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Design of Aquaculture Water Quality Detection System

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Abstract

Using Arduino's nano development board as the core control system, the detection system is composed of waterproof DS18B20 sensors, pH sensors, and TDS sensors to detect the temperature, acidity, and conductivity of the water environment. The water quality is sampled by controlling the small boat through the mobile app, and the water quality parameters are sent to the mobile app, achieving the function of multi-point detection of the water environment and remote display of detection data.

Keywords

Arduino; DS18B20; PH sensor; TDS sensor; APP.

1. Introduction

For domestic aquaculture in water quality testing or the use of manual sampling, testing cycle is long, cumbersome operation, can not be real-time dynamic reflection of water quality data and other issues, designed a small aquaculture environmental testing boat. The design collects water quality parameters through sensors such as temperature sensor, pH sensor and conductivity sensor, and uses the cell phone APP to realize the operation of the remote control testing boat, which largely saves manpower and energy, provides real-time and dynamic water quality data for aquaculture personnel, facilitates the operation and management of aquaculture personnel, and provides an effective reference for researchers in future aquaculture research. basis.

2. Design of system framework

Arduino nano development board as the control core, by the DS18B20 temperature sensor, PH sensor, TDS conductivity sensor composed of water quality detection system, through Bluetooth and cell phone APP for communication. On the one hand, the cell phone APP through Bluetooth to the nano microcontroller to send two PWM signals, control the DC motor driven by the L298N driver, control the operation of the boat; on the other hand, the nano microcontroller control each sensor for water quality data collection and computing processing, through Bluetooth to upload water quality data to the cell phone APP display. The system block diagram is shown in Figure 1.

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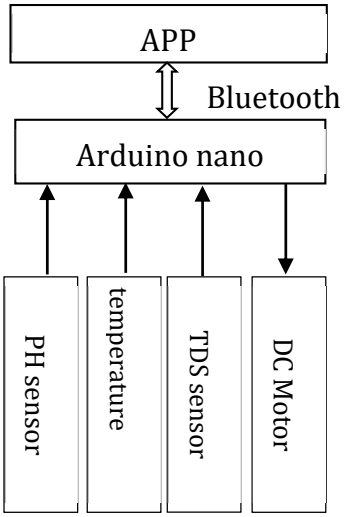

Fig. 1 System design

3. Design of hardware circuit

3.1. Design of the main control system

Arduino nano is a miniature version of Arduino uno, which uses mini-b standard USB socket. In addition to the appearance changes, other interfaces and functions of the Arduino nano remain basically unchanged, but the price is much cheaper. In this design, analog pin is used for sensor data acquisition, PWM pin is used for DC motor control, and digital i/o port is used for data line communication. The number of pins and memory requirements are not high, so Arduino nano is used as the main controller.

3.2. Design of sensors circuit

Water quality detection sensors include temperature sensors, pH sensors, conductivity sensors, turbidity sensors, etc., used to detect the pH, turbidity, microorganisms, organic matter, heavy metals, etc. of water. Considering the cost and importance of the design, TDS sensor, PH sensor, and DS18B20 sensor were selected to form the designed detection system. The physical image of the sensor is shown in Figure 2.

(a)TDS sensor (b)PH sensor (c)temperature sensor

Fig. 2 physical picture of the sensors

The pH sensor adopts the E-201-C type pH sensor, which amplifies the signal through a dual operational amplifier TLC4502. The LM285D-2.5 chip is a low-power quasi voltage reference 2.5V precision voltage source used to generate precise 2.5V voltage for pre amplifier signal amplification.

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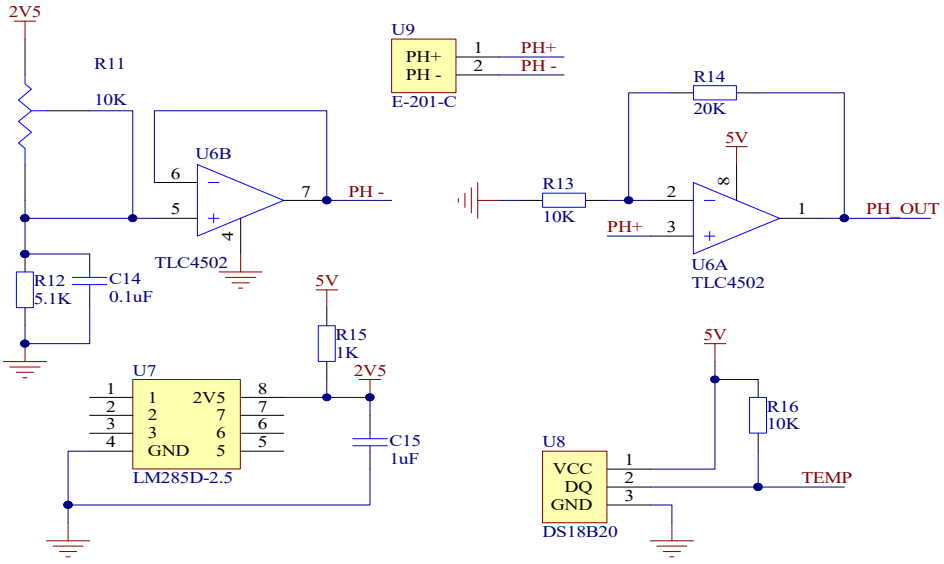

