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# A Simple Design of Clean Robot

Huichao Wu [1, a], Daofang Chen [2], Yunpeng Yin [3]

[1]College of Optoelectronic Engineering, Chongqing University of Posts and Telecommunications, Chongqing, China

[2]Research Center of Intelligent System and Robot, Chongqing University of Posts and Telecommunications, Chongqing, China

[3]Communication and Information, Chongqing University of Posts and Telecommunications, Chongqing, China

[a]christ_emily@163.com

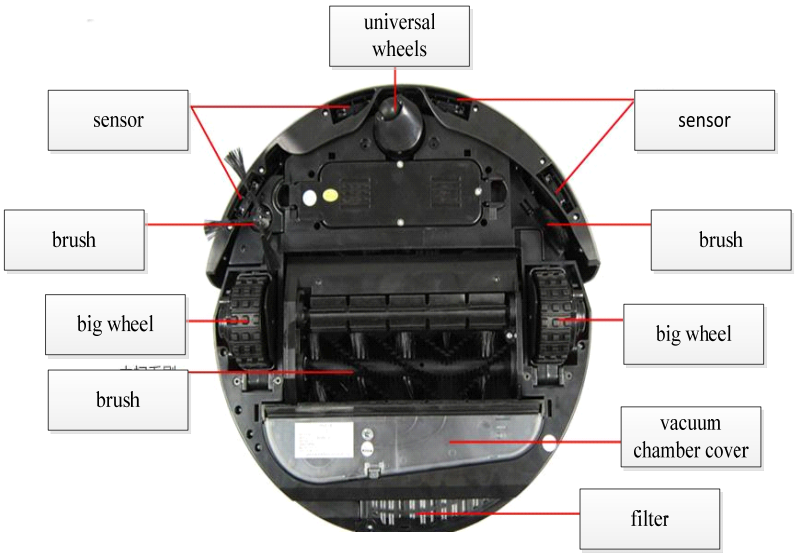
**Abstract:** With the improvement of people's living standards, comfortable and healthy home environment are more and more concerned by people. Cleaning robots with its less human intervention,time-saving,security and other advantages are entering in many familys nowadays. In this paper, a simple and cheap clean robot which has control mode and free mode is designed. Under the control mode, it can be controled by cellphone, In the free mode, it can clean the floor back and forth whose path like the shape of “#” with PID algorithm.

**Keywords:** clean robot, simple, control mode, free mode, cellphone, PID

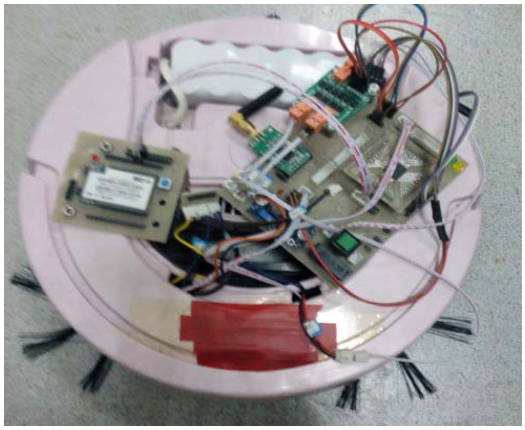
## 1. Introduction

Cleaning robot is a kind of intelligent vacuum cleaner, when in an unknown environment, will use a variety of sensors (such as collision sensors, infrared barrier sensors, anti-drop sensor, etc.) perceived in the indoor position and their own state, through intelligent control algorithm to achieve automatic obstacle avoidance, and to achieve efficient ground cleaning[1].

As we can see, the mechanism part of the clean robot proposed in this paper contains universal wheels, brushes, big wheels, vacuum chamber cover, and filter [2].




(a) The back of the clean robot



(b) The front of the clean robot

Fig 1. Structure of the clean robot

The main circuit of the clean robot consists of the master chip STC15F2K60S2、the DC motor drive AQMH2403ND based on PWM(Pulse Width Modulation), three-axis magnetic field electronic compass HMC5883L, high precision (0.5cm) ultrasonic sensor DYP-ME007, 970P/R photoelectric encoder, WIFI module, infrared sensor and so on.

