Intelligent Mower Controlled By Single-chip-microcomputer

Ma Zhenfeng[a,*], Yu Shanxin[b], Cheng Gong[c]

Applied Technology College of Dalian Ocean University, Dalian Liaoning

[a]mazhenfeng@sohu.com, [b]24261225@qq.com, [c]229273410@qq.com

*corresponding author

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Abstract: As the single-chip microcomputer becomes more and more cost effective, its performance has also been improved drastically. In this paper, the way intelligent mower is made possible by the single-chip-microcomputer is discussed. In the overall scheme, the location where the intelligent mower is put into practice is analyzed, the function of the intelligent mower is designed, the product hardware design is presented, the motor drive of the product is planned as a whole, and the software control of the intelligent mower is also designed.

1. Introduction

The research on the intelligent mower started rather early overseas, thereby accumulating plenty of design experience that have made significant advancements in making the mowers intelligent. In European countries, every family owns a great amount of lawns but doesn't have enough labor to mow them, which results in the demand of the mowers going intelligent in most families.

The main function of the intelligent mower is the route planning of automatic mowing. Regular intelligent mowers can accomplish mowing missions that are rather complicated. The fact that they can avoid obstacles using sensors during mowing means they are intelligent, but the route they are taking is random instead of planned, which means the mowing result is not the most ideal. The more advanced ones, however, can not only complete the complicated mowing missions, but can also analyze the geography of the location and plan out an effective route when they run into obstacles. This way not only lawns can be mowed more ideally, it is more time-efficient.[1]

2. Research Background and Meaning behind Research

With the rapid development of technology in China, people's demand of intelligent machines has increased. In order to reduce pollutions in the environment and replace some of human labor, intelligent mowers that are used in public lawns, soccer fields, and parks are brought under the spotlight. Compared to the traditional mowers that use gasoline, intelligent mowers are much more environmentally friendly. Intelligent mowers can sense, analyze and decide in a certain environment without human intervention through robot technology and sensor technology. They have saved people from repetitive and tedious labor, and decreased the maintenance labor and cost.[2]

Currently most of the mowers require human labor, which decreases the level of intelligence and takes more time and energy. Some parts of the lawn are mowed overly and appear very messy, which is the reason why GPS technology is also added to intelligent mowers so that they can plan their own routes and have a neat lawn after mowing.

3. Advantage of Intelligent Mowers

The hardware advantage of the product includes single-chip-microcomputer STC15W4K58S4, system detection, display module, A/D circuit, warning circuit and so on. Sensors are used to measure the edge of lawn, the height of grass, distance from the obstacles and animals. The data obtained from sensors are sent to the control system (STC15W4K58S4) and compared with the

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height of the grass. If the height of grass is taller than the height setting, mower will start working, and initiate automatic route planning using the height of grass. If there is an obstacle, it will move around it; if there is a human or animal, it will stop moving, initiate the warning system and wait until the object leaves. [3]

