An Autonomous Fruit Picking Robot System in Green Houses

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***Abstract*— Rapid increase in research and development in robotic technology has led to a gap between education and industry. Here we are going to develop an autonomous picking robot system for fruits. It consists of four major components the color sensor, servomotor, robot arm and Four channel relay. In this we use Arduino to develop the prototype. The use of robots in agriculture industry has been regarded as an important trend so that, the research aims to construct a machine vision system for fruit picking using a robot in greenhouses. The system obtains the three-dimensional coordinates of each fruit feature for the claw path planning and to improve harvest efficiency of the cluster fruits in large scale Dutch production systems, it is desirable to replace manual labor with automated machines. The study is to develop the fruit picking robot designed to harvest greenhouse-grown fruits. The robot arm is designed with two claws inside to reduce damaging the fruit when bending and gripping. The claws are bent to reduce the opening of the tip, securing the fruit inside the claws. The center of the is a fruit claws suction device, which assists the fixation of fruit to the inside claws, enhancing the holding performance.**

Keywords – Autonomous, fruit, robot, green houses.

I. INTRODUCTION

Greenhouse-grown fruits and vegetables are mostly harvested manually, and the process in Taiwan is labor-intensive. Japan, Korea, the United States, and some European countries are developing agricultural operational robots, among which, the agricultural product picking robot is an important paper. According to the development, the technology of applying robots to agricultural production has become mature. Jimenez et al reviewed previous studies to automate the location of fruit on trees using computer vision methods, paying special attention to the sensors and accessories utilized for capturing tree images, the image processing strategy used to detect the fruit, and the results obtained in terms of the correct/false detection rates and the ability to detect fruit independent of its maturity stage. Most of these works use CCD (Charge-Coupled Device) cameras to capture the images and use local or shape-based analysis to detect the fruit. The research on agricultural harvesting robots has achieved practical effects. For example, Van Henten et al designed an autonomous robot for harvesting cucumbers in greenhouses, which included the autonomous vehicle, manipulator, end-effecter, the two computer vision systems for detection and 3D imaging of the fruit and the environment, and a control scheme that generates collision free motions for the manipulator during harvesting. Van Henten et al. also developed a cucumber-picking robot that can pick cucumbers inside the greenhouse automatically. It uses a mobile CCD to capture images, and requires 124 s for searching and picking the cucumber, achieving a success rate of 74.4 %. Ling et al developed a tomato-picking robot, using a machine vision system to detect and analyze the fruit. The end-effecter device consists of four claw fingers, and a robot arm picking and releasing fruit. The success rate of detecting tomatoes is 95 %, and the picking success rate is 85 %. Kim et al. developed a strawberry-picking robot, using two CCD's and a laser distance meter to identify the position of a strawberry, and an end-effecter to cut off the strawberry. The average time for picking a strawberry is 7 s. Bulanon et al. developed a real-time machine vision system to guide a harvesting robotic manipulator for red Fuji apples. The machine vision system was composed of a colour CCD video camera to acquire Fuji apple images at the orchard and a PC to process the acquired images. Kondo et al. developed a cluster tomato-picking robot, which end-effecter has two fingers. A double-CCD vision system is used for identifying the position of a cluster tomato. This study aimed to develop an autonomous picking robot system for greenhouse-grown tomatoes, including the end-effecter, the machine vision, the robot carrier, and the control system. According to the Korean Food and Agriculture Organization (KOFAO) in 2007, the cultivating area for strawberries was 7,600 ha which was ranked 7 in the world. Production amount was 203,227 MT, ranking it in 4th place internationally, and the number of cultivating farmhouses is over 16,000. Strawberry species, Sul-hyang and Mae-hyang had a portion of 62.7% of

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total production with representing others. Labour required per 10ha was 613.9 hours in a case of semi-forcing with 250.3 harvesting labour hours. Labour required per 10ha was 590.6 hours in a case of forcing cultivation with 208.7 harvesting labour hours. There has been a great demand in Korea for the mechanization and automation of strawberry cultivation, especially in selective harvesting of ripened strawberries. Also, visual treatment technology with supporting visual information to worker to guarantee value-added high quality fresh produce was exercised during cultivation.

