Remote Monitoring System of Piggery Microclimate Based on Low-Voltage Power Line Carrier

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***Abstract* - The microclimate environment in nursery pig house is important. In this paper an environmental control system based on PLCC for piggery was designed. In order to adjust the local microclimate environment in precise, wireless network equipments like sensors and electronic hot plates were constructed. Management operation can extend from remote user into the piggery to realize the exchange of information between the environment and devices, as well as between the environment and remote user. B/S (Browser/Server) structure is used in the system, which could greatly simplify the client computer load and reduce system maintenance. The experimental results show that the performance of the system is quite stable and the system satisfies the design requirements in real-time data acquisition and environmental automatic control. The monitoring system is suitable for precision environmental management for piggery and has a good application prospect in automatic and intelligent livestock breeding industry.**

Keywords - The center point, Matlab; Tilt, Bending,Distortion

I. INTRODUCTION

At present, the attitude towards animals has developed from the simply prevention of animal abuse to animal welfare promotion [1.2]. Animal welfare is realized in farms through legislation and the formulation of norms [3.4]. In swine industry, farm house environmental control is not only the demand for animal welfare, but also one of the important factors that determine the level of pig production [5.6.7].

With increasing herd sizes in livestock farming and a decreasing labour time available per animal, adequate individual monitoring of animals becomes difficult. Therefore, automated monitoring of farm animals can be helpful and, in addition, might avoid economic losses. Automatic control of the pigs' environment is already common practice, but behavioral measurements with the potential to improve production efficiency are still lacking. Lifeng Li et al. developed a piggery environment intelligent monitoring system based on PLC（Programmable Logic Controller）, which can improve the environmental quality of farrowing house and increase breeding efficiency [8]. This system realizes whole environmental control, no further adjustment of the pigsty environment. So it cannot flexibly regulate microclimate environment according to the different personalized pigsty.

Low-voltage power line carrier communication is a technology of data transmission and information interaction, which uses the existing low power distribution network. Low voltage power line carrier communication is mainly used in residential power supply area for data transmission, and widely used in low pressure system for AMR (Automatic Meter Reading).

Based on former researches, a remote monitoring system of piggery microclimate based on low-voltage power line carrier is developed. Every monitoring node data communication is achieved by concentrator through low voltage power line carrier communication. Thus, both wiring construction difficulty and cost are reduced. Remote management is realized since system receives breeding date and gives orders via server.

II. MATERIALS AND METHODS

A. Animals and Housing

The tests were performed in a pig house at the experimental farm of the Shandong Best Farm Best Food Corp, which located in Ningyang County Shandong province of China. The size of the piggery is 70000× 12000. The piggery is divided into four types: replacement gilts piggery, obstetric crate piglet nursery, fermentation feed shop. Among them the replacement gilts has four piggery. And the area of the four types of piggery is equal. The whole piggery has 40 replacement gilts, 8 farrowing sows and 20 piglets. Piggery uses

slatted floor and has reasonable feeding density, floor plan shown in Fig. (1).

B. Overall Scheme

The monitoring system in this paper can be logically divided into three levels: field monitoring system, data concentrating system and remote monitoring system. Overall framework of control system is shown in Fig. (2). Each room has a field monitoring system. The function of the field monitoring system is collecting data, controlling the electric actuator and uploading data to concentrating system with PLCC. Each pig farm has a data concentrating system. The function of the data concentrating system is concentrating data from the field monitoring system with PLCC and upload data to remote monitoring system with internet. Taking advantage of remote monitoring system, user can monitoring piggery parameters and adjust the piggery motion parameters, even when the distance is very far or the system has many piggeries.

