Design of Multi-parameter Monitoring System for Intelligent Agriculture Greenhouse Based on Artificial Intelligence

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Abstract. In order to improve the multi-parameter monitoring capability of the intelligent agricultural greenhouse, a multi-parameter monitoring system design scheme of the intelligent agricultural greenhouse is proposed based on the artificial intelligence control, the monitoring system mainly comprises a greenhouse multi-parameter information acquisition module, a smart agriculture greenhouse bus control module, a greenhouse temperature information fusion model, a program loading module, a remote communication module, an embedded scheduling module and a human-computer interaction module, the design interface program realizes the man-machine interaction design of the multi-parameter monitoring system of the intelligent agricultural greenhouse, and the main control module of the multi-parameter monitoring system of the intelligent agricultural greenhouse is constructed, and the embedded development of the intelligent agricultural greenhouse integrated intelligent monitoring system is carried out based on the bus under the IEEE488.2 standard, Combined with the application environment of the multi-parameter monitoring system of the intelligent agricultural greenhouse, the self-adaptive output conversion control of the intelligent agricultural greenhouse is carried out, and the optimization design of the multi-parameter monitoring system of the intelligent agricultural greenhouse is realized under the DSP environment. The test results show that the method can be used to monitor the multi-parameter of the intelligent agricultural greenhouse, and the stability of the system is strong.

Keywords: Smart agriculture greenhouse · Intelligent monitoring system · Control · DSP

1 Introduction

Intelligent agricultural greenhouse is an important equipment to realize the monitoring of intelligent agricultural greenhouse. Intelligent agricultural greenhouse is interfered by disturbance harmonics and other factors in realizing the monitoring of intelligent agricultural greenhouse, which leads to the poor output stability of intelligent agricultural greenhouse. The optimal monitoring model of intelligent agricultural greenhouse is constructed, and the integrated control method is used to realize the automatic monitoring and control of intelligent agricultural greenhouse [1]. To improve the output

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stability and reliability of intelligent agricultural greenhouse, the design method of monitoring system for intelligent agricultural greenhouse is of great value in the design and application of power supply [2]. Based on the analysis of the output parameters of the power supply system of the intelligent agricultural greenhouse, the monitoring system of the intelligent agricultural greenhouse is designed. By the design of information sensing equipment in intelligent agricultural greenhouse, the working condition information of intelligent agricultural greenhouse is collected in real time to realize the control and monitoring of intelligent agricultural greenhouse.

At present, the monitoring methods of intelligent agricultural greenhouse are mainly based on embedded scheduling. Combined with fuzzy adaptive control method, the optimal monitoring and output control of intelligent agricultural greenhouse are carried out [3]. In reference [4], a wireless greenhouse environment intelligent monitoring system based on wireless low-power local area network is proposed. The system consists of sensor sub nodes and sink nodes. The sensor node is powered by two 18650 lithium batteries. The control unit stm32f107 is used as the main control chip, and the sx1278 is used as the Lora RF module to connect the sink node through the star network. The sink node is connected to the sensor node through Lora RF module in the downstream and the server through 4G network in the upstream. At the same time, SD card is designed to store the backup data. However, the intelligent monitoring output error of the agricultural intelligent greenhouse of the system is large, which reduces the monitoring accuracy.

In view of the above problems, this paper designs a multi parameter monitoring system of intelligent agricultural greenhouse based on artificial intelligence. The hardware module of intelligent agricultural greenhouse multi-parameter monitoring system is developed and designed, and the optimal monitoring technology of intelligent agricultural greenhouse based on embedded DSP is put forward. Firstly, the overall framework model of intelligent agricultural greenhouse monitoring system is established. The monitoring system is mainly composed of shed multi-parameter information collection module, intelligent agricultural greenhouse bus control module, greenhouse temperature information fusion model, program loading module. The remote communication module, embedded scheduling module and human-computer interaction module are composed of APP control in MCU control unit, the intelligent control platform of intelligent agricultural greenhouse is constructed, the hardware development of multi-parameter monitoring system of intelligent agricultural greenhouse is carried out with intelligent control chip, and the intelligent control of intelligent agricultural greenhouse is improved. Finally, the experimental test and analysis are carried out. The superior performance of this method in improving the multi-parameter monitoring ability of intelligent agricultural greenhouse is shown.

