

Design of auto-control system of water-saving irrigation of rice in cold region

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Abstract. In traditional way of rice irrigation in the Heilongjiang region, there are many problems such as huge consumption of water, complex wiring and cold water harm. To improve these problems, an intelligent irrigation control system based on PLC and configuration software is designed. The data acquisition and monitoring of water level and water temperature and other parameters are carried through the wireless transmission with PLC as the core, to decide whether irrigation and drainage. The application proves that the system has a positive effect on water—saving and improving the quality and yield of rice, improving the intelligent of irrigation system.

Keywords: rice, water-saving irrigation, soil moisture, PLC, water level

1 Introduction

Rice is one of the most important food crops in china, the water consumption is one of the biggest irrigation crops, rice in many parts of the country with the method of traditional flood irrigation for irrigation, irrigation water waste is serious cases [1]. Therefore, the application of water-saving technologies in rice irrigation to solve the problem of the shortage of water resources is important. Cold rice intelligent water-saving irrigation control system is based on the climate characteristic of built three agricultural areas in Heilongjiang province and actual production conditions, which using wireless transmission technology, automatic control technology and computer technology and water saving irrigation are discussed combining research, implement according to the laws of rice water requirement characteristics and growth for automatic reasonable scientific irrigation. It improves the precision and the real-time irrigation, and improved utilization of water resources and agricultural output benefit as well. [2].

2 Composition and function of the system

Heilongjiang province reclamation area is located in the Frigid Zone, most areas used of groundwater for irrigation. The groundwater's temperature is about 5°C, however,

the most suitable temperature for the growth of rice is between 14°C~35°C. So, direct irrigation is not conducive to the growth of rice [3]. This system is designed to saving irrigation water at the same time, adjust the water temperature to an appropriate value to increase rice production and improve rice quality. This system contains the upper unit state monitoring module, PLC, wireless data transmission radio, the environment parameter acquisition module, the groundwater heating module and intelligent water-saving irrigation module. In order to make the system work reliably, the system utilizes both cable and solar panels for uninterrupted power supply. PLC collects data information and sends commands to communicate with wireless transmission station. The system overall structure is shown in Figure 1.

2.1 PC configuration and monitoring module

PC using configuration software for real-time monitoring and management of various operation parameters, and at the same time in the form of a graph field of visual display, water level and water temperature of the drying tank level information. Through the upper computer can manually change some operation parameters, it sending the command of irrigation and drainage to control paddy water, and sending warmer water injection command control drying temperature of the pool water level etc.

2.2 PLC

PLC is the core part of the whole control system, installed in the field of farmland irrigation, using wireless communications and distributed in the data acquisition equipment, the upper computer to realize data exchange of irrigation area [4].

2.3 Wireless data radio

In the water-saving irrigation control system, agriculture irrigation area is large, and the limitation of the regional environment, large-scale use of wired control approach is not only to the production of crops bring a lot of interference, and wiring complexity which wiring cost is very high, wireless control very good solution to this problem [5].

2.4 Groundwater warming module

In the sun water pool set up large vacuum tube solar collectors, When the water temperature is below the lower limit value, using circulating pump of the water from the sun sink into the cycle to the heating tube heating, when the sun sink in the water temperature control in setting between the upper and lower, circulating pump stop working, when the temperature reaches the upper limit.

2.5 Auto-control water-saving irrigation module

PLC put the amount of water needed for growth period of rice water level sensor data with lattice Tanaka passed the comparative, to decide whether to electromagnetic valve opening and closing irrigation and drainage electromagnetic valve, irrigation or drainage on paddy field. Paddy field in excess water is discharged into the reservoir for storage, for the next irrigation cycle, so as to realize the automation of irrigation cycles.

3 System design

3.1 The design of irrigation control strategy

Control system according to the law of water requirement in different growth period of rice, the use of controlled irrigation technology respectively formulate the growth period of rice irrigation control strategy. Is given priority to with accumulation of the rain, only green rice paddies surface phase keep thin layer, other each growth period were no longer set up water. In tillering stage, the upper limit of Soil moisture is saturated, and the lower limit control in 60% of the saturated moisture content. In jointing-booting stage, the Upper limit of Soil moisture is saturated, and the lower limit is 80% of saturated water content. It is light control in heading-flowering stage. The upper limit of Soil moisture is saturated, and the lower limit of Soil moisture is 80% of saturated water content. In the milk stage, it is central control, and the lower control to 60% of the saturated moisture content.

3.2 The design of the communication protocol

System uses Mitsubishi FX2N series and computer link communication mode, namely the master-slave station protocol communication. Communication format: 8 bit data length, 1 stop bit, no parity bit. The reading data format by the master computer sent to the slave computer is showed in Figure 1[6]. The content on the horizontal line is the data format for the master configuration monitoring software sent to the slave PLC. The data at the bottom of the horizontal line is response data from the slave PLC to the master configuration monitoring software.

