Design of Greenhouse Lettuce Intelligent and Efficient Harvester

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ABSTRACT:*Aiming at the immature technology of lettuce harvesting automation equipment, a small agricultural equipment suitable for lettuce harvesting in greenhouses is developed. According to the characteristics of the actual lettuce-planting situation inside the greenhouse, the structural design of the chassis, leaf-removal, cutting device and conveying device was carried out. The harvester was modeled and simple motion simulation was carried out through Solid Works, and the prototype was successfully built.*

KEYWORDS -*lettuce harvester; structural design; modeling; Stimulate*

I. INTRODUCTION

At present, there is still relatively little research and development of lettuce harvesters in China, and most of them are carried out in universities, and there are almost no lettuce harvesters on the market. Shi Zhiming et al. of Sichuan Agricultural University designed a single-row side-mounted lettuce harvester using DF604-15F tractor as the driving power [1]; Liu Yuhao et al., Guangdong Vocational and Technical College of Science and Technology, designed lettuce planting machinery integrating harvesting and sowing[2]; Lettuce harvester designed by Liu Changlin et al. of East China University of Science and Technology [3]. Based on the experience gained in the above design, this design focuses on cutting and collecting to achieve a new lettuce harvester.

II. THE OVERALL STRUCTURE DESIGN OF THE LETTUCE HARVESTER

According to the process of manual harvesting of lettuce, the harvester is mainly divided into the following parts: mobile chassis, defoliation mechanism, cutting mechanism, conveying mechanism, and storage trough. Due to the high density of lettuce planting in greenhouses and the small harvesting space, the size of the harvester must be limited, so some tractor-pulled lettuce harvesters [4] are obviously not suitable for such occasions. Achieving all the intended functions in a limited space requires a compact design and precise cooperation between the individual parts in order to complete the task of harvesting the lettuce. The overall structure is shown in Figure 1.

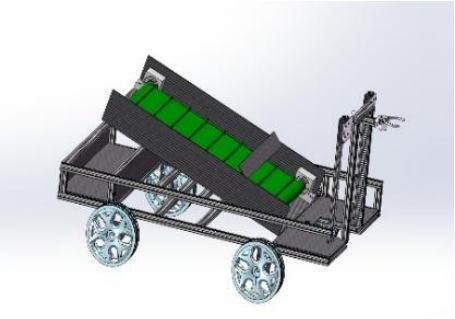

Fig.1 Overall structure of the harvester

III. STRUCTURAL DESIGN OF THE MAIN FUNCTIONAL PART

2.1 Structural design of Chassis

The actual lettuce planting in the greenhouse has the following characteristics: 1) the surface of the land for lettuce planting is not rugged and relatively flat; 2) The humidity of the land in the greenhouse is relatively large; 3) The density of lettuce planting is relatively large. Based on the

above characteristics of greenhouse lettuce planting, the chassis structure of aluminum profile frame and four load-bearing wheels (as shown in Figure 2) is selected, which can ensure the normal movement of the harvester on the planting land. The connection between the various aluminum profiles is connected by corner code and some adapters or plates.

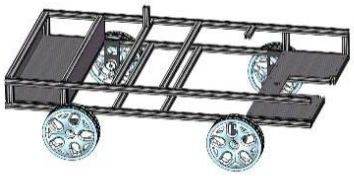

Fig.2 Harvester chassis structure

2.2 Structural design of leaf-removal

For the jaw part of the leaf-removal device, the design of narrow bottom and wide upper is adopted, and the lower edge is relatively sharp, so that when the motor moves downward, the surface of the lettuce can be easily cut and the blade removed, as shown in Figure 3. The gripper allows for better control of the area used to hold the lettuce stalks, which can be adapted to different sizes of lettuce, so that lettuce of different thicknesses can be defoliated, ensuring the effect of leaf-removal.

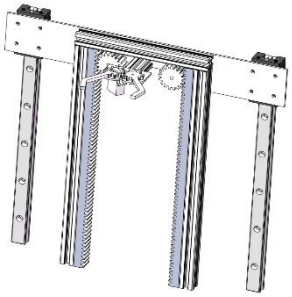

Fig.3 leaf-removal mechanism

2.3 Structural design of cutting device

Firstly, the texture of lettuce stalks was studied, and it was found that lettuce had the following characteristics: 1) The moisture content of lettuce was concentrated in 95.01%~98.00%, and the moisture content was high, so it was necessary to strengthen the waterproof and rust-proof treatment of cutting device and conveying device; 2) The maximum value of lettuce shear force is 352.65 N, and the minimum value of compressive strength is 1.50 MPa. The shear force of the design cutting device of the lettuce harvester should exceed the maximum value, and the clamping stress of the conveyor device should not exceed the minimum value of compressive strength [5]. This provides a theoretical criterion for the design of a reasonable excision mechanism.

The harvesting method of lettuce is to use a sickle to cut the plant from the roots, and according to the characteristics of the lettuce harvesting method, the cutting mechanism is designed to adapt to the lettuce of different diameters. The cutting mechanism is mounted on the chassis to maximize the proximity to the ground, thus reducing waste. The blade is located under the chassis, making it easy to cut lettuce without harming the human body. Improves the safety of the device when in use.

2.4 Structural design of conveying device

The conveyor was chosen to be driven by a conveyor belt. A guide plate is added to the conveyor belt to ensure that the transferred lettuce can enter the storage slot at the rear in the correct attitude. Considering that lettuce is cylindrical and may roll off the conveyor belt due to insufficient friction, a partition (as shown in Figure 4) is added to the conveyor belt, and each partition will produce a support force for the lettuce to support the lettuce to enter the storage tank safely.

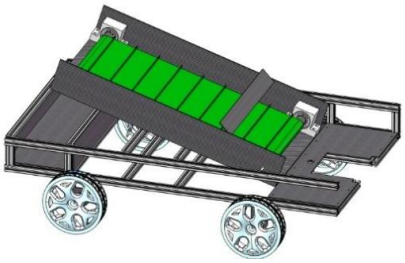

Fig.4 Conveyor mechanism

2.5 Structural design of collection device

The carbon plate is used as the four walls and the bottom of the storage groove, the carbon plate is easy to install, the strength is high, and it is not easy to be damaged, and the carbon plate at the bottom adds a certain angle, so that the lettuce can use the space of the storage groove as much as possible after entering the storage tank.

IV. CONCLUSION

This article introduces the mechanism and working principle of each part of the lettuce harvester in detail, with the close cooperation of each part of the mechanism, the lettuce can be harvested smoothly and accurately dropped in the collection frame under the transportation of the conveying mechanism. However, there are still some things that need to be improved in the machine, such as the defoliating mechanism is destructive to the lettuce stalks, and the defoliation effect needs to be improved. This is also the main point to optimize and iterate later.

Acknowledgements

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