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Design of intelligent tracing car based on infrared sensor

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Abstract. The design of the tracing system requires the car to automatically identify the presupposed roads, according to the design of the route for automatic tracking. This paper will study the software and hardware design method of using dot-matrix infrared photoelectric sensor as path acquisition module to realize automatic tracing. The PID control algorithm based on BP Neural Network is adopted for both the rudder and the motor, which effectively avoids the overshoot and oscillation phenomenon of the intelligent vehicle due to the step change of steering and speed regulation, so as to realize the fast and smooth self-driving of the intelligent vehicle along the given black line.

1. The first section in your paper

With the improvement of artificial intelligence, changes happened in the field of the advanced traffic system every day, self-driving cars had become the major trends of future cars. The artificial intelligent car shows that the combination of AI, pattern recognition, computer has becoming the research hotspot of Technology Powers.

The design of the tracing system requires the car to automatically identify the prefabricated road, according to the design of the route for automatic tracking. Intelligent vehicle self-realization tracking has a variety of methods, including infrared photoelectric sensors, electromagnetic sensors, camera tracking methods. According to the advantages and disadvantages of different methods, each has corresponding improvement measures. This paper will focus on the principle of infrared photoelectric sensor method and the matching speed control method, to achieve the intelligent car in accordance with the scheduled track to travel as fast as possible.

2. Overall system design

Intelligent car mainly includes five modules: STM32 microprocessor, rear wheel drive module, speed acquisition, display module, power-supply module, tracking sensors, rudder steering module. STM32 Series MCU is a performance, low power consumption, powerful, low-cost processor, used to control the smart car as a whole. The rear wheel drive module is mainly composed of the rear wheel drive stepper motor 28BYJ-48, which is a four phase eight beat motor, which is powered by a unipolar DC power supply. As long as the stepper motor of each phase winding safety of the appropriate timing, when making the stepper motor stepper rotation. The speed and other parameters will be shown on time through LCD1602. The tracking module mainly includes speed detection and path detection, the speed detection adopts the optical code disk, the path detection uses the infrared transmitter head and the receiving tube for judging. Power modules using LM1117-5V, LM117ADJ, LM1117-3.3V, MC34063 with others voltage regulator chip to achieve the goal of power supplying to the Intelligent vehicle modules. over management module will power supply (7.2V) after multiplex DC-DC conversions, for the central controller (5V), rudder (6V), Photoelectric sensor (3.3V), Motor Drive (5V) and other modules power supply. The power steering system of the car is driven by two rudder modules, where an integrated chip at 5.5V usually works, controlled by PWM. Furthermore, the rudder module would be protected by optical coupler equipment and the electric motors of two rear-wheels are equipped with a tachometer circuit which makes use of Hall sensor should be equipped in disks.

Figure.1 System overall block diagram

3. Design of tracing module

The main methods of the tracking system are ultrasonic ranging, camera tracking, infrared to tube tracking and other ways. The advantages of using ultrasonic ranging are that the detection distance is far and the design is convenient. The design adopts the rudder to control the front wheel steering, but in the practical application, the rudder module and the ultrasonic module interact greatly with each other, which makes the hardware module installation and software module design complicated and reduces the stability of the system, on the other hand, the ultrasonic receives feedback signals from multiple directions, etc., which are highly susceptible to interference due to space constraints. The camera handles the problem of poor positioning accuracy, but the algorithm cannot learn autonomously and lacks flexibility, and it is difficult to apply to the environment with too dark light or complex and changeable, so this experiment we adopt infrared tracking method.

When the automatic tracking intelligent vehicle adopts photoelectric tracking mode, its tracking sensor should adopt the photoelectric sensor composed of infrared photodiode and photoelectric transistor, and the black tape should be laid in advance on the walking track of the intelligent vehicle to form the scheduled walking trajectory of the intelligent vehicle. The circuit diagram of the photodiode is shown in Figure 2.

