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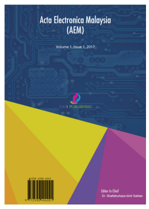

Design of Smart Car Control System Based on Camera

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ABSTRACT

Based on the microprocessor K60 as the core control unit, an smart car was designed, which can track the road automatically, and using the camera as the orientation module sensor to collect the image information of the road. The camera can generate a series of data before the car starting, and during the running process the core control unit K60 processes the image information, filtering and recognizing the path. The speed and turning control algorithm was the PID algorithm. Experimental results show that the smart car can run fast on different paths, it has good adaptability and robustness.

1. INTRODUCTION

With the extensive application of intelligent transportation system, the control of smart car system has become a concern area, which covers a wide range of knowledge, including artificial intelligence, computer control, sensor path recognition and other knowledge[1]. The design of "Freescale" smart car game as the background, using Freescale's 32-bit microcontroller K60 as the core controller, the use of OV7640 digital camera acquisition path information, designed a self-tracking intelligent car automatic control system, has the characteristics of simple structure, strong processing power, good robustness and so on[2-4].

2. INTELLIGENT CAR HARDWARE DESIGN

2.1 THE OVERALL STRUCTURE OF THE SYSTEM

The overall workflow of the smart car control system is: the OV7640 camera collects the test runway image, passes the image signal into the K60 single chip computer, filters the collected image through the image signal processing algorithm, and carries on the software binary value to the filtered image And then further processing to obtain the main track information; through the photoelectric encoder to detect the speed, through the K60 input capture interrupt pulse calculation, and get the current speed of the car; the processed data after processing into the path recognition algorithm module , To obtain control rules, in accordance with the rules of control of the steering gear steering gear and motor speed for accurate and rapid control. The smart car control system studied in this paper adopts the PID control algorithm to control the motor and the steering engine[5]. Smart car control system structure shown in Fig.1. In order to make the whole system simple and efficient, in the design process as much as possible to optimize the existing hardware structure, thereby reducing the hardware problems caused by the failure of the entire control system.

2.2 K60 SINGLE CHIP MINIMUM SYSTEM MODULE

The control chip used in this paper is FREESCALE Kinetis K60 (referred to as K60) series, which is a 32-bit microcontroller, floating point operation, FLASH 512K, the paper designed K60 minimum system board with 150M standard frequency, through the test lock Phase ring up to 400M, the bus frequency up to 200M, can make the entire control system the best, the most stable play. At the same time K60 microcontroller also has the characteristics of low power consumption, reducing the overall system power supply burden. K60 minimum system includes 3.3V power supply, reset circuit, crystal oscillator circuit and I/O port and other components[6-7]. The minimum system is necessary for the operation of the microcontroller, and the formation of the smallest system will not change, the design will K60 minimum system made of a separate module, easy to use and replace.

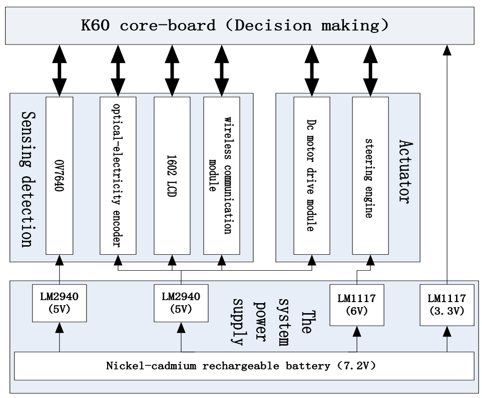

Fig. 1 The block diagram of system

2.2 POWER REGULATOR MODULE

In the entire smart car control system, the system consists of a 7.2V nickel-cadmium rechargeable battery to provide power in the entire model vehicle system, but because the different modules need different voltage, in order to make these modules are able to work smoothly, The 7.2V voltage of the battery is regulated to the operating voltage of these modules, respectively. In the design of the regulator module, not only to consider the size of the regulator and the current capacity and other basic parameters, but also pay attention to voltage conversion ratio, noise handling, circuit protection and electrostatic shielding and other factors. The voltage regulator used in this paper is the 5 V regulator chip LM2940 and 3.3 V regulator chip LM1117. Stable regulator effect is the basis for intelligent control, but also the premise of the stability of the entire system. The power supply relationship of each module is shown in Fig.2.

