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Intelligent Agriculture - Small Intelligent Agriculture Robot

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Abstract

With the development of Internet of things and artificial intelligence technology, China's traditional agriculture is undergoing a huge reform. In order to promote the development of Intelligent Agriculture in southern China, promote the mechanized automatic production of agriculture in southern China, and reduce farmers' labor time and labor cost, a small intelligent agricultural robot is designed based on artificial intelligence, Bluetooth technology, pH detection, STM32 and other technologies, It can complete the functions of land pH detection and Bluetooth communication, and can be applied to the automatic production of farmland agriculture.

Keywords

Intelligent Agriculture; Automatic Production; Bluetooth Technology; pH Detection; STM32.

1. Introduction

With the development of modern machinery and computer technology, the mode of agricultural production is gradually changing, and agricultural robots appear in every link of agricultural production. Agricultural robots are robots that use machinery to simulate manual agricultural activities, and it is a symbol of a country's agricultural development. Since the 20th century, countries around the world have carried out a lot of research on agricultural robots, and our country has also been researching agricultural robots for a long time. However, the popularity is not very high, especially in the southern regions. Due to the many terraced fields in the southern regions, harsh farming conditions and hilly terrain, traditional large-scale machines are not suitable for the southern region. The small intelligent agricultural robot of this project is to provide assistance for the intelligentization and industrialization of farming in the southern regions, to create a small intelligent mechanical product suitable for various complex farming environments such as terrace farming in the south, and help rural modernization development.

2. Overview of Intelligent Agriculture

The so-called "Intelligent Agriculture" is to full apply the achievements of modern information technology, integrate and apply computer and network technology, Internet of Things technology, audio and video technology, 3S technology, wireless communication technology and expert wisdom and knowledge to realize intelligent management such as agricultural visual remote diagnosis, remote control, and disaster warning.

Intelligent agriculture is an advanced stage of agricultural production, which integrates emerging Internet, mobile Internet, cloud computing and Internet of Things technologies, and relies on the deployment of various sensing nodes (environmental temperature and humidity, soil moisture, carbon dioxide, images, etc.) and wireless communication networks on the agricultural production site to realize intelligent perception, intelligent early warning, intelligent decision-making, intelligent analysis, and expert online guidance of the agricultural production environment, so as to provide precise planting, visual management, and intelligent decision-making for agricultural production.

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3. Hardware Design of Intelligent Agriculture Robot

3.1 Model

The radius of the shell of this project is 30.00cm and the height is 15cm. In order to meet the flexibility, the volume of the casing is designed to be relatively small. Due to material limitations, we used a cardboard case instead of a plastic case, and after many tests, the shape can meet the author's design expectations. The cylindrical design is to save space and further reduce the size, and the cylindrical design is also conducive to the realization of the functions of other components. For example, the cylindrical design can facilitate the function of the auger for digging soil and the implementation of the seeding function. One of the cores of this project, the radius of the cutting surface of the spiral tiller is 20.39cm and the height is 40cm. In order to adapt to the working environment, the author chose the alloy as the raw material of the tiller, which requires high wear resistance, high hardness and easy replacement. The author considers that the tiller is a consumable item when designing the tiller, so it is designed as a detachable design, which is easy to replace and can further save the cost of use.

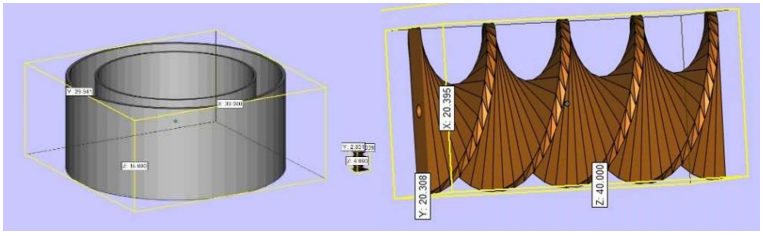

Fig.1 Appearance model **Fig. 2** Plough knife model

3.2 STM32f103 Single Chip Microcomputer

The author uses this chip as the main control chip, which controls most of the functions such as timing, storing information and so on. All indicators of the chip are in line with the author's design expectations. Although this series belongs to low-end products, it is more than enough for this project. Therefore, there is still a lot of room for development in this project, which can be updated according to different design requirements.