2 Analysis of the Overall Framework and Function Module of the System

2.1 Design of the Overall Framework of the System

Firstly, the overall design of intelligent agricultural greenhouse integrated intelligent monitoring system is analyzed and introduced. The multi-parameter monitoring system

of intelligent agricultural greenhouse is established on the general computer platform, and the modular structure design of intelligent agricultural greenhouse integrated intelligent monitoring system is carried out by using embedded B/S architecture design method. VIX bus control technology is used to realize bus integrated control and information scheduling of intelligent agricultural greenhouse multi-parameter monitoring system, the integrated information processor of intelligent agricultural greenhouse multi-parameter monitoring system is constructed, the instruction design of monitoring system is carried out by using program loading process control method [5], and the hardware development and design of intelligent agricultural greenhouse multi-parameter monitoring system is realized in DSP and FPGA integrated processing environment. Combined with the DC power amplifier intelligent monitoring and power sampling, the dynamic information of the intelligent agricultural greenhouse multi parameter monitoring is extracted, and the dynamic information fusion technology is used to realize the process optimization control of the intelligent agricultural greenhouse multi parameter monitoring. According to the above analysis, the overall structure of multi-parameter monitoring system in intelligent agricultural greenhouse is shown in Fig. 1.

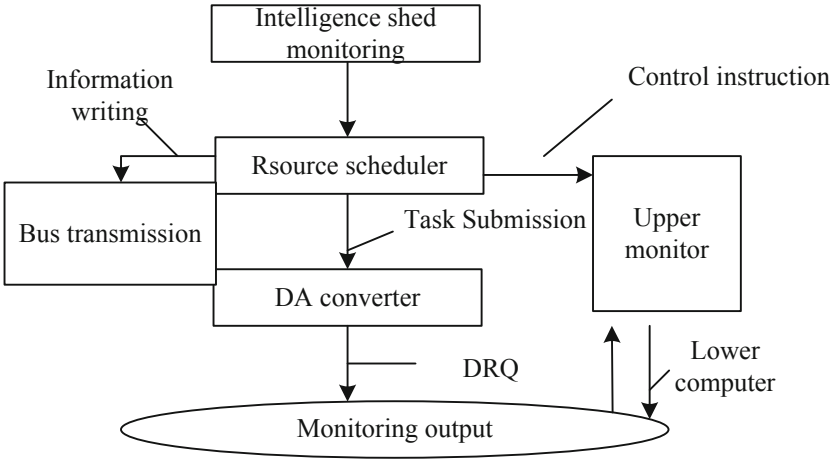

Fig. 1. The overall framework of multi-parameter monitoring system in intelligent agricultural greenhouse

According to the overall design model of multi-parameter monitoring system of intelligent agricultural greenhouse shown in Fig. 1, the component design and hardware development environment analysis of multi-parameter monitoring system of intelligent agricultural greenhouse are carried out [6]. The instruction loading of multi-parameter monitoring of intelligent agricultural greenhouse is carried out by using ISA/EISA/Micro Channel extension bus, and the hardware modularization design of

multi-parameter monitoring of intelligent agricultural greenhouse is carried out combined with discrete distributed control method. The monitoring system is mainly composed of greenhouse multi-parameter information acquisition module, intelligent agricultural greenhouse bus control module, greenhouse temperature information fusion model, program loading module, remote communication module, embedded scheduling module and human-computer interaction module. According to the output power and voltage characteristic information of intelligent agricultural greenhouse, the output power consumption of intelligent agricultural greenhouse is tested. The output pulse of the multi parameter monitoring system of the intelligent agricultural greenhouse is tested by the voltage pulse response control method, and the multi parameter monitoring system of the intelligent agricultural greenhouse is logically judged and fuzzy identified [7].