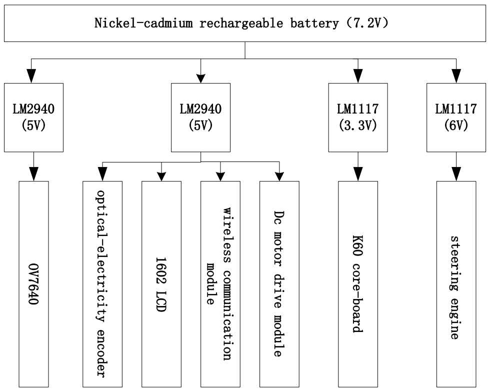

Fig. 2 Power supply diagram

2.3 CAMERA MODULE

OV7640 for the CMOS digital camera, no additional video separation and sampling circuit, and through the serial interface control bus protocol (Serial Camera Control Bus, SCCB) to flexibly set the image format, reduce the post-image processing burden. However, due to its high transmission rate, pixel clock cycle of 37 ns, ordinary microcontrollers is difficult to complete the acquisition of the signal. While the MK60 DMA transfer mode can meet the image acquisition speed requirements. Therefore, the scheme can reduce the complexity of the image acquisition circuit and the burden of the microcontroller, and improve the stability and real-time performance of the control system. OV7640 and K60 connection shown in Fig.3.

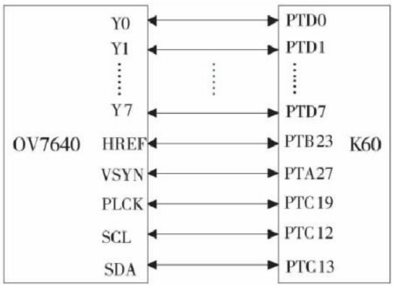

Fig.3. Hardware circuit diagram of camera

2.4 EXECUTION MODULE

K60 completes the information collection, and after the algorithm processing, completes the decision-making, outputs the control signal. At this time by the implementation of the module to achieve smart car speed and steering control. The execution module is shown in Fig.4, including the steering gear and the motor and its drive circuit. The steering gear S-D5 digital servo is controlled by a three - wire control, in which the control line is connected to the K60 pin PTA10 and is turned according to its output PWM signal. Motor drive chip selection of two BTS7960, using H bridge drive, in order to achieve rapid speed adjustment.

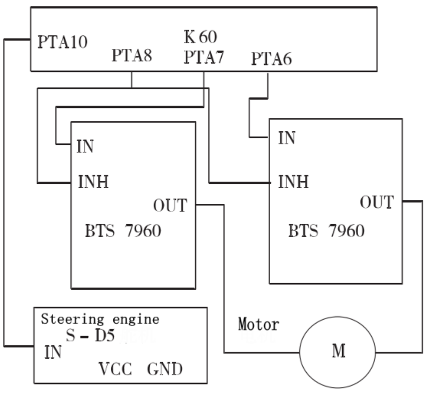

Fig.4. Hardware circuit diagram of the execute module

3. SYSTEM SOFTWARE DESIGN

3.1 SYSTEM SOFTWARE OVERALL STRUCTURE

Smart car embedded system using black and white camera to collect track image information, through the core control chip MK60 will be collected to filter the image, extract the track black line information, so as to determine the current car track type, control PWM output, Speed control of DC motor and steering control of steering engine. System software main program includes initialization, camera self-learning, track information collection, servo control, motor control, system software flow shown in Fig.5.

3.2 DATA PROCESSING AND CONTROL PROCEDURES

After the image and sensor signal acquisition is complete, the controller starts data processing and control decisions.

3.2.1 IMAGE PROCESSING

Camera images collected by the higher resolution, direct processing, will take up a lot of controller resources. For the path identification and smart car control, the use of compressed images (Fig. 6 (a)) to extract the road key feature information can be, and on the basis of binarization[8-9] (Fig. 6 (b)).

