

# Study on the Design and Control System for Wolfberry Harvesting Robot

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**Abstract:** In order to solve the problem of labor shortage, intensive labor and high cost, a new design of wolfberry harvesting robot was proposed in this paper, which would be extremely beneficial to increase margins and profits. This kind of robot comprised a self-propelled automated platform with one articulating arm, coupled with camera, sensors of all kinds and picking manipulator. Two rotor bodies inside the manipulator, which were made of two silicone wheels, every silicone with three spiral silicon tube, carried on relative motion to realize the simulation of hand-picking to pick fruit. Pinhole imaging technology for identification and PID control method for the enhancement of control system's dynamic and static performances were employed to ensure the normal order of the picking robot. The result to robot would achieve efficient work and replace manual labor, even outstrip efficiency of manual labor. Meanwhile the wolfberry fruit which was picked by robot would be more sanitary better manual.

**Key Words:** Wolfberry Harvesting Robot, Picking Manipulator, Pinhole imaging technology, Intelligent Control System.

## 1 INTRODUCTION

Wolfberry full of rich nutritional value of fruit is a kind of medical material for health preserving. The challenges need to be addressed include slow speed, low efficiency, strong labor intensity and poor sanitary conditions in the picking process, the existence of which would be the unfavorable factors of development. Robotic harvesting will be of great practical significance<sup>[1-2]</sup>.

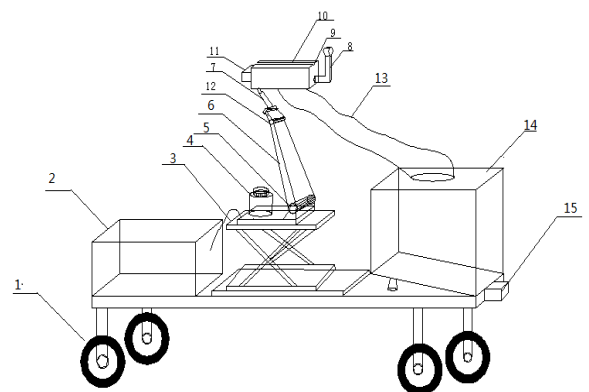
Harvesting robot is a kind of intelligent mechanized harvesting system, which relates to computer information processing, image acquisition and processing, sensor technology, kinematics analysis and other interdisciplinary studies. Harvesting robots have obtained a great development and improvement but not successfully replaced the judgment, dexterity and speed of experienced farmworker at a competing cost<sup>[3]</sup>. Wolfberry robot would achieve efficient work and replace manual labor, even outstrip efficiency of manual labor. Meanwhile the wolfberry fruit which was picked by robot would be more sanitary better manual. So much research focused in the field of strawberry, apple, cucumber picking, and fewer studies on wolfberry, the berry properties of which includes small particle size, high moisture content, thin peel, have been done in robot systems<sup>[4-9]</sup>.

## 2 THE STRUCTURE OF THE WOLFERRY HARVESTING ROBOTS

A new kind of wolfberry harvesting robot was designed, consisting of carrier, robotic arm with five degrees of freedom, picking manipulator, motor, and sensors for different uses, the overall structure of which can be seen in Fig.1. The carrier with wheels comprised components such

as loading bin, motors, steering system, industrial computer, a sensor for obstacle avoidance and so on. The robotic arm mounted with picking manipulator and sensor was employed to enable movements in a plane driven by motor and fixed on the carrier for a stronger stability.

A detailed schematic view of the picking manipulator was shown in Fig.2, the side of which was coupled with sensors. The bottom was set with a delivery pipe towards the loading bin, and the top was regarded as the entrance. When the tree trunk was immobilized, two rotor bodies, which were silicone cone with three spiral silicon tube though nylon wire, carried on relative motion by the drive motor and gear to realize the simulation of hand-picking to pick fruit. In this way, there was no harm to leaves and immature fruit when it picked wolfberry, preventing the fruits from being bruised.

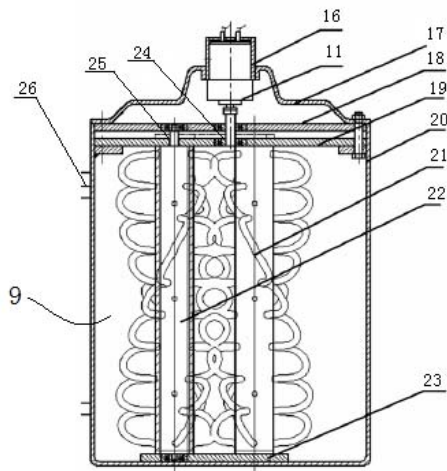


1-carrier; 2-power control equipment; 3-lifting platform; 4-waist motor; 5-big arm motor; 6-big arm; 7- small arm; 8-branch; 9-picking manipulator; 10-rotor body; 11-dc motor; 12-small arm motor; 13-delivery pipe for fruit; 14-loading bin; 15-sensor for roadblock

Fig 1. Overall structure of Wolfberry Harvesting Robot

### 3 THE CONTROL METHOD OF THE WOLFBERRY HARVESTING ROBOTS

An image collection and processing system, based on pinhole imaging technique, was designed including data acquisition card and analog-digital conversion. In order to improve the motion control of joint angle of robot, fuzzy-PID control was introduced to the robot servo control to deal with the target fruit's position information from the image processing system. The process of picking robot can be described as follows: identification, location, picking and collecting, which was shown in Fig.3. Visual control, color collection, and the corresponding relation of coordinate between camera and fruit position provided messages comprising the number and accurate locations of fruit in each specific region. The obstacle perception and recognition was studied to provide fairly perfect environment information for automatic navigation and obstacle avoidance.



9-picking manipulator; 11-dc motor; 16-motor bracket; 17-top head; 18-top plate; 19-lower plate; 20-outer shell; 21-flexible tube; 22-silicone cone; 23-bed plate; 24-transmission gear; 25-rotor gear;  
Fig.2. A schematic diagram of Picking Manipulator

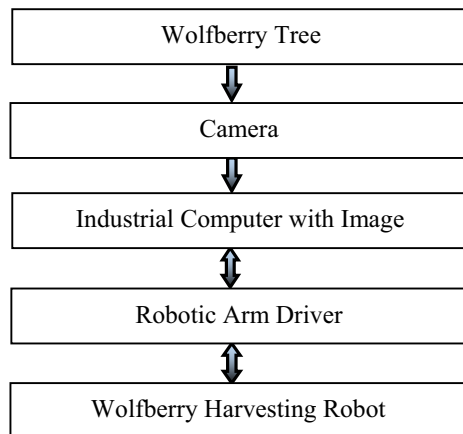


Fig.3. Flowchart of Wolfberry Harvesting Robot

### 4 CONCLUSION

A new design of wolfberry harvesting robot was proposed in this paper, the structure of which included a self-propelled automated platform with one articulating arm, coupled with camera, sensors of all kinds and picking manipulator. The manipulator contained two silicone wheels, the relative motion of which was driven by two gears to realize the simulation of hand-picking to pick fruit. The rotating speed of the wheel would depend on the size and maturity of the wolfberry. When the size was bigger, the speed would slow down. Meanwhile, pinhole imaging technology for identification and PID control method for the enhancement of control system's dynamic and static performances were employed to ensure the normal order of the picking robot. This kind of picking robot would solve the problem of slow speed and low efficiency. Besides the automated picking process of robot was extremely beneficial to improve the poor sanitary conditions, because there was always bacterial on the farmer's hands in the hand manual picking.

### ACKNOWLEDGMENTS

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