Design of Intelligent Car Based on the uC/OS-II Operating System

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Abstract

The paper presented the design of a intelligent car that use the AVR microcontroller and the Real Time Operating System uC/OS-II. Its use the ultrasonic sensor and touch sensor to detect the surroundings, and use the photoelectric sensor measure speed. Smart car can automatically avoid obstacles, to complete the task of traveling from point of origin to the specified location. Actual debugging, the system is running stable, Achieved the design target.

Keywords

ATmega128, uC/OS-II; ultrasonic sensor, intelligent car.

1. Introduction

Intelligent car is a kind of wheeled mobile robot, which is a combination of artificial intelligence and electronic technology. Application of artificial intelligence theory of mobile robot with perception environment, can make the decision and the ability to complete a certain function, can work in the environment that is dangerous、worse condition or human can not set foot, more should be used for scientific exploration, military and life services and other fields. In this paper, the intelligent car has the ability to perform autonomous operations in a certain unknown environment, that is, to detect and automatically avoid obstacles to the implementation of a set of motion procedures. The intelligent car system includes its mechanical, electric circuit and software system, and the AVR microcontroller ATmega128 as the control chip is designed. UC/OS-II is a multi task real-time operating system for embedded devices, which has the characteristics of small memory space, good portability, good cutting ability, especially for small control system of intelligent car.

2. System hardware structure

Figure 1 is the overall hardware structure diagram, mainly including micro controller, sensor, display device and motor drive part.

Micro controller using ATmega128, its internal Flash bytes in the system can be programmed ROM 4K, 128K bytes SRAM, 4K byte EEPROM, the highest can reach the speed of 16MIPS. Micro controller as the core control sensor, motor drive and display device.

Environmental detection using ultrasonic sensors and contact sensors, ultrasonic sensors as the main sensor for detecting obstacles in the distance, and in order to generate a map of the environment, contact with the sensor as a sensor for detection of ultrasonic detection of the blind spot in contact with the car. The display device adopts LCD character LCD display module, display the position coordinates of the car and other information.

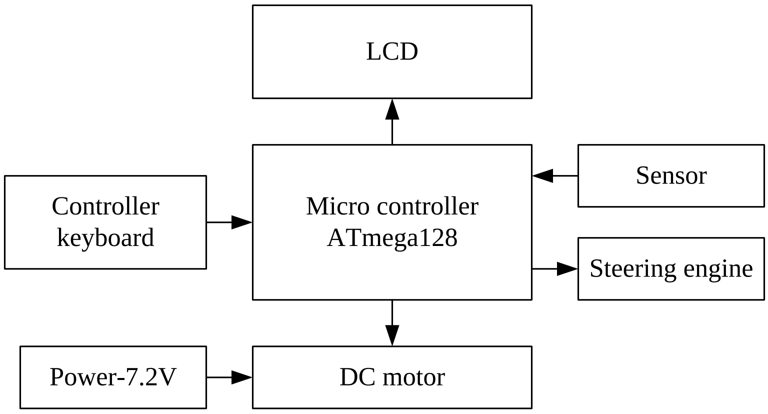

Fig.1 Hardwera configuration of intelligent car

3. Hardware circuit design

3.1 Sensor circuit

Ultrasonic sensor measurement object is the use of time difference method, that is, at a certain time to launch 40KHz 5~8 ultrasonic pulse, the sound wave to reach the object is reflected back, calculate the time difference between the acoustic emission and the time of the return moment can be calculated according to the speed of sound. By sending and receiving of ultrasonic sensor, the emission sensor driving circuit is shown in Figure 2, is composed of two inverters and inverter chip using 74hc04. When the input is 1 when the inverter output is 0, input 0 when the inverter output is 1, for the ultrasonic transmitter can be 10V input pulse. Using this simple inverter driving circuit can effectively increase the detection distance.

