Design of a Live Pig Breeding System Based on ZigBee

Shihua Song*, Changyu Liu, Chenyu Liu, Tengfei Zhao, Xinqiang Lan
Hebei University of Science & Technology, Yuxiang Street, Shijiazhuang, Hebei, 050024,China
** Corresponding Author*

Abstract: This paper designed a breeding system based on ZigBee. The system consists of an environment detection module based on ZigBee technology and a video monitoring module based on BP neural network algorithm. The environment detection module is a wireless sensor network based on ZigBee technology. The sensors with different functions interact with the data through the ZigBee wireless communication module, and monitor the environment under the coordinated control of the router and the main control. The video surveillance module adopts the deep learning mode based on BP neural network algorithm, with Raspberry PI as the main control unit, and equipped with deep learning algorithm to identify the body temperature and behavior of pigs, and facilitate the management of pigs by users. The system can effectively monitor the environment of pig houses, the behavior and health of pigs, and improve the efficiency of breed ink the data.

Keywords: Breeding System; ZigBee Technology; BP Neural Network; Algorithm Monitoring Terminal

1. Introduction

With the continuous development of the Internet of things, 5G, big data technology, more and more intelligent equipment tend to be miniaturization integrated development, which makes the originally suitable for large farms mechanization equipment can miniaturization intelligent, thus suitable for small farmers, let the traditional breeding on the modern ride, this system is for small farmers breeding experience, high labor cost, pig disease death rate high characteristic design, help users to master pig development, real-time feedback pig growth environment, reduce the breeding manpower costs.

2. System Design Scheme

The system is divided into two elements: environmental monitoring module and video monitoring module. It is mainly divided into four levels: data acquisition layer, data interaction layer, data processing layer and data feedback layer. The data acquisition layer includes a variety of sensors with different functions, such as temperature sensor, humidity sensor, gas concentration sensor, microbial detector, etc., and also includes the behavioral information and body temperature information collected by video surveillance. The data interaction layer includes the wireless transmission of the data collected by sensors to the sensor through the ZigBee wireless communication module and router, as well as the transmission of video surveillance information, which transmits the collected data to the data processing layer and the data feedback layer. The data processing layer includes the sampling processing of sensor data by STM32F407 microprocessor and the processing of monitored and collected video information based on BP neural network deep learning algorithm carried on Raspberry Pi. The data feedback layer mainly includes two feedback directions. One is that the STM32F407 microprocessor compares the sensor sampling data with the preset value of the system, and adopts the PID feedback algorithm to transmit the feedback information to the control device through the ZigBee wireless communication module and then change the real environment to meet the expected requirements [1]. In addition, the data collected by the sensor is fed back to the display end in real time. Second, the behavior patterns and vital signs of live pigs obtained from the video information processed by Raspberry PI are fed back to the display end in real time [2], so as to facilitate users to grasp the development stage and health situation of live pigs in real time shown in Figure 1.

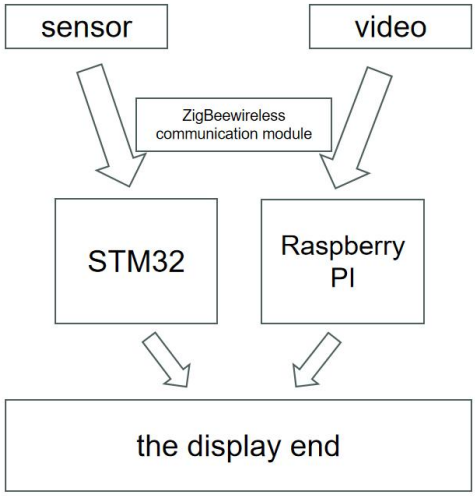

Figure 1. Schematic Diagram of the System Frame Structure

3. Environmental Monitoring Module Based on ZigBee Technology

The overall structure of this farming system consists of four parts: ZigBee wireless sensor network, embedded inter-network connector, WIFI wireless router and monitoring center operated by the upper computer, in which ZigBee wireless sensor network is the core to realize real-time environmental monitoring.

