ISSN: 2414-1895 DOI: 10.6919/ICJE.202312_9(12).0003

Design and Implementation of Intelligent Navigation Car based on MM32F3277 Single Chip Microcomputer

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Abstract

In view of the requirements of the 17th National College Student Intelligent Car Competition extreme cross-country group competition, the team designed a self-positioning navigation and tracking intelligent car based on MM32F3277 MCU as the main control chip control. The intelligent car system adopts modular design, including power management module, motor drive module, GPS module and other peripheral modules, to realize the autonomous tracking and obstacle avoidance function of the intelligent car around the runway of the 400M playground. The test verifies that the smart car can run at a speed of more than 13m/s, and the stability of the motion system is good.

Keywords

MM32F3277; GPS Inertial Navigation; MM32SPIN360C; Intelligent Car; Extreme Cross-country.

1. Introduction

With the rapid development of intelligent vehicle technology, intelligent car competition as an important platform to test the performance of intelligent cars has become more and more concerned. As an important part of the intelligent car competition, the extreme cross-country team is responsible for realizing the autonomous navigation and path planning of the intelligent car. This paper will study and discuss the technology of the 17th National University intelligent Car Competition extreme cross-country group.

2. System Design

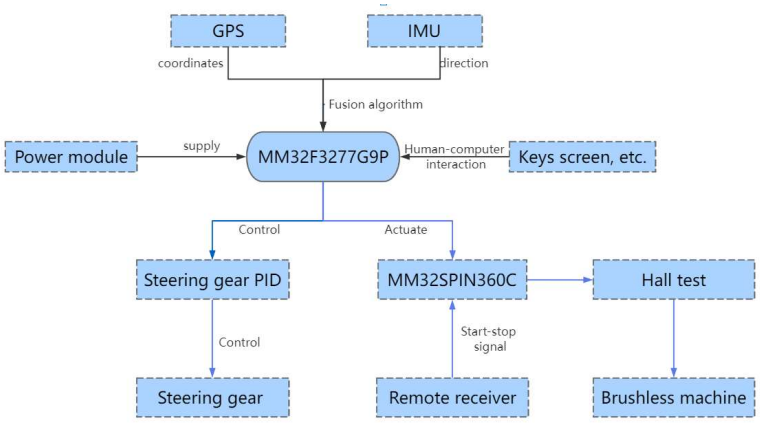

Figure 1. The general frame diagram of the system

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According to the requirements of the seventeenth National College Students Intelligent Car Competition, the overall framework of the system is shown in Figure 1 below, which includes the main control chip, power module, control module, drive module and other components. This design uses 3S battery, rated voltage 11.1V, capacity of 2200mA. GPS+IMU fusion for trackfinding navigation. Realize the autonomous operation of the car.

3. The System Hardware Circuit Design

This hardware mainly involves the following parts: main control module, power module, driver module, tracking navigation module and so on.

(1) Main Control Module

The main control module uses the MM32F3277G9P chip as the main chip of the intelligent car. It uses high-performance Arm® Cortex-M3 as the core of the 32-bit microcontroller, up to 120MHz operating frequency, built-in high-speed memory, rich I/O ports and a variety of peripherals, with three 12-bit ADCs, can fully meet the needs of this development.

(2) Power Module

The power supply is the source of energy for each module of the intelligent car, and if the power supply is not stable, it will affect the stability of the system. As shown in the figure below, 3S lithium battery (specification capacity 2200mA rated voltage 11.1V) is used as the power supply, and the 6V servo is powered by the TPS54531 step-down chip. And through the LM2596CS-V to convert 12V to 5V power supply to the motherboard and LM39100 low voltage drop regulator and 3.3V voltage peripheral power supply.

