Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920

Volume 3, Issue 6, June 2024

Design of Plant Protection Car Based on PLC and Stepper Motor

Tang Maoyin[1], Zhu Zhenglong[2,*], Guo Lili[1], Zhou Yongxin[1], Zhao Xinyue[2]

1 Department of Automobile, Guizhou Aerospace Vocational and Technical College, Zunyi 563006, China; 2 College of Engineering, Zunyi Normal University, Zunyi 563006, China;

*Corresponding to: Zhu Zhenglong

Abstract: Firstly, this paper studies and designs the mechanical structure of a new type of plant protection car, then designs the hardware and software of the four-motor control system of plant protection car, and finally designs the touch screen control interface. The plant protection car designed can solve the problems such as the high price of UAV plant protection and the influence of artificial plant protection on health.

Keywords: Plant protection car; PLC; Control system

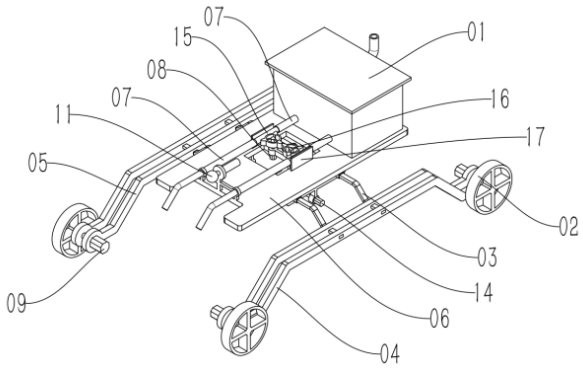
1 INTRODUCTION

At present, in Zunyi, Guizhou, the plant protection of characteristic vegetable plants needs to be completed manually, and there are problems such as high labor intensity, low operation efficiency, time-consuming and laborious long-term bending and affecting health. The UAV plant protection is expensive, the cost of drip irrigation technology is relatively high, and a large amount of plant protection liquid is retained in the pipeline at the same time, resulting in the waste of plant protection solution, and the plant protection liquid will deteriorate in the tube for a long time, which will affect the vegetables. Based on this, this paper designs a plant protection machine based on PLC and stepper motor, which is equipped with a remote control remote control, which can realize remote control, which can well solve the problems of high price of UAV plant protection and the impact of artificial plant protection on physical health [1].

2 MECHANICAL STRUCTURE DESIGN OF PLANT PROTECTION TROLLEY

The plant protection trolley designed in this paper adopts two stepper motors to drive walking, realizes steering through motor differential, drives hoses to convey plant protection liquid through two stepper motors, and a camera is installed at the front end of the motherboard, which identifies vegetables through the camera, and feeds back the category of identified vegetables, and can identify and judge certain kinds of vegetables; The other end of the motherboard is designed with a spraying system composed of a water tank, a water spray pipe, a motor, a hose and a hose extrusion wheel, so that the plant protection liquid in the water tank can be accurately sprayed to the vegetables through the water spray pipe and hose, so as to realize the plant protection of the identified vegetables.

The trolley is designed with beams, screw rod sleeves, connectors, etc., and the wheel spacing on both sides is controlled by controlling the step control, so that the plant protection trolley can walk in the field with different vegetable spacing, so as to carry out plant protection on different types of vegetables.



Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920

Volume 3, Issue 6, June 2024

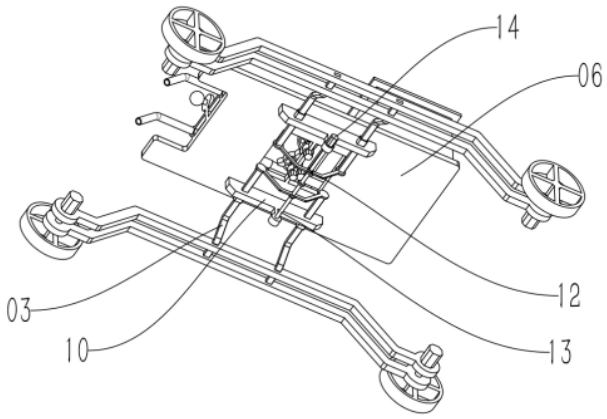


FIG.1 THREE-DIMENSIONAL MODEL OF PLANT PROTECTION TROLLEY

01-WATER TANK 02-WHEEL 03-FRAME BEAM 04-FRAME I. 05-FRAME II. 06-MOTHERBOARD 07- WATER SPRAY PIPE 08-MOTOR I. 09-MOTOR II. 10-CONNECTOR 11-CAMERA 12-SCREW SLEEVE 13-SCREW ROD 14-MOTOR III. 15-HOSE 16-EXTRUSION WHEEL 17-BAFFLE