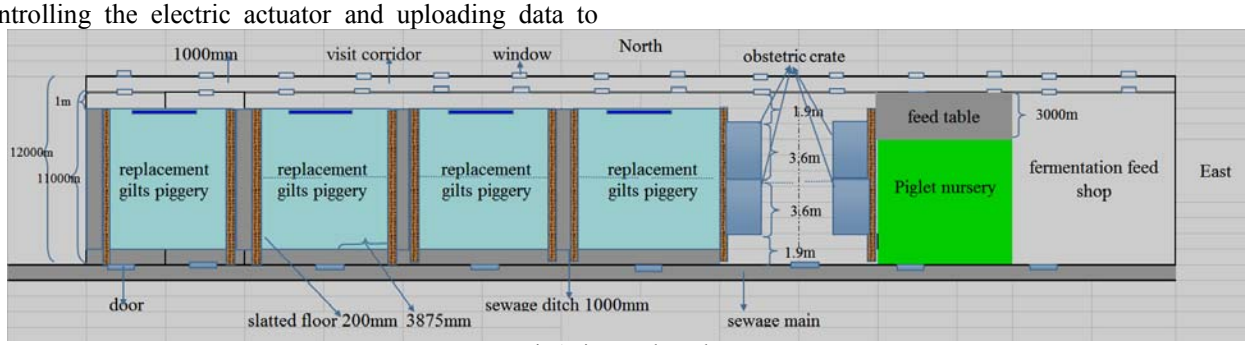

Fig.1 Piggery Floor Plan

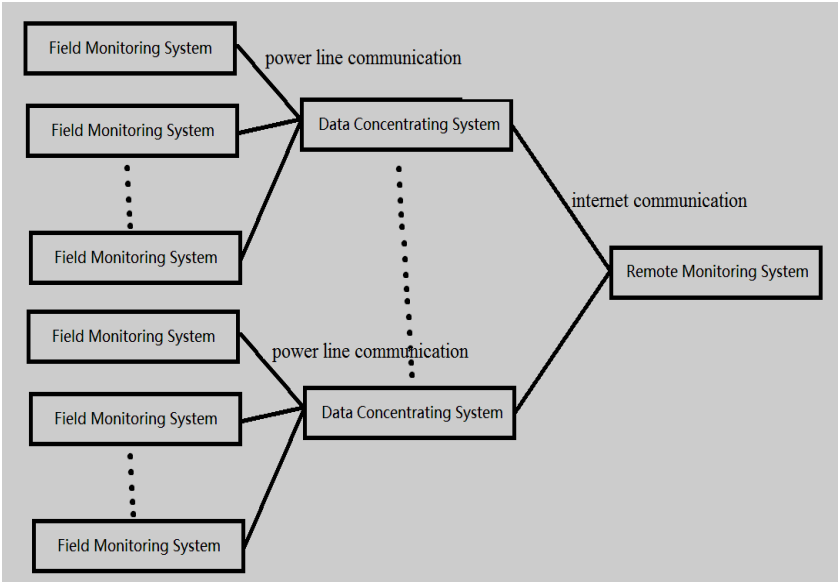

Fig.2 Overall Framework of Control System Based on Power Line Communication

C. Design of Subsystem

1) Field monitor system

Piggery microclimate remote monitoring system has four monitoring targets: temperature, humidity, harmful gas, and light intensity. The function of field monitor system is to collect the relevant environmental parameters, and to determine the corresponding action according to the previous value to adjust piggery microclimate. At the same time, the system receives instructions sent by data concentrating system through the low voltage power line carrier communication to modify the local setting value, or send the historical local environment parameters data and acting event to data concentrating system through data concentrating system query. Overall framework of field monitor system is shown in Fig. (3). Each barn is equipped with a separate field monitor system, with independent CPU and low voltage power line carrier communication function.

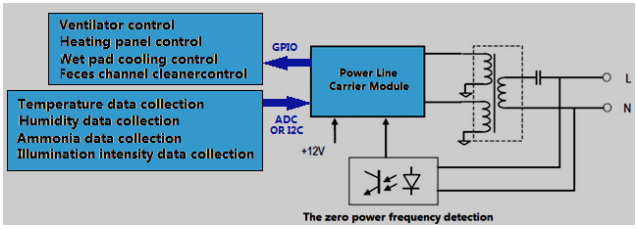

Fig.3 Overall Framework of Field Monitor System

Power line communication chip LME2980（Leaguer Microelectronics， Shenzhen china） based on narrow band OFDM is the control core of Field monitor system. It provides 3.3V DC power, MCU Processor and multiple ADC and DAC, reducing the peripheral circuit wiring and increasing the reliability of the system. The field monitor system upload data using coupling of high frequency signals in the power line. The system can not only reduce field wiring, but also be suitable for the reconstruction of the old farm.