Fig.3 pH sensor circuit

The conductivity detection circuit uses TDS detection electrodes, LMV324 operational amplifiers, and CD4060BM counters. LMV324-N is a four channel low-voltage operational amplifier. CD4060 is composed of an oscillator and a 14 bit binary serial counter bit, which is counted in binary. Use Smit trigger on the clock pulse line to limit the rise and fall time of the clock. The schematic diagram of TDS sensor is shown in Figure 4.

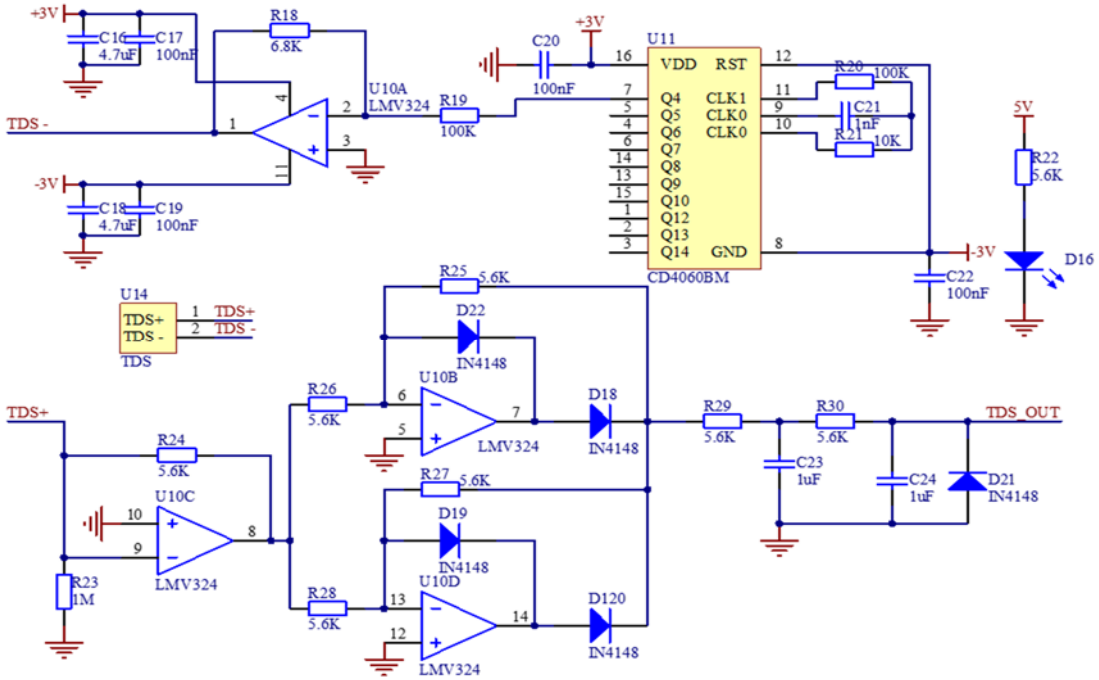

Fig.4 TDS sensor circuit

DS18B20 is a digital temperature sensor, with a 10K resistor pulled up at the signal output end and the output signal pulled up. The microcontroller can directly read the digital signal.The circuit connection is shown in figure 5.

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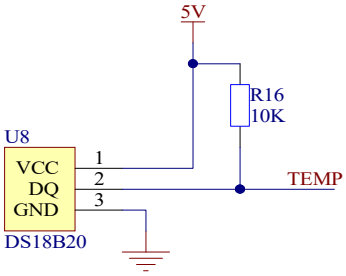

Fig.5 Flame Circuits

3.3. Design of DC Motor Drive Circuit

The motor driving circuit uses an L298N chip to drive the motor, and the four OUT output terminals of the L298N driving chip are connected to two DC motors through a voltage regulator diode. The driving signal output at the output end is controlled by four IN input signals, with a driving signal of 5V TTL level. The driving signal can control the forward, reverse, and stop of the DC motor.