The environmental monitoring system consists of four parts: perception layer, transmission layer, platform layer and application layer [3]. The main hardware devices are temperature sensors, humidity sensors, hazardous gas detectors, air flow rate sensors and other devices, which collect information on environmental temperature, humidity, air flow rate and hazardous gases. Sensors collect environmental data, use ZigBee technology to form a wireless sensor network to transfer data, sent to the main control node, calculated by the STM32 microprocessor to control the peripheral feedback to regulate the environmental situation [4,5].

3.1 The Technical Principles

ZigBee wireless sensor network consists of terminal nodes STM32, routers at each node and coordinator nodes. The terminal nodes are connected to a variety of monitoring sensors such as wind speed, light intensity and various gas concentrations for routine environmental data monitoring. The router has a relay forwarding function, which can send the data from the more distant nodes to the coordinator node via multi-hop. The main function of the coordinator node is to form the sensor network, summarize the information from each node, and forward the data between the embedded inter-network connector and the sensor network. The embedded inter-network connector carries out communication protocol conversion to realize two-way interactive communication. The serial transceiver module of the connector and the ZigBee coordinator node are connected through asynchronous transceivers to realize serial communication [6]; the WIFI module is connected to the Internet to realize remote monitoring of the breeding system. The monitoring center controlled by the upper computer will display the current temperature and humidity, various types of gas concentration and other environmental information in real time, and start the system's environmental control equipment in a timely manner [7], so that the environment to achieve the appropriate, so as to realize the real-time monitoring of the aquaculture system. See Figure 2.

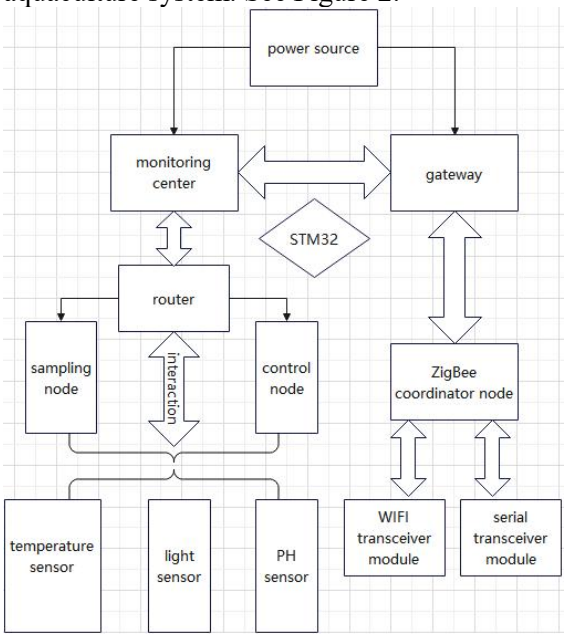

Figure 2. Block Diagram of the Principle Flow

3.2 The Workflow

The camera collects the picture information inside the system and transmits it to the server via WiFi wireless network. The transmission layer mainly takes the coordinator and STM32 microcontroller as the core to realize the data interaction between the perception layer and the platform layer. The platform layer includes

a server and a database, the server is mainly used to receive the data information sent by the transmission layer and the video information from the camera module, which is analyzed and stored in the database. The application layer includes the Web monitoring interface of PC, which allows the managers to view the internal environmental data and observe the real-time video screen in real time, and remotely operate the external equipment. The external devices mainly include fans, heat preservation furnace, wet curtains, rolling shutters, etc., which are connected with STM32 through relays. When the sensor data detected by STM32 shows that the temperature is too high, it will start the fan to work to make the system temperature drop; on the contrary, when the temperature is too low, it will start the heat preservation furnace to work to make the system temperature rise. When the sensor data detected by STM32 shows that the humidity is too high, it starts the dehumidification mechanism, including ventilation and air exchange, release of dehumidifier, etc.; on the contrary, when the humidity is too low, it starts the wet curtain work.

