Analysis of black soil environment based on Arduino

Y Li¹, Y F Zhang¹, C H Wu¹, J F Wang¹,*
¹Anhui Science and Technology University, No. 9 Donghua Road, FengYang, Anhui, China
*Correspondence:jfwang1@aliyun.com;Tel:+86-550-673-2024;Fax:+86-550-673-2094

Abstract. As everyone knows, the black soil of Heilongjiang bred rice is famous in the world. How to use networking technology to detection the growth environment of Heilongjiang rice, and expands it to the local planting environment to our country is the most important topic. However, the growth environment of rice is complex. In current research, some importnat factors such as carbon dioxide, oxygen, temperature and humidity, pH value and microbial content in black soil that affect the growth of plants are selected, and a kind of black land based on data acquisition and transmission system based on the Arduino development environment and the mechanism construction of Kingview has been realized. The collected data was employed to establish the simulation environment for the growth of rice in Heilongjiang. It can be applied to stimulate the rice growing environment of Heilongjiang province, and gives a improvement of rice quality in other areas.

Keywords: Arduino; Kingview; living environment

1. Introduction
Our country since the implementation of the South-to-North Water Diversion Project for the national people brought huge benefits, while the northern black land contains vitality by scientific methods can also be transferred to the south, looking for an implementation of the scheme has become a major topic of agricultural workers. With the improvement of people's living standard, people's taste and quality of rice is getting higher and higher, so the quality and yield of rice is of great significance to our country. With the development of computer network and agricultural technology, it is possible to establish and realize the rice production environment in the whole country. This paper is based on the Arduino as the control core, establish data acquisition monitoring system with Kingview PC, to achieve real-time acquisition of data using sensor technology [1]. The primary task of this design is to collect the data of the black land, as well as the temperature and humidity, oxygen, carbon dioxide and organic matter content, and ultimately to improve the environmental conditions of the South loess.

2. The establishment of black soil environmental monitoring system
The system consists of Arduino control board, Kingview monitoring system, pH sensor, humidity sensor, CO₂ sensor, O₂ sensor and microbial sensor. Among them, Arduino microcontroller is the control center of the system, is responsible for the collection of data, and sent it to the host computer. All kinds of sensors are used to detect soil environmental factors [2]. The detection of oxygen and carbon dioxide also provides a reference for the detection of microbial populations. The system framework is shown in Figure 1.
3. Hardware implementation of Arduino control board and sensor

Arduino is an open source hardware control platform, with its own integrated development environment (IDE). This system uses the Arduino unit of Arduino UNO R3, which is the latest version of Arduino USB series interface. The core processor is ATmega328, with 14 digital input/output (6 as PWM output), 6 analog input, support I2C and SPI communication protocol [3]. A variety of Arduino peripheral functional circuits can be selected, including motor drive, wireless communications, music playback and a variety of sensors (humidity, temperature, speed, etc.).

3.1 pH value sensor

pH value measurement is simple, convenient and practical, designed specifically for the design of Arduino analog pH meter. When it works, only the pH sensor is connected to the onboard BNC, the onboard pH1.0 is connected to the analog acquisition port of the Arduino controller, and the Arduino open source test code can be used to measure the pH value of the solution. The software design includes the Arduino as the core of the signal processing module, data processing module and PC Ardu module, which mainly realizes the receiving of sensor signal conversion, receive, read. Using the built-in C/C++ based on Arduino programming language that has a huge repository function, this module to write simple programs related to the initialization, and then read the calculation of standard voltage, and then through the Aiduino signal data acquisition, PC USB serial voltage acquisition, and then the related data processing, the USB transmits the data to the host computer, display the measured data, the specific circuit is shown in Figure 2.
3.2 Soil temperature and humidity sensor
DHT11 can simultaneously measure the temperature and humidity, and humidity measurement range is 20–90%RH with a measuring accuracy of 5%RH. Due to DHT11 in the temperature measuring range is small (0–50°C), and the precision is relatively low [4]. It should be noted that the simultaneous measurement of the temperature and humidity will present a larger error. The specific circuit is shown in Figure 3.

Additionally, we have found that a higher accuracy could be obtained if an additional temperature sensor was used. DS18B20 is a digital temperature sensor, only one data line can be achieved with the microprocessor communication and a temperature range of -55 to 125 degrees centigrade. The specific circuit is shown in Figure 4.
3.3 Carbon dioxide sensor

TGS4160 carbon dioxide sensor is a kind of solid state electrochemical gas sensitive original [5]. The element is suitable for electricity at room temperature for long time. Its output signal voltage of CO2 concentration is 0-3V, which is equivalent to the concentration of 0-3000PPM. There are relay transfer control ports, which can output high and low threshold signals for external control. The specific circuit is shown in Figure 5.

3.4 Microbial sensor

The microbial sensor is composed of molecular recognition of the original (sensor) and the signal converter with a (transducer) composition analysis tool or system. It is senstive to the change of biochemical signals, and employed for sensing a measurable electrical signal, then realize connection detection and control board [6].

A BOD sensor (the sample dissolved in pure water) that used to detect polymer immobilized microorganism preparation of biological particles was selected, too. In a specific environment, it can fully contact with the measured samples. It works as the following process. Firstly, the decomposition of organic matter in the sample process will consume dissolved oxygen, then with the obtained dissolved oxygen concentration, the electrode will change detection record values of dissolved oxygen, and then it was compared with the standard value, thus get the value of organic matter by calculating. The current signal measured by the dissolved oxygen probe is connected in parallel with a large resistance to a voltage signal, and then the signal is amplified and input to the control panel to obtain the measured dissolved oxygen concentration. The specific circuit is shown in Figure 6.
4. **Host computer**

PC interface is developed by Kingview software design, the software supports more communication protocols, which has the advantageous of easy development, powerful and developed interface [7]. It can be very intuitive response system work process. Kingview built-in communication protocol, only need to configure serial port baud rate can be achieved and the communication of information. The system interface is shown in Figure 7.

![System interface](image)

**Figure 7.** System interface.

5. **Conclusion**

The system of Arduino and Kingview analysis of black soil environment, including sensor module, data acquisition module, PDA display module and data storage etc. has been designed in current study. From the front of the sensor rod contact with the soil, soil pH, temperature and humidity can be collected. The specific environment of statistical analysis on soil organic matter is assisted by the data acquisition module, graphHics display. Based on data collected from the monitoring data to the host computer of the system configuration save, the rice planting environment has been presented. The system has the characteristics of high precision, simple operation and strong anti-interference ability, and has high popularization and application value. It will show a great potential in environment monitoring of rice planting. The current design can be improved by adding a automation control module.

6. **References**

[1] Zuo X G, Liu Y C and Wang J P 2016 *J. Agricul. Mechan. Res.* 2 pp 213
[2] Yao S F, Feng C G and JIA Y Y 2011 *J. Agricul. Mechan. Res.* 7 pp 190
[3] Fu J Q 2015 *J. Packaging Engineering*. 10 pp 76
[4] Liang N X 2016 *J. Science & Technology Economy Makket*. 3 pp 21
[5] Zhang H H, Zhao X S, Yu X H, Cheng L Y and Ma S J 2016 *J. Journal of Shenyang Normal University*(Natural Science Edition). 4 pp 454
[6] Zhang L, Liu J, Guo H and Li Y H 2017 *J. Chinese Journal of Public Health Engineering*. 1 pp 36
[7] Sun H H, Mo Y P, Ma R and Qian K 2016 *J. Industrial Instrumentation & Automation*. 4 pp 102