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A smart vehicle with multi-functions of paving straw-checker board, fixing sand, and planting seeds

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Abstract: A smart vehicle is designed with multi-functions, such as straw grid laying and vegetation seeding. The vehicle realizes the automatic and integrated laying of horizontal and longitudinal straw curtains and then carries out climbing plow sowing and planting auxiliary work. The straw tubes can also be replaced automatically. The vehicle can realize human-computer interaction, remote control, and other intelligent operations through an APP and voice module, this intelligent equipment can be used in harsh environments with serious desertification.

Keywords: Straw curtain integrated laying, plowing seeding, automatic weeding, human-computer interaction, remote control

I. Introduction

With the gradual deterioration of the global environment, desertification and desertification have become one of the most serious environmental problems in China. According to statistics, China's desertification area (including the Gobi and so on) reaches 1,721,200 square kilometers, and more than 400 million residents are deeply affected by desertification, especially in the northwest region. It endangers the people's living and development space seriously and poses a huge threat to the sustainable economic and social development of China's western region. Among them, straw-checkered sand fixation is one of the most effective measures.

To actively respond to the land greening action and control land desertification in China, we designed a multi-functional straw grid laying sand fixing truck, which can automatically and intelligently realize various functions such as straw grid laying and vegetation seeding, and contribute to the construction of a beautiful China.

II. The Design Scheme of the Device

A. Display of The Device

This device is a kind of automatic integration to realize horizontal and longitudinal straw curtain laying, straw tube replacement, soil plowing, and vegetation seeding. The off-road wheels have strong adaptability to the terrain. Through an APP and voice modules, automatic driving and human-computer interaction can be achieved. There are other advantages of this intelligent vehicle, such as small body size, high internal space utilization, and simple and flexible work.

B. Workflow of The Device

During the working of the device, the guide wheel and the plowing blade always maintain a downward pressure state during the driving process. Firstly, the straw tube is driven by the friction shaft to put the straw curtain down. When the head of the straw curtain passes through the L-shaped mechanism, the straw curtain will be rubbed by the roller in the L-shaped mechanism and then guided by the J-shaped guide groove to approach the ground. As the vehicle moves forward, the straw curtain will be inserted into the ground in the longitudinal by a circular guide wheel. Subsequently, the transversal straw-placing mechanism starts running. The head of the transversal straw curtain will be restricted in the middle of a friction wheel mechanism, and then transported to the plane of the synchronous belt. An inverted push rod is used to press the transversal straw curtain into the ground. Through the infrared sensor installed on the wall, the longitudinal straw curtain will be replaced automatically after being used up. The work procedure is shown in Fig. 1.

