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Design of Intelligent Tracking Car Based on Arduino Mega 2560

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Abstract: *In certain special circumstances, human beings cannot enter to carry out expeditions or rescue missions. As a result, a smart tracked adventure vehicle equipped with multiple sensors has been created. In this study, an Arduino Mega 2560 is used as the main control board to design an intelligent trajectory adventure cart with automatic trajectory, metal detection, sound and light alarm, and obstacle avoidance functions. An intelligent cart system based on 2560 as the core, sensor information detection and fusion, audible alarm and LED display, and PID control [1] is built. The design has a simple structure, a full set of functions, and a certain degree of intelligence.*

Keywords: *Arduino Mega 2560, Intelligent tracking, PID, Path planning*

1. Introduction

With the development of the times, more and more high-tech industries have begun to develop vigorously. Robot technology is one of the more popular ones. The vigorous development and application of the robot industry can well reflect the level of scientific and technological development of a country. Artificial intelligence robots will also bring great changes to the global manufacturing industry. Since the successful birth of the world's first industrial robot in 1959, robot technology has begun to change the layout of the entire manufacturing industry at an incredible rate of development. Robot technology has now brought together automation technology, computer network technology, sensor technology, electronic and electrical technology, artificial intelligence technology, mechanics and bionics and other technologies to achieve a highly integrated degree of intelligence. For the development of a country, the manufacturing and application level of robots is its best embodiment. From China's "manufacturing" to China's "intelligent manufacturing" is the transformation stage we need to develop now. Therefore, accelerating the scale of robot applications has played a significant role in promoting the transformation and upgrading of China's intelligent machinery development. To make new breakthroughs in robotics and narrow the distance from other aspects of many developed countries, our country not only needs the existing talent efforts and technological innovation but also needs to consider the long-term direction. The new generation of new talent training is equally important. Only a steady stream of new blood can ensure the long-term development of our robots in the future. This research combines the background of the Jiangsu Robot Competition-Mishijubao Project, and independently designs and develops an intelligent robot car. The basic fundamental of BP neural network.

2. Overall system design

This design uses arduino2560 as the main control of the tracking car [2-4] in this study. Arduino Mega2560 uses a USB interface. The 2560 control board has multi-channel digital input and output, which is more suitable for the tracking car project that requires a lot of IO interface design. At the same time, 16 digital inputs and output can let the car receive more signals, and the crystal oscillator with a 12 MHz main frequency can provide clock timing for the main board. Therefore, the 2560 board has all the resources to support a tracking car main control board. It can automatically select a variety of power supply methods: power supply through the power socket directly external DC power supply; GND and VIN pins are powered by battery power connectors; provide 5V interface USB DC power supply. At the same time, it is very power-saving and has fast processing speed. The VCC and GND pins are more than five, making it easy for Mega 2560 to connect to other hardware. The 16-channel grayscale is used as the main sensor of the tracking line to track and count, and the 7-channel grayscale scans the intersection. Based on the 16-channel sensor, two laser sensors are added for control, so that different intersections

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use different judgment conditions so that the vehicle is more compatible with different road conditions. Reduce other effects caused by the distance length and the body's incorrectness on the way, so that the car's turning body is more correct, thereby improving the stability of the vehicle tracking. The system design flow chart is shown in Figure 1:

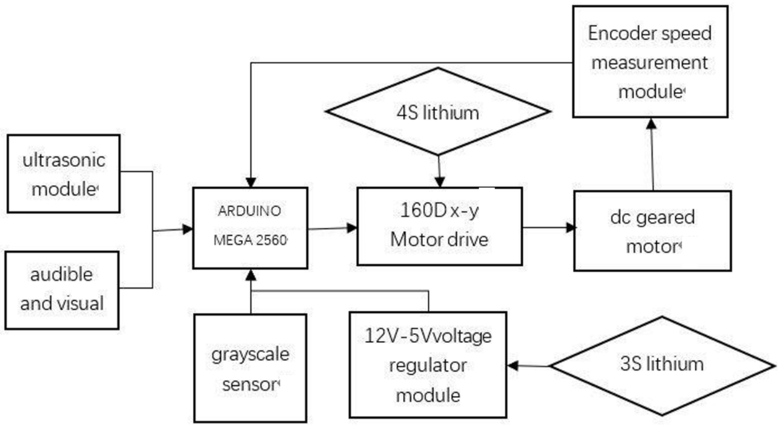

Figure 1: System design process

3. Mechanical structure design

3.1 Center of gravity

The center of gravity of the vehicle body is designed at the rear. Due to the large acrylic bottom plate of the vehicle body, the main mass source battery on the upper part of the vehicle does not produce many obstructions to the vehicle body. However, there is still a problem with the center of gravity of the vehicle during the rapid movement and turning of the vehicle body. Therefore, the battery is placed on the left and right sides of the main control board.

