Application of Machine Vision Technology in Garlic Planter

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Abstract: Mechanized garlic planting is a very necessary trend. At present, most garlic planters do not have the function of correcting garlic posture during the seeding process, which will greatly affect the growth of garlic seedlings [1]. This paper mainly describes how to recognize garlic orientation before garlic planting based on machine vision using Python language and LBP feature algorithm, and then correct it. This machine can accurately achieve the purpose of garlic clove scale buds facing upwards and increase the rate of positive buds.

1. Introduction

The garlic planter consists of power device, garlic seed box, garlic transmission chain, pressing hole mechanism, garlic vertical planting device, machine vision system and auxiliary mechanism. Ja168fa ordinary gasoline engine is used as power source, and coaxial cylindrical two-stage reducer is used for deceleration. The bottom of the frame is equipped with two front and rear rollers. In the middle are the seed picking, row spacing and plant spacing, scale bud identification and upright planting devices, which are connected with the depth adjuster to ensure the depth of seeding. The outer side of the earth-covering wheel is fixedly connected with an annular ring through a shock-absorbing spring, and an auxiliary wheel and a ditch opener are used to break, ditch, and cover the ground surface. The scale bud recognition device connects the steering gear with the Yuan bao type seed scoop to keep a single garlic seed in the small seed scoop [2]. Garlic direction is recognized by machine vision device. The machine's recognition principle is to compare one of the multiple images collected by the OV7725 with the template image stored in the SD card, and use the LBP algorithm to determine the direction of the garlic scale buds. The steering gear is controlled to rotate to a correct position, and then vertically drops to the duckbill opening and closing mechanism through the inverted seed tube. The duckbill opening and closing mechanism contacts the duckbill opening and closing control track when approaching the lowest position, and the duckbill opening and closing plate rotates to open the duckbill [3], plant the garlic seeds into the soil and complete the sowing. Finally, the soil after sowing is compacted by the pressing wheel to ensure the good contact between the garlic seeds and the soil. Because the machine is small and light, it can adapt to different terrain environments, continuous operation can improve efficiency.
2. Mechanical system scheme design

2.1. Decelerator: coaxial cylindrical two-stage decelerator can make the transverse size smaller, and the oil immersion depth of the two main gears can be roughly the same.
TABLE 1 Spindle output status table

|                  | Gasoline engine shaft | High speed shaft I | Medium speed shaft II | Low speed shaft III |
|------------------|-----------------------|---------------------|-----------------------|---------------------|
| power P/(kW)     |                       |                     |                       |                     |
| torque T(N·m)    | 71.4626               | 171.5102            | 501.3451              | 1465.5542           |
| speed n/(r/min)  | 1470                  | 588                 | 191.2133              | 62.1812             |
| transmission ratio | 2.5                  | 3.0751              | 3.0751                |                     |
| efficiency       | 0.09                  | 0.9506              | 0.9506                |                     |

2.2. Transmission device: reasonable mechanical device for power transmission is adopted. Considering the working conditions of agricultural machinery [4], chain transmission is used for power transmission.

2.3. Picking and Planting device: the transmission chain device is the key part of the mechanism. The chain drive drives the seed scoop to extract garlic seeds from the garlic seed box and transport them to the designated place. Through the cooperation with the directional overturning device, after the garlic falls from the tray, the garlic is under the action of gravity. The existence of vertical planting tube can make garlic continue to maintain the original correct upright posture to reach the seed hole.

![Figure 3: Seeding mechanism assembly](image)

3. Hardware design
Open MV module is a low-cost [5], extensible machine vision module that supports python. The design is as follows according to the functional requirements and size.
3.1. Power Supply: In the circuit, the single chip microcomputer needs 3.3 V, the camera needs 1.8 V, so the voltage needed for the circuit is generated by AMS1117 and TPS73101DBVR respectively.

3.2. CPU control module: Stm32h7xl Series MCU is based on high performance Arm® Cortex®-M7 core with 400MHz working frequency and dual precision FPU and L1 cache.

3.3. COMS Camera module: The circuit adopts the COMS camera of ov7725 with 300000 pixels. It controls multiple formats of sub sampling or windowed 8-bit / 10 bit images through the serial camera control bus (SCCB) interface. The maximum resolution is 640 × 480. These parameters basically meet the requirements of image recognition.

4. Software design
The garlic planter control system based on machine vision uses open MV as the core of control, and uses open MV ide to write and debug the program. The whole system consists of seven parts: control part, sensor part , connection part, output part, execution part, code editor and template storage.
The recognition of garlic seed orientation is based on LBP feature algorithm \cite{6}, which has the obvious advantages of gray invariance and rotation invariance; the algorithm is simple, easy to calculate and fast. The extracted LBP Operator can get a LBP code in each pixel. After extracting the original LBP Operator from an image, the original LBP feature is still an image, which increases the accuracy of the execution results.

When the garlic enters the sowing barrel, the garlic seeds will be put into the Yuanbao type seed scoop through the garlic conveyor chain. When the scoop moves to the detection range of the sensor, it will be photographed by the camera under the illumination of the linear light source, and the information will be transmitted to the CPU. According to the received information, garlic orientation is recognized by central processing based on machine vision algorithm. According to the captured image data, the image processing operation is carried out, and then the edge of the image is extracted. Compared with the template image stored in SD card, a similarity value is obtained. When the similarity is greater than a certain value, the direction of garlic is positive. On the contrary, it controls the actuator to act and correct the position of garlic. The garlic petals enter the duck beak opening and closing mechanism through the seed guide tube in an upright posture by controlling the two steering gears to rotate in turn. The programming framework is shown in the figure.
5. Conclusion
Mechanized seeding of garlic is the trend of the present era, and in the future, people will gradually leave manual farming on the premise that machines can meet the requirements of planting, and the future research direction will be more focused on "single seed picking, upright seeding, intelligent seeding, accurate seeding ", the structure will be more perfect and the efficiency will be higher.

The main feature of the garlic planter design is that the combination of software system and hardware system effectively solves the problem of garlic seed direction. The reference of camera detection system is more accurate and effective for garlic direction. The system can make the most correct judgment according to the different direction of each garlic drop. It further solves the problem of vertical planting of garlic during mechanical planting and improves the positive bud rate. The seed picking device realizes the transmission of seed by grain through the transmission chain, and improves the stability of seed picking.

Acknowledgments
Financial supports come from the design and development of a machine vision-based garlic planter (S202014439007). National College Student Innovation and Entrepreneurship Training Program of Shandong Agriculture And Engineering University.

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