

# Design of Automatic Mower Based on Single Chip Microcomputer

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**Abstract.** With the development of city construction, there are increasing demands on the greening, but the traditional mowing way is always by man hand, which has low efficiency, high noise, and also has the existence of security risks. In this paper, a kind of automatic mower is designed based on the Single Chip Microcomputer, automatic mower has high efficiency, low noise, and also can avoid the staff safety problems. It provides a new idea for the development of a lawn mower.

**Keywords:** Single Chip Microcomputer; Automatic mower; Control system.

## 1. Introduction

The invention of robot brings great help to the work of production. With the continuous progress of industry, production mode has gradually come to the trend of automation and high efficiency, which makes the robot has been applied in more and more fields [Zhang et al., 2004]. The development of city construction makes demand for afforestation increasing, and it brings the problem that how to manage lawn [Wang et al., 2013]. The traditional way to mowing is by man hand, which has low efficiency, high noise, and also has the risks of security [Hou et al., 2012].

Automatic mower belongs to the category of intelligent robot, its main function is to substitute man to finish mowing work. Automatic mower has the advantages of high efficiency and low noise, and it also can avoid the safety problems of staff, nowadays there are researches on automatic mower, these automatic mowers mostly use industrial computer as a control element [Li et al., 2003], there are shortcomings such as large volume, poor reliability, low flexibility and poor portability. In this paper, the automatic mower is designed based on Single Chip Microcomputer, in recent years, Single Chip Microcomputer with the advantages of fast processing speed, good reliability has been widely applied [Dong et al., 2009]. Automatic mower can mow the lawn in a certain region along a given estimation, and it can avoid the various obstacles along the way, the full automation of mowing is realized, it provides great convenience for afforestation management.

## 2. The control system design

### 2.1 The overall design

Automatic mower structure is shown in Figure 1, the main body is a car with four wheels, the front wheels are guide wheels, and the rear wheels are driving wheels. Front guide device uses universal wheels, the rear wheels are driven by the stepping motor. Automatic mower is designed to replace human labor, automatic mower can work automatically without the intervention of man.

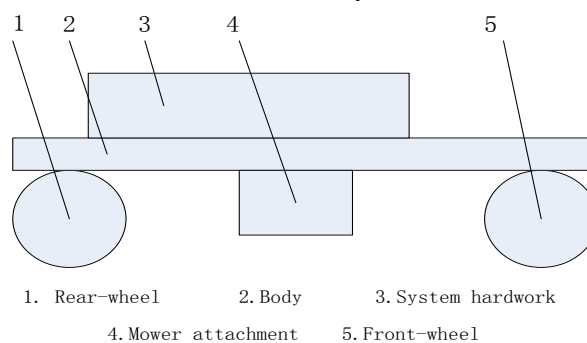


Figure 1. Automatic mower structure

Control module for automatic mower is shown in figure 2. Automatic mower adopts modular design, it is composed of a few parts which are the control module, execution module, manage module, detection and feedback module and an interaction module, each section independently works and has relationships with each other, if there is a module has error ,it will affect the overall operation of the process.

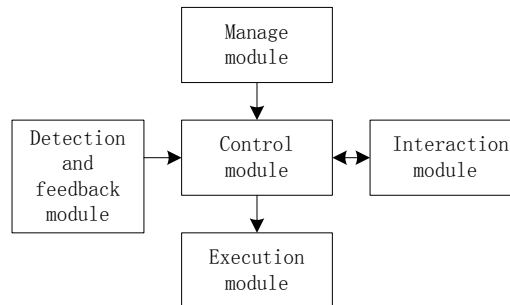


Figure2. Control module for automatic mower

**2.2 Single Chip Microcomputer**

In recent years, the Single Chip Microcomputer with its advantages of fast processing speed, good reliability has been widely applied. In this paper, the requirements of Single Chip Microcomputer is to communicate with the host computer and servo drivers accurately and fast, it means that the response time should be short, and real-time data transmission and real-time feedback measurement should be ensured, which will realize accurate control of automatic mower.

**2.3 Detection device**

In this paper, the detection device uses the sensor. The sensor is an equipment based on induction of physical phenomena for the purpose of generating an output signal. Automatic mower sensing system needs to detect the distance and obstacles, so the ultrasonic sensors, infrared touch sensor, temperature sensor, pyro electric infrared sensor, touch sensor and rotary encoder will be used. The ultrasonic sensor is a sensor developed by ultrasonic characteristic, it is shown in figure 3. Ultrasonic sensor has characteristics of high frequency, short wavelength, the less diffraction phenomenon, good direction and directional propagation. When ultrasonic sensor encounters impurities or interface, it will produce significant reflection, when it encounters moving objects, it can produce Doppler Effect. Therefore, the ultrasonic sensor can be used for measuring distance of the automatic robot lawn mower and obstacle when working. But the ultrasonic sensor can't detect the distance less than 30cm in the region at the front of the barrier, the region is known as the blind area, therefore an infrared touch sensor is required (Figure 4) to measure the near distance obstacle.