3.2 Unit

Grabbing treasure mechanism in this study, the scheme of 3D printing substructure was adopted, and the mechanism of detecting and grabbing treasure was added to the lower side of the front middle of the car. The rear position does not interfere with the front sensor. The front of the machine uses a metal detector to detect the treasure iron block in front, and at the back of the metal detector, two large circular magnets are used to adsorb the iron block at close range. The distance between the magnet and the ground should be controlled within one centimeter without rubbing the ground. The connection of main structure of the vehicle is connected by a screw connection.

Obstacle avoidance functions this study, a 3D printed ultrasonic bracket was used to place the ultrasonic wave in four directions to meet the detection function required by the competition. The support is divided into the front and rear upper support and the left and right lower support. The front and rear upper support are that the front and rear lower mechanism has occupied too much space, so the upper mechanism should be adopted, while the left and right lower support are that the active motors are relatively idle, and there is free space to place the redundant mechanism.

Tracking functions this study, the 16-channel gray sensor in the front and the seven-channel sensor on the left and right sides are used. The front sensor is mainly responsible for straight-line tracking and right-angle intersection detection during the competition, and the seven-channel sensor on the left and right sides is responsible for detecting the turning after the intersection. Since the sensor detection is easily affected by the illumination of the site, 3d printing is used to separate all sensors and add a black shell to reduce interference.

The front uses a dual laser sensor with a pillar. The height laser sensor can predict the subsequent action earlier. At the same time, the sensor bracket is used as the placement point of the flag during the competition. The two laser sensors aim at the center of symmetry and are about 15 cm apart.

The rubber wheel with more textures is selected. The friction force of the four wheels is large, which

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reduces the skidding phenomenon during the sprint and turning, and the wheel texture cannot be wrong. The coupling is selected from the manufacturer's coupling.

Considering the occurrence of the impact event, the vehicle structure design must withstand a strong impact without damage. The chassis of the vehicle adopts a 5 mm integral acrylic plate, all parts are fixed on the bottom plate, and the main control plate is supported by a stud to prevent collision and short circuits.

4. Electronic module parameters and circuit design

4.1 DC deceleration motor

Through comparative tests, it is found that the 370 DC deceleration motor with a deceleration ratio of 30: 1 meets the requirements of control and passing. Therefore, the smart car is equipped with four 370 DC deceleration motors. The motor tail has a magnetic encoder, which can detect the speed. The rated voltage of the motor is 12V, the rated current is 0.36A, the stall current is 3.2A, the rated speed is 293rpm, the rated torque is 1 kg/cm, and the rated power is about 4W. DC motor design diagram is shown in Figure 2:

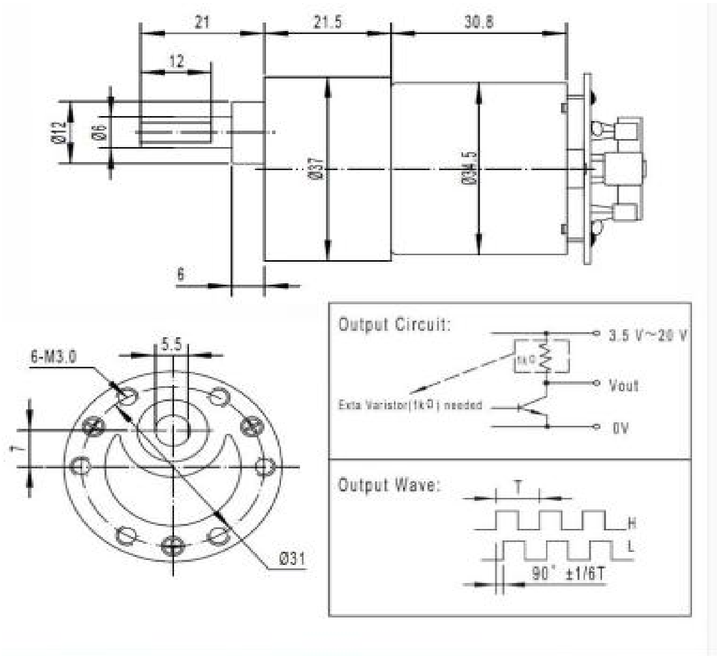

Figure 2: DC motor design diagram

4.2 Motor drive module

The H-bridge driver imitating L298 logic is selected. The maximum input voltage is 27V, and the maximum output current is 7A, with a self-recovery fuse, under-voltage over-current protection, and PWM frequency support range of 0-10 kHz. This drive fully meets the needs of robot motion.