2.1 PLANT PROTECTION TROLLEY PLANT PROTECTION LIQUID SPRAYING STRUCTURE DESIGN

The three-dimensional model of the vegetable plant protection trolley designed in this paper is shown in Fig.1, the main board 06 is fixed with camera 11, the vegetables in the direction of travel are identified, can be identified for a certain kind or several kinds of vegetables, the vegetables that are confirmed are not the set species, the plant protection liquid is sprayed after confirmation, the other end of the main board 06 is fixed with water tank 01, two water spray pipes 07 are fixed on the water tank 01, and the middle part of two water spray pipes 07 is provided with hose 15, The outer side of two hoses 15 is provided with baffle plates 17 that are fixedly connected to the main board 06 for fixing the hoses, stepper motors 08 that are fixed on the 06 plates are designed between the two hoses, the output shafts of the two motors 08 have extrusion wheels 16, when the camera 11 recognizes the confirmed vegetables, start two motors 08, the motor output shafts drive two extrusion wheels 16 to rotate, and the two extrusion wheels 16 rotate to extrude to two hoses 15, and change the pressure in the two hoses 15, Thereby realize that the liquid in the water tank 01 flows into two water spray pipes 07 through two hoses 15 and then sprays to the vegetables that are identified, the ends of the two water spray pipes 07 are bent downward, and the rotation direction of the extrusion wheel 16 is opposite, so that the two extrusion wheels 16 can be guaranteed to be extruded from the inner side of the two hoses 15, thereby the liquid flow in the hose 15 is driven, and in the process of the two water spray pipes 07 traveling, can carry out precise plant protection for the specific vegetables identified by the camera 11, avoid the waste of plant protection liquid.

2.2 PLANT PROTECTION TROLLEY WALKING STRUCTURE DESIGN

In the four wheels 02, the two wheels close to the camera side are equipped with stepper motors, and the motors 09 are fixedly connected to the corresponding frames 05 and 04 respectively, and the motors are started, and the output shafts of the motors drive the wheels 02 to rotate, so that the travel of the plant protection dolly is realized; The lower end of the main board 06 is fixed with connector 10, the frame beam 03 is slidably connected on the two connector 10, the frame 04 and the frame 05 are fixedly connected on the two frame beams 03, the two sides wheel 02 are connected to the corresponding frame 04 and the frame 05, when the wheel 02 rotates, two frames 04 and 05 are driven, and two frames 04 and 05 drive two frame beams 03 to travel, so that two connectors 10 are driven, and then the main board 06 and the water tank 01 are driven, Realize plant protection for vegetables.

Two frame beams 03 are fixedly connected with screw rod sleeves 12, two connectors 10 are fixed with screw rods 13 that drive the movement of two screw rod sleeves 12, when controlling stepper motors to control screw mandrel 13 rotation, screw rod 13 drives two screw rod sleeves 12 to slide relative to each other or against each other through threads, realizes the spacing adjustment of frame 04 and frame 05 on both sides of motherboard 06, and then realizes the spacing adjustment of wheel 02 on both sides of motherboard 06, and there is an adjusting device 14 at the end of screw rod 13, It is fixedly connected on the corresponding connector 10, and the adjusting device 14 can drive the screw rod 13 to rotate, so that the spacing of the wheel 02 on both sides of the main board 06 can be adjusted, so that the trolley can walk in the field of different vegetable spacing, and adapt to more use conditions.