Moreover, the chip supports a low-power mode, which can save costs and save resources. The new series of microcontrollers also continue the low-voltage and energy-saving advantages of the STM32 product family. There are four low-power modes in total, which reduce current consumption to as little as two microamps. High-speed startup from low-power mode also saves power; the startup circuit uses an 8MHz signal internally generated by the STM32 to wake the microcontroller from stop mode in less than 6 microseconds. On the whole, the whole module can not only save energy, but also run extremely fast, which has obvious advantages compared with other processing modules STM32f103.

3.3 The pH Detection Module

Soil pH plays an important role in agriculture. Soil pH is an important chemical property of soil and an important indicator of soil fertility. In the process of vegetable cultivation in protected areas, whether the applied fertilizer can be absorbed and utilized smoothly, and then transformed into the power to increase production, is closely related to soil pH. The pH of the soil is often referred to as the soil pH. Most vegetable crops are suitable for neutral to slightly acidic soils, and the best absorption and utilization of 17 nutrients necessary for vegetables is also within this range. It can be seen that maintaining a suitable pH of the soil can stimulate the potential of increasing vegetable yield, so the author chose an electrode-type pH detector for this module considering cost and technical reasons. The product consists of two modules, a pH sensor module and a pH composite electrode. Since the PH composite electrode outputs a voltage signal of mV level, the single-chip microcomputer cannot directly identify and process it, so the PH sensor module is used. The author designed this

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module to complete the function of soil pH test. This function can transmit the pH of the land to the user, so that the user has a certain understanding of the land they use, and according to the pH of the land, the user can propose crops suitable for planting on the land. The module is not only easy to use, but also has high measurement accuracy, low price, and it can directly output 0-5V or 0-3V analog voltage signals.

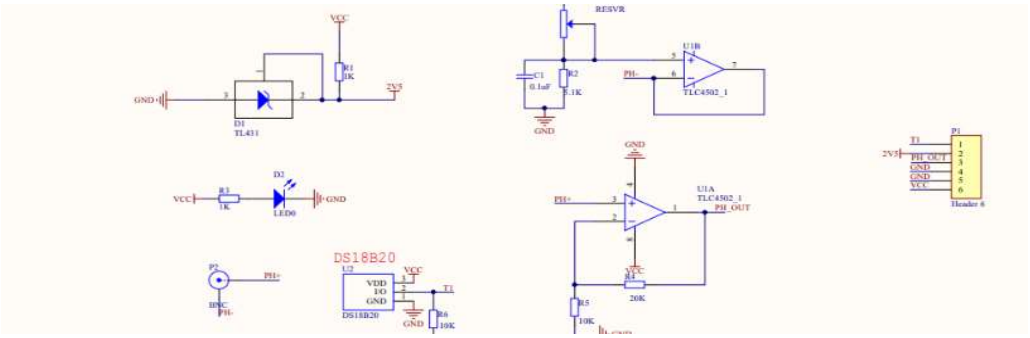

Fig. 3 Design of pH sensor signal conditioning module

3.4 Bluetooth Module

In order to facilitate the operation of the remote control product, the author uses the HC-05 Bluetooth serial communication module for remote communication, and the Bluetooth module has two working modes: one is the command response working mode; the other is the automatic connection working mode.

When the module is in the automatic connection working mode, it will automatically transmit the data connected according to the pre-set method; it can autonomously control the system to complete some simple commands without consuming manpower.

