Based on Arduino Design of Intelligent Exploration Vehicles

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Abstract: This paper details the design and implementation of the hardware circuit of the intelligent cart motion control system, and uses a variety of virtual reality and visual sensing technologies to design an environmental detection and search and rescue robot under complex conditions. Infrared technology is used to achieve the function of automatic obstacle avoidance of the trolley, ultrasonic technology is used to achieve the function of distance measurement, Bluetooth is used to achieve the function of wireless remote control of the trolley, GPS technology is used to display the geographical position of the trolley, a homemade bionic robotic arm is installed, and the robotic arm servo can be controlled by PC upper computer, Bluetooth and homemade body remote sensing controller to work to achieve the removal of obstacles and unknown environment and dangerous areas. The information is collected through a PC, Bluetooth and a home-made body telemetry controller.

1. INTRODUCTION
The intelligent exploration vehicle system consists of two parts: firstly, the upper computer system written by Labview I controls the movement of the vehicle's robot arm and displays the real-time position of the vehicle and live photos; secondly, the lower computer system written by the Arduino IDE. The lower computer system establishes communication with the upper computer system through the Bluetooth module. The lower computer system uses Arduino as the controller and the peripheral circuit consists of three parts: firstly, the control of the bionic robot arm via L298N; secondly, the sensor detection circuit including the temperature and humidity sensor DHT11 and the infrared release sensor HC-SR501 for biosensing; thirdly, the wireless communication circuit led by the Bluetooth module, and the design block diagram is shown in Figure 1.
2. Design of the system hardware circuit

The design takes into account the special application environment of the exploration vehicle, the body is designed with stainless steel plates, the controller uses Arduino as the main controller and communicates through the Bluetooth module to achieve the uploading of field data and the control of the exploration vehicle.

2.1. Introduction to the Arduino uno board R3 controller

The Arduino uno R3 uses the ATMega328P chip as the main controller, which stores the bootloader program and can be downloaded directly via USB to serial. There are fourteen digital I/O ports from 0 to 13 and six analogue I/O ports from A0 to A5. The six digital ports 3, 5, 6, 9, 10 and 11 can be used as PWM outputs and the six analogue ports from A0 to A5 can input not only analogue signals but also digital signals, corresponding to digital I/O ports 14 to 19 respectively.

2.2. Intelligent exploration vehicle drive circuit design

The L298N module is equipped with six pins, ENA, ENB, IN1, IN2, IN3 and IN4. IN3 and IN4, which can be controlled to change the direction and speed of rotation of the DC motor. The logic truth table for the motor drive is shown in Table 1. Pins ENA, ENB, IN1, IN2, IN3 and IN4 are connected to digital ports 5, 6, 2, 3, 4 and 7 on the control board using Dupont wire. The pin connection diagram is shown in Figure 2.

Table 1: L298N Motor drive truth table

| DC motors | Rotation method | IN0 | IN1 | IN2 | IN3 |
|-----------|----------------|-----|-----|-----|-----|
| Motor1    | Positive       | 1   | 0   |     |     |
|           | Reversal       | 0   | 1   |     |     |
|           | Standby        | 0   | 0   |     |     |
|           | stop           | 1   | 1   |     |     |
| Motor2    | Positive       | 1   | 0   |     |     |
|           | Reversal       | 0   | 1   |     |     |
|           | Standby        | 0   | 0   |     |     |
|           | stop           | 1   | 1   |     |     |

In Table 1, "1" stands for high level; "0" stands for low level; "PWM" stands for pulse width modulated wave, which regulates the duty cycle. IN1, IN2 control DC motor 1; IN3, IN4 control DC
motor 2; the two circuits are completely independent. The input Inx has an anti-common-state conduction function and is equivalent to a low level input when suspended.

2.3. Obstacle avoidance module circuit design
The design of the obstacle avoidance module uses an HC-SR04 ultrasonic obstacle avoidance module and an SG90 servo assembled together, which is mounted with fixing screws on the front of the car body servo so that the ultrasonic sensor can detect obstacles in the front, left and right of the car to achieve flexible obstacle avoidance.\[^3\] The ultrasonic sensor has four pins: the power pin (VCC), the ground pin (GND), the transmit pin TRIG and the receive pin ECHO. Pins VCC, GND, TRIG and ECHO are connected to the URF01 port on the control board via Dupont wires as shown in Figure 3.