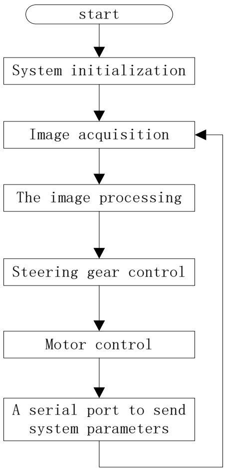

Fig.5 System software flow pattern

In order to avoid the noise in the image and the influence of the path on the path, it is necessary to filter the binarized image. After filtering (Fig. 6 (c)), the outer side of the path is black and the inside is white. After completing the above-mentioned processing, by finding the edge of the path and finding the track center line from the edge position, the extraction effect is shown in Fig. 6 (d).

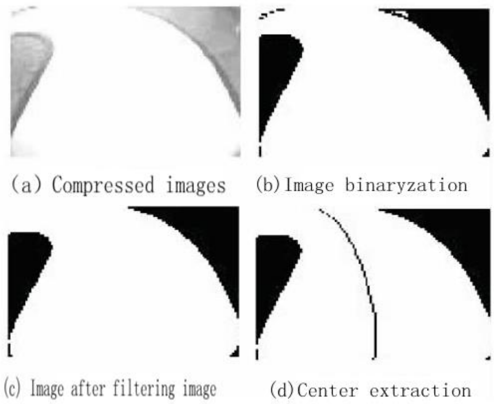

Fig.6 Image processing steps

3.2.2 CONTROL STRATEGY

The motor and steering engine control is based on the road center line obtained after image processing. The center line divides an image into two parts, and the image area is divided into two parts. The image area is divided into different paths, such as large corners, small corners, crossroads, straight roads and so on. Therefore, this paper will center line left and right track area difference as the basis of steering engine attitude control. While the motor speed control is adjusted according to the traffic information to achieve the average speed to maximize. The unit is realized by two subroutines, respectively, smart car speed control and steering control. When the system to complete the decision, the system parameters sent to the host computer through the serial port.

3.3 CONTROL ALGORITHM FOR steering engine and motor

PID control is a very flexible control mode, according to the system, by adjusting the PID parameters, the use of PID control motor and steering engine with a high response speed. Intelligent car system for digital PID control, and digital PID output can be divided into position PID and incremental PID control. Which the position PID control algorithm output has a cumulative effect, the control system prone to overshoot phenomenon. And incremental PID control to avoid this phenomenon, but also through the logic to determine the wrong action, so the latter[10-13].

After the image processing, the center line is obtained, and the area difference e (k) is obtained. It can be seen that for large corners, small corners and S corners of the center line on both sides of the area difference is obvious. While the sides of the straight and crossroads are almost equal. The solid line S curve and the dotted line S curve are similar, can be classified as a class. Therefore, the algorithm is divided into four ways.

After completing the path recognition, select the corresponding control strategy according to the path, set the steering engine control parameters P, I and D, and calculate the control increment Δu (k). Finally, according to Δu (k), and determine whether the error exceeds the maximum or minimum range, limit the output amplitude, call the steering engine control function, change the PTA10 port PWM signal pulse width to adjust the steering engine attitude.

The motor control also takes the above algorithm. The difference is that the control increment is from the feedback of the photoelectric encoder, and after the path determination is completed, the motor PID control parameter is set and the motor speed is set.

4. TEST

The performance of the system testing, the first camera to debug, its forward distance debugging in 1.9 m or so, and then the motor debugging, in the normal operating voltage, the debug PWM output, you can achieve the motor speed and forward and reverse run The Will be smart car on the white KT board, self-learning to collect straight information, self-learning success, the car began to drive on the track, after continuous debugging, based on the camera on the big prospect, you can well predict the track information, To achieve stable and fast operation in different paths, straight speed of up to 2.2 m / s, curve speed up to 1.8 m / s.

5. CONCLUSION

This paper discusses the design of intelligent car camera control system based on the analysis of the image processing algorithm of camera. The test results show that the automatic running of the smart car can achieve stable and reliable on different paths, has strong robustness; and the speed and steering control response time is short and the error is small, and in complex path can reach an average speed of 2 m/s.

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