2.2 Description of System Development Environment and Function Module Analysis

On the basis of the overall framework design of the multi-parameter monitoring system of the intelligent agricultural greenhouse, the hardware design of the system is carried out, the control instruction input control of the multi-parameter monitoring of the intelligent agricultural greenhouse is carried out in the executing mechanism, a fuzzy control method is adopted, the output bus design and the automatic monitoring test of the multi-parameter monitoring system of the intelligent agricultural greenhouse are carried out, and the information acquisition module for multi-parameter monitoring of the intelligent agricultural greenhouse is established, by adopting the ITU-656 PPI pattern recognition method, the bus integrated transmission control of the multi-parameter monitoring system of the intelligent agricultural greenhouse is carried out, and the output magnetic induction intensity of the power supply is obtained as follows:

$$B_{tx} = \frac{\mu \times n \times I_{tx} \times a \times b}{4\pi\sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{b}{2}\right)^2 + x^2}} \times \left(\frac{1}{\left(\frac{a}{2}\right)^2 + x^2} + \frac{1}{\left(\frac{b}{2}\right)^2 + x^2}\right) \qquad ((1))$$

Wherein, n, a and b respectively represent the parameters of the impedance coefficient and the power consumption coefficient of the intelligent agricultural greenhouse, the invention relates to a development and design of a multi-parameter monitoring system of a smart agriculture greenhouse in a combination of network technology and an embedded technology, The man-machine interaction module and the output control module adopt the ADSP21160 as the core processor and use the ISA/EISA/Micro Channel expansion bus to carry out the bus transceiving control of the multi-parameter monitoring system of the intelligent agricultural greenhouse, and the functional module structure of the system is shown in Fig. 2.

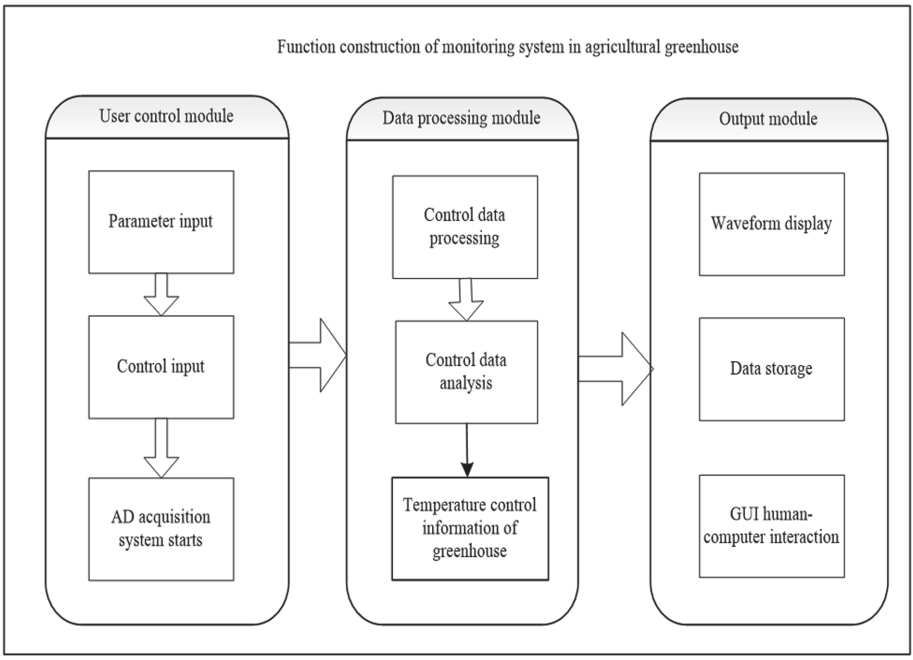

Fig. 2. Functional Module composition of Multi-parameter Monitoring system in Intelligent agricultural greenhouse

In combination with the application environment of the multi-parameter monitoring system of the intelligent agricultural greenhouse, the function modular analysis of the multi-parameter monitoring system of the intelligent agricultural greenhouse is carried out, and the peripheral actuator control of the multi-parameter monitoring system of the intelligent agricultural greenhouse is carried out under the control of the PLC logic programmable chip. The multi-channel data record dynamic range of the intelligent agricultural greenhouse control information acquisition is set to −10 dB to +10 dB, and a large amount of the Linux kernel configuration is 12 KB, and the hardware modular design of the multi-parameter monitoring system of the intelligent agricultural greenhouse is carried out according to the design index [8].

3 The Hardware Design and Implementation of the System

Based on Bus under IEEE488.2 standard, the embedded development of intelligent agricultural greenhouse integrated intelligent monitoring system is carried out. the monitoring system is mainly composed of greenhouse multi-parameter information collection module, intelligent agricultural greenhouse bus control module, greenhouse temperature information fusion model, program loading module, remote communication module, embedded scheduling module and human-computer interaction module [9].