3 DESIGN OF PLANT PROTECTION TROLLEY CONTROL SYSTEM BASED ON PLC

3.1 HARDWARE WIRING DIAGRAM DESIGN OF PLANT PROTECTION TROLLEY CONTROL SYSTEM

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920
Volume 3, Issue 6, June 2024

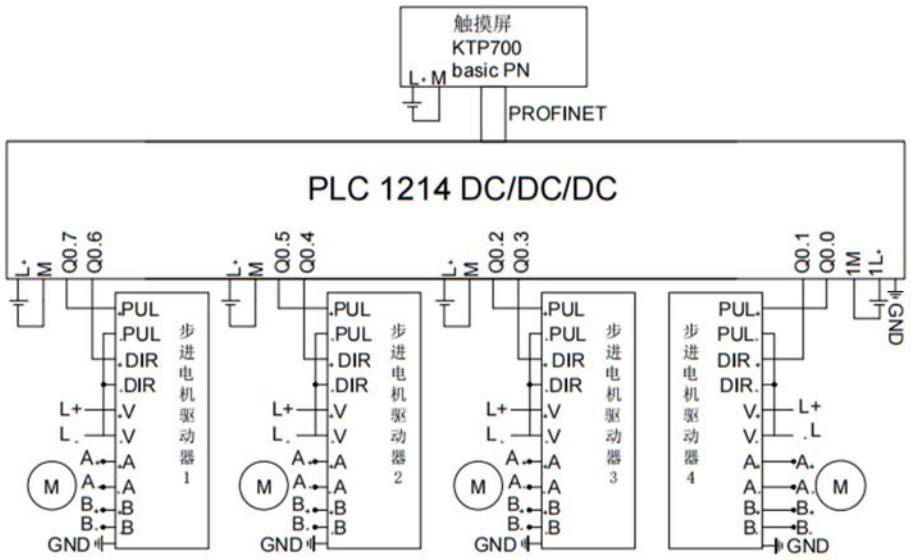


FIG.2 HARDWARE WIRING DIAGRAM OF PLANT PROTECTION TROLLEY

In order to meet the requirements of walking and spraying of the plant protection trolley, the stepper motor is used to drive the control system, and the hardware wiring circuit of the control system is shown in Fig.2 [2-3], in which the PLC is PLC1214 DC/DC/DC, and the touch screen is KTP700 basic PN.

3.2 CONTROL SYSTEM SOFTWARE DESIGN

The walking direction and speed of the plant protection trolley and the flow control of the spraying of plant protection liquid are controlled and input by touch screen, and the PLC input and output address allocation table is shown in Table 1.

TABLE 1 I/O ADDRESS ALLOCATION TABLE

class	name	address
Stepper motor 1	Motor 1 is enabled	M1.0
	Motor 1 rotates forward	M1.1
	The motor 1 is reversed	M1.2
	Motor 1 stops	M1.3
	Motor 1 speed setting	MD100
	Axis_1_pulse	Q0.0
	Axis_1_direction	Q0.1
Stepper motor 2	Motor 1 is enabled	M2.0
	Motor 1 rotates forward	M2.1
	The motor 1 is reversed	M2.2
	Motor 1 stops	M2.3
	Motor 1 speed setting	MD104
	Axis_2_pulse	Q0.2
	Axis_2_direction	Q0.3
Stepper motor 3	Motor 1 is enabled	M3.0
	Motor 1 rotates forward	M3.1
	The motor 1 is reversed	M3.2
	Motor 1 stops	M3.3
	Motor 1 speed setting	MD108
	Axis_3_pulse	Q0.4
	Axis_3_direction	Q0.5
Stepper motor 4	Motor 1 is enabled	M4.0
	Motor 1 rotates forward	M4.1
	The motor 1 is reversed	M4.2

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920
Volume 3, Issue 6, June 2024

	Motor 1 stops	M4.3
	Motor 1 speed setting	MD112
	Axis_4_pulse	Q0.6
	Axis_4_direction	Q0.7

The main program of the walking direction and speed of the plant protection trolley and the flow control of the spraying of the plant protection liquid is shown in Fig.3, the forward and reverse rotation and speed control program of the screw rod and the plant protection liquid stepping motor are shown in Fig.4, and the forward and reverse rotation and speed control program of the trolley walking motor are shown in Fig.5, wherein M1.0, M2.0, M3.0,M4.0 is the enabling input signal of the motor, M1.1, M2.1, M3.1, and M4.1 are the forward rotation control input signals of the motor 1, M1.2, M2.2, M3.2, and M4.2 are the reverse control input signals, M1.3, M2.3, M3.3, and M4.3 are the stop control input signals, and MD100, MD104, MD108, and MD112 are the input terminals for setting the speed of the motor 1 [4-6].

