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Henhouse Carbon Dioxide Acquisition System on Different Location

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Abstract: A henhouse carbon dioxide monitoring system was designed based on WSN to collect henhouse different location carbon dioxide. The system composed of hen atmega16L processor, nRF905 wireless communication module and S-100 CO₂ sensor module was developed. The system had the function automatic collection, storage, and wireless transmission henhouse different points carbon dioxide. The experiment showed that: The system power can work more than 3 months, and the system has achieved effective henhouse carbon dioxide acquisition on different location.

Key words: Henhouse, carbon dioxide, WSN, Data acquisition

INTRODUCTION

Henhouse environment control plays a very important role in the poultry production (Ni *et al.*, 2002; Ni *et al.*, 1999), environmental control is the best choice to solve the blight problem (Liu, 2003) and to improve the production performance (Tian, 2003), carbon dioxide is the primary environmental factors affect bird health and performance play (Yu and Yuan, 2003). Therefore, Real-time monitoring henhouse carbon dioxide, constructing the henhouse carbon dioxide network system, has an important significance to improve the laying hens production capacity, reduce morbidity and mortality (Li, 2003).

Wireless sensor networks as a new information acquisition and processing technology has the node size, small volume, low cost, self-networking features, have broad application prospects in the field of environmental monitoring (Ren *et al.*, 2003). In recent years, wireless communication technology was used in the greenhouse field, such as Distributed Greenhouse Monitoring System Based on Bluetooth (Du and Chen, 2005), greenhouse monitoring system based on GSM (Ju and Shen, 2004), wireless sensor network was applied to monitor the cattle research. Australian Federal Scientific and Industrial Research Organization application of sensor networks to establish smart farm, cattle neck wear Global Positioning System the GPS (global position system) and wireless sensor nodes collar to records related to the environment and cattle of behavior characteristics, analysis of the case and thus extended to the entire herd (Handcock *et al.*, 2009; Watanabe *et al.*, 2008; Guo *et al.*, 2006).

A henhouse carbon dioxide monitoring system which had low power consumption, low cost, flexible

networking, friendly man-machine interface, convenient remote management was designed according to the characteristics of the henhouse structure.

SYSTEM ARCHITECTURE

Considering coop area, structure, cages height, automatic feeder location factors, carbon dioxide monitoring system was designed based on wireless sensor networks. The structure was shown in Figure 1, Wireless sensor network nodes collected the coop carbon dioxide information, transmitted to the cluster head node, cluster head node received the coop carbon dioxide information from each sensor node, then sent the processed results to the aggregation node, aggregation node connected to the Internet and remote monitoring.

HARDWARE DESIGN

Wireless sensor node design: Sensor nodes are the basic unit of carbon dioxide monitoring system, having the carbon dioxide acquisition, data processing and wireless communication capabilities. Wireless sensor node hardware block diagram was shown in Figure 2. The low cost, low power consumption, stable and reliable was considered in sensor nodes design.

Sensor selection: Considering coop parameter detection requirements, sensor power, accuracy, range, cost, convenience and other factors, S-100 CO₂ sensor was chosen to monitor carbon dioxide, the sensor size is 33 × 33 × 12.7mm; life is 10 years, the supply voltage is 5V, current consumption 25mA / h; measuring range: 0 -