4. Webcam Surveillance Module Based on Backpropagation Neural network

This design is based on the infrared camera to carry out the identification of body temperature and behavior of livestock for the judgment of vital signs, the monitoring of body temperature is mainly through the thermal imaging principle of the infrared camera to carry out online real-time temperature measurement of the exposed part of the body of livestock, and the behavioral identification is mainly through the deep learning model to predict the behavior of livestock, first of all, before judging whether the current movement target is a recognized feature object, the different angles, different illumination. First, before determining whether the current movement target is the recognized feature object, the key frames of animal characterization behavior in different angles, different lighting, and different locations are learned, and the semantic model of abnormal behaviors and events is extracted [8]. For example, whether the livestock has influenza disease and whether the livestock is in heat can be predicted by the model. However, due to the different morphological features, patches, body patterns and viewing angles of the livestock themselves, the surveillance video captured images have the effects of occlusion, shadows, smudges and so on, and the prediction model is not ideal, which poses a great challenge to the video target detection and analysis. So this design adopts a nonlinear, high-precision BP neural network as a prediction model, using this model to predict short-term changes in temperature and behavior, and to provide early warning when approaching the threshold [9].

Backpropagation Neural network is a large amount of data to make the neural network learning and training, so as to adjust the weights of each neuron linking synapses. The model that makes the neural network has the ability of adaptive output, the schematic diagram of the model is shown in Figure 3 below:

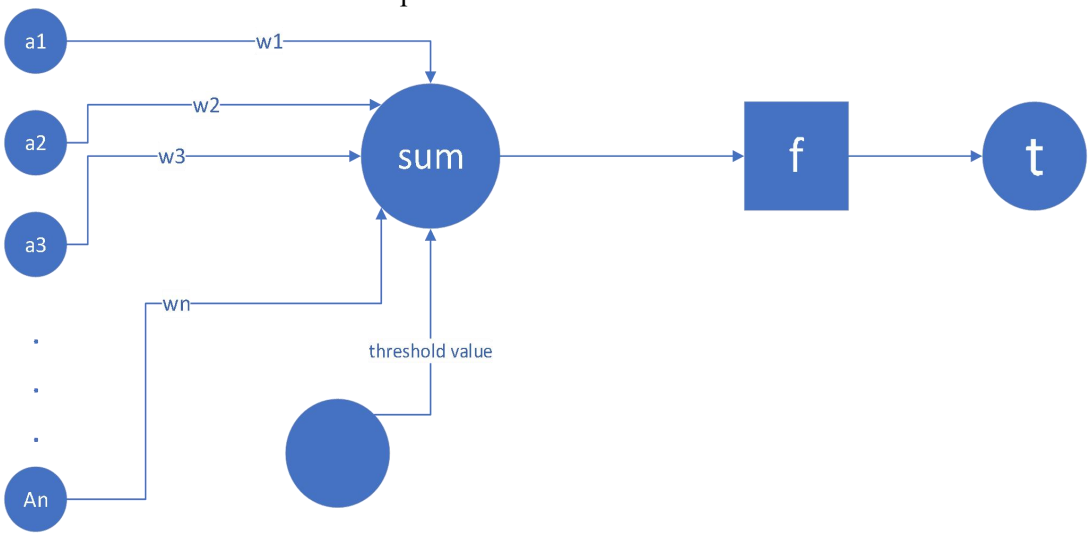

Figure 3. Single Neuron Model

From the above figure a1-an is the value of each component of the input vector of the neuron, w1-wn is the weight value of each synapse connected between the neuron. b is the threshold value, only when the input vector and the inner product of the weight value is greater than the threshold value, after the transfer function output is not zero. The function f is the transfer function, and the f function is usually nonlinear, usually the tansig() function, sigmod() function, logsig() function, and so on. The function of a neuron is to find the inner product of the input vector and the weight vector and then processed by the transfer function to finally get the result, which can be used for the next layer of neuron computation.

This model uses three neuron networks, according to the characteristics of the three-layer Backpropagation Neural network model that can approximate any nonlinear function, the BP network is learned and trained using the historical temperature and behavior recognition data that have been collected, so as to establish an accurate prediction model. This design adopts such an accurate prediction model to realize the temperature and behavior recognition of livestock, and warns in advance when the threshold is near. Afterwards, the warning information is sent to the interface display, and the farmer only needs to pay attention to the situation of the livestock when the warning is given, which can realize the machine monitoring and warning and reduce the waste of manpower.