4.3 Ultrasonic module

HC-SR04 ultrasonic ranging module [5] can provide a 2cm-400cm non-contact distance sensing function, and ranging accuracy can reach 2mm; the module includes an ultrasonic transmitter, receiver, and control circuit.

Place an ultrasonic wave in the front, back, left, and right of the car, open the ranging mode at the specified position, identify the obstacle, and immediately perform the avoidance program after identifying the obstacle. The flow chart of ultrasonic ranging is shown in Figure 3:

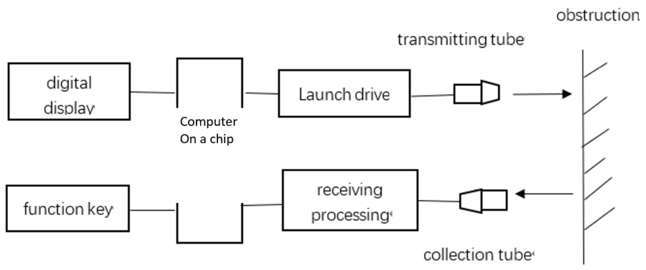

Figure 3: Ultrasonic ranging flow chart

(1) Using IO port TRIG trigger ranging, to at least 10 us high-level communication.

(2) The module automatically sends eight 40khz square waves to detect whether there is a signal return.

(3) There is a signal return, through the IO port ECHO output a high level, high-level duration time is the ultrasonic wave from launch to return time. Test distance = (high-level time * sound velocity (340M/S)) /2 ;

An ultrasonic wave is placed in the front, back, left, and right of the car, and the ranging mode is opened at the specified position to identify the obstacle. After the obstacle is identified, the avoidance program is immediately executed.

4.4 Grayscale sensor

Although the 16-channel intelligent grayscale module (Figure 4) has IIC, USART serial ports, and analog output ports after position quantization, this study directly chooses to use the 16 I / O ports of 2560 to read the gray levels of each channel of the 16-channel intelligent grayscale module directly. The digital signal is sent back to the 2560 single-chip microcomputer, which is processed by the single-chip microcomputer to enable it to track. This method can collect the signal of the sensor more quickly than IIC and USART serial port communication. The 16-way digital smart sensor is shown in Figure 4:

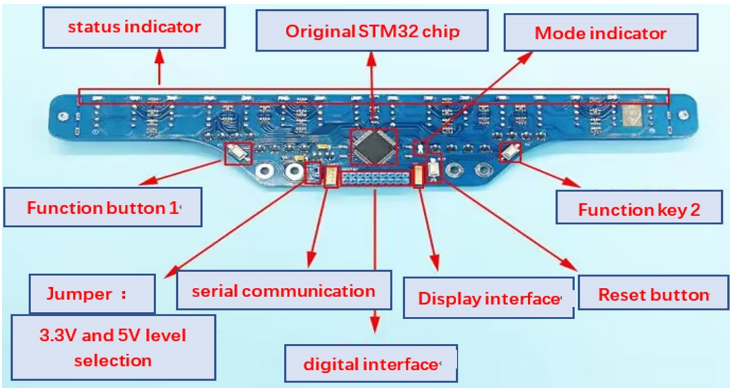

Figure 4: 16 digital intelligent sensors

4.5 Expansion board design

Considering that the smart car is often affected by external conditions when it is moving, it produces bumps. The construction of the intelligent vehicle platform should not be connected by more DuPont lines. To ensure the stability and reliability of the vehicle, the MEGA2560 extended version is designed to meet the needs.

PCB circuit board has strong maintainability. Once the system fails, we can quickly, easily, and flexibly change the wiring, to quickly restore the entire working system. At the same time, the PCB circuit board also has high reliability. The PCB board will pass a series of inspections and tests before it is printed out to ensure its long-term and reliable work. However, there are also many precautions when drawing PCB boards. It is necessary to carefully check the arrangement of components. After checking the completion of the wiring, it is necessary to pay attention to not missing or misconnecting. When connecting large current signals and high voltage signals, they should be isolated from small signals. After completing the overall wiring, it is necessary to make some minor adjustments to the text, individual

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components, and wiring. Finally, it is to lay copper on the plate. When laying copper, we must pay attention to whether the ground of the plate is connected, because the default ground will be laid when laying copper, so we must pay attention to whether it is missed. Otherwise, after hitting the board, the board will lose its due function.