3.1 Multi-parameter Information Acquisition Module for Greenhouse

The multi-parameter information acquisition module of the greenhouse is an original data acquisition function for realizing the intelligent agricultural greenhouse integrated intelligent monitoring system, the data acquisition of the intelligent agricultural greenhouse multi-parameter monitoring system is carried out by adopting the ISA/EISA framework mode, the collected AD information has the output current of the power supply system, information such as voltage, voltage-stabilizing characteristic and power consumption is adopted, the method for adjusting the power factor is adopted [10], the AD information conversion of the intelligent agricultural greenhouse integrated intelligent monitoring system is carried out, a bus development design method is adopted, and the output instruction control of the power supply monitoring is carried out. Using the ADSP-BF537BBC-5A to realize the design and analysis of the intelligent agricultural greenhouse control bus, the multi-parameter information acquisition module of the greenhouse is obtained as shown in Fig. 3.

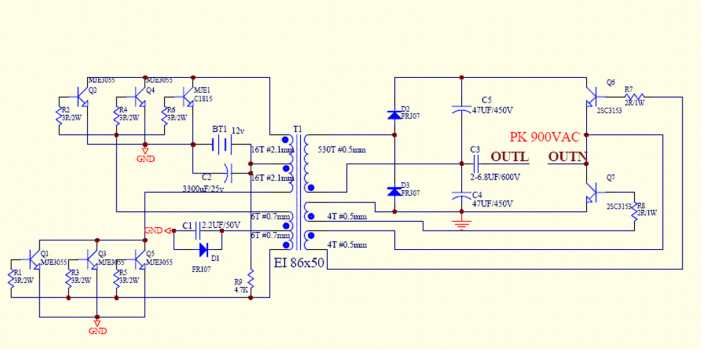

Fig. 3. Multi-parameter information acquisition module for greenhouse

3.2 Bus Control Module

The bus control module realizes the information integration processing of the intelligent agricultural greenhouse multi-parameter monitoring system, designs the automatic control transmission protocol of the intelligent agricultural greenhouse control, and realizes the instruction loading and output conversion control of the intelligent agricultural greenhouse multi-parameter monitoring system in the program loading module [11]. The design circuit of the bus control module is shown in Fig. 4.

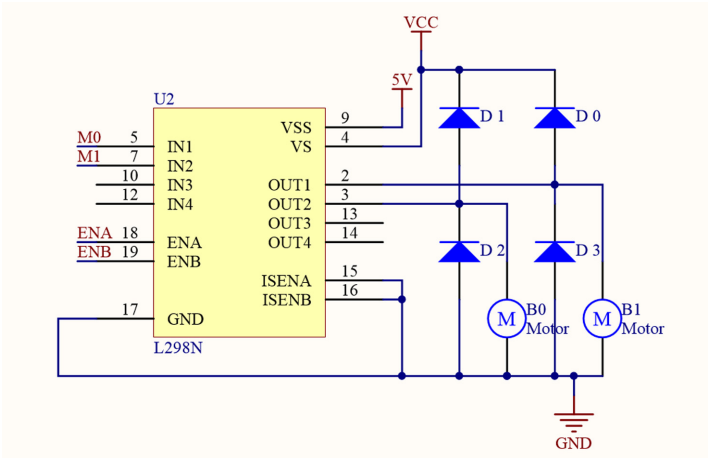

Fig. 4. Bus control module

3.3 Program Loading Module of Greenhouse Temperature Information Fusion Model

The program loading module of the greenhouse temperature information fusion model adopts the PCI bus for embedded development and integrated information processing of the multi-parameter monitoring system of the intelligent agricultural greenhouse. The clock bus circuit and the reset circuit are constructed, the program cross-compiling design of the multi-parameter monitoring system of the intelligent agricultural greenhouse is carried out, and the automatic energy-saving adjustment of the intelligent agricultural greenhouse is realized by adopting the ADSP21160 processor system [12], the design program loading module realizes the program loading of the intelligent agricultural greenhouse integrated intelligent monitoring system, and the obtained program loading module is shown in Fig. 5.