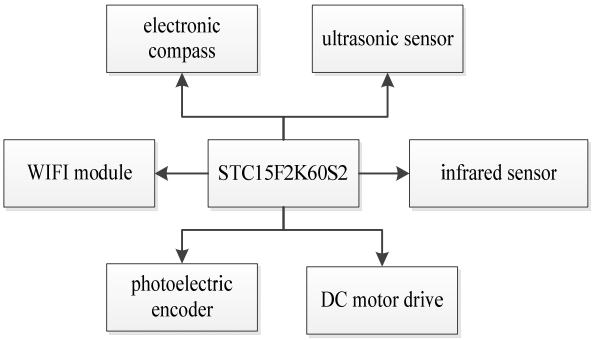



Fig 2. Structure of the control circuit

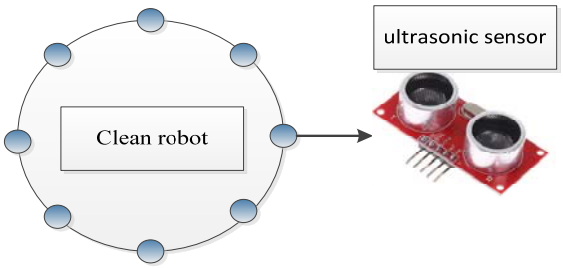



Fig 3.Ultrasonic sensor distribution

To guarantee the cleanliness of this robot, the software part also includes the PID algorithm.

## 2. Operating modes

### 2.1 Control Mode

In this mode, the clean robot can be controlled by cellphone through the WIFI. The WIFI module is set to AP mode, which generates a WIFI hotspot named "Clean Robot" for user's connection. An interface of cellphone application base on Andrew system is shown below. With simple control commands, you can lead this clean robot go to the specified room to start cleaning.

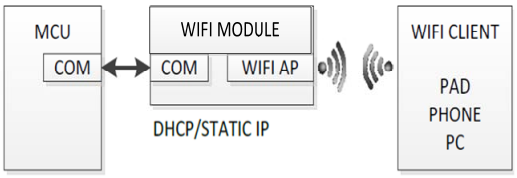



Fig 4.WIFI (AP) model

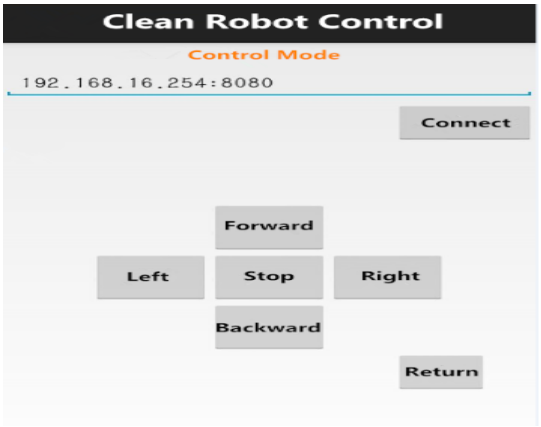



Fig 5.A interface of Andrew application

## 2.2 Free Mode

In this mode, the clean robot will be able to repeat the cleaning of some dirty areas automatically. It can clean the floor back and forth whose path like the shape of "#" with PID algorithm[4-6]. The program flow chart is descripted as Fig 4.