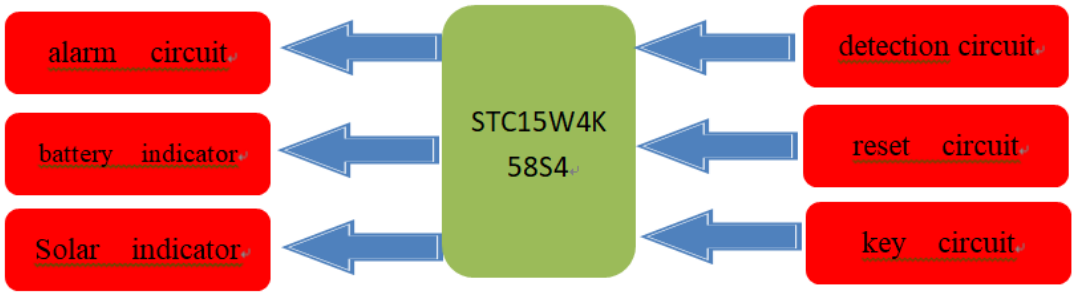

Figure 1 Control principle of intelligent lawn mower

4. Current Research of Intelligent Mowers

Even though China started rather late on researching on intelligent mowers and has limitations on the research fields, it has gained plenty of experience and results. It has improved on the overall intelligent design of the mower, the automatic route planning, and the function of the control system. At the same time, statistics on the intelligent mower has also been analyzed, which provides the design demand of motor drive, control system circuit, and main components, which also builds a strong foundation developing intelligent mowers further.

5. The Overall Design of Intelligent Mowers

5.1 Hardware design of Intelligent Mowers

The dynamic drive of the intelligent mowers is divided into two decelerating DC motors. Intelligent mowers need two mower engines other than two direct drive motors; in reality, when the intelligent mowers are on an outdoor mission, there might be various situations. If the intelligent mowers run into obstacles or sudden situations that make the mowers lift, fall on their side, hurt people or run into other accidents as such, the pressure sensor will be initiated. When the pressure is different on the two sides of the mowers, the single-chip-microcomputer will thus come to the conclusion and make corresponding responses; moreover, in order to prevent the body of the mowers lift and show their blades which may hurt people, the system incorporates light sensor -- when illumination is bigger than a certain value, the system will automatically treat it as being lifted. The micro-chip computer will send a signal to stop the motion of the mower blades and therefore reduce the chances of accidents; intelligent mowers recognize the edge of a lawn through color sensors, and then control its motion range through the micro-chip computer. Other than that, in order for the mowers to plan its route, the system also used electronic compass sensor, which can send feedback of the angles of the mowers in real time, allowing the intelligent mowers to plan their route automatically. Besides, for the mower and people to interact in real time, the intelligent mowers uses a 12864LCD LED screen and a 4x4 matrix keyboard. The overall structure of the system is shown in the figure 2[4]

The main control chip of this system is STC15 W4 K58 S4 chip made by HongJing company. The main external device of this system includes a generator circuit, keyboard device, data display, sensor module, and electronic compass design. On the front of the mower, there exist two obstacle detection modules – ultrasonic module, which respectively lie on the two sides of the front of the car; infrared sensors for human body are situated around the body of the mower; color sensors are located on the front, left, and right of the mower base; electronic compass is located right in the middle of the mower body; mower engine is placed on the central bottom of the mower; the main controlling chip STC15W4K58S4 is located on the central front, using wires to connect each

detection module, electronic compass, and so on with the main controlling chip; battery is placed on the battery holder on the front. The layout of each component is shown in figure 3.[5]