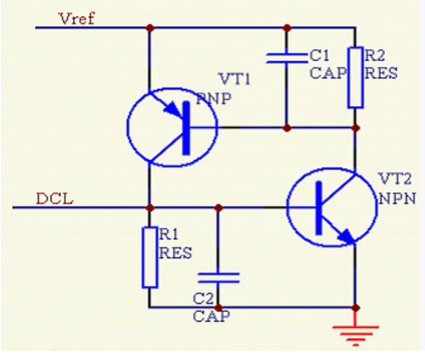

Fig. 5. Programming module design

3.4 Remote Communication Module

The remote communication module adopts the 16-bit 196.608KSa/ Sec/ Chan digitizer HP E1433A for remote communication of the multi-parameter monitoring system of the intelligent agricultural greenhouse, the remote communication module configures the asynchronous memory through the boot ROM [13], uses the PF10 as the SPI interface in the SPI interface, using the high-speed A/ D chip AD9225 as the information transmission center of the intelligent agricultural greenhouse control. And the pulse control and the remote communication of the multi-parameter monitoring system of the intelligent agricultural greenhouse are realized, and the remote communication module is obtained as shown in Fig. 6.

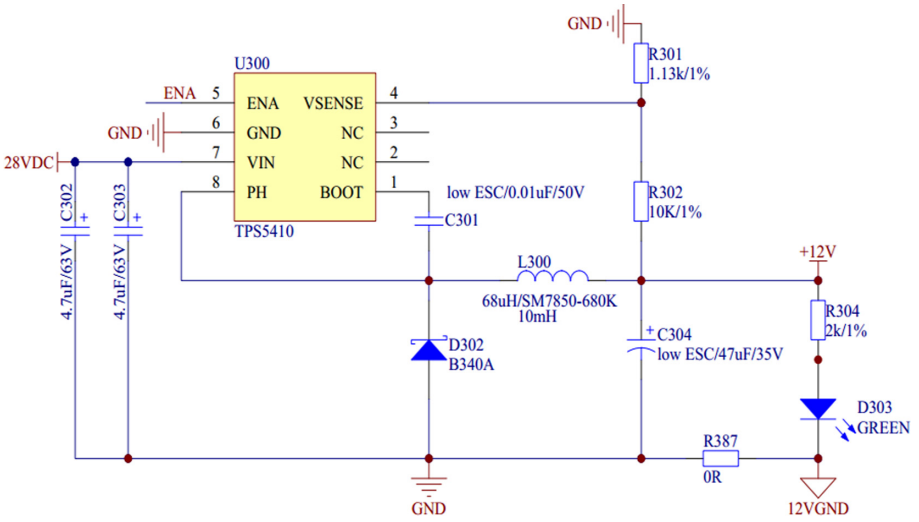

Fig. 6. Upper computer communication module

Comprehensive analysis, combined with the application environment of intelligent agricultural greenhouse multi-parameter monitoring system, the adaptive output conversion control of intelligent agricultural greenhouse is carried out, and the optimal design of intelligent agricultural greenhouse multi-parameter monitoring system is realized under DSP environment [14, 17].

4 System Test Analysis

In order to test the application performance of the intelligent agricultural greenhouse multi-parameter monitoring system designed in this paper, the experimental test analysis is carried out. Figure 7 is an environmental greenhouse intelligent monitoring system of an agricultural greenhouse.

Fig. 7. Intelligent monitoring system of greenhouse environment in agricultural greenhouse

The dynamic coupling parameter of the intelligent agricultural greenhouse is set to be 1.23, the amplification factor of each frequency component of the current is 2.5, the amplitude is 12.4 V, the phase angle is 24 rad/s. The output power loss of the power supply is 15.6 dB and the maximum power value is 34 kW. According to the above simulation parameter setting, the multi-parameter monitoring simulation of the intelligent agricultural greenhouse is carried out, and the output real-time value and the imaginary part value of the monitoring data of the intelligent agricultural greenhouse are shown in Fig. 8.