Temperature humidity sensor use SHT10(Sensation, Switzerland).it's temperature range is-40℃～+123.8℃, with resolution of 0.01℃, and humidity measurement range 0 ~ 100% RH, resolution of 0.03% RH. Measurement range and precision can meet the requirement of the project. As shown in Fig.(4), SHT10 is connected to control core through two-wire I2C protocol.

Fig.4 Temperature Humidity Sensors

Ammonia sensor is 4NH3-100(RAE System， American)， as shown in Fig.(5). Measurement scope of this sensor module is 0-100ppm, and the resolution is 0.5ppmOutput current signal is connected to phase ADC of the control core after converted to voltage signal.

Light intensity sensor adopts GY-30（Dihuitech， Beijing china）as shown in Fig.(6). The measuring range of this module is 0-65536 LX, resolution is 1 LX and output mode is I2C bus. Output pin is connected with control core directly.

Fig.5 Ammonia Sensor

Piggery cooling is realized by wet curtain and ventilation fan, as shown in Fig. (7). Obstetric crate is heated by the heating plate at crate bottom, and replacement gilts piggery is heated by special heating cables in cement floor.

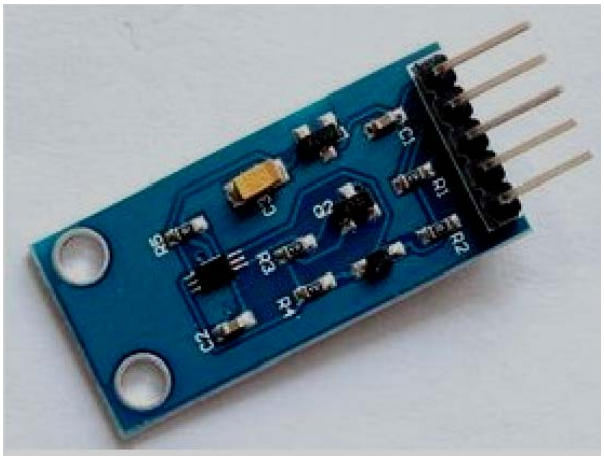

Fig.6 Light Intensity Sensor

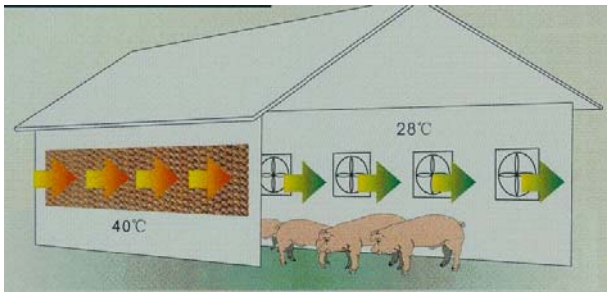

Fig.7 Sketch of Piggery Ventilation

Flow chart of main program of field monitor system is shown in Fig. (8). Piggery environmental data collected periodically, heating device is turned on as temperature below the lower limit and ventilator is turned on as temperature higher than the lower limit or humidity and noxious gas concentration higher than the upper limit. At the same time, the current environmental data, event and occurrence time are recorded. After received active query of the data concentrating system, field monitoring system upload the data. If the ventilation does not work within 24 hours, it will be forced work in accordance with the standards of table I. Air volume of the ventilation is 1200 m^3/h.

TABLE I. STANDARD VENTILATION TIME OF PIGGERY

The category of the piggery	Ventilation time of cold weather(h)	Ventilation time of warm weather(h)
Replacement gilts piggery	0.4	1.7
Obstetric crate	0.7	2.7
Piglet nursery	0.1	0.5