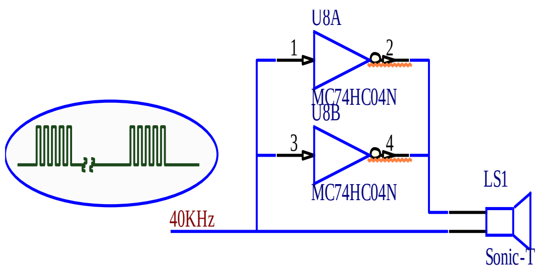

Fig.2 Ultrasonic pulse and drive circuit

Ultrasonic receiving circuit, such as Figure 3, consists of an amplifier circuit and a comparator shaping circuit. Amplifier circuit with single supply amplifier LM358, three amplifier circuit to apply ultrasonic sensor output signal is magnified 1000 times. In the first two stage amplifier, the electric potential of the amplifier in the event input is 0.5Vcc, which can be used to amplify the AC signal in a single source, and the AC signal is used as the input of the post - stage amplifier. The third stage amplifier is connected with the input terminal of the amplifier, and only the negative half cycle of the input signal is amplified, and the output signal is filtered by the capacitor C12 to remove the high frequency component. The LM393 pulse signal is used to detect the echo signal of the 5V square wave pulse as the micro controller.

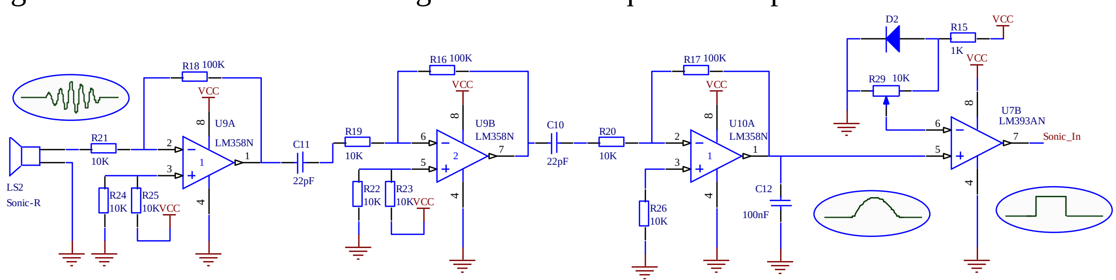

Fig.3 Ultrasonic receive circuit and signal wave

3.2 Motor driving circuit

DC motor and servo motor using pulse width modulation (PWM) mode drive, DC motor drive circuit uses the full bridge driver chip TA8428, which contains a control circuit unit and a full bridge circuit, the external has two control inputs IN1, IN2 and two OUTA, OUTA\, can output 1.5A drive current, and has the output short-circuit protection function. The actuator is directly connected to the I/O pin of the microcontroller as shown in Figure 4.

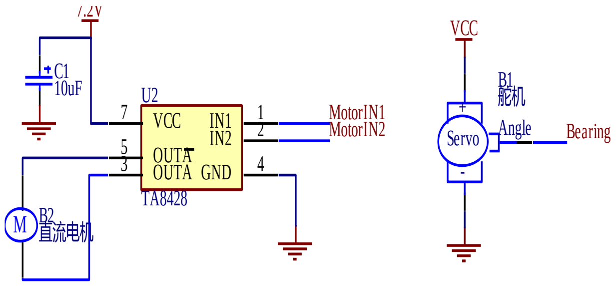

Fig.4 Motor drive circuit

3.3 Speed measuring circuit

In order to allow the car to know its position coordinates, the need for real-time calculation of the distance, speed and direction of travel, the use of the wheel mounted on the wheel of the photoelectric detection of the angle of the detection circuit, as shown in figure 5. With the rotation of the wheel, the A point of the output pulse waveform, after filtering capacitor C9 filter input comparator U7A plastic, after the output is 5V pulse. The output of the comparator is connected with the T/C2 external event count output pin T2 (PIN32), and the T/C2 records the number of pulses, thereby calculating the travel distance. The speed of the car can be calculated by measuring the interval between two adjacent pulses.