In this study, the self-designed 2560 single-chip microcomputer expansion circuit board is used to integrate the circuit, and the signal circuit and the power circuit are separated to prevent interference. The UNO single-chip microcomputer expansion circuit board is installed above the 2560 single-chip microcomputer for external timing. After installing the expansion board, the electronic circuit is integrated and beautiful without messy lines. The design principle of the extended version is shown in Figure 5.

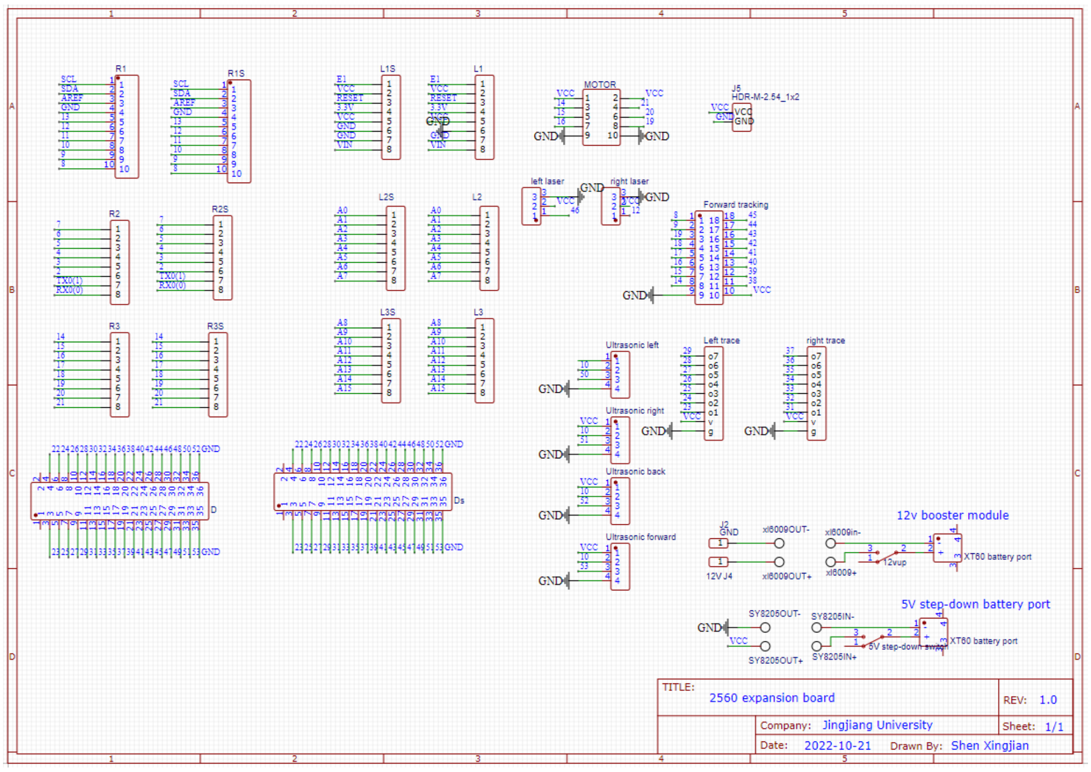

Figure 5: Extended version design schematic

5. Program design

The intelligent vehicle must adopt negative feedback closed-loop control to ensure stability and rapidity at high speed. The group combines the feedback of the gray sensor and uses the PID algorithm to control. After many times of parameter adjustments, the final stability is good while maintaining high speed, effectively avoiding the occurrence of overshoot. Considering the particularity of right-angle turning, the group combined the advantages of intelligent vehicle gray sensor configuration, and used the segmentation method to encapsulate the turning program separately, which greatly improved the speed and accuracy of turning.

5.1 Motor control method

By using four PWM waves to control two 160 D motor drive boards, the speed control of the two motors is carried out respectively, and the differential speed control of the left and right sides of the motor is carried out to realize the left and right correction or steering. Because the encoder is not used, the motor speed cannot be closed-loop controlled, and there is a certain factory mechanical difference between the motors, which will cause the motor to have a differential speed at the same driving voltage, resulting in a difference in the speed of the four wheels. Therefore, different initial speed values are given to the motor in advance in the program to reduce the speed difference value of the four motors, thereby alleviating the problem of four-wheel tracking swing.

