A harvesting robot system for cherry tomato in greenhouse

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Abstract. *In order to improve the , a new harvesting robot system for cherry tomato was designed and tested, which mainly consisted of a railed-type vehicle, a visual servo unit, a manipulator, a picking end-effector, and other accessories. According to the greenhouse environment and the standard planting mode, the robot configuration was determined, whose operating space could be adjusted horizontally and vertically in order to enlarge the harvesting range. Besides, a harvested fruits automatic transport device was to decrease the time cost spent on the manipulator's transporting movement, so as to improve the harvesting efficiency and range. In view of the multi-fruits' clustering in a bunch, a dynamical visual servo unit was adopted to locate the single fruit and measure the fruit bunch, and a laser sensor of the visual unit was aimed at the target fruit to detect the rang information through visual servo method based on the dynamic image. A railed-style vehicle was used for carrying the robot system moving along the plant row, and a DENSO VS-6556 operated a stem-cutting end-effector to approach the bunch stem. A field test showed that the harvesting robot averagely spent 12 sec on picking one bunch tomato, and the successful rate is 83%.*

Keywords. *Cherry tomato, Harvesting robot, Visual Servo, Configuration design, Field test*

1. Introduction

Fresh-eating tomato is greatly product and consumed every year in China, of which the cultivated area is more than 732 000 hm^2 and the daily consumption is 21 kilograms per person (Yan). And the timely harvesting is necessary to ensure the edible quality, however the harvesting cost is significantly increasing these years due to continuous rise of labor cost, or rather, the harvesting cost has reached 1/4 of the total cost. Faced with agricultural population loss and labor cost increase, the automatic harvesting technology has caused extensive concern for the potential application in the future. In this paper, a harvesting robot system for berry tomato, the main fresh tomato in China, is introduced, which is supposed to achieve the automatic pick for bunched-shaped fruit. Besides, the robot's performance is tested in the greenhouse.

2. Harvesting robot system

The work condition for tomato harvesting robot is shown in Fig.1. The harvesting robot, shown in Fig.2, which mainly consists of a railed-type vehicle, a visual servo unit (Feng), a manipulator, a picking end-effector, and other accessories, moves on the rails to pick tomatoes in its both sides. Once the vision unit identifies the mature fruit bunch based on the dynamic image information, the robot will stop moving and locate the bunch's 3D position, then its manipulator will operate the end-effector to approach the target. The end-effector picks the fruit bunch and releases it to the transport belt. Finally, the fruit bunch is transported to the fruit container. So far, the whole automatic harvesting cycle is finished.

Fig.1 Work environment

Fig.2 Robot prototype

3. Field test

The robot performance was tested in greenhouse in March 2015, Beijing. The result showed that the robot could reach the mature fruits bunch in the rectangular region of height 1500mm × width 300mm. The measuring error of bunch shape was less than 8.55mm, average time cost was 12 sec per one bunch tomato, and the successful rate was 83%.

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