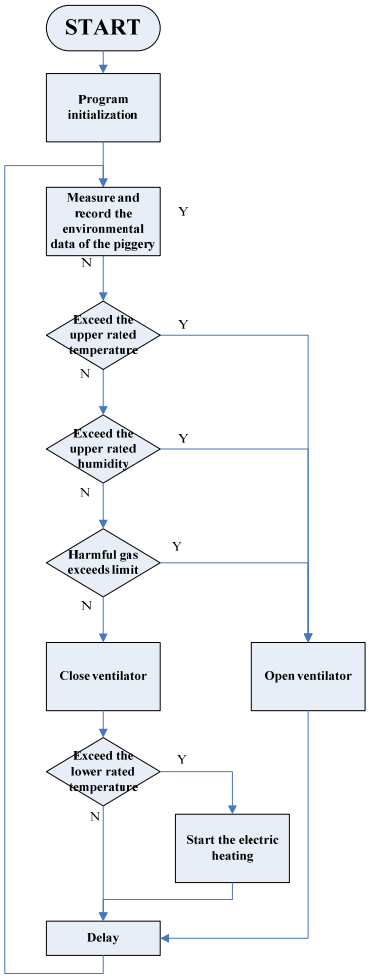

Fig.8 Flow Chart of Main Program

2) Data concentrating system

Overall framework of data concentrating system is shown in Fig.(9). Control core uses LME2980 chip with internal PLCC, and Ethernet converter adopts transparent transport protocol 5210i(TERI , Shenzhen china), connected to LME2980 through TTL.

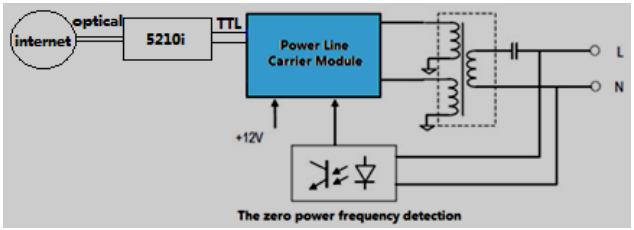

Fig.9 Overall Framework of Data Concentrating System

3) Remote monitoring system

System uses WWW (World Wide Web) technology to install web service software IIS (Internet information server) in the server computer and develops web site and dynamic web based on ASP. Net, implement the remote networking, which can be used to query remote data and monitor Piggery breeding environmental information, system logs and operating records, as shown in Fig.(10).

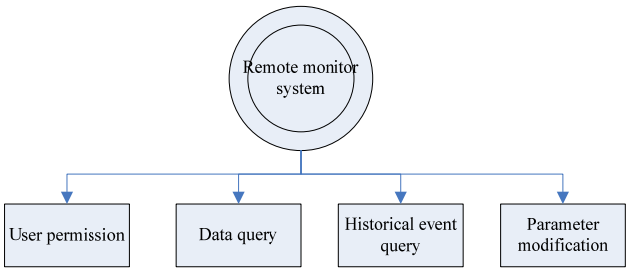

Fig.10 Function of Remote Monitoring System

III. RESULTS

Browser-based user interface of environmental monitoring and control system is shown in Fig.(11).

Fig.11 Browser-based User Interface of Environmental Monitoring and Control System

Fig.(12) shows when operating at automatic control mode, the control effect of temperature inside the piggery under the precise control. Control effect of humidity is shown in Fig. (13), which test date is July 17, 2015, 18 pm to July 18, 2015, 18 pm. According to the optimum temperature and humidity of piggery, control interface temperature is set at 20～28℃ and humidity is 40%~85%. in piggery ,when temperature is higher than 28℃, or humidity is higher than 85%, ventilator is set to be turned on in program .The working station of the ventilator is shown in Fig.(14).

