Small Pepper Transplanting Machine Based on Arduino MEGA2560 Main Control Drive

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Abstract: In view of the traditional agricultural pepper transplanting technology using artificial, labor-intensive, low transplanting efficiency, difficult to achieve large-scale production and other issues, we propose a Arduino Mega2560 based on the main control drive system to plant intelligent background to design a small pepper transplanter, pepper seedlings for automatic transplanting. The transplanting mechanical device is mainly composed of five mechanisms: planting mechanism, transmission mechanism, fertilization mechanism, storage mechanism and control mechanism. The transplanting mechanical device has the characteristics of simple structure, functional integration and automation, which reduces manpower and material resources, improves planting efficiency, and improves the mechanization level of transplanting planting.

Keywords: pepper transplanting machine; arduino MEGA2560; automatic transplanting; agricultural machinery.

1 INTRODUCTION

China is a big country of pepper planting, but also a big country of pepper consumption. Guizhou is the first province in China to put pepper on the table, and it is the main producing area of pepper in China[1]-[2]. Compared with the traditional artificial planting, pot seedling transplanting can advance the growth and development cycle of pepper by about 15 days, improve the multiple cropping index of pepper, so as to improve the yield of pepper, and the root system is more developed after pot seedling transplanting, and the consistency and uniformity of seedling growth state are higher[3]. Therefore, at present, most pepper planting adopts pot seedling transplanting technology. However, the traditional agricultural planting technology is carried out manually, which has high labor intensity, low transplanting efficiency and is difficult to achieve large-scale production. In order to improve the efficiency of agricultural production, agricultural planting gradually tends to be mechanized, and agricultural machinery and equipment are developing towards intelligence. For pepper planting, mechanical transplanting has become the first choice for pepper transplanting in China.

At present, the design of agricultural transplanting machinery has become a research hotspot of many scholars. Transplanters in developed countries are mainly divided into two categories, one is a small automatic transplanter represented by Japan, and

the other is a large automatic transplanter represented by Western countries[4]-[6]. Although many scholars in China have done a lot of research on the transplanter, the function integration and function control are not high. For example, for the seedling pick-up mechanism of the transplanting machine, the simulation optimization and test of the finger-clip seedling pick-up claw based on EDEM- RecurDyn studied by Hu[7], the design and test of the vertical plate feeding mechanism of the vegetable pot seedling automatic transplanting machine studied by Yu[8], the optimization design and test of the penetrating vegetable pot seedling transplanting mechanism studied by Zhou[9], and the optimization and test of the small spacing planting mechanism of the transplanting machine studied by Li[10] .It can be seen that most of the scholars research on crops focuses on the optimization of institutions.

Therefore, in order to solve the problems of single function and low control ability of transplanting machinery, this study designed a pepper transplanting machine based on Arduino Mega2560 as the main control drive system.

2 DESIGN SCHEME

In today's situation that a large number of scholars study the optimization of transplanting machine mechanism, the control mechanism is added to the transplanting machine to improve the

efficiency of agricultural machinery and improve the intelligence of agricultural machinery. The transplanter uses Arduino Mega2560 as the control module and ATmega2560 as the processor core. The use of Arduino Mega2560 as the controller not only meets the control requirements of the pepper transplanting machine, but also has the advantages of low cost and easy to use. The Arduino Mega2560 control board is used to receive the return value from each module and make judgments based on the returned results and control the running state of the machine to realize the intelligence of the transplanter.