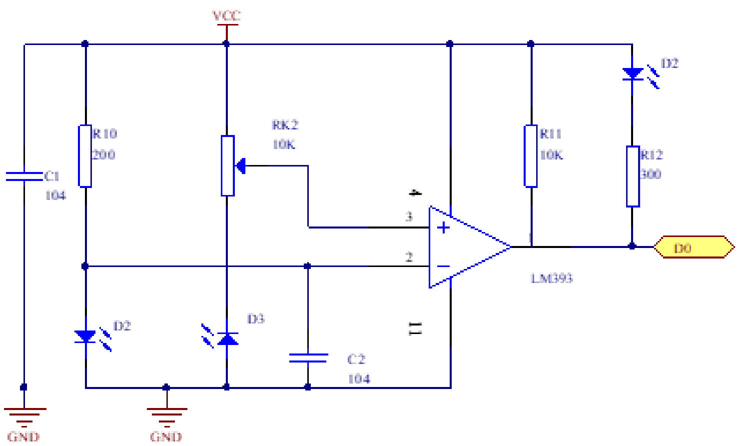

Figure.2 circuit schematic diagram of infrared photoelectric sensor

The infrared receiving/accepting array module is the core of intelligent robotic lawn mower, which could recognize former boundary of 0-80 cm (which can be adjusted by the variable reactor). The simple module usually dose not require complicated data calculation and extraction of image signal. Hence, the cost is lower and much more practical. The photoelectric sensors continue to emit infrared light to the external environment, according to the difference in the degree of infrared reflection of black tape to identify the track of the Smart car.

The workflow of Intelligent vehicle: In order to obtain the position of the car with accuracy and timeliness，it is necessary to install infrared sensor in the front of the car. When the trace detection encounters black lines, infrared reflection back to be receiving tube receiving. Under the control of power steering system, the car should follow the road automatically. By using internal timer interrupt, the output of PWM wave can adjust differential operation of the motor at both ends of the rear wheel. In addition, the intelligent vehicle can go straight and turn in accordance with the preset track, accelerate and slow down, achieve the goal of automatic tracking through closed-loop feedback control.

4. Speed control and simulation implementation

In general, the incremental PID control strategy is used to realize the stable and uniform driving of intelligent vehicle, and its calculation formula is:

$$\mathrm{u(k)} = \mathrm{u(k)} = \mathrm{u(k-1)} + K_p[e(k) - e(k-1)] + K_i e(k) K_d[e(k) - 2e(k-1) + e(k-2)] \quad (1)$$

Speed Error e (k) subtract the feedback speed for a given speed; e (k) is the set speed value.

Through practice detection, it is found that incremental PID. The control strategy does not apply to situations where the change rate of track curve is too large and the speed error is large. Therefore, on the basis of incremental PID control algorithm. This paper combines the advantages of BP Neural network control algorithm to PID parameters have been improved. When the preset speed difference between the actual speed is not large, the incremental PID control algorithm is called, and when the preset speed difference is very different from the actual speed, the BP Neural network is called to set the PID control algorithm.

BP Neural Network tuning PID the schematic diagram of the parameter is shown in the figure 3 shown by

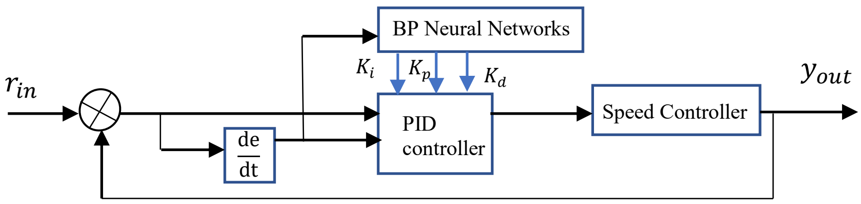

Figure.3 PID controller structure based on BP Neural network

A three-layer 3-8-3 is constructed in this paper. BP Neural Network, the structure is shown in Figure 4. The number of input node is m, the number of hidden nodes is q, and 3 output nodes. The number of input variables m depends on the complexity of the controlled system. Output nodes correspond to three parameters of PID controller, respectively K_p、K_i、K_d，because the output parameters of PID cannot be negative, so select the output layer neuron activation function to take the non-negative Sigmoid function.