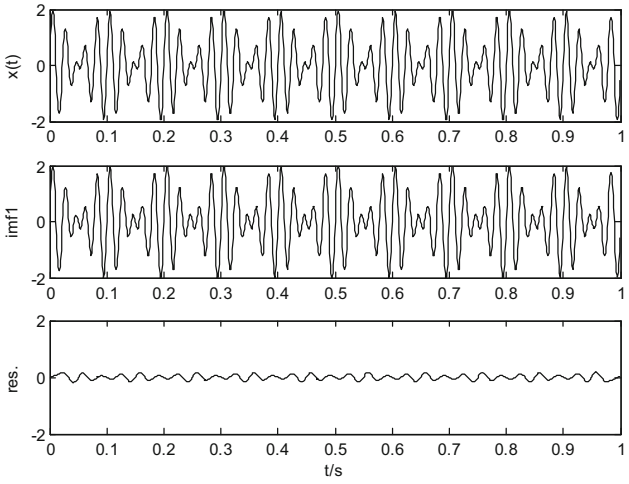

Fig. 8. Output real part value and imaginary part value of monitoring data in intelligent agricultural greenhouse

The analysis of Fig. 8 shows that the method can effectively realize the intelligent monitoring of the intelligent agricultural greenhouse, the anti-interference of the harmonic impedance is good, the voltage amplitude and the current amplitude of the output are tested, and the result is shown in Fig. 9.

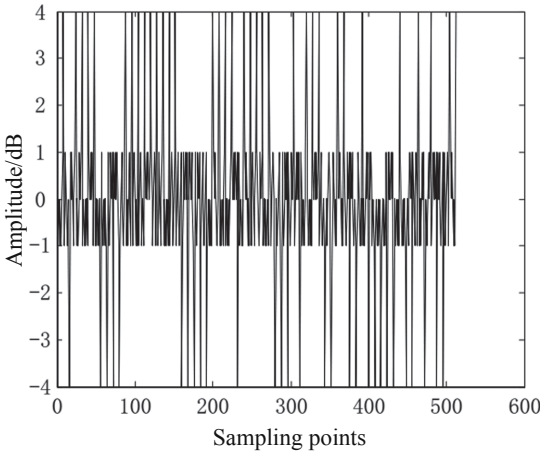

Fig. 9. Output temperature amplitude and humidity amplitude

The analysis Fig. 9 shows that the stability of the output temperature and humidity of the power supply can be improved by using this method, and the output error is measured. The comparison results are shown in Table 1.

Table 1. Comparison of output error of intelligent agricultural greenhouse monitoring

Number of experiments	Proposed method	Reference [4]
100	0.113	0.154
200	0.056	0.134
300	0.012	0.116

Analysis Table 1 shows that the output error of this method to the intelligent agricultural greenhouse monitoring is low.

In order to further verify the effectiveness of this system, the accuracy rate of multi parameter monitoring of intelligent agricultural greenhouse based on this method and traditional method is compared and analyzed.

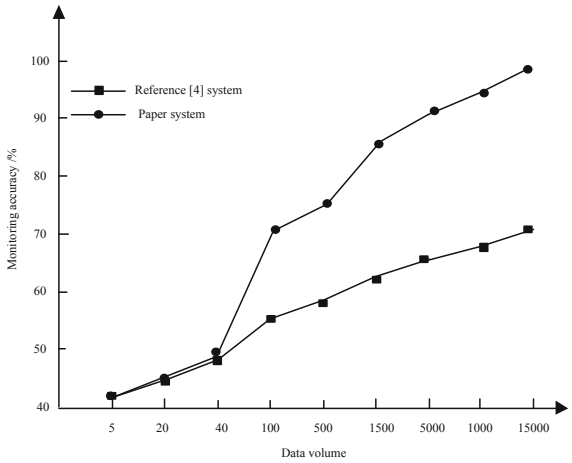

Fig. 10. Comparison of multi parameter monitoring accuracy of intelligent agricultural greenhouse

According to Fig. 10, the multi parameter monitoring accuracy of intelligent agricultural greenhouse in this system can reach up to 100%, which is higher than that of traditional system.

5 Conclusions

In this paper, the design scheme of intelligent agricultural greenhouse multi-parameter monitoring system based on artificial intelligence control is put forward. The monitoring system is mainly composed of greenhouse multi-parameter information collection module, intelligent agricultural greenhouse bus control module, greenhouse temperature information fusion model, program loading module, remote communication module, embedded scheduling module and human-computer interaction module. The integrated information processor of multi-parameter monitoring system in intelligent agricultural greenhouse is constructed, the instruction design of monitoring system is carried out by using program loading process control method, the intelligent monitoring AD sampling of current power supply is carried out with DC power amplifier, the dynamic information of multi-parameter monitoring in intelligent agricultural greenhouse is extracted, and the process optimization control of multi-parameter monitoring in intelligent agricultural greenhouse is realized by using dynamic information fusion technology. The embedded development of intelligent agricultural greenhouse integrated intelligent monitoring system is carried out, and the adaptive output conversion control of intelligent agricultural greenhouse is carried out. The optimal design of multi-parameter monitoring system of intelligent agricultural greenhouse is realized in DSP environment. The analysis shows that the output stability of intelligent agricultural greenhouse monitoring is high, and it can accurately monitor the multi parameters of intelligent agricultural greenhouse.