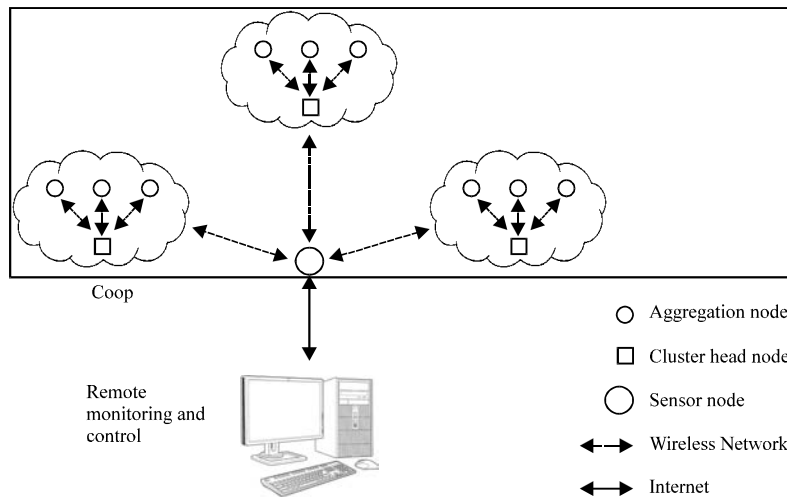


Fig. 1: Architecture of WSN system

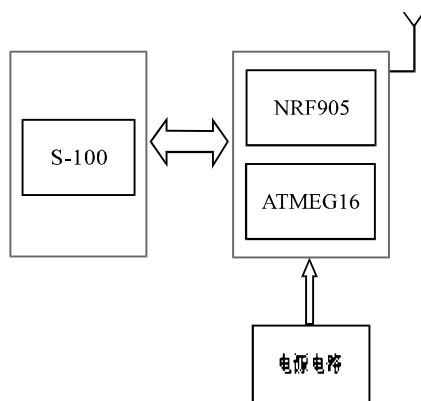


Fig. 2: Schematic hardware system of sensor node

5000ppm, high accuracy, $\pm 30\text{ppm} \pm 5\%$ of reading; provide serial and I²C digital communication interface.

Wireless transmission module: Henhouse environment is special, dust, wet summer, winter high concentration of harmful gases, corrosive, parameters acquisition needs to take protection measures such as waterproof, dustproof, in the large-scale farming all sensor nodes battery can't be replaced frequently, how to save energy of sensor nodes, to ensure a continuous supply of energy needs to consider. ATMEG16L was used for transmission module, the main characteristic of this processor is low power consumption, six kinds of sleep mode support node way. NRF905 was used for Wireless transmitter-receiver, working voltage is 1.9-3.6V, working at 433/868/915 mhz, has 3 ISM channel, nRF905 can automatically complete processing and CRC (cyclic redundancy check) for work, it can be finished automatically by the on chip hardware Manchester encoding/decoding, use SPI interface communicate with

microcontrollers, configuration is convenient, its power consumption is very low. NRF905 particular transceiver module circuit design of the method is simple, you need less peripheral devices.

Cluster head node design: Using a wireless signal communication between the node and the common node of the cluster head, cluster-head nodes receive a normal node sends data packets, and forwarding these packets through network aggregation node, cluster head node wireless data transmission module direct transmission module using ordinary nodes to reduce costs.

SYSTEM SOFTWARE DESIGN

Sensor node modules: Sensor node module mainly includes data collection and send, using CodeVision AVR, it is a HP Info Tech specially designed for AVR a low-cost C language compiler, it produces the code very strict, the efficiency is very high. Program flow chart shown in Figure 3.

Monitoring center management software: Data analysis system for analysis, storage, query the data obtained, the display, and draw a time graph of various parameters. System management software is based on the C # development, the operating system is Windows XP, the software flow chart shown in Figure 4. For the convenience of the user, all friendly graphical interface design management software, human-machine interface. System management software is set by the parameter module, data acquisition module, data processing module and data management module. Parameter settings module to achieve a set of various system parameters, such as the work of each WSN node mode settings, data sampling