When the module is in the command response mode, it can execute AT commands, and the user can send various AT commands to the module to set control parameters or issue control commands for the module. By receiving commands from the remote end in real time, it can complete more complex functions and improve the work efficiency of the product.

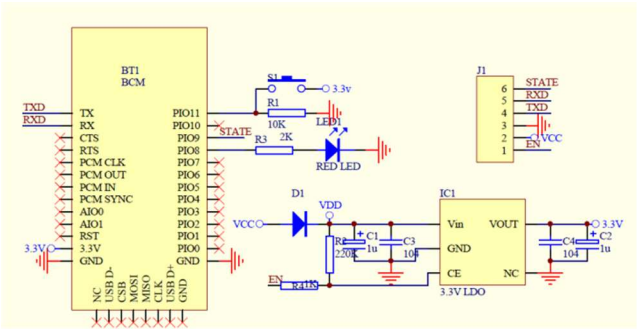

Fig. 4 Bluetooth module circuit design

3.5 Telescopic Module

In order to meet the planting and excavation functions of this project, the author chose this telescopic device. This project requires intelligent agricultural robots to perform functions such as digging and sowing, so a flexible telescopic device is required, which is small in size but powerful in function and can complete the expected functions. And the module can be replaced independently, which can reduce maintenance costs. This module is also equipped with ip54-level waterproof performance, which can be used freely in the farmland. Moreover, the module is made of aluminum alloy, which has strong anti-corrosion ability, which also reduces the influence of the outside world on the module, and the aluminum alloy shell also reduces the weight of the module. The noise of this module is less

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than 50dB during operation, which can reduce the noise pollution of the project to the environment. This module only needs 12vdc, 0.3A DC voltage and DC current, which can be well adapted to the STM32f103 single chip microcomputer of this project.

3.6 Power Module

3.6.1 GA370 Coded Geared Motor

The motor met our design expectations and was finally selected after many tests. The motor is made of high-precision one-time forming rotor high-quality material, high conductivity, high wear resistance, and adopts pure copper group, low resistance, heat generation, low loss, small volume, and stable operation. The motor reducer casing is made of high-quality metal, with good impact resistance and durability, which can well adapt to the working environment of the southern farmland, and can effectively reduce noise and prolong the service life of the reducer casing. And the motor is inexpensive to manufacture. In order to facilitate replacement and maintenance during the design, the author deliberately separated it from the driver board, so that the motor can be replaced independently, saving a large part of the maintenance cost.

Motor Illustration.

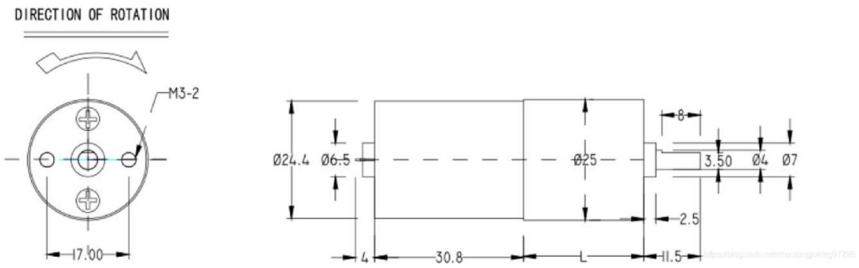

Fig. 5 Motor diagram

3.6.2 L298n Motor Driver Board

This module is used to control the power module of the intelligent agricultural robot, and it is the robot's various actions, including controlling the working parts such as the auger blade and the track. This module uses L298N of ST Company as the main driver chip. (L298N is a dual H-bridge motor driver chip, in which each H-bridge can provide a current of 2A, the power supply voltage range of the power part is 2.5-48v, the logic part is powered by 5v, and accepts 5vTTL level.) Because the working environment of this project is relatively harsh, the module is required to have strong driving ability, low calorific value and strong anti-interference ability. In order that the module can work well in the required working environment, the author separates the motor drive board and the motor, both of which are relatively inexpensive, and this design is convenient for users to maintain it.