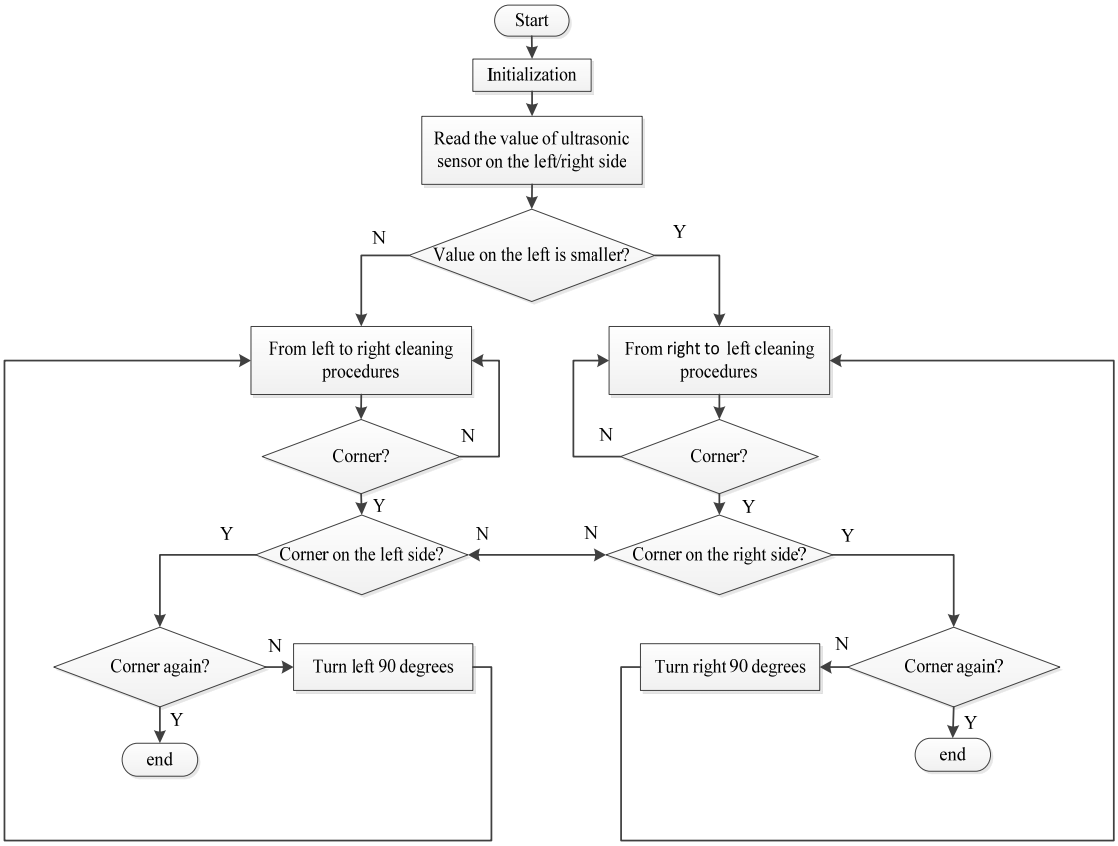



Fig 6. The program flow chart of free mode

In this work, because of the "#"-shaped needs the robot to walk a lot of straight line, so the incremental PID algorithm is used in the program.

Linear combination of proportion、integral、differential constitutes the control amount *u(t)*, and PID is the abbreviation of proportion, integral, and differential .

In the single-loop control system, the deviation of the controlled parameter will deviate from the given value due to the disturbance. The adjustment unit of the automatic control system performs the proportional, integral, derivative (PID) operation from the measured value of the transmitter compared with the given value, and outputs the unified standard signal to control the operation of the actuator to realize Automatic control of temperature, pressure, flow, and other process parameters.

