Design of Grass Lattice Planter for Complex Environment Based on Adaptive Suspension Technology

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Abstract

The Complex environmental grass grid growers based on adaptive suspension adopted the high-performance stm32 as the master chip, and use the Bluetooth communication module, so that users can easily control the vehicle driving, feeding and the posture of the pressing wheel through the mobile phone application. In addition, we have introduced new mechanical structures such as adaptive suspension to ensure effective planting of grass squares in complex terrain such as sloping land. Our vehicle uses a Mecanum wheel motion system to squeeze seeds by rotating the friction wheels at high speed.

*Keywords:*STM32F103ZET6, Adaptive suspension, Machine vision, Machine learning

1. Introduction

In recent years, severe weather has become more and more frequent. In some inland China, the rainfall is decreasing year by year, and the land desertification is becoming increasingly serious. The sharp decrease of arable land has led to the harsh environment such as yellow sand, which seriously affects People's Daily life. With the scientific concept of development to today's clear waters and green mountains are gold and silver mountains, China has formed a set of localized sand control route: grass square sand fixing. Grass square sand is getting more and more attention because of its extraordinary sand prevention effect [1]. However, most of the existing grass square planting methods in China are still artificial. Although there has been professional grass planting equipment in recent years, the investigation and interview found that most of the machines can only be applied to flat land. Under rolling roads and dune landforms, there is no machine to plant, and it is still manual work. The harsh and changing environment in the desert greatly increases the risk of manual work [2].

In order to conduct the actual test of the developed grass square planting system, the team designed and developed the corresponding mechanical structure that can control the movement and integrate the feeding and planting. In the circuit of this project, the stm32 microchip as the main control chip and the Bluetooth as the communication module can control the walking, feeding and grass wheel posture of the vehicle through the mobile phone APP [3], and then complete the grass square planting in the slope with the new adaptive suspension and other mechanical structures. The method is the McNham wheel motion system, which uses the motor to drive the friction wheel and squeeze the tennis ball at high speed to launch, and uses STM32 to control.

The remainder of this paper is organized as follows. The second part introduces the mechanical structure design for the implementation of the robot function. In the third part, the hardware circuit design of the robot is given. In the fourth part, the electronic control program design of the robot is given. The fifth part summarizes the main content of this article.

2. A Mechanical Structure Design

2.1. An Adaptive structure design

In the four-wheel movement system, the front and rear wheels on the same side are connected by the connecting rod structure shown in the figure, and the left and right side connecting rods are connected through two sets of

swing arm structure. The swing arm can move up and down through the linear bearing, and finally the left front wheel and the right rear wheel move up and down synchronously, and the left rear wheel and the right front wheel move up and down synchronously. The above structure can realize the all-directional adaptive of various slope landforms, and can operate in the desert undulating terrain [4]. Adaptive suspension diagram is show in Fig. 1.

Fig. 1 Adaptive suspension diagram

2.2. An Electric swing arm link design

In order to better adapt to the undulating terrain such as desert and Gobi, the wheel group hanging swing arm is designed with three degrees of freedom, which can meet the rotation of Pitch axis, Yang w axis rotation and Y axis sliding at the same time.

The following is the details of the upper and lower movement of the swing arm: the village sleeve and the screw set the distance between the two steel swing arms, the flange is fixed on the swing arm through the screw, the straight bearing is fixed on the flange by welding, and the steel column is fixed on the steel plate 1 and 2 with the screw, thus fixed on the frame. The linear bearings can move up and down around the steel column or rotate. Structural details of the swing arm connecting rod contact point: the sliding shaft and the crosshead are fixed, through the sliding shaft, the sliding coat can be rotated by a small margin, and the swing arm can be rotated around the shaft through the thrust bearing and steel column. The distance of the distance is fixed between the two links by rigid jacket. Through the above mechanism, the movement realizes the slip and the rotation on the whole node space.[5]Details of the swing arm mechanism is show in Fig. 2.