Figure 3. The ultrasonic sensor

Figure 4. The infrared touch sensor

**2.4 Execution device**

In this paper, the execution device to drive mower rear wheel is stepping motor, the normal operation automatic mower is ensured by power device. The output of step motor depends on the input signal of the motor, which is accurate. Input step signal exists through the form of pulse, in the appropriate combination of the pulse, the stepping motor will work in clockwise or counterclockwise direction, and the input pulse determines the speed of the motor, so the speed control and direction

control device can use step motor as driving. Step motor uses differential speed control on rear wheels, the different trajectories will come out through different speed between the two wheels.

### 3. Software design

#### 3.1 Working process

First, open the equipment switch, system begins to initialize; select automatic mower trajectory, set related parameters. Automatic mower operates, when it encounters obstacles, the system will make judgment that continue to walk or interrupt walking. If walking is interrupted, the automatic mower will be reinitialized and begin a new process. Automatic mower control flow chart is shown in figure 5.

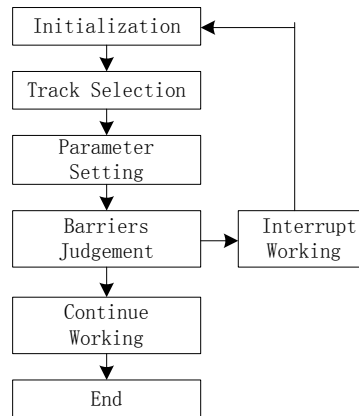


Figure 5. Automatic mower control flow chart

#### 3.2 System I/O distribution

The system I/O distribution is shown in table 1. The signal of each detection device will feedback to the Single Chip Microcomputer, Single Chip Microcomputer will do real-time control based on the feedback information of the operation status of the automatic lawn mower, the completion of the mowing work will be done in this way.

Table 1. System I/O distribution

	Input		Output
IN0	Ultrasonic sensor	OUT0	Rear-wheel servo motor 1
IN1	Infrared sensor	OUT1	Rear-wheel servo motor 2
IN2	Temperature sensor		
IN3	Pyroelectric infrared sensor		
IN4	Contact sensor		
IN5	Rotary encoder		

#### 3.3 Path planning

Path planning is divided into the center radiation extended cover method and Straight line cycle cover method, it will be chosen in the work according to the actual situation.

The center radiation extended cover method, as shown in figure 6. When using this method, it uses the point of radiation to the entire plane. The automatic mower will maximally complete area coverage. In the working process of induction, when encountering obstacles, it can pass through the sensor system and the control system judgment, and it will not affect the size of coverage area. At this time, the automatic mower will serve obstacle as the center, and repeat the method.

Straight line cycle cover method, as shown in figure 7, it works on the whole plane step by step. This method is relatively simple, but because of the need for 180 degrees turn at the boundary, so it is difficult to avoid overlap part of steering. But the method has higher work efficiency.

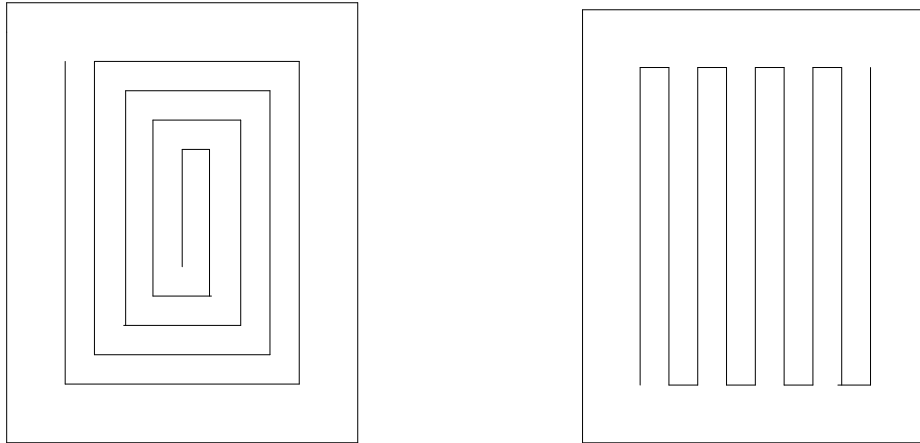


Figure 6. The center radiation extended cover method    Figure 7. Straight line cycle cover method

#### 4. Conclusion

Aiming at the existing problems of traditional lawn mower, a kind of automatic mower is designed based on Single Chip Microcomputer. The automation of mowing process is realized, it is instead of manual labor, and it greatly improves the production efficiency and reduces production cost. The lawn mower work in conjunction with each module according to the system path planning, it needs not care, real mowing automation is realized. It provides a new idea for the development of automatic mower

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