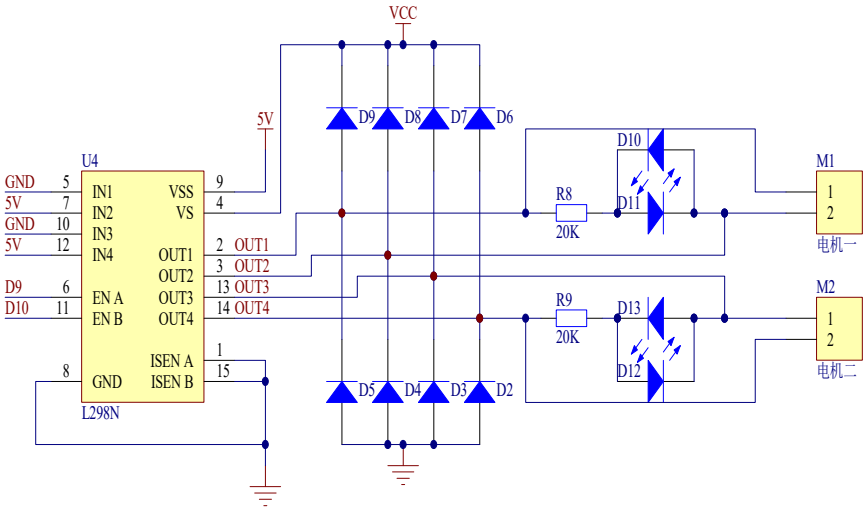

Fig.6 DC Motor Drive Circuit

3.4. Design of Bluetooth communication circuit

Bluetooth communication uses the HC-05 module, powered by a 5V power supply, and communicates with the microcontroller through a serial port for data communication. The TXD end of the serial port is connected to the RX end of the microcontroller serial port, and the RXD end of the serial port is connected to the TX end of the microcontroller serial port.The schematic diagram of the Bluetooth module is shown in Fig 7.

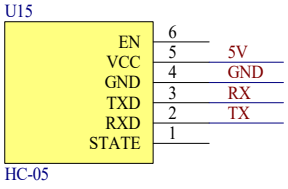

Fig.7 Bluetooth communication circuit

4. Design of software

4.1. Mobile App Design

The flowchart of the mobile app software program is shown in Figure 8. After the software starts, you need to select the system carrier Bluetooth. After connecting Bluetooth, the software

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will enable a timer for timing. The timer is set to 1 second timing, and the software sends a detection data return command to the lower computer. By reading the data returned by Bluetooth, the data is integrated and displayed in the pH, temperature, and conductivity detection data display text box.

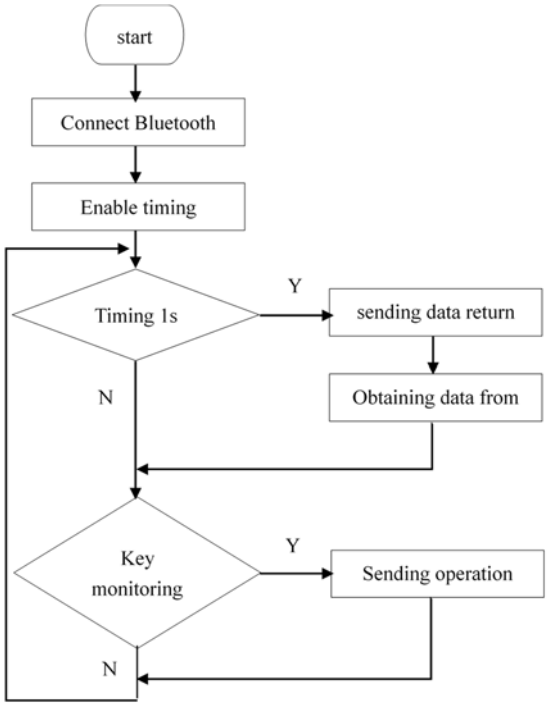

Fig. 8 Flow chart of APP software program

The Mobile app software programming tool is MIT APP INVENTOR 2. This development software is based on a graphical programming tool, suitable for creative development that is not proficient in upper computer software programming. It performs logical splicing of graphic instructions based on the creative functions, and its engineering interface is shown in Figure 9. The interface is concise and easy to operate.