References

1. Rui, M., Yigeng, H.F., Dongdong, Z., et al.: Modeling simulation and experimental test of proton exchange membrane fuel cells in multiphysical domain. J. Power Supply **17**(2), 3–11 (2019)
2. Quan, L., Chenglin, L.I., Feng, Z., et al.: Algorithm of works' decision for three arms robot in greenhouse based on control with motion sensing technology. Trans. Chin. Soc. Agri. Mach. **48**(3), 14–23 (2017)
3. Drabo, A.: Climate change mitigation and agricultural development models: primary commodity exports or local consumption production? Ecol. Econ. **137**, 110–125 (2017)
4. Zheng, G.L., Wang, T.C.: Design of greenhouse environment intelligent monitoring system based on Lora. Jiangsu Agri. Sci. **47**(10), 216–219 (2019)
5. Ntalli, N., Monokrousos, N., Rumbos, C., et al.: Greenhouse biofumigation with Melia azedarach controls Meloidogyne spp. and enhances soil biological activity. J. Pest. Sci. **91**, 29–40 (2017)
6. Zhang, S., Zhang, C., Ding, J.: Disease and insect pest forecasting model of greenhouse winter jujube based on modified deep belief network. Trans. Chin. Soc. Agric. Eng. **33**(19), 202–208 (2017)
7. Li, Y., Zhou, W., Song, S., et al.: Design of experimental prototype of flexible chassis used in greenhouse. Trans. Chin. Soc. Agric. Eng. **33**(19), 41–50 (2017)
8. Guo-rong, H.A.O., Xu, H.A.N., Wen-jie, D.U., Cheng, L.U.: Fusion estimator with stochastic sensor gain degradation for uncertain systems. Control Decis. **31**(08), 1413–1418 (2016)
9. Liu, Y.: Joint resource allocation in SWIPT-based multi-antenna decode-and-forward relay networks. IEEE Trans. Veh. Technol. **66**(10), 9192–9200 (2017)
10. Du, C., Chen, X., Lei, L.: Energy-efficient optimization for secrecy wireless information and power transfer in massive MIMO relaying systems. IET Commun. **11**(1), 10–16 (2017)
11. Wang, W., Wang, R., Mehrpouyan, H., et al.: Beamforming for simultaneous wireless information and power transfer in two-way relay channels. IEEE Access **5**, 9235–9250 (2017)
12. Hu, S., Ding, Z., Ni, Q.: Beamforming optimisation in energy harvesting cooperative full-duplex networks with self-energy recycling protocol. IET Commun. **10**(7), 848–853 (2016)
13. Wen, Z., Liu, X., Beaulieu, N.C., et al.: Joint source and relay beamforming design for full-duplex MIMO AF relay SWIPT systems. IEEE Commun. Lett. **20**(2), 320–323 (2016)
14. Park, J.J., Moon, J.H., Kim, D.I.: Time-switching based in-band full duplex wireless powered two-way relay. In: URSI Asia-Pacific Radio Science Conference (URSI AP-RASC), pp. 438–441 (2016)
15. Liu, S., Zhang, Z., Qi, L., et al.: A fractal image encoding method based on statistical loss used in agricultural image compression. Multimedia Tools Appl. **75**(23), 15525–15536 (2016)
16. Peter, C., Helming, K., Nendel, C.: Do greenhouse gas emission calculations from energy crop cultivation reflect actual agricultural management practices? – a review of carbon footprint calculators. Renew. Sustain. Energ. Rev. **67**, 461–476 (2017)
17. Green, A., Tzilivakis, J., Warner, D.J., et al.: Problems of benchmarking greenhouse gas emissions in dairy agriculture. Benchmarking Int. J. **24**(3), 12–24 (2017)