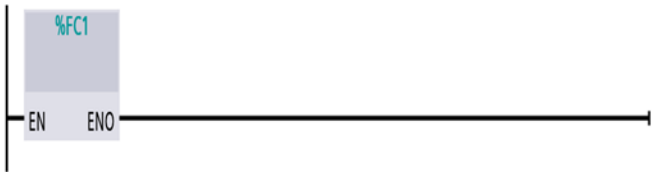


FIG.3 MAIN PROGRAM

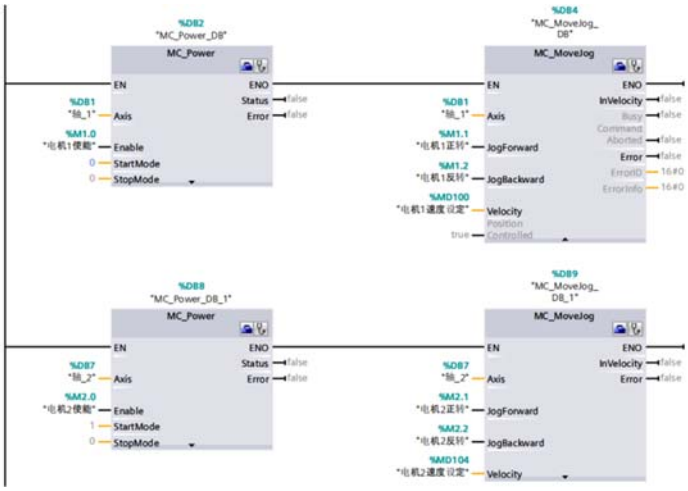


FIG.4. FORWARD AND REVERSE ROTATION AND SPEED CONTROL PROGRAM OF SCREW ROD AND PLANT PROTECTION FLUID STEPPER MOTOR

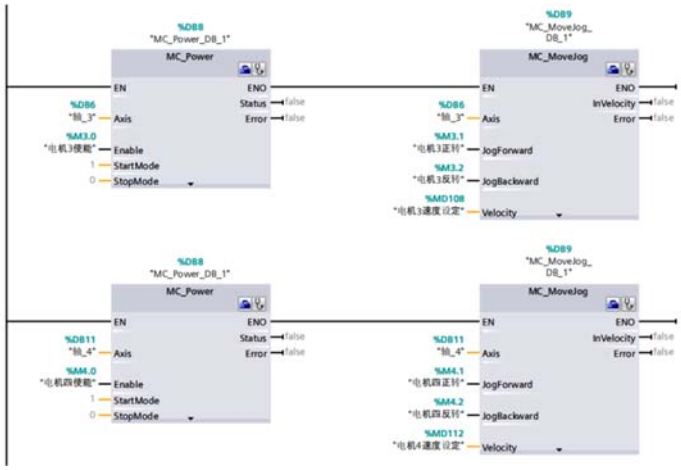


FIG.5. FORWARD AND REVERSE ROTATION AND SPEED CONTROL PROGRAM OF TROLLEY TRAVEL MOTOR

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN: 2957-3920
Volume 3, Issue 6, June 2024