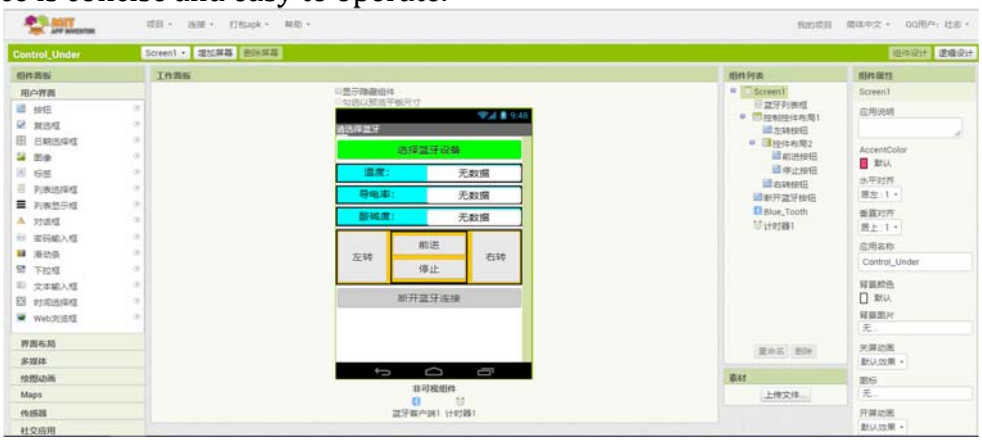

Fig. 9 Mobile app software engineering interface

4.2. MCU main program design

According to the function of the detection boat system, the software driven design mainstream process diagram is shown in Figure 10. The system power on software section initializes the system first. After the system initialization is completed, it enters the main task cycle of the system, which mainly includes obtaining water environment detection data and controlling the direction of the small boat. The NANO core control system will detect the control commands transmitted by Bluetooth communication. When the detection data upload command is determined, the core control system will obtain the pH, temperature, and conductivity data

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through the detection system, and calculate and process the upload. When the control command for the operation status of the small boat is determined, the core control system outputs corresponding PWM signals through the D9 and D10 pins, and drives the DC motor through the L298N driver. The speed of the two DC motors can be changed to achieve four actions of the small boat forward, left turn, right turn, and stop.

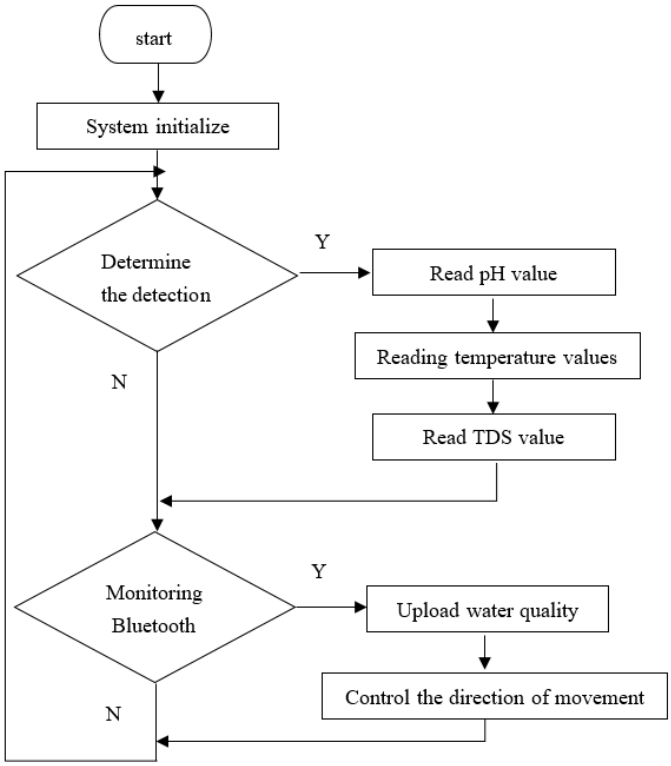

Fig. 10 main program flow diagram

5. System tests

The hardware circuit of the aquaculture water quality detection boat is shown in Figure 11. After the mobile app is connected to Bluetooth, real-time water quality data information of the breeding area can be received on the phone, and the DC motor can be controlled through the four buttons of "left turn, right turn, forward, and backward" to detect the movement of the boat position, as shown in Figure 12.

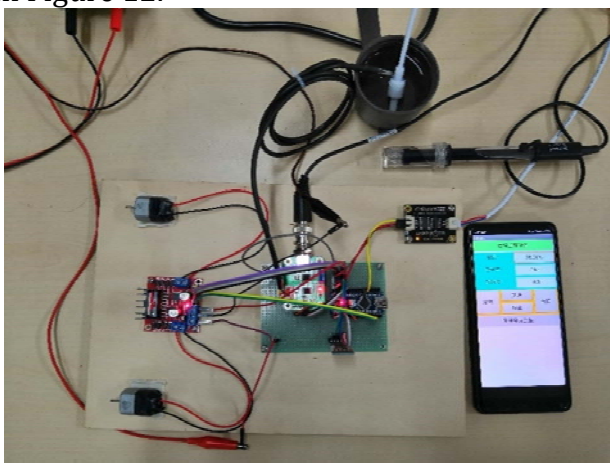

Fig. 11 Physical diagram of overall system debugging

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Fig. 12 Data transmission debugging diagram

6. Conclusion

This paper designs a water quality detection system for aquaculture waters. Control the running status of the small boat through a mobile app. The relevant water quality sensors carried on the ship mobile phone through Bluetooth communication module. Aquaculture personnel can query and analyze the data to improve work efficiency and achieve the goal of saving manpower and material resources.

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