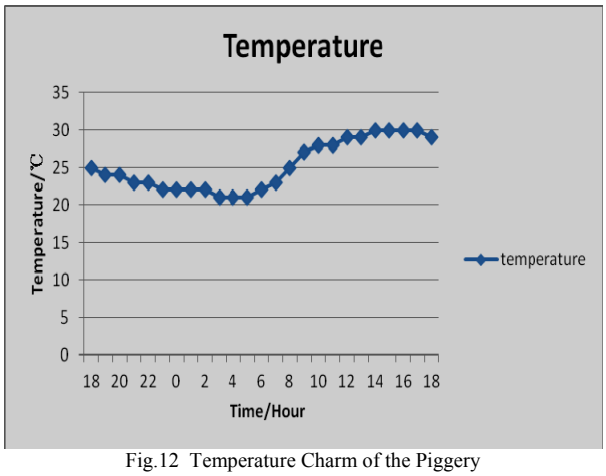

Fig.12 Temperature Charm of the Piggery

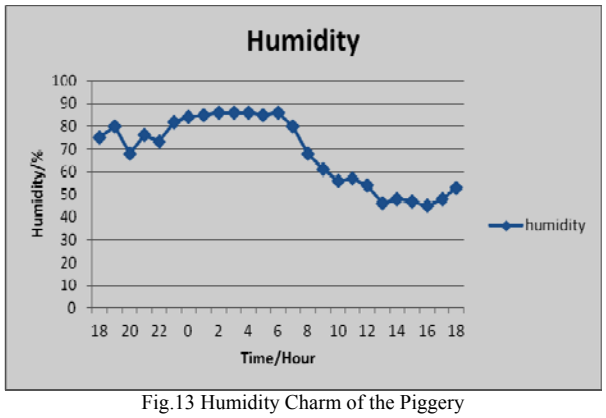

Fig.13 Humidity Charm of the Piggery

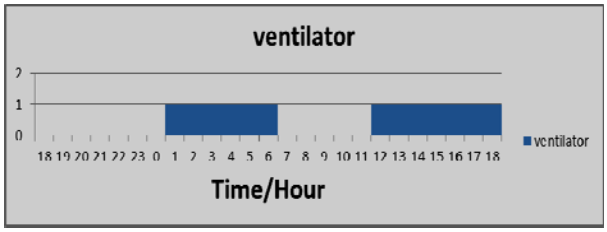

Fig. 14 Work Station of Ventilator

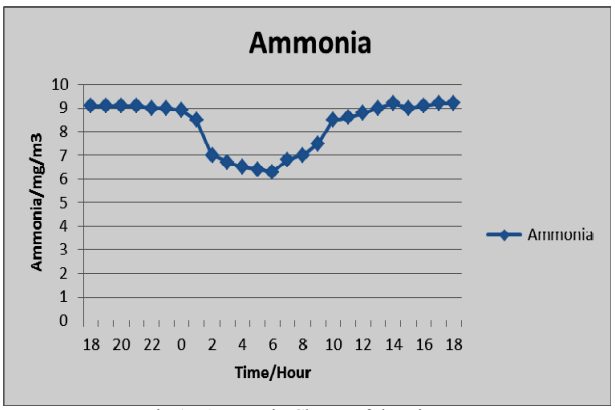

Fig.15 Ammonia Charm of the Piggery

IV. DISCUSSION

The control system proposed in this paper contains a number of parameters. In the actual experiment, the parameters of ammonia gas barely exceed limit. so the experimental data of temperature and humidity are selected as major test data. In the date selected in experiment, July 18, 2015, 0 am to July 18, 2015,5am rained, so piggery humidity value was high during that period. Although at this period exhaust fan is turned on, humidity value still exceeded the maximum set value 85% reached 86%. On July 18, 2015 at 11， ventilator is turned on since temperature exceeding the upper limit value, as shown in Figure 14. due to the high temperature of outdoor, temperature of pigsty is still slightly higher than the set value. in the selected time period Although temperature and humidity actual value exceeds the set value range, the experimental data show that, the system can run normally according to the way it is set. Under the control of the system, parameters such as temperature and humidity can be effectively adjusted, and the comprehensive effect is good. By taking temperature and humidity as the experimental subjects，the results show that the system can accurately obtain the environment parameter, and precisely control the various equipment. With this system, the microclimate of the piggery conforms to the requirement, and achieves the anticipated effect.

V. CONCLUSIONS

This paper discussed design method and development process for remote monitoring system of piggery microclimate based on low-voltage power line carrier, and tested application effects. Research and practical application indicate that, the client side is extended into pigpen and the inside equipment through this system, It realizes the information exchange and remote communication between the equipment and LV power carrier communication equipment, and also between the equipment and the persons the automatic control, accurate adjustment and remote real time monitoring in the pigpen is realized. System Function can also be extended to automatic supplying to realize the accurate feeding. So this system has bright future in agricultural and pastoral field.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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