ESP-JETA
ESP Journal of Engineering & Technology Advancements
ISSN: 2583-2646 / Volume 3 Issue 1 February 2023 / Page No: 51-56
Paper Id: JETA-V3I1P109 / Doi: 10.56472/25832646/JETA-V3I1P109

Original Article

Development of Solar Power Agriculturally Based Fruit Picking Robot

Imran Miah1, Selim Sultan2, Jigdrel Wangchuk3, Savitha R4

[1,2,3,4] *Department of EEE, Jain deemed to be University, Karnataka, India*

Received Date: 17 January 2023 Revised Date: 03 February 2023 Accepted Date: 08 February 2023

Abstract: *Fruit harvesting has shown to be a substantial obstacle to both market and production during the harvest season. Because hand-picking involves so much labor and time, it is difficult to fully satisfy the urgent demands of each market, especially given the recent human resources and aging issues in agriculture. The farmer can be helped to pick the fruits quickly and effectively by a fruit-picking robot that is based in agriculture. Solar power design and development are included in this project. In addition to having an arm that aids in picking desired fruits, the robot has four wheels, and each wheel uses an L-type DC motor. Batteries that are charged by solar panels are connected to motors. A Raspberry Pi serves as the central controller of this robot. It takes information from the camera and ultrasonic sensors. A mobile or desktop application can be used to control the whole system. It supplies electricity with environmentally friendly solar panels.*

Keywords: *Solar Panel, Battery, DC Motor, Picking Robot, Computer Vision, Agricultural.*

I. INTRODUCTION

The world's largest industry is agriculture. Most industries rely on agricultural raw materials. Because of this, every nation's GDP, economy, and progress depend on how well its agriculture is doing. Since agriculture requires much manual labor, robots use to help. The potential for Agro-robots is considerable in India, the world's second-largest agricultural producer and seventh- largest exporter of farm products. Robots can function in hazardous environments, allowing them to undertake risky tasks that people cannot. They can handle the heavy lifting, dangerous materials, and repetitive tasks. Robotics is widely used in industry, but it has had far less success in agriculture The industrial environment is typically sterile, dry, predictable, and well-lit, in contrast to the agricultural setting, where light, weather, and topography have dramatically changed. Industrial automation employs standardised components that are robust enough for robotic manipulation, unlike agricultural technology, which must deal with crops whose colour, size, and form vary widely, are typically partially concealed by foliage, and are subject to harm during handling. There are economic advantages to using automation in agriculture, particularly in countries with high labour costs. Crop manual harvesting is laborious, and finding and keeping workers to accomplish it is a persistent issue. It is a recent concept to use robotic technology in agriculture.

Robots have a considerable potential to increase production in agriculture, and more and more of them are beginning to appear on farms. The automation of agriculture could aid farmers in reducing their workload and effort. Jimenez et al. (2000) reviewed earlier studies on simplifying the position of fruit on tree branches using image processing algorithms, focusing on the sensing devices and apparel used to take footage of the trees, the technique of image processing used to identify the fruit, and the results obtained in terms of the accurate prevalence rate and the ability to see fruit regardless of its stage of maturation. CCD cameras are typically used in these studies to capture images and either local or shape-based analytics are utilized to identify the fruit. The study suggests that this method could potentially be more effective and efficient than conventional framing methods in crop-harvesting robots. To pick cucumbers in greenhouses, Van Henten et al. (2001) created an autonomous robot featuring several cutting-edge characteristics, including an autonomous vehicle, computer vision systems, a manipulator with an end-effector, and a control scheme that guaranteed collision-free travel. A robotic cucumber-picker that can automatically select cucumbers inside a greenhouse was created by Van Henten et al. in 2002. With a success rate of 70.4%, it employs a mobile CCD to record photos and searches and picks the cucumber in 122 seconds. To identify and analyze the fruit, Ling et al. (2003) created a robot that picks tomatoes.

A robot arm and four claw fingers make up the end-effector device, which selects and releases the targeted object. The chances of finding tomatoes are 95%, and the chances of selecting them are 85%. Kim et al. (2008) developed a strawberry-picking robot that employs two CCD cameras, a laser distance meter, and a laser rangefinder to find strawberries and a cutting end-effector to remove them. Strawberry picking typically takes seven seconds. Bulanon et al. (2004) created a live vision system to control robotic picking robotic operator ofred Japanese pears. As part of the machine vision system, pictures of Fuji apples were taken in the orchard using a color CCD video camera, and the pictures were processed on a computer.