Pepper transplanting machine is composed of five institutions: planting mechanism, transmission mechanism, fertilization mechanism, storage mechanism and control mechanism. The control mechanism controls the other four mechanisms, with Arduino Mega2560 as the control center, as shown in Figure 1. This composition realizes the integration of planting and irrigation, reduces the labor force and greatly improves the planting efficiency. Agricultural machinery and equipment will be further developed towards intelligence.
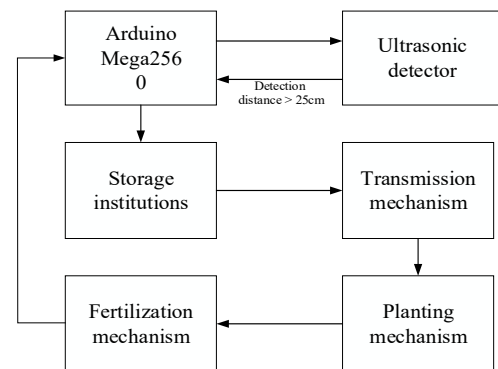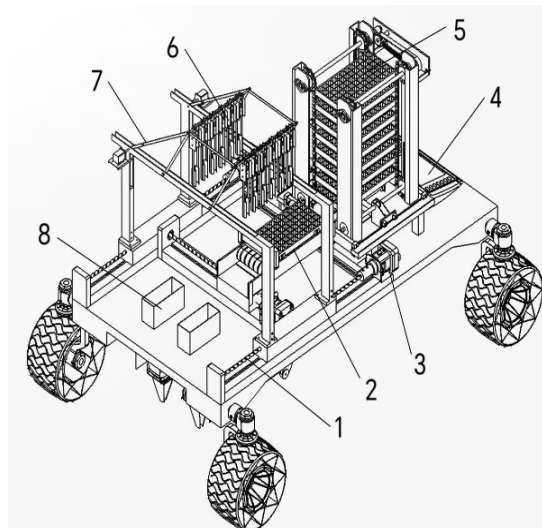

FIG.1 CONTROL SYSTEM DIAGRAM

3 MECHANISM DESIGN AND MOTION PROCESS

3.1 OVERALL STRUCTURE

1.SCREW ; 2. AREAS TO BE TRANSMITTED ; 3.MOTOR ; 4.CONTROL PLATFORM ; 5.CULTIVATION PLATE ; 6.MANIPULATOR ; 7.CRANK ROCKER ;8.PLANTING INSTITUTIONS.

FIG.2 THE WHOLE STRUCTURE OF PEPPER TRANSPLANTING MACHINE

The overall structure of the pepper transplanting machine is shown in Fig.2. It is composed of planting mechanism, transmission mechanism, fertilization mechanism, storage mechanism and control mechanism.

3.2 WHOLE MACHINE MOVEMENT PROCESS

The overall control process of the pepper transplanter is shown in Fig.3. The transplanter uses Arduino Mega2560 as the control core to realize the operation of the transplanter. Firstly, the pepper transplanting machine is moved to the experimental field, and then the electric energy is provided to the control board to complete the initialization program. The operator inputs the operation instruction, and the robot uses the ultrasonic detection sensor to scan the distance between the operation site and the fuselage after receiving the instruction. When the detection distance is not more than 25 cm, the transmission mechanism begins to operate, and the seedlings that need to be transplanted are transported from the storage device to the planting mechanism mend the planting instructions are issued to the planting mechanism. After receiving the instructions, the planting mechanism began to operate, and the transmitted seedlings were inserted into the test field. After the operation

was completed, the irrigation and fertilization instructions were issued to the fertilization mechanism. After receiving the instructions, the fertilization mechanism carries out irrigation and fertilization to the planting seedlings, and after the fertilization is completed, the forward instructions are issued to the drive control mechanism. After receiving the instruction, the driving control mechanism uses the ultrasonic detection sensor to scan the distance between the working place and the fuselage. If the detection distance is not greater than 25 cm, the transplanter repeats the above operation. If the detection distance is greater than 25 cm, the operation is completed.
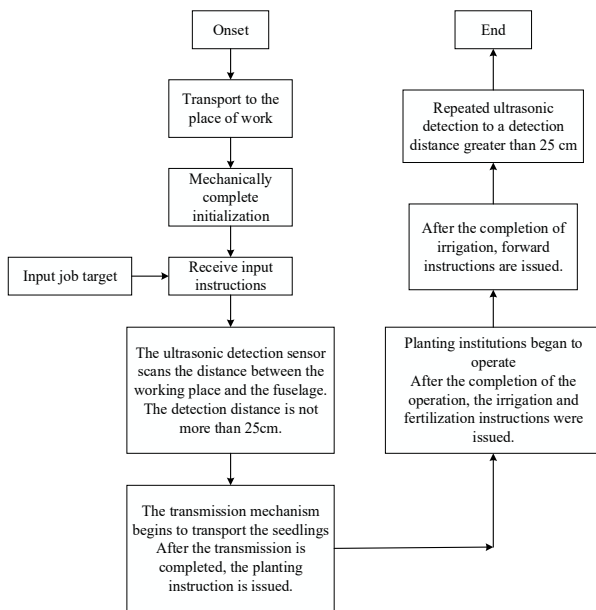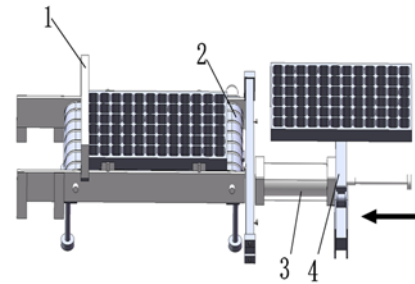