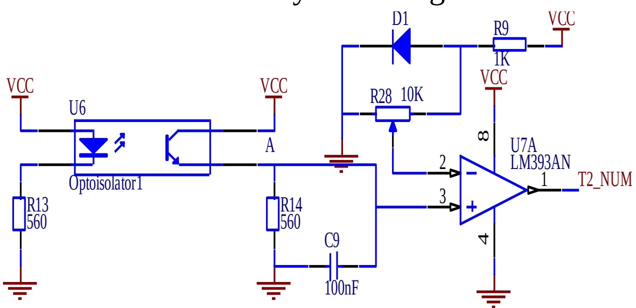

Fig.5 Photoelectric sensor circuit

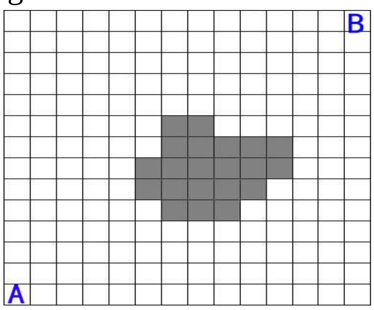

Fig.6 Grid map

4. Control algorithm

4.1 Environmental representation

Environmental information is not only to consider how to store environmental information in a computer, but more importantly, the use of convenient, making the problem of solving a higher efficiency. We use two dimensional Cartesian rectangular grids to represent the environment, as shown in Figure 6. The space of 4m * 4m is divided into 1600 10cm * 10cm square grid cells, each grid has a cumulative value CV, which indicates the existence of obstacles in this direction, the high CV value indicates the possibility of obstacles. Sensors keep the fast sampling environment, the existing obstacles of the grid will continue to be detected, resulting in high CV value, the system according to the car's position, attitude to calculate the number of cells occupied by the obstacle, and labeled storage.

4.2 Locating method

In the environment map, the initial position of the car is set to the origin of the coordinates, the center of the front wheel of the car is the coordinate point, according to the direction of the car's movement and the angle of the steering gear, the position and attitude of the car are determined. That the car after each movement of a short distance to calculate the position coordinates, and the movement direction and the angle of view in the distance is fixed, as shown in figure 7.

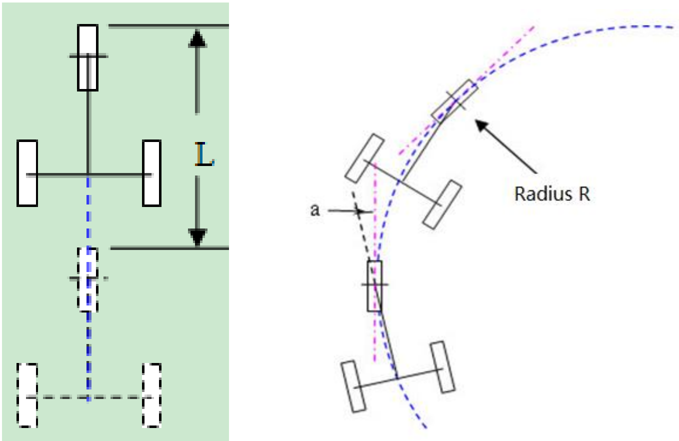

Fig.7 Locomotion model of intelligent car

4.3 Path planning

Path planning means that the intelligent vehicle can be based on the environment and location method, which is independent from the initial point to avoid obstacles to reach the target position path. In this paper, a direct search method is used, which is considered to be able to be used in the area that is not detected in the map. Intelligent vehicle is close to the target. When the sensor detects the obstacle, the system coordinates the information according to the information of the environment map. The intelligent vehicle moves in the direction of the two edge of the obstacle.

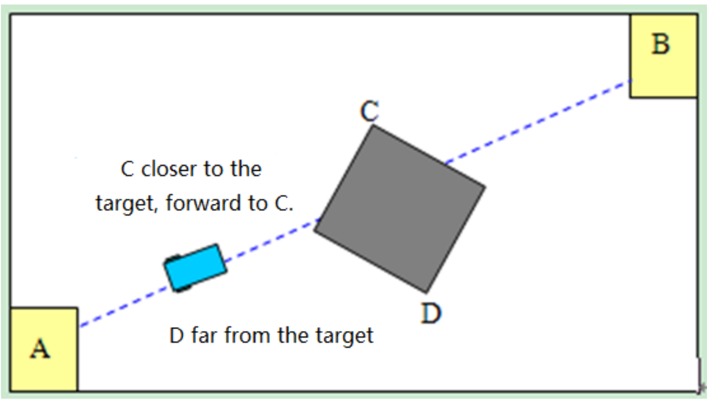

Fig.8 Sketch map of intuitionistic search means

5. System software design

According to the functional requirements of the system, the software design mainly includes c/osII, memory allocation and user applications.