Figure 1: Fruit Picking Robot System for Picking Tomatoes

II. LITERATURE SURVEY

As precision agriculture by agricultural robots is the newest emerging technology in the agriculture sector to save the time and energy wasted in repetitive farming operations, automation in farming processes is very advantageous today. Agro-Bot, a prototype agricultural robot, is made to carry out a variety of jobs like planting, ploughs, fertiliser spraying, and irrigation systems. [1].

Agriculture must still employ updated practices outmoded in today's technologically advanced world. In many areas of agriculture, automation is highly desired. This project involves the design and construction of an autonomous agricultural robot that aids the farmer in a variety of farming tasks, including the application of pesticides, weed control, and material handling. By moving in the intended route plan that is input to the controller using GPS technology, this robot totally automates the field monitoring [2].

An autonomous multipurpose agricultural robot is developed to perform laborious farmingtasks like seeding, cutting grass, and insecticide sprays. Two different-sized seeds will be sown using this project. Reduced human interaction and effective resource use are two advantages of robots. Bluetooth is used to transmit commands to the system, ensuring that there is no direct human touch and guaranteeing the operator's safety [3].

The end effector's fruit detachment force reported in this investigation, from 6 to 30.5 N, seems to be similar to the results reported by Flood (2005), from 5 to 29 N. Differences may result from seasonal or variety variability, late winter frost damage at the fruit peduncle union,or both. At a 90-degree approach angle, the end effector successfully scooped up 80.8% of the fruits. Over 93% of the fruit wasremoved from the picking while using the second vacuum control setting [4].

The objective of this work was to develop a greenhouse tomato picking robot system. An end-effector, a robot carrier, a robot vision system, and a control system make up the system's four core components. A visual control and processing system was constructed [5].

This study conducted a bibliometric analysis to track this topic's development and present state. For improved possibilities in the future, thisinvestigation assessed the existing performance traits of numerous fruit and vegetable-picking robots. For the large-scale mechanical production of fruits and vegetables in modern agriculture, five viewpoints, including robotic arms, end effectors, vision systems, picking settings, and picking performance, were offered [6].

The goal of the project is to develop an intelligent mobile picking robot for agricultural use based on the STM32 development board, which uses color sensor, infrared sensor, and ultrasonic sensor instead of CCD sensor to determine maturity and make the algorithm simpler, allowing for quick picking tasks. This is in line with the objective of wisely automating and modernizing agriculture, which is highly valued by governments everywhere [7].

This study introduces a robot that derives its power from solar photovoltaic (PV) panels, negating the need for an external power source. The complete system is controlled by an Android application that interfaces with a PIC18F4520 over Bluetooth and provides the robot with the signals it needs to do its tasks. Therefore, the use of dc motors is used for seed planting and hard plowing. For seed planting, consistent separation is maintained. Water is applied to the crop using a sprinkler with revolving nozzles. To effectively cut the unwanted grasses, the lawn mower's rotating blades have sharpknife edges on both sides. [8].

A review of the design, production, and development of a solar-powered agricultural robot is presented in the publication "A Review of Solar Operated Multipurpose Agriculture Robot." The robot can plow the ground, plant seeds, seal the soil with a leveler, and sprinkle fertilizer with a pump. These systems all operate using solar and battery power. A remote control is required to operate the vehicle [9]. A self-contained kiwifruit-picking robot's design concept and current state of development are shown. Only "excellent" fruit is selected according to the robot's clever visual acuity apparatus.

This robot is controlled wirelessly and navigates the orchard independently while collecting fruit, emptying full fruit bins, retrieving empty containers, and shielding the gathered fruit from the elements [10]. The cultivation must become more economical if the strawberry sites in Europe are to be protected. A strawberry-picking robot is created by the agricultural R&Dfirm Octonion for use with tabletop farming systems. The robot is an entirely autonomous system that can identify ripe fruits, pick them up without causing any damage, and place them in a punned (box in which strawberries are put). A mobile platformwith the picking equipment placed on it can move about the greenhouse on its own. A strawberry can be picked by the robot's current prototype in 4 seconds [11].

The methods for choosing tomatoes that are effective and have broad agricultural applications will be covered in the study. Solar PV, which is environmentally beneficial, provides energy. One method will beused to detect good fruits and pick good fruits in one container. It also can see damaged fruit and pick it up to store in another container.