Through the analysis, we can know that the learning algorithm of the weighted value of the output layer

$$\Delta w_{li}^{(3)}(k) = \eta \sigma_i^{(3)} O_i^2(k) + \alpha \Delta w_{li}^{(3)}(k-1) \quad (2)$$

$$\delta_i^{(3)} = e(k) sgn(\frac{\partial y(k)}{\partial u(k)}) \frac{\partial u(k)}{\partial O_1^{(3)}} g'(net_l^{(3)}(k))$$

At the same time, the learning method which can get the implicit layer weighting coefficient

$$\Delta w_{li}^{(2)}(k) = \eta \sigma_i^{(2)} O_i^1(k) + \alpha \Delta w_{li}^{(3)}(k-1) \quad (3)$$

$$\delta_i^{(2)} = f'(net_i^{(2)}(k)) \sum_{l=1}^{3} \sigma_1^{(3)} w_{li}^{(3)}(k)$$

The controller algorithm based on BP Neural network tuning PID is summarized as follows:

(1) to determine the structure of BP Neural Network, that is, to determine the output layer node and number m, the number of implicit layers Q, and give the initial value of each layer weight coefficient, the learning rate is η, Inertia coefficient is α, at this time k=1;

(2) sampling is obtained $r_{in}(k)$, $y_{out}(k)$ to calculate the error at the moment error=$r_{in}(k)$- $y_{out}(k)$;

(3) Calculate the input and output of neurons in the neural network NN layers, and the output of the NN output layer is three adjustable parameters of the PID controller.;

(4) calculate the output u(k) of the PID controller;

(5) Neural Network learning, on-line adjustment of weighting coefficient, and the adaptive adjustment of PID control parameters is realized.

(6) k=k+1, return to 1) step

In MATLAB software, the output results of BP tuning PID algorithm simulation are shown in Figure 4.

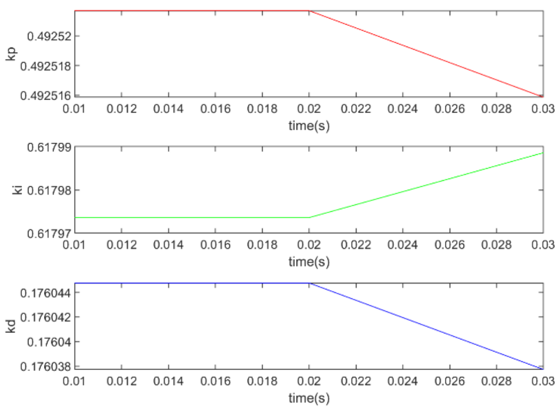

Figure.4 PID output parameter

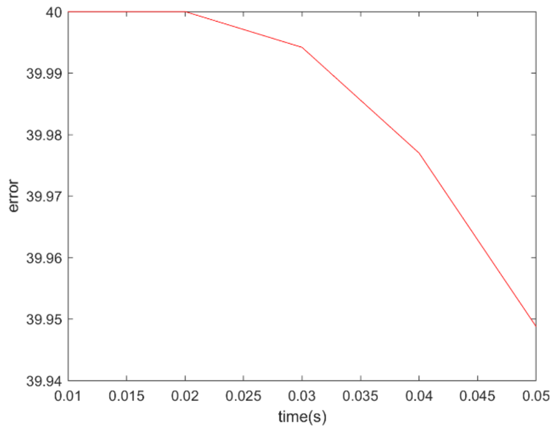

Figure.5 Error simulation parameters

5. Conclusion

It has been tested to find that smart cars are almost unaffected by visible light and can operate normally in any brightness environment. Because the principle of infrared photoelectric tracking mode and measurement and control circuit are relatively simple, so the cost is lower than the camera and electromagnetic tracking mode, not easy to malfunction, high reliability. Because of the realization of the speed regulation system based on BP Neural Network, the delay of turning ratio is reduced effectively. This paper uses the idea of modularization to distribute the realization of each function of the intelligent vehicle into each module, and each module is relatively independent and has a certain connection, and then completes the control of the whole intelligent tracking car.

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