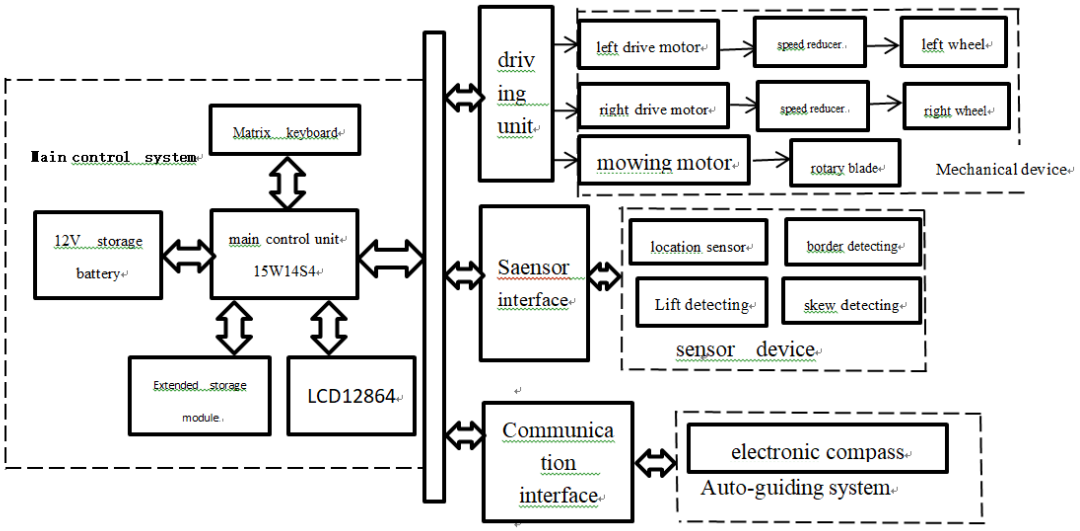

Figure 2 Overall Frame Diagram of System Structure

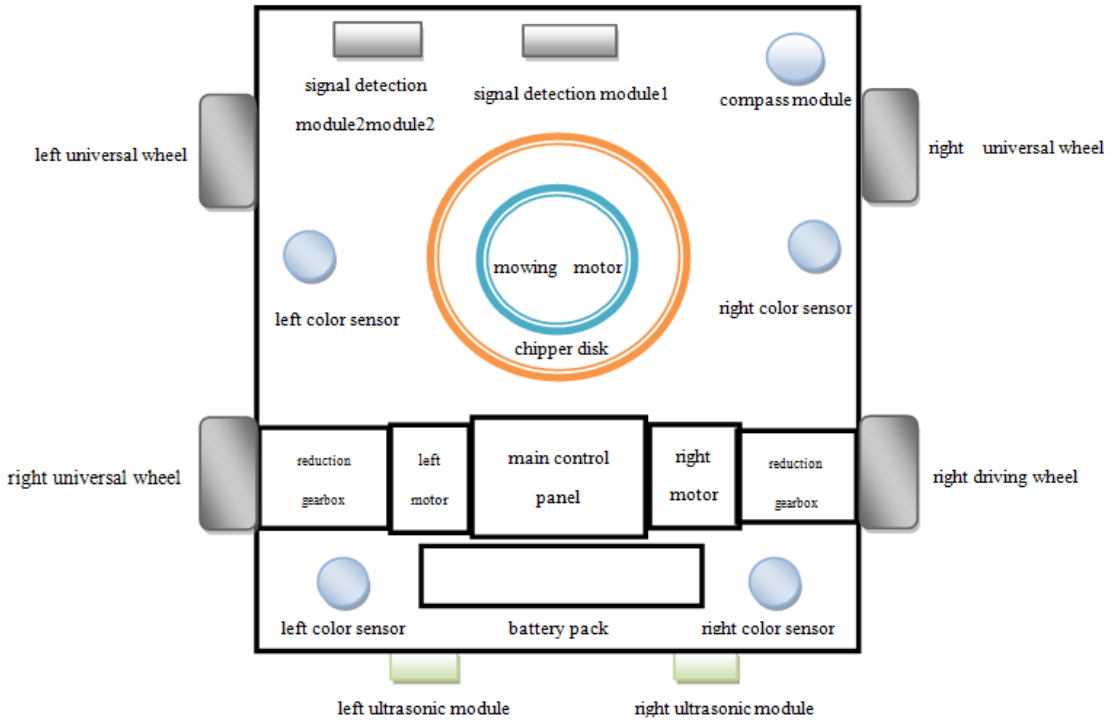

Figure 3 Device Structure of Intelligent Lawn Mower

5.2 Design of Route Planning

This design utilizes HMC5883L electronic compass to refine the mowing route of the intelligent mower, which is why the hardware circuit of the electronic compass is very important. Modular design is used to achieve a higher stability of the system. The electronic compass design is put on one single circuit board and the processed signal is used to communicate with the main controlling chip through IIC communication.

6. Software Coding of the Intelligent Mower System

Intelligent mower software is a gigantic program. Here this program is divided into multiple modules to code: keyboard scanning software, LCD12864 LED screen display drive, three axis

straps down magneto resistive digital magnetic compass driver, etc. The mission modules are divided as the figure 4 shows.