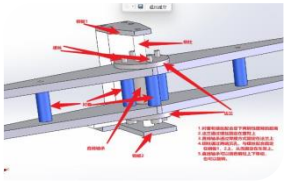

Fig. 2 Details of the swing arm mechanism

2.3. A Material supply design

The double output motor 1 is flange and the power is transferred to the roller 4. The roller is fixed on the aluminum pipe base through the bearing and steel shaft. The roller connected with the motor is the active wheel, and the roller not connected with the motor serves as the driven wheel.

During operation, the motor rotates, the active roller rotates, the active roller and the driven roller pre-tighten, the active rod rotates and drives, and produces friction with the grass between the main and slave roller, so as to realize the feeding function.

The slot explains: adding the slot can realize the adjustment of forage with different thickness and width, so as not to produce excessive stress between the rollers and increase the practical service life of the structure. Material supply mechanism diagram is show in Fig. 3.

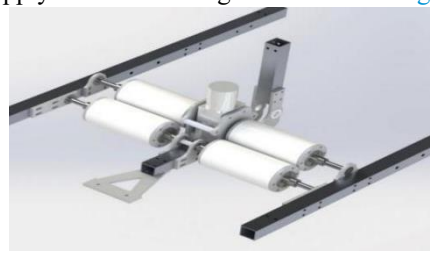

Fig. 3 Material supply mechanism diagram

2.4. A Management mechanism design

This structure adopts multi-link structure, through the rotating motion into linear motion, drive the upper rod 3 rotate around the hinge 8 , the swing of the upper rod 3 will make the shock absorber 4 compression, then transfer the force to the lower rod 6 , the lower rod 6 will rotate around the steel shaft centering by the horizontal support, so as to realize the upper and lower movement of the pressing wheel.

According to the calculation and analysis, the structure has only one degree of freedom, so the control of the structure can be fully realized by controlling the number of circles turned by the motor, and the structure is

simple and easy to use. Managing mechanism diagram is show in Fig. 4.

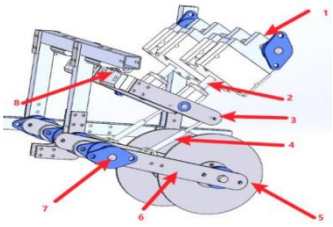

Fig. 4 Managing mechanism diagram

2.5. A Design of shock absorption structure

(1) The function of the shock absorber
- Realize the transmission of force;
- The expansion of the shock absorber 4 can ensure the balance between the grass pressing wheel and the ground of the force, to ensure the quality and efficiency of planting;
- Bear the impact of the irregular ground, protect the vehicle structure, improve the service life;

(2) Advantages: This system does not use the rigid connection, but uses the shock absorber as a flexible connecting rod, thinking from suspension, innovative application solved the rolling road may produce the disadvantages of rigid stress stress structure, and by ensuring the range between the ground wheel always small fluctuations and always fit the ground, so the car can not only in the plane planting, but also can be in the plane planting (slope, tunnel, etc.), and has the very good practical application [6]. Damper is show in Fig. 5.

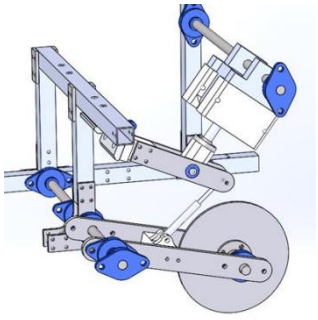

Fig. 5 Damper

3. A Hardware Circuit Design

3.1. STM32F103ZET6 Master control module

Up to 8 timers, containing a separate watchdog timer and a window-type timer, allowing for automatic microreset. This chip has up to 72 MHz working frequency. The bus system is a synchronous serial peripheral interface that enables the MCU to communicate with various peripherals in a serial manner to exchange information. The MCU architecture features an easy-to-use STM 32 platform ideal for motor drive [7]. STM32F103ZET6 Master control module is show in Fig. 6.