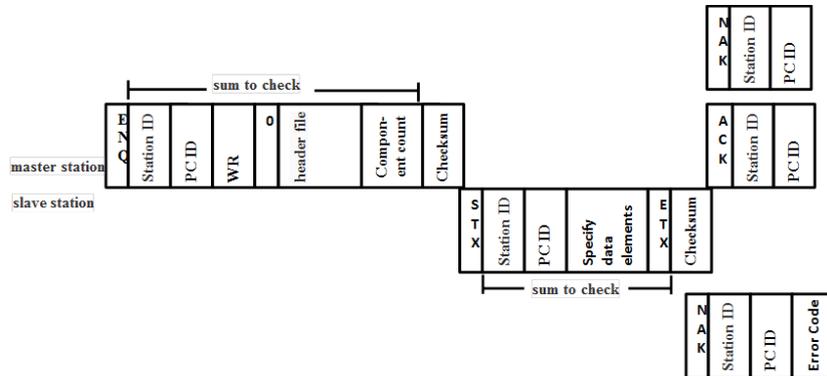


Fig.1. The reading data format

The writing data format by the master computer sent to the slave computer shown in Figure 2. Code definition in data is basically the same with reading data format by the master computer sent to the slave computer.

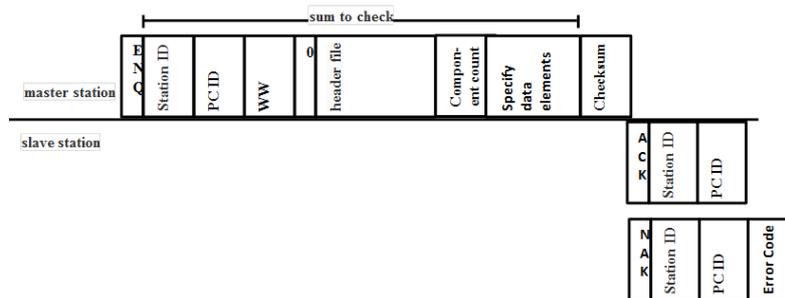


Fig.2. The writing data format

3.3 The design of the main program

Sun sink and solar water heater heating methods, it will achieve the required water temperature in each growth period of rice. The temperature of Sunning water pool is measured by the temperature sensor. When the water temperature is below the set thresholds, circulating pump continuously injected into the water from the sun sink into the solar collector to heat. Circulating pump stops working when the temperature reaches the upper limit. If the light intensity is lower than 0.3, the solar heating system is shut down. Intelligent irrigation system according to the water level and soil moisture conditions in paddy decides whether irrigation water or drainage water. If the temperature of the irrigation water is lower than the critical value of the period in which the growth temperature, stop irrigation and start solar heating systems.

4 Conclusion

This system solves the problem of field power supply by using solar energy for PLC and sensor and electromagnetic valve. It breaks the limitations of wiring through wireless transmission way. This system with PLC as the core to realizes Auto-control water-saving irrigation, implement well water temperature and remote monitoring, etc. The comparison chart of water use efficiency and the comparison chart of irrigation water use efficiency are shown in Figure 3.

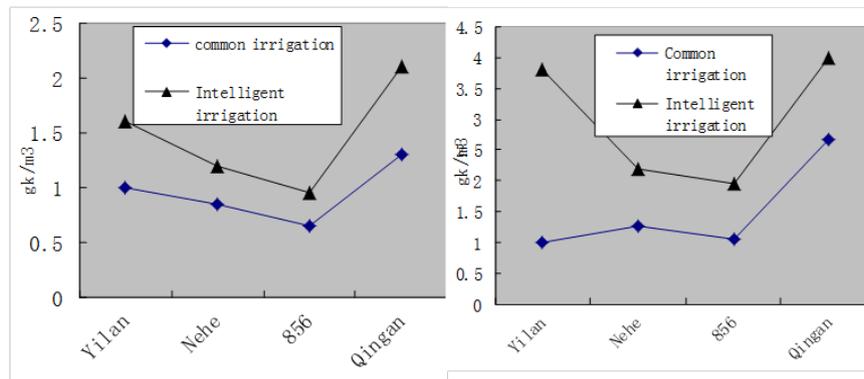


Fig.3. Comparison chart of water use efficiency and Comparison chart of irrigation water use efficiency

The results of application show that the application of rice in cold intelligent control system save irrigation water. For these tropical regions of large-scale rice production , the application of the system can get rid of the traditional agricultural production depend on the weather and use their experience production, embarking on the road of fine production, reducing labor use. The application results of this system is only in some regions in Heilongjiang province, and is obtained in field plot control conditions, its practical applications remains to be further validation.

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