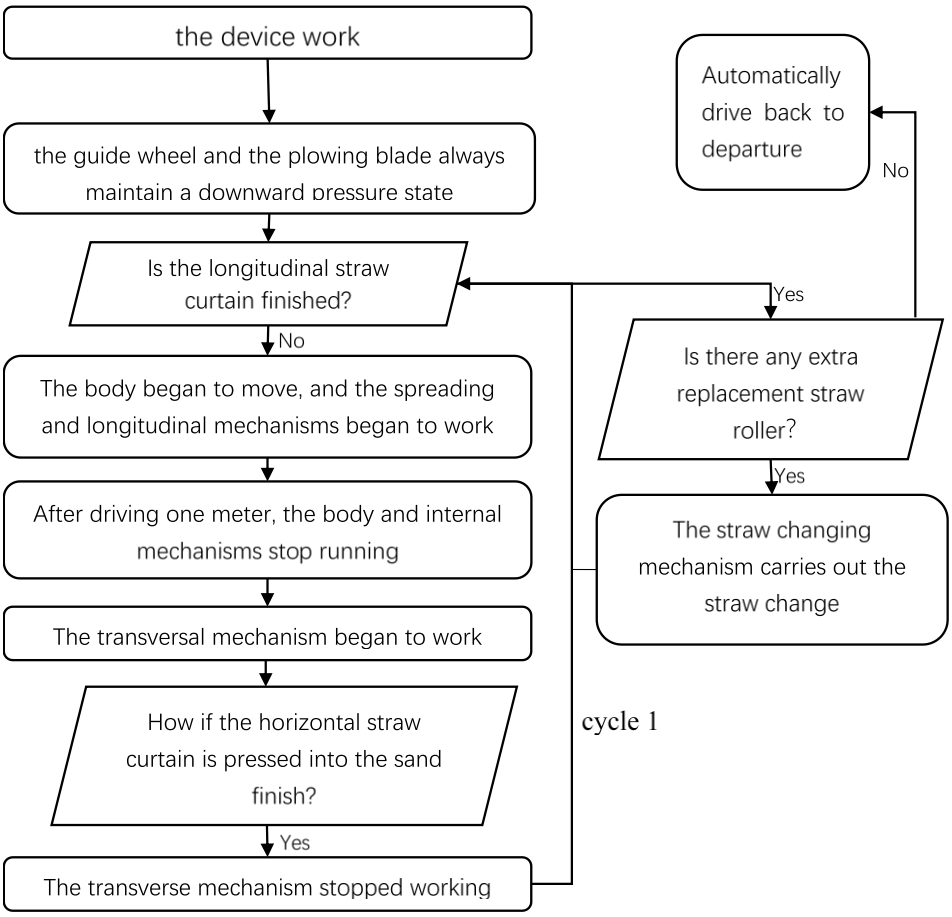

Fig. 1 Flow chart of the device's working procedure

C. Mechanical architecture and control strategy

1) Longitudinal straw curtain laying mechanism

As shown in Fig. 2, the longitudinal laying mechanism is a crank slider mechanism composed of an inverted T-shaped press knife, motor, rocker, slider, and slide rail. Through the motor work, drive the rocker to do circular motion, so that the slider moves left and right in the groove, and drive the press knife to continuously move up and down repeatedly to complete the longitudinal laying work.

2) Seed plowing device

The circular guide wheel and the plowing device are connected by a rigid member. As shown in Fig.3, the seeding device consists of a square-shaped storage box and a crank linkage mechanism that controls the opening and closing of the bottom. The crank linkage mechanism works to drive the rectangular plate through holes to move left and right in an orderly manner to complete the seed-sowing work.

3) Transverse straw curtain laying mechanism

As shown in Fig. 4, the transverse laying mechanism consists of an inverted pushing rod, connecting rods, a pressing bar, and a slicer. When the pushing rod starts working, the connecting rods go down to push the pressing bar and the slicer downward, leading to the completion of the transversal straw curtain placement.

4) Straw curtain conveying mechanism

The transverse straw conveying mechanism is consisting of a friction wheel mechanism,a synchronous belt, and a conveyor belt. The straw curtain is placed in the middle of the friction wheel mechanism in advance, and the motor drives the friction wheel mechanism to roll the straw curtain in. The synchronous belt transports the straw curtain to the lateral pressure position.

The longitudinal straw conveying mechanism is shown in Fig. 5. the straw curtain comes down, the L-shaped mechanism is manually closed, the straw curtain is clamped, and the motor drives the inner roller to rotate to realize the straw curtain transportation. Thestraw curtain passes through the J-shaped guide groove,the guide wheel presses the straw curtain against the ground.

5) Straw curtain replacement mechanism

When the machine starts to work, a diagonal push bar located below moves the board down, rolling the waste straw tube into the waste tank and then resetting the push rod.The upper pushrod pulls the divider down to ensure that the pushrod is reset after the new straw tube is rolled into the working position.