$$u(t) = K_P e(t) + K_i \int_0^t e(t)d\tau + K_d \frac{de(t)}{dt} \tag{1}$$

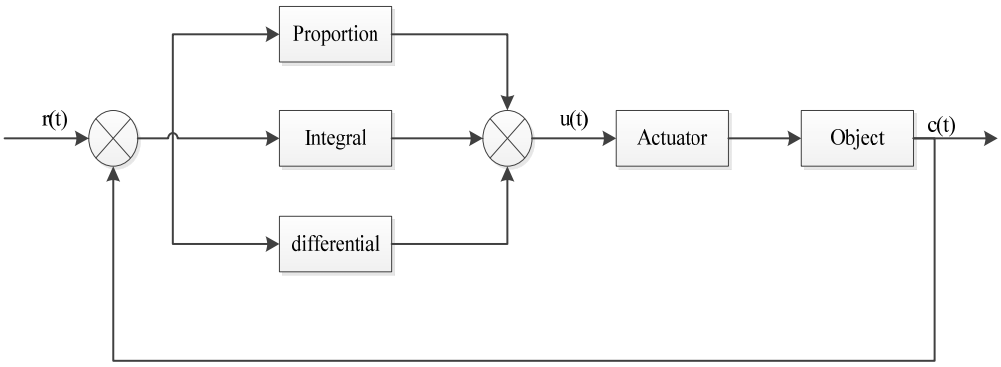



Fig 7.PID closed-loop control system

We first fixed the electronic compass on the robot, in the beginning of the operation the initial value of the electronic compass will be read, and then due to the trajectory shifting of the robot after operation makes the value of the electronic compass will produce a small range of floating, at that time the microcontroller continuously reads the data of the electronic compass through the IIC bus, and later compares the read value with the initial value, assigns the difference to the PID control subroutine, calculates it using the PID algorithm, and finally assigns the calculated value to PWM variable, thus changing the PWM duty cycle to adjust the speed of the left and right wheels, twist the movement of the robot trajectory, to achieve the purpose of straight walking.

## 3. Design of the circuit

### 3.1 Smallest System of STC15F2K60S2 controller

It has 44 pins, 42 GPIOs. Power supply voltage is 5V, clocked at 35MHz, 61K ROM. In order to improve the voltage pull-up capability, so in the P0 port connected to a rejection.

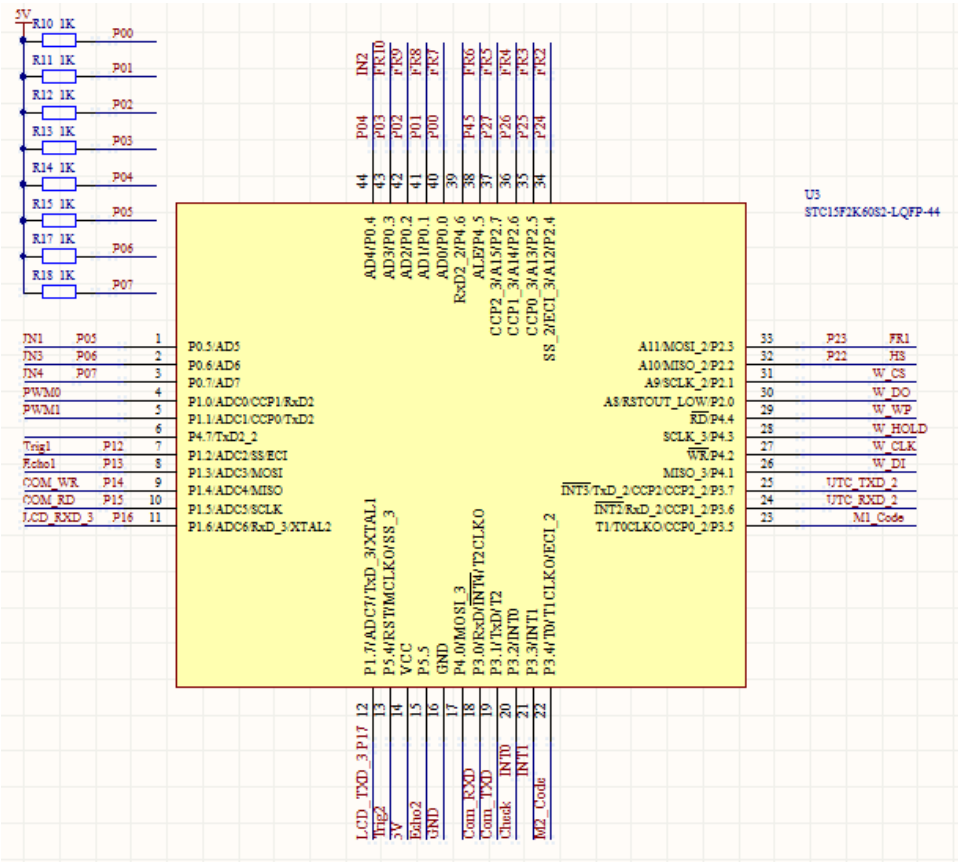



Fig 8. Smallest System of STC15F2K60S2 controller

### 3.2 DC motor drive module

This paper uses AQMH2403ND dual output DC motor driver, the size of only 3.5cm * 4.3cm, the output power is 30W when input 12V. Only three-wire level can control the motor to enable, turns positively and negative or brake, Enable pin can be connect to PWM pin of controller to adjust the motor speed. The DC motor drive module interface circuit of this work is shown in Fig.4