5.1 UC/OS-II transplantation

Transplantation condition

To achieve the transplantation of C/OS- II, the processor and the compiler must meet certain conditions:

The C compiler used can generate a re - entry code.

Can re - enter the code is a more than one task can be called, without having to worry about the code will be destroyed. Can re - enter the code can be interrupted at any time, after a period of time can be re run, and the corresponding data will not be lost, not re - entry code is not. The V6.29 ICCAVR compiler used in this paper can generate a ImageCraft code.

C language can be opened and closed interrupt.

The V6.29 ICCAVR compiler used in this paper is supported by the () and SEI () CLI (), which supports the assembly statement in the C language. In this way, it is easy to switch in C language.

The processor supports interrupt, and can generate a timer interrupt (usually between 10 to 100Hz) in this paper using the ATmega128, there are 3 timer, can produce a C/OS- ii.

Processor support to accommodate a certain amount of data on the hardware stack. This paper uses the ATmega128 RAM 4K, the hardware stack can be opened in this RAM 4K.

The processor has a stack pointer and other CPU registers that are read from memory and stored in a stack or in memory. The general microcontroller to meet the requirements (such as PUSH, POP), and ATmega128 also has direct access to the I/O register (OUT, IN, etc.).

Realization of transplantation

The transplantation of C/OS- II includes the following contents:

Typedef statement with the compiler related 10 data types (OS_CPU.H)

Setting a constant value (OS_CPU.H) with #define

#define declares three macros (OS_CPU.H)

Using C language to write six simple functions (OS_CPU_C.C)

Write four assembly language functions (OS_CPU_A.S)

According to these elements, and gradually to complete the transplant task.

5.2 Memory allocation and task management

For the design of the memory capacity, the size of the C/OSII kernel code and application code are considered. Each task is independently run, and the stack space (RAM) must be provided for each task. μc/osII allows the simultaneous operation of 64 tasks, the removal of the 8 system, the user can use 56 tasks, and the priority of each task is different. Therefore, when the software design, the system needs to achieve the function of segmentation for a number of tasks, and reasonable allocation of their respective priorities, c/osII is responsible for the scheduling and synchronization of tasks, each task through the signal between the amount of information, mail, message queue and other communication mechanisms for data sharing and task communication.

5.3 Application design

Compared with the previous control system, the system is embedded in real time operation system. In the preparation of the program can call the interface function, making the application design is simple and easy to debug. The code in the application's Main function is given below:

```
int Main (int proc, char*prod) // Main function
{ ATmega128TargetInit( ); // System hardware initialization
OSInit( ); // Initialization operation system
Hr_ResetMMU(); // Reset MMU
LCDInit( ); // LCD module
// The following create system tasks: 1 seconds timer, serial scanning, the main task and LCD update
OSTaskCreate(Time_ls_Task, (void*)0, (OS_STK*)
&Time_ls_Stack[STACKSIZE*8_l], Time_1s_Prio);
```

// Similar to create 2 other tasks

InitRtc( ); // Initialization clock

Nor_Rw_sem=OSSemCreate (l); // Create Nor_Flash read and write control semaphore, the initial value of 1 to meet the conditions of mutual exclusion //

LCDFresh_MBox=OSMboxCreate(NULL); // Create LCD refresh mailbox

Lcd_Disp_Sem=OSSemCreate(l); // Create a LCD buffer control semaphore

ATmega128_Targetstart(); // Starting system hardware

OSStart(); // Start multi task operation system

6. Conclusion

The experimental results show that the system uses AVR+μC/OSII to develop the intelligent car can automatically avoid obstacles in accordance with the predetermined route and speed, adaptive strong, the overall control effect is good, to achieve the predetermined design goals of the smart car. Because of the introduction of the environment coordinate system, this control algorithm has the ability to perceive the external environment changes, which has a certain prospect in the complex dynamic environment.

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