III. PROPOSED SYSTEM

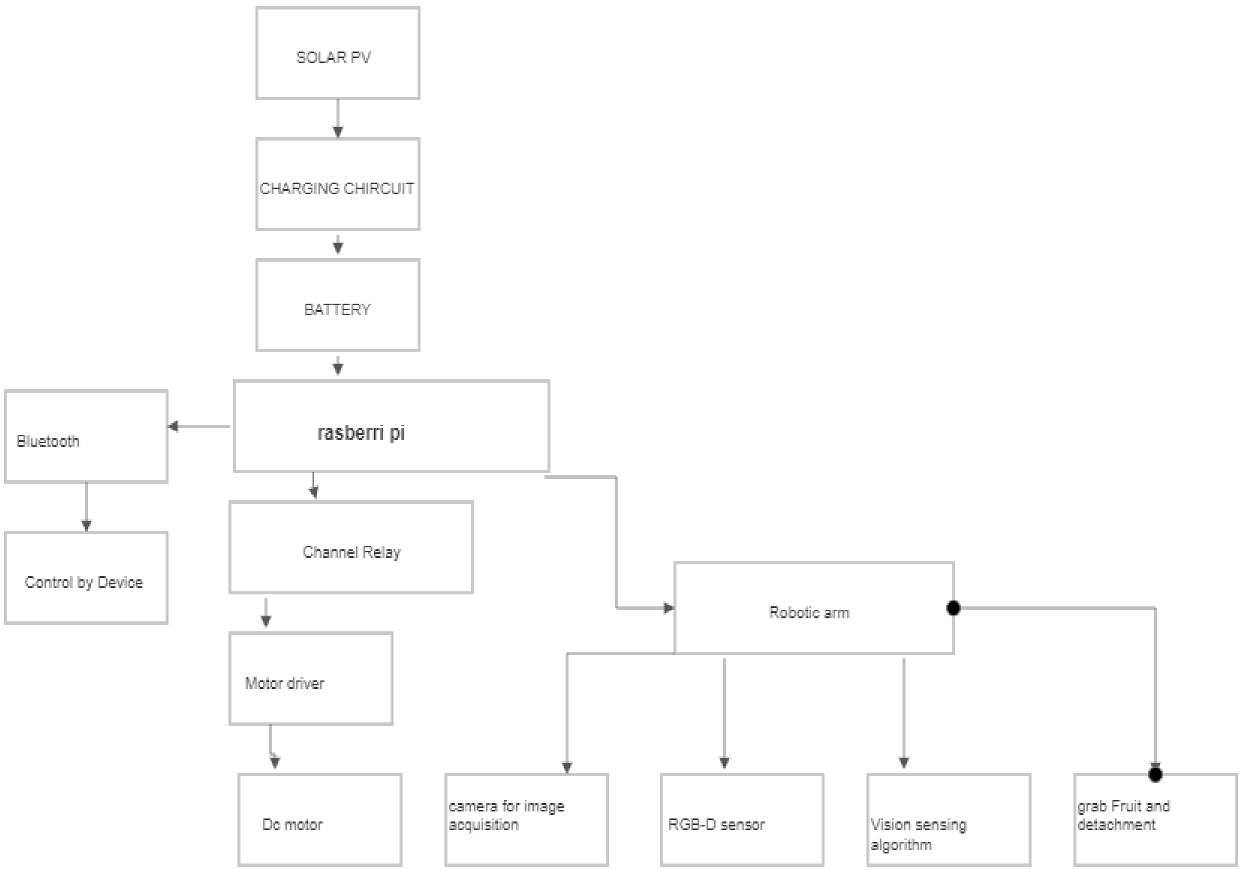

Figure 2: Block Diagram of a Solar-Powered Fruit-Picking Robot

Solar-powered tomato-picking robot with an agricultural foundation is discussed in the suggested diagram. It uses a visual sensing technique to function. Vision sensors use collected pictures from cameras to assess the presence, accuracy, and alignment of parts. These sensors are separate from picture-inspecting "systems" in that they include a single unit that combinesthe camera, light, and controller, making the device's installation and use simple. It can recognize the position and orientation of the fruit as well as determine if it is of excellent or terrible quality. A specific type of depth-sensing device called an RGB- D Sensor works in conjunction with an RGB (red, green, and blue color) sensor camera to add detailed information (accordingto a distance to the sensor) to the conventional image on a per-pixel basis. Solar PV is used to power the circuit and carry out the project. Raspberry Pi is the main kit. It oversees every action. It requires power to operate, which it receives from the solar-powered battery. A Bluetooth-based wireless network is employed to control the entire operation. Using