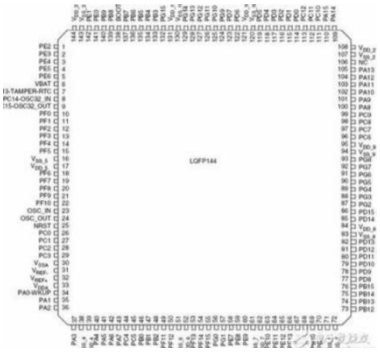

Fig. 6 STM32F103ZET6

3.2. A4988 Stepper motor drive module

Can adapt to the effects of various natural environments to better achieve work in harsh environments. The selected A4988 DMOS micro-step drive module with converter and overcurrent protection has more stable performance. A4988 Stepper motor drive module is show in Fig. 7.

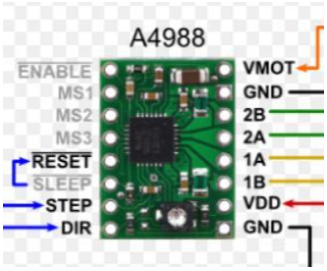

Fig. 7 A4988 Stepper motor drive module

3.3. The HC-12 Bluetooth module

The super-long transmission distance and acceptance performance of the Bluetooth module can well realize the

purpose of long-distance control. The HC-12 Bluetooth module is show in Fig. 8.

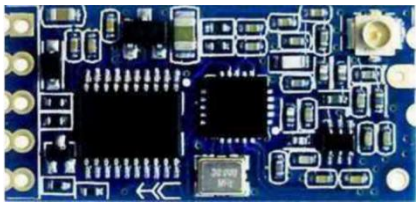

Fig. 8 The HC-12 Bluetooth module

3.4. L298N DC motor drive module

L298N can be used to drive our 12V DC deceleration motor, L298N can directly control the motor, set the control level through the I / O input of the main control chip, can drive the motor forward reversal, simple operation, good stability, can meet the high current driving conditions of the DC motor. L298N DC motor drive module is show in Fig. 9.

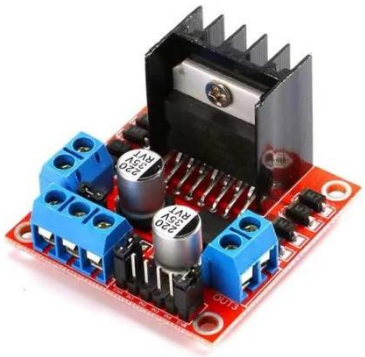

Fig. 9 L298N DC motor drive module

3.5. 12V DC deceleration motor

12V DC deceleration motor is widely used, because its excellent performance is often used in smart home, electronic products, smart car driver, precision medical equipment, etc. In this grass square unmanned planting car, the price is appropriate, product depression purchase and assembly and other excellent performance. L298N DC motor drive module is show in Fig. 10.

Fig.10 L298N DC motor drive module

3.6. Circuit logic control

The overall electrical route of the machine is arranged to make the machine line structure stable and safe, and will not be damaged due to external or internal interference, especially for the line layout where the line is concentrated. Circuit chassis design makes most of the circuit placed in the back of the body, increase the convenience of human-machine interaction, while the circuit, convenient line arrangement.

Select the power line, signal line and other electronic components needed for the robot, reasonably arrange the line of the robot, to ensure the stability and safety of the robot operation [8].

3.7. A Chassis module design

(1) Main components: Bluetooth module, STM32 main control, L298N DC motor drive module, 12V DC deceleration motor.

(2) Implementation mode: the main control board receives the chassis control instruction through the Bluetooth module, then calculates the corresponding instruction as the corresponding control information, and controls the motor speed with a PWM control pulse through the IO port.

(3) Electrical connection: the 12V power supply directly supplies power to the L298N DC motor drive module, and the motor drive module is connected to the motor and directly supplies power to the motor. The 12V power supply supplies power to the STM32 main control board after the 12-5V step-down module, and the development board supplies power to the HC-12 Bluetooth module through the 3.3V interface.

