy of agricultural sciences et al. developed the monitoring and control system of broiler healthy breeding environment [6]. This system can ensure that the temperature of the broiler house is constant basically, and the concentration of inhalable particles, ammonia, relative humidity in the house are kept in a proper range. Qi Lihong of Shandong Academy of Agricultural Sciences et al. studied the monitoring of environmental parameter and production performance analysis of broilers in different feeding modes in winter[7]. The differences between environmental parameters and production performance of three kinds of broiler feeding modes (thick cushion feeding, online flat feeding and three-layer ladder cage) were analyzed in detail, which provided theoretical basis for the control of environmental parameters of different breeding modes. Shen Liyan of Shanxi Academy of agricultural sciences et al. studied the measurement of the internal environment of the laminated three-dimensional chicken house and its influence on the production performance of the white feather broiler in winter, which provides a
detailed parameter basis for the environmental control of the laminated three-dimensional chicken house[8].

3. Intelligent chicken state recognition

3.1 Introduction
The state of broiler includes physiological parameter, behavior characteristic and calls characteristic. The abnormal state recognition of single broiler can detect disease and dead broiler, deal with and prevent disease spread in time. Characteristics collection, data analysis and model establishment of broiler group state can reflect the information of animal welfare, whether the breeding environment is suitable, and whether the breeding equipment is in failure. According to the judgment of broilers’ eating and drinking behavior, water and feed can be supplied on time and quantity to realize automatic and precision feeding. Because of the small body of a single broiler and their short breeding period relatively, it is not suitable to implant a single sensor to identify the individual state. Therefore, it is the main research hotspot to recognize the state of broiler by machine learning algorithm through collecting video and audio in the broiler house. In general, the group status recognition of broiler is more operable, more accurate and more meaningful, which can provide the basis for intelligent decision-making for the intelligent facility breeding system.

3.2 Research progress abroad
In recent years, scientists have made some progress in recognizing specific behaviors of chickens through video and audio analysis. Turkish scientist A. Aydin et al. used sound technology to automatically detect short-term feeding behavior of broilers[9]. Through the analysis of chicken pecking sound, the feeding behavior of broilers was obtained. The results of the algorithm were highly positively correlated with the feeding behavior recorded by camera. These researchers also developed a real-time monitoring system to automatically measure the broilers group intake through sound analysis. Based on the analysis of pecking sound of broilers, the intake of broilers was obtained. The results of the algorithm are highly correlated with the feed intake recorded by the weighing system. The algorithm has high accuracy and low cost, so it can be applied in commercial conditions. The advantage of the system is that it can be continuously measured in a completely automatic and non-invasive way during the whole period of broiler feeding. The results are applied to the automatic feeding system in the broiler house. Belgian researcher Mohamadamin kashiha, developed an abnormal early warning system for broiler houses by using computer vision technology[10]. The system used the distribution position of broiler in the house to convert the distribution index, and automatically judged the failure of feeding, water supply and ventilation equipment in the house through the distribution index of broiler, in order to warn earlier. The system is tested in commercial chicken farm. British scholar Marian stamp Dawkins et al. studied the method of evaluating the welfare of chickens by using light flow model and herding behavior[11]. The automatic analysis of the long video of the camera can be completed by the optical flow pattern statistical descriptor generated by the movement of the broiler group. The results showed that there was a significant negative correlation between the number of walking broilers and elbow burns. And there was a significant positive correlation between the skew values, peak values of light flow and the number of chickens walking continuously for at least 10 seconds. The results revealed the correlation between the light flow index and chicken death, elbow burn, dermatitis and gait scores, which replaced the earlier and more invasive measurement methods. This study was used to evaluate the welfare of broilers, and also to predict the abnormal behavior of broilers. Ilaria Fontana, an Italian researcher, reported a method for predicting the weight gain of broilers in closed house[12]. Relationship between sound frequency and body weight was determined by recording and analyzing the calls of broilers under normal conditions. The results showed that the frequency of the animal’s voice was inversely proportional to age and weight. This method can be used to predict the growth rate and welfare of broilers. In addition, based on the method of specific voice recognition, early warning of abnormal behavior of broilers can
be proposed. American scholars have developed a UHF RFID system to study the feeding behavior of broilers[13]. This system can accurately detect and record the feeding and drinking behaviors of individual broilers in the group environment, which provides the basis for the intelligent feeding system of broilers.

3.3 Domestic research progress
Du Xiaodong of China Agricultural University et al. studied the method of monitoring abnormal events in broiler house based on image and sound technology[14]. A non-contact, 24-hour continuous and automatic monitoring method is proposed. Kinect equipment is used to synchronously collect image and sound data. Based on LabVIEW software, abnormal events in broiler house are analyzed and forewarned. This method combines image and sound technology to obtain the average daily activity index and sound energy of broiler population, in order to study the early warning of abnormal events affecting broiler performance in the broiler house. Jiang Wuhao of Zhejiang Agricultural and Forestry University et al. studied the intelligent feeding strategy of broiler based on Data Mining Technology [15]. A broiler information collection system is designed. The system mainly collects the behavior of Broilers' drinking. Through the analysis of feed weight changes, the quantitative extraction and visual analysis of the behavior of broiler drinking were carried out. Finally, a behavior prediction model based on LSTM was designed to predict the behavior of broilers eating and drinking in order to get the specific feeding time and feeding weight.

4. Summary
At present, broiler breeding is gradually transiting to scale and standardization in China, but the general level of machinery and equipment is not high, and the intelligent facility breeding is still in the initial stage. Application of "Internet of things +" based fine breeding technology on broiler facilities is more reflected in environmental information perception and data transmission. Based on the growth physiological regulation model and on-demand decision-making control technology of broiler, which is still in the stage of imitating factory control. The single factor application of perception without decision, and decision without control is common. The application of "perception learning decision negative feedback" has not been formed yet, which greatly reduces the effect of facility breeding on the transformation of traditional broiler breeding.

The architecture of the intelligent facility breeding system for broiler is composed of the sensing layer, data transmission layer, data processing layer and data application layer, as shown in Figure 1. In the future, facility intelligent breeding technology should be based on the big data information system which can reliably acquire and store the original data. It is the future research direction to digitize domain expertise, optimize professional algorithms, and analyze and process massive data and information using various intelligent computing technologies such as cloud computing and fuzzy recognition.
Figure 1. Figure with architecture of intelligent facility feeding system

Acknowledgements
Paper supported by national broiler industry technology system post scientist project (CARS-41-G25). In addition, paper supported by major project of Internet integration and innovation program of Tianjin Science and Technology Bureau: research, development and application support for precision production of livestock and poultry based on Internet of things and big data analysis (18ZXRHNC00080).

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