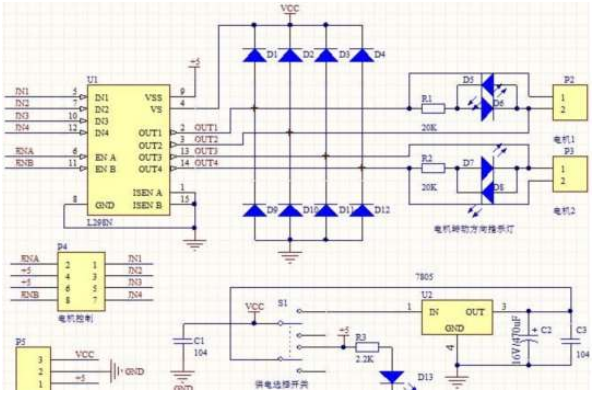

Fig. 6 Design of L298N motor drive board module

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4. Program Design of Intelligent Agricultural Robots

4.1 The Overall Design Process of the System

The robot is a product based on the STM32F103 chip, which mainly realizes functions such as driving, artificial intelligence, cloud computing, and precise ranging as an auxiliary. It cooperates with the rotary tiller of the grader to realize ploughing, and separates, expands and closes the half-shaped conical blade, so as to realize the land excavation. At the same time, inflow channels are added on both sides of the cone, one side is used as a seed channel, and the other side is used as a fertilizer channel, so that seed sowing can be realized during the opening and closing of the cone, which greatly reduces the sowing time. The program of this project is written and compiled by the software MDK5.

