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Design of an Adaptive Intelligent Planting Machine for Tuber Crops

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Abstract
To solve the problems of labor-intensive and inefficient yam planting in the process of yam planting, this paper designed an adaptive intelligent planting machine for tuber crops. The device integrates mechanical control, electronic control system and intelligent interactive module, and realizes the efficient dislocation planting of yam seedlings through the automatic operation of the whole process of ditching, positioning, seed conveying, seed arrangement and soil covering. The main control chip STM32FA07VET6 was adopted, integrated with a mobile app for remote control, and designed to support solar power supply and multi-mechanism collaborative operation. Compared with traditional manual planting, this device reduces labor costs, improves planting accuracy and efficiency, and provides a scalable solution for the mechanization of tuber crop planting.
Keywords: *smart agriculture, structural design, yam cultivation,intelligent planting machine.*

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I. INTRODUCTION

With the rapid development of science and technology and the rapid expansion of the population, agricultural production is facing unprecedented challenges**Error! Reference source not found.** At a time when land resources are scarce and climatic conditions are deteriorating sharply, tuber crops have become the main crops due to their high survival rate and rich nutrient content. As a kind of tuber crop, yam has also come into people's attention with its excellent economic value and the characteristics of both vegetable and medicinal properties. However, due to the downward growth characteristics and irregular shape of yam, the cultivation of yam still requires a lot of manpower, which will cause a shortage of labor. Therefore, the cultivation of yam urgently needs to be mechanized to reduce labor costs and open up markets.

In order to solve this problem, combined with the rise of intelligent agriculture in recent years**Error! Reference source not found.** that is, the Internet of Things, big data and other intelligent analysis technologies are integrated, and an intelligent device for yam planting is designed, which has simple structure, low cost, relatively strong adaptability to various varieties, high economic value and practical value, and can save labor costs.

II. STRUCTURE DESIGN

2.1 OVERALL ARCHITECTURE

This design is a kind of automatic planting device for yam, which aims to improve the efficiency of yam planting and save labor cost. The device consists of mechanical structure, box structure, power drive system and planting function module.

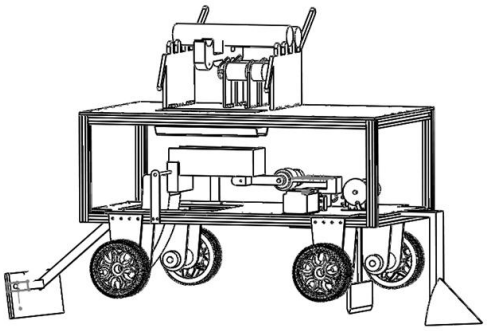

Figure 1: The overall structure of the machine

2.2 MECHANICAL STRUCTURE DESIGN

The core mechanical structure module includes:

1. Ditching mechanism: single core plow structure is adopted to plow 10-15cm planting ridge;

2. Planting positioning mechanism: Based on the eccentric wheel and guide rod for line marking positioning; After the start of operation, the motor controls the rotation of the eccentric wheel, which in turn drives the guide rod to move up and down for line marking operations, so as to realize the planting positioning. The planting positioning mechanism receives and feeds back information to the mechanical control structure through data lines laid out.

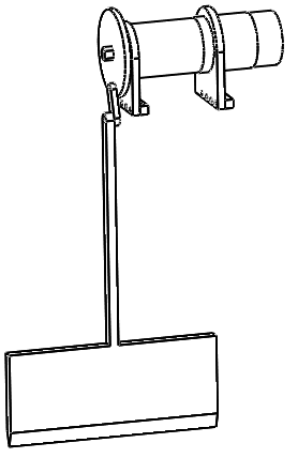

Figure 2: Implant positioning mechanism

3. Step-by-step seed conveying mechanism: accurate seed delivery through crank connecting rod and toothed seed conveying trough; After the planting positioning action is completed, the crank connecting rod mechanism enters the seedlings into the upper toothed seed conveying groove through the rotation action, and then drives the connecting rod mechanism through the DC motor to regularly input the yam seedlings into the discharge port. The yam seedlings at the discharge port fall by gravity and enter the seeding and seeding mechanism.

4. Seed arrangement and seed delivery mechanism: simulate the movement of the human arm, and use the lead screw to adjust the transverse position to achieve dislocation planting; The seeding and sending mechanism imitates the principle of human arm movement, fixes the longitudinal position of the end by the end screw, starts to work at the front end, lifts the seeding groove and forms a certain angle with the horizontal plane, the yam seed slides into the seeding groove by the seeding groove, and enters the ridge by the gravity through the seeding groove of low ground clearance, and completes the planting task. At the same time, the seedlings can be received by plugging bolts and adjusting the seed delivery trough; Through the end lead screw device, the planting position of the seed trough is adjusted during planting, and then the dislocation planting is realized.

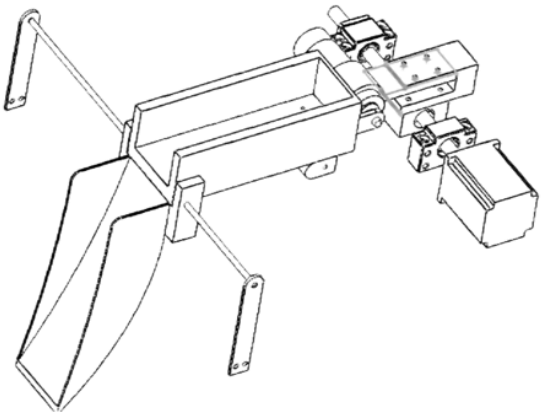

Figure 3: Seed distribution mechanism

5. Soil covering mechanism: complete the soil backfill through the glass fiber connecting rod and the covering plate.

III. HARDWARE PART

The development board adopts STM32FA07VET6 as the main control chip, QFP100 package, and leads the redundant IO port to 2 rows of pin headers. The development board comes with 2 RS845 interface circuits and 2 CAN button circuits, which can support the use of multiple 485 and 2 CAN interfaces. It supports TFT interface, and can be displayed locally on the TFT display screen under SPI. The multiplexing function of the pins provides more different options, such as drive motors, LEDs, read sensors, etc. The figure below shows the function of the STM32FA07VET6 pin. The development board can be powered with a wide range of voltages, supporting 9-24V power supply, and users can use external power supply or DC port power supply.

IV. CONCLUSION

Compared with the prior art, the design has the following characteristics:

(1) Compared with the existing technology, it is more suitable for large-scale planting and use. This machine adopts a multi-mechanism linkage method of connecting rod mechanism and cam mechanism to carry out planting positioning, seed transportation, seed arrangement and seed delivery, automatic planting, and simple operation;

(2) Part of the work is completed in an electric way and with the help of gravity, which reduces the consumption of energy and manpower. At the same time, the present invention also pre-installed solar panel for electrical energy supplementation, can achieve the cleaning effect of reducing carbon emissions. Compared with the existing technology, the driving power is used more efficiently, and the energy consumption is reduced and the cost is reduced.

(3) The motion state of the trolley can be intelligently adjusted, and the interactive operation is designed. Among them, the touch screen and mobile phone are suitable for users to be convenient to carry, and compared with the prior art, there is no need to configure a special controller, and it is more suitable for popularization and use.

The adaptive tuber crop intelligent planting all-in-one machine designed in this paper significantly improves the automation level of yam planting through the efficient coordination of mechanical and electronic control systems, and provides a practical reference for the development of intelligent agricultural equipment.

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