1.BAFFLE ; 2.CONVEYOR BELT ; 3.HYDRAULIC CYLINDER ; 4. CROSS-FRAME.

FIG.4 HYDRAULIC CYLINDER EXPANSION

3.4   TRANSMISSION MECHANISM

The transmission mechanism of pepper transplanting machine is composed of two parts : manipulator and slider. The crank rocker is used to rotate the manipulator to the transmission area below. After the manipulator grabs the seedlings, the slider begins to move to the planting area, as shown in Figure 5. Screw transmission is used in the transportation of the slider. The screw transmission can achieve high-precision linear motion, and the self-locking performance is good, which reduces the situation of grasping and throwing dislocation of the manipulator during transportation. The crank rocker has high stability and reliability during operation, and can work continuously for a long time, which simplifies the operation of the transport mechanism[2].
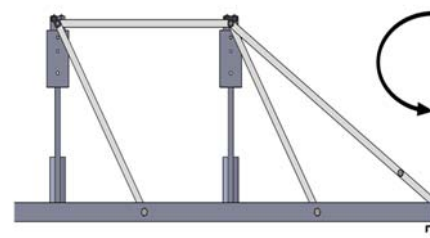

FIG. 3 MOTION PROCESS OF THE WHOLE MACHINE

3.3   STORAGE INSTITUTIONS

The storage mechanism of pepper transplanting machine adopts chain transportation. The driving ability of chain transportation is strong, so it can carry a large load. At the same time, the operability of chain transportation is strong. The plate is placed between the chains, and the seedling tray can be placed. At the same time, the top-down transportation of the seedling tray for cultivating pepper seedlings facilitates the user to replace the pepper seedling tray in time. When the seedling tray is transported to the bottom horizontal frame, the hydraulic cylinder under the horizontal frame begins to retract and transmit the seedling tray to the conveyor belt. The conveyor belt sends the seedling tray to the baffle, and the baffle blocks the seedling tray to avoid the seedling tray continuing to move with the conveyor belt. As shown in Figure 4 :

FIG.5 CRANK ROCKER AND MANIPULATOR

The end effector of the manipulator used in the seedling picking mechanism is a cylinder-driven clamping device, as shown in Figure 6. When the crank rocker rotates, the manipulator needs to pick and release the seedlings from the seedling tray to achieve periodic operation. Its performance increases the success rate of picking seedlings. It improves work efficiency while reducing unnecessary waste.
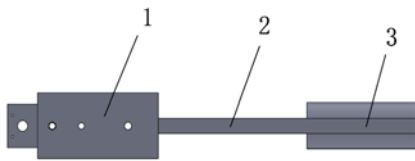
1. CYLINDER ; 2.CLAMPING NEEDLE ;3.CLAMPING CLAWS.

FIG. 6 MANIPULATOR

3.5 PLANTING INSTITUTIONS

The planting part of the pepper transplanting machine we used the duckbill transplanting parts, as shown in Figure 7. The planting bucket can ensure the vertical drop of the seedlings and accurately fall into the planting part of the duckbill. The schematic diagram of the duckbill is shown in Figure 8.

