Design and implementation of an intelligent car obstacle avoidance system based on deep learning

Hongwei Guo, Tuo Yang
Jilin University of Architecture and Technology. jilin ChangChun 130114

ABSTRACT: Through the integration of deep learning technology, from the simplest driving method to the realization of the "car-network road" interaction, the use of STM32F103 microprocessor control chip, and through the PWM technology to achieve the speed and steering gear regulation, at the same time, the use of deep learning self-cognition technology, so that intelligent vehicles can make self-cognitive decisions like human minds , by looking for the best route to avoid some obstacles on the road surface, and the selection of the optimal forecast route, and through the tracking controller to achieve the black line function, through the anti-collision system to achieve the vehicle detection and obstacle avoidance function.

Keywords: Smart Car; Stm32f103; tracking module; deep learning

1. Introduction

Since 2019, deep learning of robots and smart cars has become a hot research direction. The development of intelligent car, in the continuous crossing of the traditional meaning of the means of transportation, to the diversified comprehensive application field development, and promote the car power, economy and continuous improvement, make the car application function more extensive, has an important role and significance.

The intelligent car can obtain the external environment information and internal motion state through various sensors to realize the autonomous movement in the complex environment background, so as to complete the robot intelligent system with specific functions. However, when dealing with the same complex environment each time, it needs to re-avoid obstacles and collect information independently, which does not achieve the role of system optimization, but just carries out the same work repeatedly. After the integration of deep learning, while the intelligent car surveys the environment again, deep learning can build a multi-level neural network to extract image features, and then classify the feature environment content, divide the image into background content and target object, process the image, and compare these contents with the mode saved in the database. Better identify the content submitted by the application object. Through deep learning, we can better complete target detection and route planning, and truly realize the "vehicle-network-road" interaction.

2.Systematic Design

In this project, a camera is installed on the car according to the principle of deep learning method, and the image is collected according to the movement path of the car, and the image collected by the sensor or camera is preprocessed to obtain the image information of obstacles in the image, calibrate the size and position of the image and select the path to avoid obstacles. At the same time, when the car is moving, obstacle avoidance program can take priority over tracking program, can use the ultrasonic obstacle avoidance circuit to distance and avoid obstacles, in the ultrasonic function module, we use the steering gear to control the direction of ultrasonic emission, with infrared detection circuit to achieve the car tracking function, so as to realize the intelligent car obstacle avoidance system function based on deep learning.

2.1 Central Processing Module

The system sends the collected sensor information to the STM32 microcontroller, and the STM32 microcontroller makes different judgments according to the collected signals, so as to control the motor motion direction and driving speed in the intelligent car. With STM32 microcontroller as the core, the system collects different signals through sensors to make judgments, and then changes the motor direction and speed.

2.2 Motor Drive Module

The driver chip of the motor is L298N. The motor drive signal is provided by the single chip microcomputer. After the signal is isolated by the optical coupling, it is transmitted to the PWM control chip L298N, which is connected to the two motors through the output pin of L298N. The circuit diagram of car motor drive module is shown in 2.1:

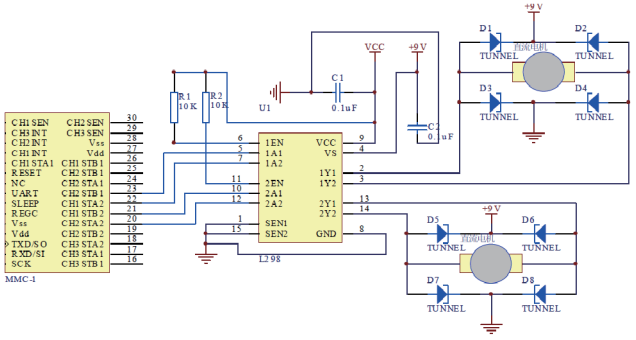

Figure 2.1 Circuit diagram of motor drive module

The movement of wheel motor is realized by the output of GPIO port, and the motion direction and speed are mainly configured. To control the motion speed, we must use PWM and adjust the speed by changing the duty cycle of PWM. Implemented by void TIM4_PWM_Init(unsigned short arr,unsigned short psc), the following registers are needed to make the TIMx timer of stm32 produce PWM output: Pre-division register (TIMx_PSC), automatic reload register (TIMx_ARR), capture/compare mode register (TIMx_CCMR1/2), capture/compare enable register (TIMx_CCER), capture/compare register (Timx_ccr1-4).

2.3 Tracking Module

The design of tracking module is to make the intelligent car can accurately identify the black belt trajectory. The central processing module of the car obtains data from the tracking module, and then the central processing module drives the motor module to complete the corresponding actions according to the collected data.

The IR5 integrated module used in this experiment is composed of three identical IR detector circuits, so we only need to understand the working principle of one IR detector. We know that IR detector is composed of infrared transmitting tube, infrared receiving tube and part of the circuit. The basic principle is that infrared radiation emitted by the infrared transmitter tube is reflected by the ground. The infrared light is absorbed in the black region and reflected in the non-black region. The infrared receiving tube provides the analog quantity for the comparator according to the intensity of the reflected light, so as to output the corresponding level.

2.4 Obstacle Avoidance Module

Obstacle avoidance module can collect external terrain data, and then transfer the collected terrain data to the central processing module, so as to achieve the function of avoiding obstacles. We used HC-SR04 ultrasonic detection, which has strong detection ability and wide propagation path.