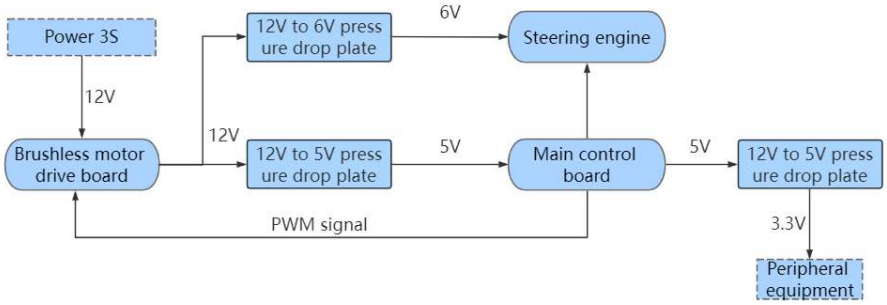

Figure 2. The frame diagram of the power supply system

(3) Driver Module

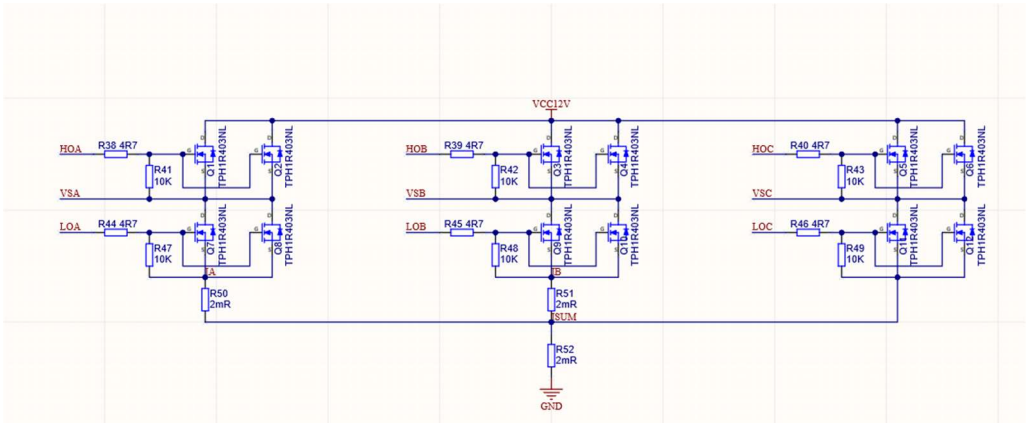

Figure 3. Schematic diagram of the MOS driver

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According to the requirements of the competition, the team selected MM32SPIN360C, a microcontroller from MindMotion, as the main controller. The microcontroller has 3 op amps and 3 comparators, and there is no need to add op amps and comparators in the circuit. Due to the fast speed of the brushless motor and the large current in the circuit, we use the TPH1R403NL MOS tube, the current of this MOS tube is as high as 150A, the internal resistance is as low as 1.2 milliohm at 10V, and the opening voltage is as low as 2.5V. The schematic diagram of three-phase six-arm MOS tube module is shown in the following figure.

(4) Tracing navigation module

This competition requires the use of cameras and GPS for tracking navigation, but considering the uncertainty of outdoor light and other factors, the team uses GPS for tracking navigation. After testing, in the case of high-speed movement, due to the slow position information rate obtained by GPS, the car can not track to the next point in time, so as to leave the track movement. Through comprehensive consideration and verification, the team adopted the guidance method of GPS+IMU module integration and optimized the algorithm to make the intelligent car still maintain good track recognition and tracking performance at high speed.

Among them, GPS uses a dual-frequency GPS satellite positioning module, supporting GPS, BDS, GLONASS and other satellite receiving frequency bands, positioning accuracy up to one meter, support the maximum 10HZ update frequency and 115200 baud rate transmission, the actual measurement can better meet the needs of the competition.

IMU adopts Guangyun GY-95T series products to support the output of three axes (acceleration, gyroscope, Angle, magnetic field) and other data, with high accuracy, and can better meet the timeliness and accuracy of navigation requirements in actual measurement.

4. System Software Design

(1) Kalman filter algorithm is used when processing GPS data and IMU fusion. In order to solve the problem of IMU error in high-speed operation, its data and GPS settlement data are fused and Kalman filtering is carried out, so that the error will not diverge excessively. Kalman filtering greatly improves the stability and reliability of the data in the high-speed operation state of the system, greatly reduces the system error, and plays a decisive role in improving the performance of the vehicle.

(2) The average value is used to process GPS data. In order to avoid the influence of the mutation value on the alignment, 50 points are collected and averaged before alignment, and the error between the measured points and the theoretical points is small after alignment.

(3) Separate channel adjustment of PID parameters. One for the straight and one for the curve, with separate speeds for the curve and straight, switching depending on the waypoint into the curve or into the straight.

(4) Use FLASH to save data. FLASH has the characteristics of power down to save, so the next time you do not need to re-save the point, it is easy to view the content of flash storage, and then with the help of MATLAB and other software analysis we can easily draw the trajectory, Angle error and other images, so as to intuitively see the problem, greatly improving the efficiency of debugging.

5. Experimental Results and Analysis

In the development of the intelligent car system, through the design of hardware circuit, optimization algorithm, and organic combination, finally on the basis of successfully completing the requirements of the competition, the intelligent car can have the ability to run at high speed, and adapt to bad weather, and can also run as usual in rainy days and complete the established goals.

6. Conclusion

This paper mainly explains the hardware components completed by my team according to the needs of the race of the extreme cross-country group, and Outlines the software design. By integrating GPS

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positioning technology, path planning algorithm and real-time positioning, it realizes autonomous navigation and path planning of intelligent car. Future research should further optimize the tracking algorithm, improve the navigation accuracy and response speed, and promote the further development of intelligent navigation technology.

Acknowledgements

Supported by Anhui University of Finance and Economics College Student Innovation and Entrepreneurship Training Program(S202210378227).

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