The planting of duck-billed transplanting parts reduced the lodging phenomenon of pepper seedlings during the planting process, reduced the damage of pepper seedlings, and improved the quality of pepper transplanting.

1.PLANTING BARREL ; 2.STENT ;3. DUCKBILL.

FIG.7 PLANTING MECHANISM

1.CONNECTING ROD ; 2. SPRINGS ; 3.DUCK MOUTH ; 4. STENTS.

FIG.8 THE SKETCH OF DUCKBILL

4 PRINCIPLE OF ULTRASONIC DETECTION

Considering that the ultrasonic wave will gradually attenuate in the air, in real life, the ultrasonic sensor with a frequency of 40 kHz is widely used, so the ultrasonic frequency selected for the transplanter is 40 kHz. The time sequence diagram of the ultrasonic signal is shown in Figure 9 :
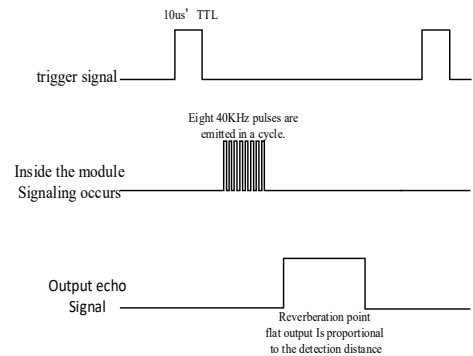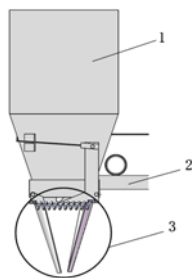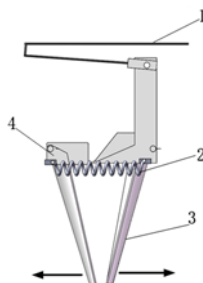

FIG.9 ULTRASONIC SIGNAL TIMING DIAGRAM

The pepper transplanting machine adopts HC-SR04 ultrasonic sensor, and the signal line of the ultrasonic sensor is connected to the pin of Arduino Mega2560. The detector calculates the distance between the sensor and the measured obstacle by sending and receiving ultrasonic waves and using the time difference and the propagation speed of the sound wave. The parameters used are shown in Tab.1.

TAB.1 SENSOR PARAMETERS

	parameters
Model	HC-SR04
Working voltage	DC 5V
Operating current	3.3mA
Working temperature	-40—85℃
Output mode	GPIO
Detection distance	2cm—600cm
Detection accuracy	3mm
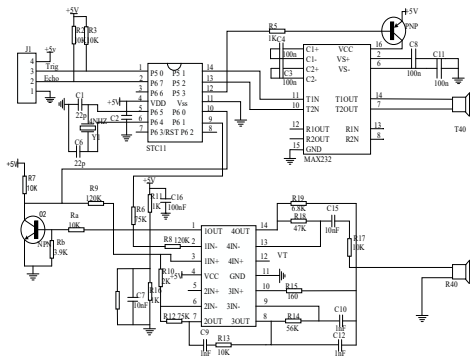
FIG.10 WORKING PRINCIPLE OF HC-SR04 SENSOR

The sensor uses the principle of time-of-flight (ToF) to measure the distance. It briefly emits a 40 kHz ultrasonic pulse and propagates in the air until the sound wave is reflected back by the obstacle on the north side, forming an echo and being captured by the sensor. The sensor operation formula is: distance = (high level time*sound speed)/ 2. Its working principle is shown in Fig.10.

5 CONCLUSION

1) Arduino Mega2560 as control A small pepper transplanting machine is designed, and its storage mechanism, transportation mechanism and overall operation process are studied in detail, which improves the planting efficiency of pepper and improves the automation of agricultural machinery.

2) The experimental analysis of the detection sensor HC-SR04 ultrasonic sensor of pepper transplanting machine is carried out, and the parameters and working principle of the detector are introduced.

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