When using HC-SR04 module for ultrasonic ranging, we can use the steering gear to assist. The main function of steering gear is to change the irradiation direction of HC-SR04 module, so as to control the emission direction of ultrasonic wave. In the process of programming, if the car in front of the obstacles, we can directly control the steering engine steering, and the car body can remain unchanged, after the measurement, the car to do the corresponding action.

3 System Testing

3.1 Software debugging

We use Keil software to simulate the program, and then FlyMcu software to burn the object file we get into the processor, i.e. program download. It has powerful software simulation function, and has the advantages of small startup code and high performance.

FlyMcu is used to download the serial port software. This software belongs to the third party and is provided by the single-chip online programming network. The startup interface of this software is shown in Figure 3.1:

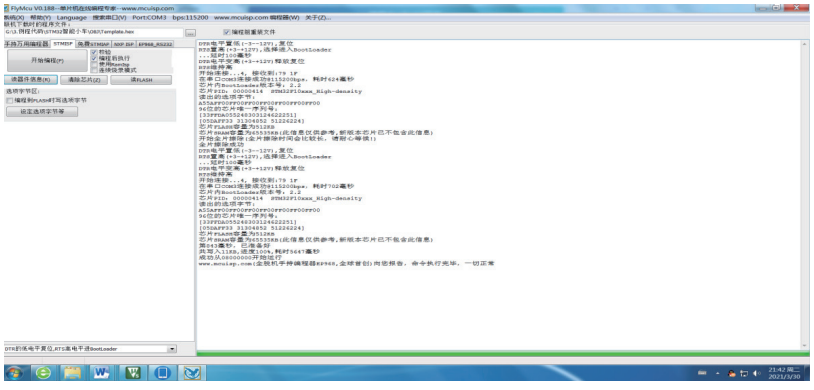

Figure 3.1 FlyMcu program download diagram

3.2 Hardware test

Test the hardware to verify the success of the scheme design.The tracking module works in an interrupted way. The STM32 microprocessor issues different commands to the motor by collecting infrared detector data, Flymcu hardware debugging tool is used to download the program, which verifies the stability and practicability of the system.as shown in FIG. 3.2:

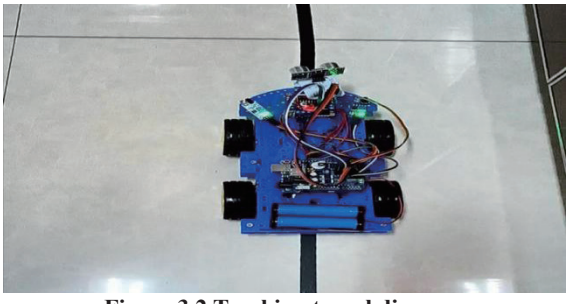

Figure 3.2 Tracking travel diagram

4 Conclusion

When the car is moving, obstacle avoidance procedure is preferred over tracking procedure, and the ultrasonic obstacle avoidance circuit is used for ranging and obstacle avoidance. Under the ultrasonic module, we use the steering gear to control the direction of ultrasonic emission, and the infrared detection circuit is used to realize the tracking function of the car. On the basis of hardware design, a software design scheme is proposed to realize the motor control function, simple tracking and obstacle avoidance function of intelligent car, and the corresponding control program is written in the STM32 integrated development environment Keil, and the FlyMcu software is used to download the program. In addition, the smart car has its own independent deep learning system. The whole intelligent car system takes STM32 microprocessor as the core, and the peripheral circuits include obstacle avoidance circuit, tracking circuit, motor drive circuit, etc. These peripheral circuits are combined by STM32 microprocessor, so that each module can ensure the accuracy of the work at the same time, improve the intelligent car.

References

[1] Tang Lili. Design of Intelligent Car Control Based on EEG Signal[J]. Journal of Physics: Conference Series,2022,2365(1).

[2] Chen Pengzhan,Pei Jiean,Lu Weiqing,Li Mingzhen. A deep reinforcement learning based method for real-time path planning and dynamic obstacle avoidance[J]. Neurocomputing,2022,497.

[3] Qi Jingtao,Bai Liang,Xiao Yandong,Wei Yingmei,Wu Wansen. The emergence of collective obstacle avoidance based on a visual perception mechanism[J]. Information Sciences,2022,582.

[4] Liu Li sang,Lin Jia feng,Yao Jin xin,He Dong wei,Zheng Ji shi,Huang Jing,Shi Peng. Path Planning for Smart Car Based on Dijkstra Algorithm and Dynamic Window Approach[J]. WIRELESS COMMUNICATIONS & MOBILE COMPUTING,2021,2021.

[5] Samuel M. Alade,Adebayo S. Afonrinwo. Design and Implementation of an Improved Obstacle Avoidance Model for Land Mower[J]. International Journal of Information Technology and Computer Science(IJITCS),2022,14(5).

[6] Tang Yaokun,Chen Qingyu,Wei Yuxin. Robot Obstacle Avoidance Controller Based on Deep Reinforcement Learning[J]. Journal of Sensors,2022,2022.

[7] Zhu Hongjie,Ouyang Huimin,Xi Huan. Neural network-based time optimal trajectory planning method for rotary cranes with obstacle avoidance[J]. Mechanical Systems and Signal Processing,2023,185.