2.4. Hardware design of the biomass sensing module
The HC-SR501 module has two yellow manually adjustable knobs, the distance potentiometer can be turned clockwise or anti-clockwise to increase and decrease the sensing distance of the sensor up to approximately seven metres, and vice versa to approximately three metres. The delay potentiometer can be rotated clockwise to increase the sensing delay to around 300 seconds, and counterclockwise to shorten it to around 0.5 seconds. It is fixed to the front of the car body to ensure that it can detect people in front of it during travel. The pyroelectric infrared sensor module has three pins, in addition to the power line (VCC) and ground line (GND) there is also a high and low level output pin (OUT), the high and low level output pin is connected to the main control board through the Dupont wire to the number 19 digital port that is the A0 port. as shown in Figure 3.

2.5. Hardware design of the traction module
The tracking module uses an infrared reflective sensor TCRT5000, the four modules are split and equally spaced at the bottom of the front of the car and fixed tightly with screws, the module detects the sensing diode towards the ground, when a black line is detected, the module output is high and the diode light goes out, if no black line is detected, the module output is low and the diode light goes out,
then the four signal input pins IN1, IN2, IN3 and IN4 of the module are connected to digital ports 8, 9, 10 and 11 on the control board via Dupont wire for four-way signal detection, as shown in Figure 3.

2.6. Wireless communication hardware design
The HC-06 Bluetooth module is selected as the wireless communication module. There are four pins on the module, namely the power pin (VCC), the ground pin (GND), the data transmit pin (TXD) and the data receive pin (RXD), the data transmit pin (TXD) and the data receive pin (RXD) are connected to the digital ports 0 and 1 on the control board respectively. (When burning the program, disconnect TXD and RXD from the control board, otherwise the program will fail). The HC-06 Bluetooth module will automatically switch to AT mode when powered on and then connect to the PC using USB to TTL. The name and baud rate of the transmission are set using the serial debugging software on the computer and then simply used as a normal serial port. Data transfer via Bluetooth makes it easy to control the exploration trolley remotely, as shown in Figure 3.

3. Control of the bionic mechanical arm
Intelligent exploration vehicle not only to control the route of the car, but also to control the grasp of the control obstacles, so the control of the manipulator is particularly important, this design uses the sensor MPU-6050 and microcontroller for serial communication, used to detect the action of the manipulator, integrated circuit bus IIC requirements in the data transfer, during the SCL high, the requirements must keep the data on SDA stable, only during SCL low, the SDA line is allowed to carry out data transmission. At this point, the microcontroller reads the angular velocity, acceleration values from the sensor memory for X and Y axis angle conversion. The data acquisition flow is shown in Figure 4.
There are many control methods for robotic arm systems. Examples include PID, fuzzy control, adaptive control etc. Fuzzy control and adaptive control have a high degree of accuracy. It is a widely used control method in the modern control field, especially in the military and aerospace fields. PID control is the most basic control method. Its control method is not high compared to the first two. However, PID control algorithms are mostly used in less demanding situations. In most fields several control methods can generally be used in combination to achieve an optimal combination of performance and price. In the case of less demanding robotic arms, PID control from classical control theory can be used. It can be fast and agile, but also smooth and accurate, and as long as the strength of the three effects is matched properly, a satisfactory regulation can be obtained. PID (Proportional/Integral/Differential) is a closed-loop control algorithm that must have a closed-loop system in hardware, i.e. a control system and a feedback system. PI is used in this system and the control algorithm flow chart is shown in Figure 5.

4. System testing
In order to verify the rationality and feasibility of the system, several running tests were carried out in the laboratory. The operational data in the field shows that it can realize the intelligent driving and automatic obstacle avoidance of the intelligent survey trolley and the remote control of the trolley movement and obstacle grasping through the APP, and it can realize the remote monitoring display of the temperature and humidity of the exploration trolley environment and the organism by the Labview upper computer. When the temperature and humidity test is carried out, the monitor reads the temperature every second to show that the temperature is 24 degrees and the humidity is 33%. When the blowing test is carried out, the monitor shows that the temperature changes from 33 to 35 degrees
and the humidity is 37% to 42%. When someone passes within the sensing range of the HC-SR501 module, the OUT terminal of the HC-SR501 module will output a high level and show "someone" on the display of the serial monitor. When the trolley is in normal motion on the track, if there is bright light or too much light in front of the trolley, it will cause the TCRT5000 infrared sensor to be insensitive to the recognition of the black track, which will lead to the trolley not being able to correct its movement route normally and thus drifting off the track. In summary, a semi-transparent baffle can be installed on the lower front of the trolley to block out the glare and reduce the impact of the glare on the TCRT5000 IR sensor.

5. Conclusion
This paper focuses on the design and development of a LabVIEW and Arduino-based vehicle for remote exploration and obstacle avoidance. The system's hardware and software are combined to solve the key problem of the vehicle automatically avoiding small obstacles or removing them with the help of a remote control system. Experimental data shows that the vehicle has good obstacle removal and environmental information collection capabilities and can be applied to real life.

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