In the case of greenhouse cultivation, the lighting system was composed of a combination of natural and artificial lights. In automating the harvest process using computer vision to select the ripened strawberries, visual images acquired under this lighting environment usually had problems with distortion caused by the variation of light reflection and shadow effects according to the direction of the light. The harvest robot using a suction type end effecter was developed for the strawberries cultivated in the soil ground by Kondo. Fruit detachment and on-line classification of strawberry ripeness was proposed by Guo Feng et al. A strawberry harvesting robot system was developed using visual servo technology. A endoscope type end effecter was also developed. A computer vision system was utilized as a visual servo to detect and trace ripened strawberries selectively.

II. METHODOLOGY

The fruit picking robotic arm is implemented using color sensor through Arduino that recognizes the color of the fruit required for harvesting of ripened fruit.

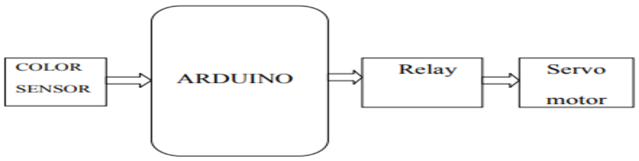

Fig1: Block Diagram of Fruit Picking Robot.

A. Arduino Microcontroller (UNO)

The microcontroller used in the system is arduino; it basically does all the computing, controlling and displaying tasks. Arduino is an open- source paper that created microcontroller-based kits for building digital devices and interactive objectives that can sense and control physical devices.

B. Color Sensor

The TCS3200 and TCS3210 programmable colour light-to-frequency converters that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance). The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital inputs and digital output allow direct interface to a microcontroller or other logic circuitry. Output enable (OE) places the output in the high-impedance state for multiple-unit sharing of a microcontroller input line.

C. Four Channel Relay

The Four Channel Relay interface board that allowed to control various appliances, and other equipment's with large current. It can be controlled directly by using arduino. The 4-Channel Relay interface board, and each one needs 15-20mA Driver Current. So that, Both are controlled by 12V and 5V input Voltage. It is Equipped with high-current relay, AC250V 10A; DC30V 10A.It has a Standard interface that can be controlled directly by using Arduino. It has an Opto-isolated inputs indication LED's for Relay output status.

D. Servo Motor

Servomotor is tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. Any servo code, hardware or library can be used to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

III. HARDWARE & SOFTWARE DETAILS

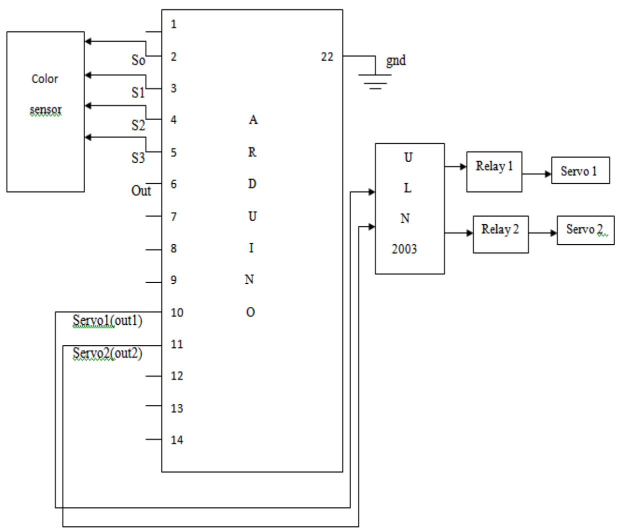

Fig2: Proposed Circuit Diagram.

The circuit diagram consists of color sensor, arduino, ULN 2003 IC, relays and servo motors. The color sensor is connected to arduino input, the output from arduino is connected to IC ULN 2003, the output of IC is connected to two relays and from relay output to two servo motors.