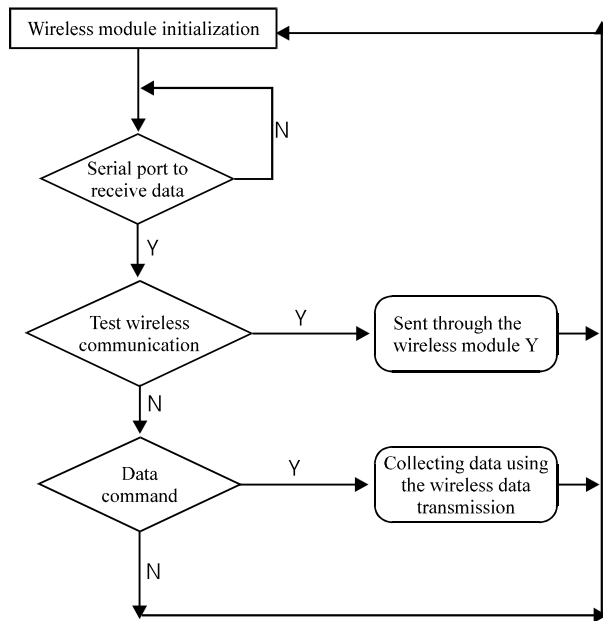


Fig. 3: Flow chart of sensor node

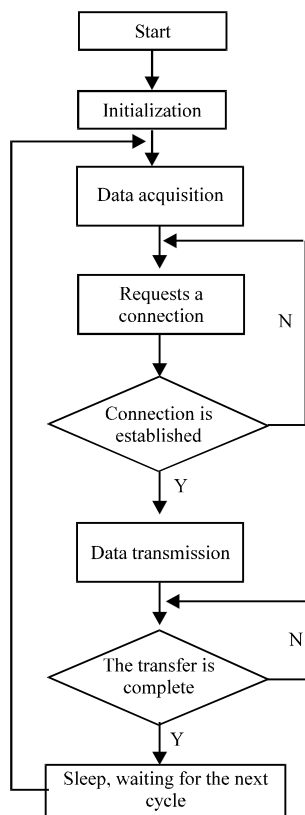


Fig. 4: Flow chart of Data management

time set. The data acquisition module to achieve multi-channel data acquisition synchronization, waveform displayed in real time. Dynamic way of real-time graphs and tables show the various indicators for monitoring changes in information. The data processing module mainly realizes processing on the received data packets, such as digital filtering, numerical scale conversion, the logical judgment. Data management module collect data management, including storage, query, print, and data analysis and statistics. Using a relational database, SQL Server 2000 collected data storage and management, using graphs and tables show the various monitoring indicators of historical data query information.

THE TEST RESULTS AND ANALYSIS

Test deployment method: Test in a chicken farm in shijiazhuang. The hen house is 28 meters long, 8 meters wide, 3 meters high, adopt three layer cascade caged, inner four cages in two columns. Carbon dioxide sensor location according to the situation inside the hen house, in order to better grasp the chicken near carbon dioxide, each layer of the chicken cage in front of the sensor, each layer cages from west to east 3 groups, west chicken coop have a control room, control room has a computer connected to the remote monitoring center through the network. Network node, sensor, which is used to test the installation location, number is shown in Fig. 5.

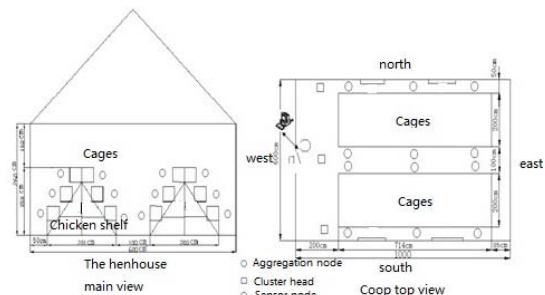


Fig. 5: Installation of experimental system

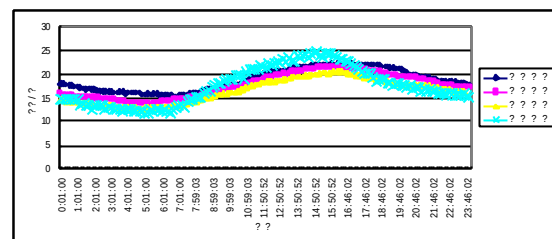


Fig. 6: The temperature curve of the upper, middle, lower, and outdoor in spring

Acquisition node sampling period was set for 10 min, All acquisition nodes use time trigger works, cluster head nodes and gathering node use event triggers work, all the node configuration 1500 mah lithium battery.

Test time from the 2012-02-16--2012-02-16, a total of 70 d; Contrast the read data and remote monitoring center received data, calculate the different node energy consumption, verify that the designed system can realize the henhouse carbon dioxide data remote, real-time, reliable, and wireless transmission.

The test results: Experimental results showed that, without any measures of low power consumption, 1500 mah capacity lithium battery can work for WSN nodes only 2.5 days. By controlling the data sampling interval and adopt measures to sleep such as low power consumption, a single charge of lithium batteries used in single section for WSN node work more than 3 months.

Figure 6 shows the temperature curve of the upper, middle, lower, and outdoor in spring.

CONCLUSIONS

In this paper, a henhouse co₂ detection system was designed based on wireless sensor network (WSN), the system can realize rapid ad-hoc network sensor node and the henhouse real-time collection, transmission and display of carbon dioxide. Experimental results showed that by controlling the data sampling interval and dormancy and other measures to reduce power consumption, the system can realize the henhouse remote, accurate measurement of carbon dioxide.

On the basis of existing research, the next step will increase the henhouse monitoring parameters, in order to realize the henhouse environment parameter more accurate monitoring.

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