5.2 PID fine-tuning strategy for straight driving

The deviation value error between the center line and the track of the smart car is read by the 16-way gray sensor. The more the deviation, the greater the absolute value of the error. The parameter values of KP, KI, and KD are given in sections. From the formula below, the value of PID _ sd can be calculated.

$$P = error \tag{1}$$

$$l = l + error \tag{2}$$

$$D = error - previous\_error \tag{3}$$

$$previous\_error = error \tag{4}$$

Based on the calculated PID_sd value, the PID speed control is carried out in sections. The PWM value of the left and right wheels can be determined by the formula below, to achieve the purpose of closed-loop control.

$$L = L - PID\_sd \tag{5}$$

$$R = R + PID\_sd \tag{6}$$

5.3 Right-angle turning segmentation method

Based on the 16-way grayscale sensor, the group divided the 90-degree arc into eight parts after identifying the right angle and completing the brake deceleration. Each small angle can be configured according to the characteristics of the turning. Therefore, the segmentation method can maximize the speed and stability of the turning under limited control conditions, and the finer the segmentation, the better the effect.

6. Control strategy

The robot uses the Arduino Mega 2650 main control board. Its advantage is that it has a large number of pins. Based on the fast processing speed of the high-performance core processor, it can process the digital signals and analog signals received by each sensor in real-time during the operation of the program, to adjust and control the body posture in real-time during the movement of the car. The whole control system is divided into two parts, the tracking part, and the turning part. The tracking part mainly uses 16 digital grayscale sensors, and the turning part mainly uses laser sensors and seven sensors on both sides. The two parts coordinate with each other to control the behavior of the robot. The turning part and the tracking part have their own triggering methods and guidance and do not conflict, which is a coordinated relationship.

6.1 One and sixteen gray sensors black line count

By using the gray sensor to count the intersection, when the car runs to the intersection, the big cycle is started to stop the tracking program to enter the turning program, and the car stops. At the same time, the gray sensor is used to judge the turning of the intersection, so that the car knows the turning position and stops accurately.

6.2 Track turning function

At the beginning of the test, a program was used for each turn. It was found that the stopping conditions of different positions of the car at different intersections were the same, and the car body was not positive. The reason was that the length of the car exceeded at different intersections was different, thus affecting the turning body. Too much will affect the car body to move to one side, and too little will affect the car body to turn not in place. Therefore, the emergency stop is delayed for 0.2 seconds at the intersection, and the seven-way sensor on both sides of the car is used to detect the start of parking.

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7. Conclusion

The automatic obstacle avoidance and tracking function are not only of great significance to the safe driving of the intelligent car but also can improve the working efficiency of the intelligent car, which is of great help to the automatic performance of the intelligent car handling goods, unmanned driving and other functions. At the same time, the sound and light alarm control function makes the operation of the car more flexible and intelligent. This paper focuses on the design of a set of intelligent car systems with automatic obstacle avoidance function and sound and light alarm control function, which integrates the selection and cooperation of gray sensor, the selection of car core, the cooperation of motor and PID control, circuit design and so on.

References

[1] Yingchun Zhang, Tao Hao, Zuoxun Wang. Intelligent tracking car design based on Fuzzy PID control [P]. emeit-12, 2012.

[2] Zhaoran DONG, Mingwei LI, Ying XIAO. Design and Implementation of Automatic Intelligent Tracking Car Based on CCD [C]//. Proceedings of 2016 6th International Conference on Information Engineering for Mechanics and Materials (ICIMM 2016)., 2016: 555-559.

[3] Li Xin, Xiang Qiang. Design of Intelligent Car Based on Single Chip Processor STC89C52[C]//. Proceedings of 2015 International Power, Electronics and Materials Engineering Conference (IPEMEC 2015), 2015: 265-270.

[4] Xiangyu Li. Intelligent Tracking Car Based on MSP430F5529 [J]. Journal of Sociology and Ethnology, 2021, 3(6).

[5] Lisang Liu, Dongwei He, Jishi Zheng, Ying Ma, Jing Huang, Junfeng Fan, Xiaoyu Wei, Jinxin Yao. Design and implementation of intelligent tracking car based on machine vision [J]. Journal of Intelligent & Fuzzy Systems, 2020, 38(5).