A. Arduino Software

Arduino is an open source computer hardware and software company, paper, and user community that designs and manufactural single board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the

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physical and digital world. The paper's products are distributed as open source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

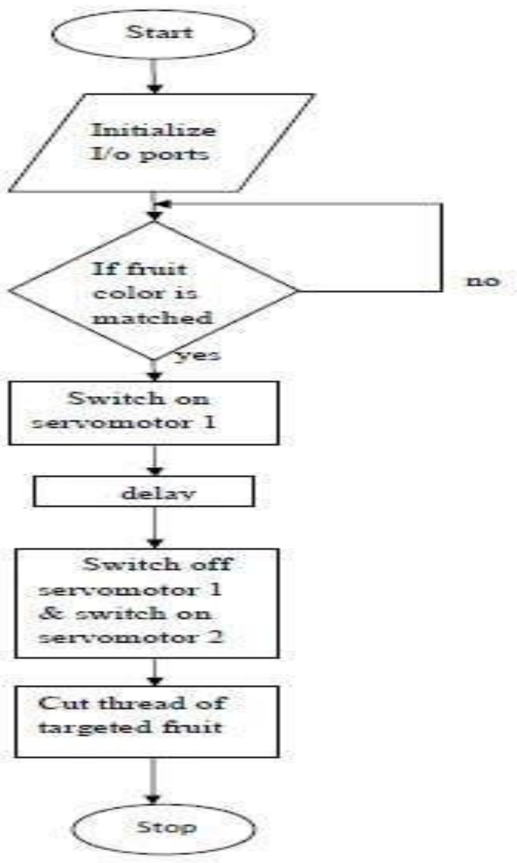

Fig3: Flow Chart of the System

IV. Result

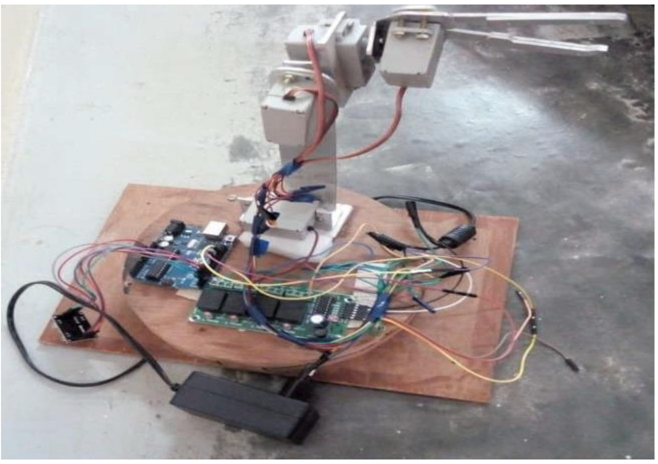

Fig4: Prototype

1. Start.
2. Initialize the I/O ports.
3. The Matching of fruit color is checked. (If it's not matched, Step 2 will be repeated again)
4. If Matched , Servo motor 1 is switched ON , after Certain delay , Switch off the servo motor 1 & Switch ON Servo motor 2.
5. Then Cut thread of target fruit.
6. Stop.

V. Conclusion & Future Scope

In this study, the prototype for picking fruit in green houses has been developed using color sensor and Arduino IDE. The end effecter is designed with two fingers in a scissor fashion and the fruit thread is cut when the fruit is detected. The prototype has the ability to detect the fruit by its color using sensor and cut the thread of a fruit by controlling the servo motor. The prototype can be made wireless using wireless components which can reduce the complexity of the hardware circuit. The end effecter of the robot arm can be made flexible for free movement around 360 degrees, it can be made of like 5 claws in a similar fashion of human hand. The claws can be designed in such a way it does not harm the fruits as well as the leaves. The prototype can be made along with the additional features such as container to carry the harvested fruits. Abundant robotics in California has built an automated fruit picker that uses a vacuum system to suck a fruit straight off of the trees. This prototype can also combined with other applications such as pesticides spray, cotton picking etc.

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