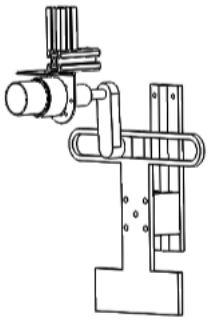

Fig. 2 Longitudinal straw curtain laying mechanism

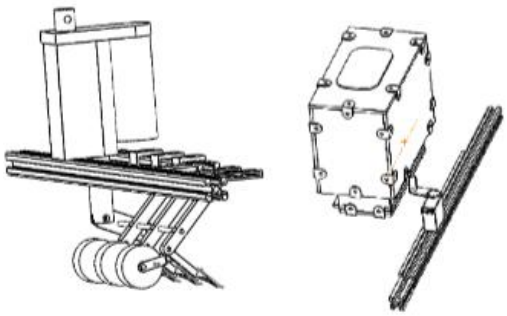

Fig. 3 Auxiliary institutions

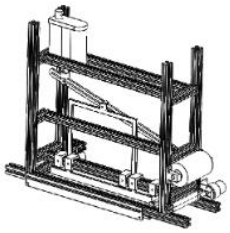

Fig. 4 Transverse straw curtain laying mechanism

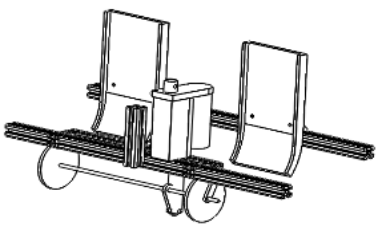

Fig. 5 Longitudinal straw transport mechanism

D. Sensors and electrical architecture

The main controller and control board as shown in Fig.6. The core control chip of this car adopts STM32F103ZET6, which integrates the motor drive, relay, and other modules to reduce the spaceand facilitate wiring.

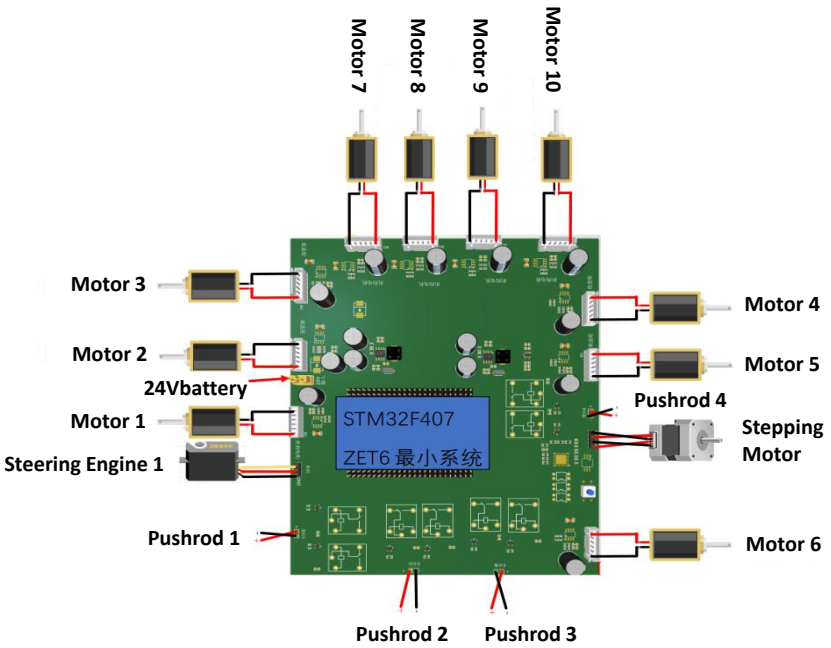

Fig. 6 The main controller and control board

Five motor drives are integrated into the main control board, mainly used to drive rollers and rotating shafts, and 4 relays are also integrated on both sides of the circuit board to control the expansion and contraction of the actuator. The servo of the seeding mechanism in the auxiliary plant is also connected to the STM32 master. The chassis motor and stepper motor with chips RZ7899 and TB67S109A are used to control and drive the driving work of the whole vehicle, and both are 24v DC transmission; The other mechanisms installed on the 12V DC output, the chip is RZ7899 brushless working motor. The servo and the actuator equipped with the relay are directly controlled by the main control chip. All pins are connected directly to the STM32 master to ensure operational reliability.

III. Conclusion

The multi-functional straw grid sand fixing auxiliary planting vehicle has a simple overall structure, intelligent automatic work, relatively low cost, and can adapt to a variety of terrain environment work, after preliminary experiments, the sand fixing truck can efficiently, quickly, and accurately complete the laying task of the straw square, eliminating a series of problems such as the need to adjust the head of the car; In addition, it can also realize the auxiliary planting function of plowing and sowing. It has a good effect on effective wind protection and sand fixation, increasing the vegetation area of sandy land.

However, due to the impact of the epidemic, physical production has not been carried out for the time being, so there are still some defects in the electronic control components and the overall appearance, and we will try our best to improve and optimize them in a later time.

Acknowledgment

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