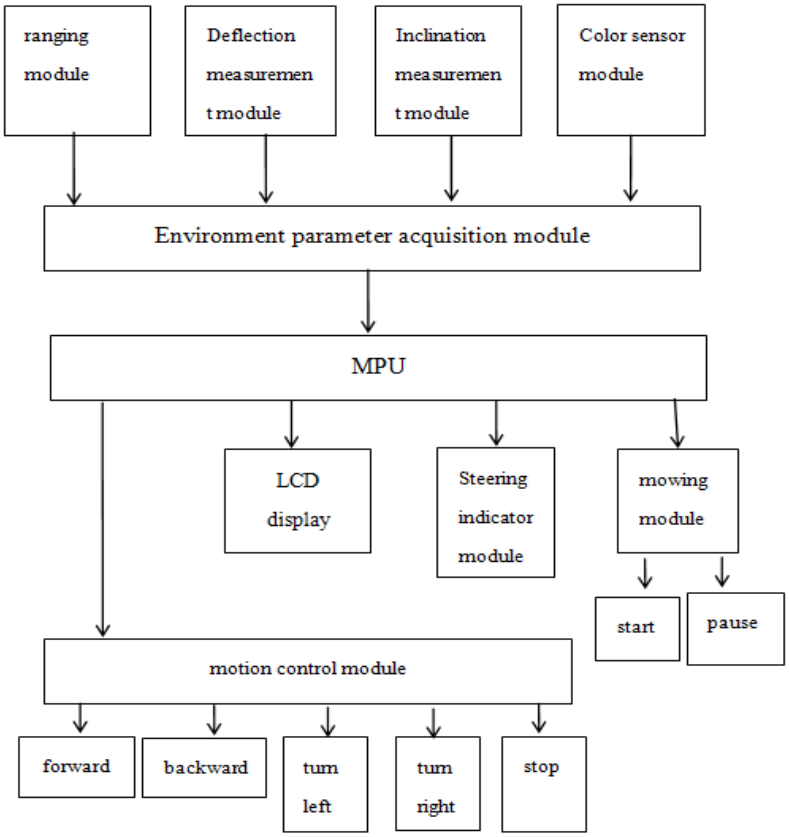

Figure 4 Software Module Partition of Intelligent Lawn Mower

To start off, the program will constantly scan the keyboard when it first starts. The keyboard is recorded as: forward button, backward button, brake button, switch button, working timer. The electric level of P2 port corresponding to the IO port of MCU micro-chip computer needs to be low to be effective. If the forward button is pressed, the intelligent mowers will move forward and start the intelligent mower system so that the mower can work without supervision; if the backward button is pressed, the mower is driving backwards without actually mowing; if stop button is pressed, the intelligent mower will stop working; when switch button is pressed, the LED screen will switch to displaying the running data of the mower; if the timer button is pressed and inputs data, the intelligent mower will work for the amount of time set.

The program needs to scan constantly, and every time a scanning action is made, electric level will be lowered in order. This action is repeated – IO port will decide whether electric level is high or low one by one. If the electric level is low, it means that one of the button is pressed, and the button that is pressed can be determined through judgement of ranks. Because the machine button will be vibrating, there will also be part of the program that will eliminate that vibration.

7. Conclusion

This essay analyzes people's demand of intelligent mowers on a deeper level and proposes a structural, diverse, and intelligent design based on reality, combining the future prospect and developing direction of the intelligent mowers. It also puts an emphasis on the structure and appearance of the mower, its engine controlling system, route planning strategy, and ultrasonic obstacle avoiding system. In order to make the mowers run in a more accurate and stable fashion, the design incorporated color sensor, ultrasonic sensor, and infrared sensor as a supplement of the mower route planning, which refines the intelligent mower even more.

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