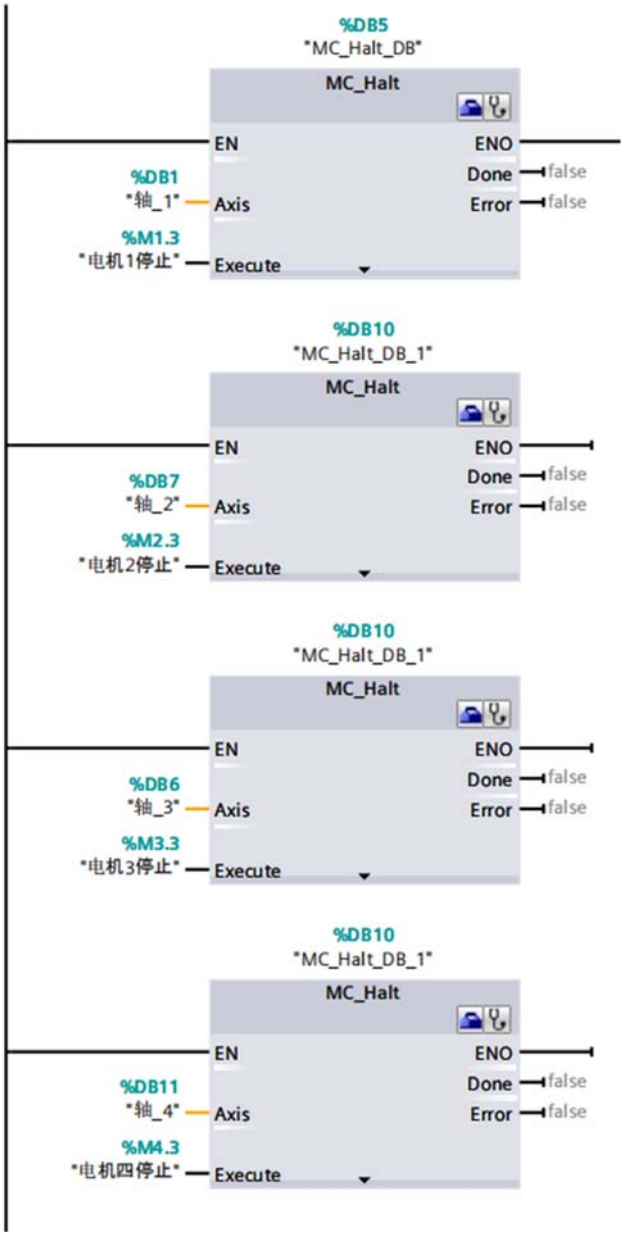


FIG.6. STEPPER MOTOR STOP CONTROL PROGRAM

3.3 *EXPERIMENTAL DEBUGGING*

The walking direction and speed of the plant protection trolley, the flow control of the plant protection liquid spraying is controlled by the touch screen KTP700basic PN, and the designed touch screen control panel is shown in Fig.7 below [7], and the test is carried out on the test bench, the test bench is shown in Fig.8, after test verification, the design of the electrical control system hardware wiring diagram, PLC control program, The touch screen control interface can meet the walking direction and speed of the plant protection trolley and the flow control requirements of plant protection liquid spraying, and achieve the expected design effect.

FIG.7. TOUCHSCREEN INTERFACE OF PLANT PROTECTION TROLLEY

FIG.8 STEPPER MOTOR CONTROL TEST BENCH

4 CONCLUSION

1) A set of vegetable plant protection trolley mobile mechanical structure was designed. 2) A set of vegetable plant protection trolley plant protection mechanical structure was designed. 3) The designed trolley can replace manual work, and the cost is relatively cheap. 4) The electrical control wiring diagram, PLC program and touch screen control of the plant protection trolley were designed and experimentally verified.

FUNDING

Zunshi Kehe HZ Zi [2022] No. 41; Zunhong Ke Heshi Zi [2022] No. 06; Zunshi Kehe HZ Zi (2023) No. 152; Zunshi Ke Ren Cai [2021] No. 2; Zunshi Kehe HZ Zi (2023) No. 163; Zunshi Kehe HZ Zi (2023) No. 161; Zunshi XM [2023] No. 1-02;

ABOUT THE AUTHOR

TANG Maoyin, female, from Zunyi, Guizhou, is a teacher, associate professor and undergraduate of the Department of Automotive of Guizhou Aerospace Vocational and Technical College, mainly engaged in scientific research and teaching of machinery and automation control.

REFERENCES

[1]Qin Weihua, Ran Yunliang, Zhu Chenhui, et al. Design and experimental research on autonomous walking plant protection vehicle[J].Agricultural Equipment and Vehicle Engineering,2021, 59 (07):19-23.)

[2]Huang Yonghong, Diao Xiaoyan, Xiang Qianwen.Electrical control and PLC application technology[M].Beijing:China Machine Press. 2018.

[3]XIANG Xiaohan. Siemens PLC advanced application examples[M].Beijing:China Machine Press.2019

[4]HE Yuhui, WEN Heng, MIAO Yugang, et al. Design of drive control system based on S7-1200 PLC stepper motor[J].Automation Technology and Application, 2023,42(12):46-49.DOI:10.20033/j.1003-7241.(2023)12-0046-04.

[5]GONG Lihua. Design of three-dimensional warehouse module based on S7-1200PLC[J].Modern Information Science and Technology,2023,7(12):55-57+61.) DOI:10.19850/j.cnki.2096-4706.2023.12.014.

[6]CAO Zhicheng,ZHANG Peijiong,ZHAI Yifei. Position control of stepper motor based on S7-1200PLC[J].Mechatronic Information,2023,(06):57-60.)

[7]Wang Xiaoyu,Li Haoyu. Design and implementation of material sorting control system based on PLC and HMI[J].Automation and Instrumentation,2023, 38(01):38-42.)