5. Interface Display Based on VC++ 6.0 Embedded Flash Program

This system uses VC++ 6.0 embedded Flash solution for interface display. Although VC++ 6.0 has powerful data processing functions, it is not as colorful as Flash in terms of interface display, so we use swflash.ocx, an ActiveX control provided by VC++ 6.0, to realize the interface display of embedded Flash in the program of VC++ 6.0, which improves the friendliness of the programming interface. Flash interface display in VC++ 6.0 program, which improves the friendliness of the program design interface. The program sends data from the back-end to the front-end, and the front-end gets the data for processing, and the data can be visualized in the form of line graphs or tables, which makes the data more convincing and objective, and enables the management to get the data sent from the back-end more clearly, and improves the efficiency of the interface. The overall framework of the interface is shown in Figure 4.

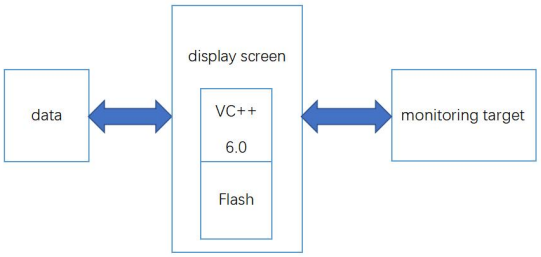

Figure 4. Overall Framework Diagram of the Interface

Since Flash provides the function of defining variables, and VC++ 6.0 Flash provides the GetVariable and SetVariable functions for data transfer from VC++ 6.0 programs to Flash controls, use the SetVariable function in VC++ 6.0 programs. When generating the form view class CPage1View, generate the form view class CPage1View:public CFormView, insert the item Shockwave Flash Object in the form resource of the ActiveX control; set the property ID of this control to IDC-PAGE1, and generate the corresponding class CShockwave for the control. corresponding class CShockwaveFlash m-swfPage1; in the DoDataExchange function to set the class and control of the association DDX-Control (pDX, IDC-PAGE1, m-swfPage1) [10]; VC 6.0 embedded Flash way to realize the back-end data display to the front-end of the code shown in Figure 5.

```
#include "shockwaveflash.h"
CShockwaveFlash m_flash;
m_flash.CreateFromControl(IDC_FLASH, WS_CHILD | WS_VISIBLE, this);
m_flash.SetMovie(_T("path_to_flash_file.swf"));
CRect rect;
GetClientRect(&rect);
m_flash.MoveWindow(rect);
m_flash.DestroyWindow();
```

Figure 5. Code For Passing Data from the Back-end to the Front-end for Processing

Through the interface display of VC++ 6.0 embedded Flash solution, the temperature, humidity, light, CO2 and video surveillance can be displayed on the web page, and then these data can be analyzed and processed through the data processing, so that the managers can efficiently monitor and control the data and situation in the pig farm. Figure 6 shows the actual display.

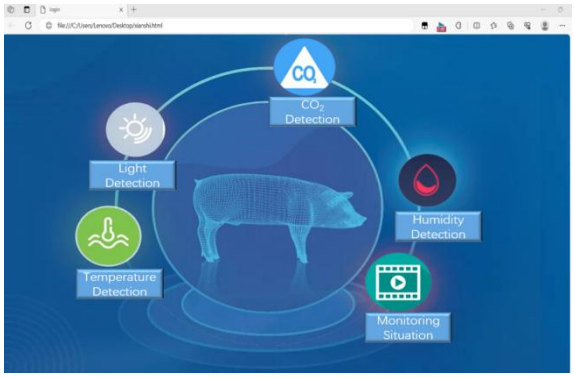

Figure 6. Actual Display

6. Conclusion

The system design based on ZigBee wireless transmission network and deep learning technology, realize the intelligent monitoring and regulation of environmental conditions, as well as the monitoring of biological behavior and health, and can real-time feedback monitoring data to help users to grasp the breeding situation, suitable for intelligent management of small farmers, help to save manpower cost, reduce the difficulty of breeding, with scientific and technological innovation power traditional breeding development.

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