3.8. A Material supply module design

(1) Main components: Bluetooth module, STM32 main control, L298N DC motor drive module, 12V DC deceleration motor.
(2) Implementation mode: the main control board receives the control instruction through the Bluetooth module, then calculates the corresponding instruction as the corresponding control information, and issues the PWM control pulse to control the feeding motor through the IO port, so as to realize the material supply and discharge.
(3) Electrical connection: the 12V power supply directly supplies power to the L298N DC motor drive module, and the motor drive module is connected to the motor and directly supplies power to the motor. The 12V power supply supplies power to the STM32 main control board after the 12-5V step-down module, and the development board supplies power to the HC-12 Bluetooth module through the 3.3V interface.

3.9. A Management module design

(1) Main components: Bluetooth module, STM32 master control, A4988 step motor drive module, 42 step motor.
(2) Implementation mode: the main control board receives the control instruction through the Bluetooth module, then calculates the corresponding instruction as the corresponding control information, and sends the PWM control pulse and IO level control the rotation of the stepping motor through the IO port, so as to realize the control of the depth of the pressing structure.
(3) Electrical connection: the 12V power supply directly supplies power to the A4988 stepping motor drive module, and the motor drive module is connected to the stepping motor to directly supply power and control it. After the 12V power supply supplies power to the STM 32 through the 12-5V step-down module, and the development board supplies power to the HC-12 Bluetooth module through the 3.3V interface [9].

4. An Electric Control Program Design

4.1. A System main body logic design

Program flow chart is show in Fig. 11.

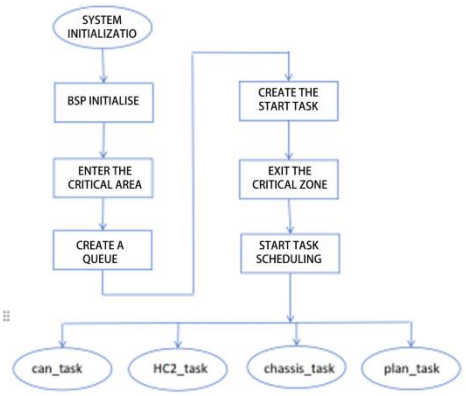

Fig. 11 program flow chart

4.2. A Chassis system logic design

Chassis.c Three subroutines are set up, namely, chassis motor initialization program, stepper motor initialization program and chassis control program.

(1) In the chassis initialization program, complete is the GPIO used for the chassis motor.
(2) In the initialization program of the stepping motor, the initialization of the IO port of the control stepping motor is completed.
(3) In the chassis control program, according to the control information after the incoming processing, set the PWM wave with different duty cycle ratio to complete the control of the motor speed and steering under the corresponding situation.

4.3. A Logical design of the communication system

After receiving the message at the serial port, we need to process it. However, because there is more logic in this project, we set up a separate structure to integrate the information flow and facilitate us to process the data uniformly.

In this structure, we integrate the information of chassis speed, direction, stepping motor status and feeding motor status. In the serial receiving interrupt, we directly judge the received message in the interrupt, a character check function is called to judge the instruction

according to the received characters and rewrite the variables of the structure body.

In addition, in order to facilitate the user's control, we also set a timer interrupt, for timing to clear instructions, can realize the micro operation of the robot, complete fine control.

5. Conclusion

Dunes or gobi desert governance is a long time, now large machinery is mainly plane industry planting, planting can not complete the dunes, moreover, due to the dune itself has strong liquidity, not only lead to human resources in the same repeated continuous consumption, also has a potential danger: quicksand, a threat to people's life and property safety. However, in order to create a long-term sustainable green water peak, we shall not ignore the one in the field of governance, so the team proposed adaptive suspension has been practical, break through the existing laying machinery technical problems, can set foot on the ecological restoration in this field, and the wireless control, no one to close interference do industry, great guarantee the personal safety, the design breakthrough existing laying machinery technical problems.

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