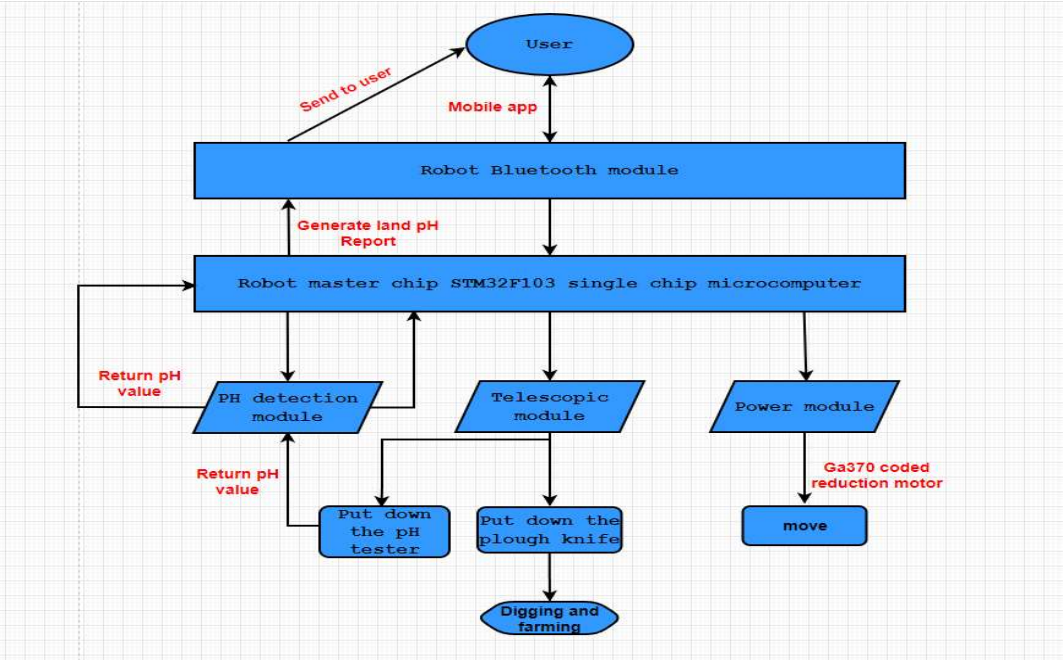

Fig. 7 Control flow chart

Some functions are as follows:

```
1. #include “lanya.h”
2. static void NVIC_Configuration(void)
3. {
4.  NVIC_InitTypeDef NVIC_InitStructure;
5.
6.  NVIC_PriorityGroupConfig(NVIC_PriorityGroup_2);
7.  NVIC_InitStructure.NVIC_IRQChannel = USART1_IRQn;
8.  NVIC_InitStructure.NVIC_IRQChannelPreemptionPriority=3 ;
9.  NVIC_InitStructure.NVIC_IRQChannelSubPriority = 3;
10. NVIC_InitStructure.NVIC_IRQChannelCmd = ENABLE;
11. NVIC_Init(&NVIC_InitStructure);
12. }
13. void USART_Config(void)
```

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```
{
  GPIO_InitTypeDef GPIO_InitStructure;
  USART_InitTypeDef USART_InitStructure;
  RCC_APB2PeriphClockCmd(RCC_APB2Periph_USART1|RCC_APB2Periph_GPIOA);
 
 USART1_TX PA.9
  GPIO_InitStructure.GPIO_PIN = GPIO_Pin_9;//PA.9
  GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
  GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF_PP;
  GPIO_Init(GPIOA, &GPIO_InitStructure);
  pa.10 USART1_RX
  GPIO_InitStructure.GPIO_Pin = GPIO_Pin_10;
  GPIO_InitStructure.GPIO_Mode = GPIO_Mode_IN_FLOATING;
  GPIO_Init(GPIOA, &GPIO_InitStructure);
  USART_InitStructure.USART_BaudRate = 9600;
  USART_InitStructure.USART_WordLength = USART_WordLength_8b;
  USART_InitStructure.USART_StopBits = USART_StopBits_1;
  USART_InitStructure.USART_Parity = USART_Parity_No;
  USART_InitStructure.USART_HardwareFlowControl = USART_HardwareFlowControl_None;
  USART_InitStructure.USART_Mode = USART_Mode_Rx |USART_Mode_Tx;
  USART_Init(USART1, &USART_InitStructure);
  NVIC_Configuration();
  USART_ITConfig(USART1, USART_IT_RXNE, ENABLE);
  USART_Cmd(USART1, ENABLE);
  //USART_ClearFlag(USART1, USART_FLAG_TC);
}
void USART1_IRQHandler(void)
{
  if(USART_GetITStatus(USART1, USART_IT_RXNE) == SET)
  {
  USART_ClearITPendingBit(USART1, USART_IT_RXNE);
```

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```
45.  }
46.      }
```

5. System Test and Analysis

According to the above design scheme and strictly standardizing the relevant national design regulations, various electrical components are used to design each link of the small intelligent agricultural robot system, so that the components are arranged coherently, reducing power consumption, increasing system stability, and ensuring the normal operation of each module. After repeated debugging and analysis after one assembly, the Bluetooth module has a very low delay in sending and receiving information, and can accurately receive control information from the remote control of the mobile phone, and control the robot to complete corresponding commands such as automatic extension and driving direction, and the detection time of the pH detection module is shortened, the response is sensitive, and the LCD module displays the data collected by the sensor in real time and accurately.

6. Conclusion

The author designs a small intelligent agricultural robot by using STM32 series single chip microcomputer and various modules. After many tests and researches in the later stage, the overall system of the product of this project is running stably, and all the data are accurate. When the user enters the remote control of the mobile phone, the product will automatically connect, and the mobile phone can remotely click the button of the corresponding function to allow the product to execute different commands. The data collected by the sensor will also be fed back to the mobile phone through serial communication, and displayed on the mobile phone. Of course, so far, the environment for product testing has been relatively ideal. In the actual environment, the project team also needs to carry out various tests in order to continuously improve the product functions, make the product development more mature, and have greater market competitiveness and social benefits.

Acknowledgments

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