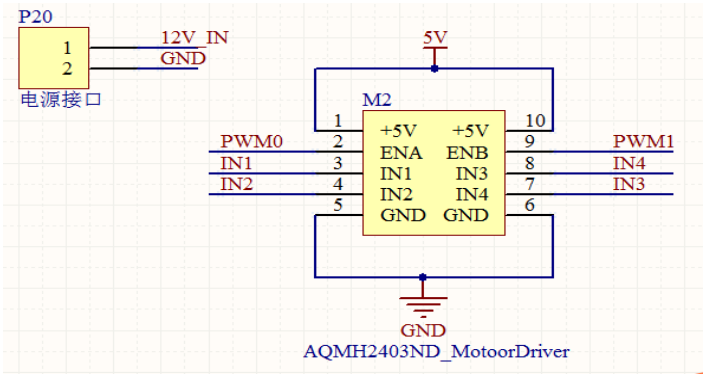



Fig 9. DC motor driver module

### 3.3 Photoelectric Encoder Interface Circuit

As the photoelectric encoder and the motor are coaxial, when the motor rotates, the grating plate and the motor are at the same speed, the light-emitting diodes and other electronic components of the emission device to output a number of pulse signals, by calculating the number of pulses per second photoelectric encoder output can reflect the current motor speed.

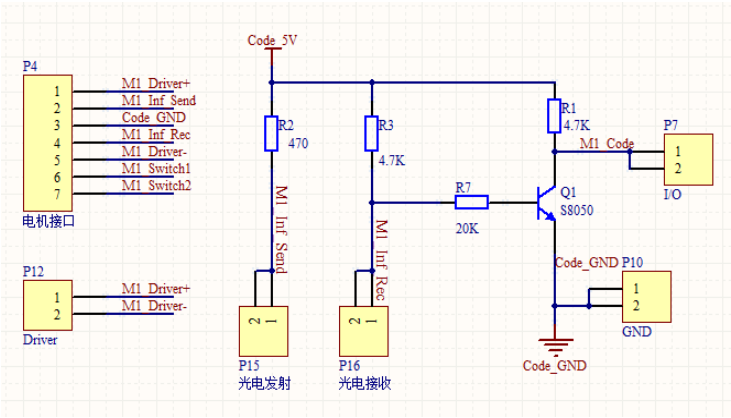



Fig 10. Photoelectric encoder interface circuit

### 3.4 Photoelectric Encoder Interface Circuit

In the process of cleaning due to various factors will lead to the clean robot from the original plan of the cleaning line, then the electronic compass can find the deviation from the angle in time, and the data transmitted through the IIC bus to the control center, Thereby adjusting the speed of the two wheels until the electronic compass offset becomes a small value.

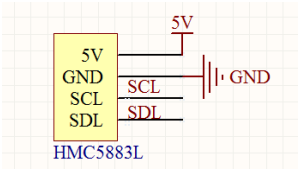



Fig 11.Electronic compass interface circuit

## 3.5 WIFI communication module peripheral circuit

This work WIFI module comes from the supplier HI-LINK, with stable and reliable operation. It is embedded TCP/IP protocol, and has three modes of operation: wireless card mode, wireless access point mode, wireless router mode. This article uses the wireless router mode (AP mode).

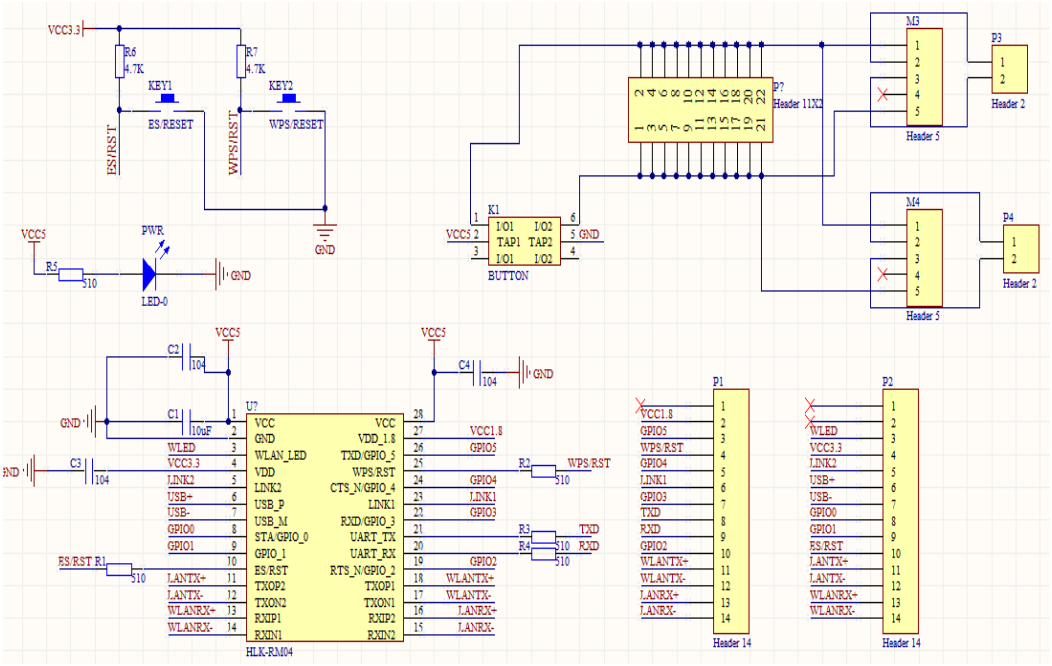



Fig 12. WIFI communication module peripheral circuit

## 3.6 Ultrasonic Sensor Interface Circuit

The DYP-ME007 ultrasonic rangefinder module provides a 3cm-3.5m non-contact distance sensing function. The basic working principle of measurement is: give a trigger signal to the sensor first, when the ultrasonic projects to the object and reflects back, the module outputs an echo signal. The time difference between to trigger the signal and the echo signal can determine the distance of the object.

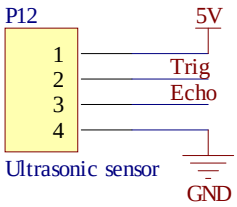



Fig 13.Ultrasonic sensor interface circuit

### 3.7 Power Module

In order to be compatible with microcontrollers and other sensor power supply, this paper uses AMS1117-3.3 chip 5V voltage will be converted to 3.3V.

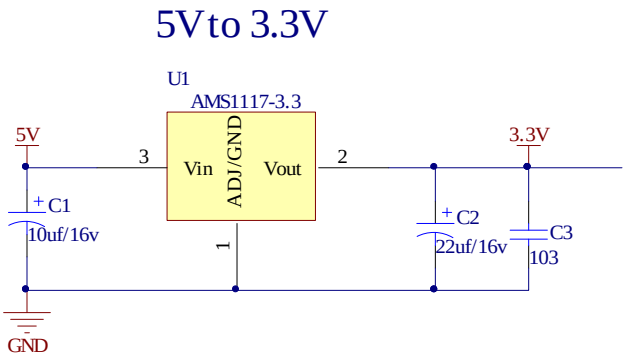



Fig 14. Power module

### 3.8 Buzzer Module

The cleaning robot needs to respond when it receives the instruction and needs an alarm when encountering an obstacle, and therefore requires a simple buzzer.

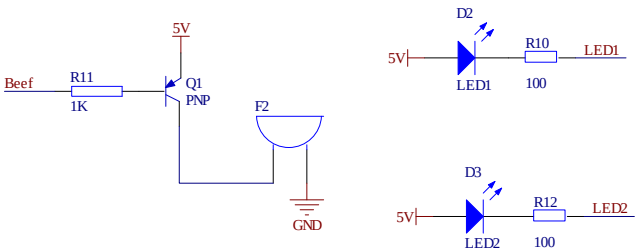



Fig 15. Buzzer module

## 4. Conclusion

With the rapid development of global robot, clean robots that can liberate the human labor force have become an important subject and have broad prospects for development. This work takes full account of the service robot environment, which must have safe and stable characteristics, and on this basis, the design of a simple clean robot is completed. When it works, it can receive simple commands from human, and road signs is not required which means depends less on the environment. It is cheap and simple, thus has certain application value.

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