Bluetooth, a remote device, such as a laptop or desktop, can operate the robot. A relay is a switch that is electrically triggered, as seen in the block diagram. Although it uses solid-state relays as one of its operating principles, it also uses an electromagnet to act mechanicallyas a switch. One low-power signal or two signals can be used by a relay to regulate a circuit. In early computers and telephoneexchanges, relays are utilized to carry out logical processes.

IV. IMPLEMENTATION OF ALGORITHM

The below diagram depicts entire process flow of the system.

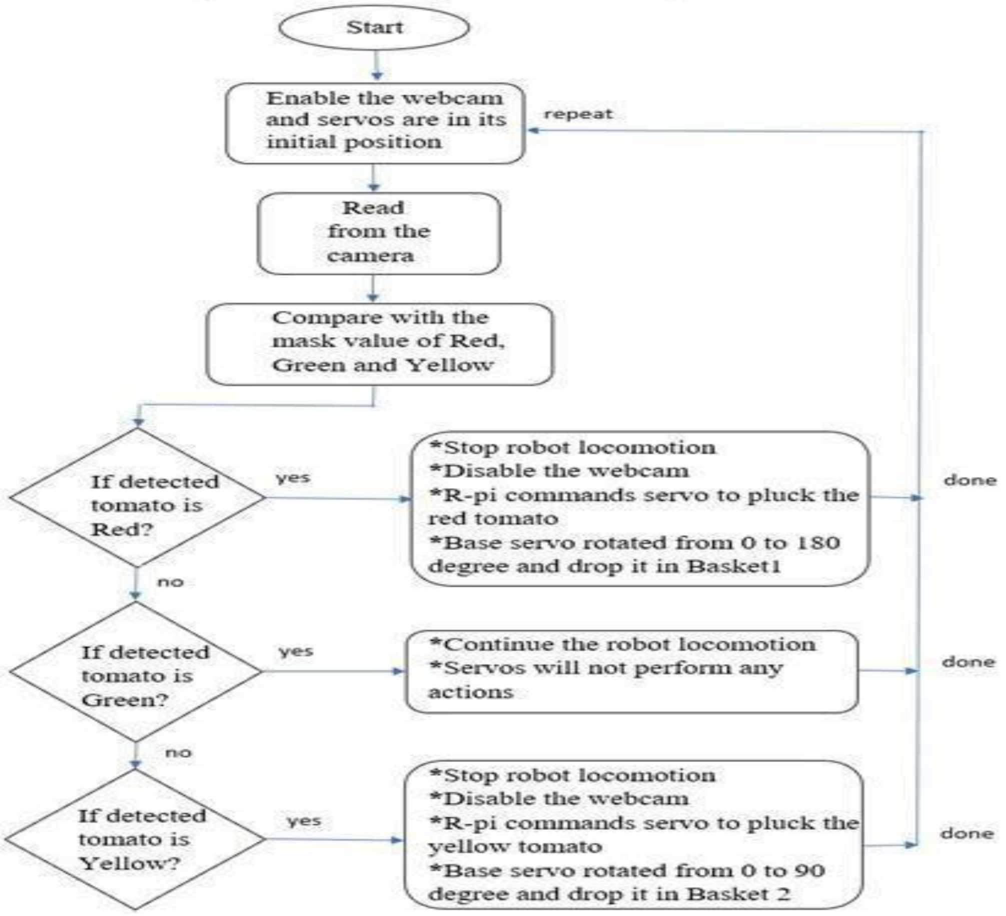

Figure 3: Working chart of the Tomato Picking Robot

- Enable webcam access in the Raspberry Pi configuration settings, then launch the main program. All servos will be in their starting positions once the main program has begun to run.
- To determine the color and shape of the tomatoes, real-time object detection is used.
- After the object has been read from the webcam, it is compared to previously defined red, green, and yellow mask values. If the detected tomato is red, then robot locomotion is stopped, a webcam is disabled, the gripper servo will pluck the tomato, and the base servo will rotate its base to 0 to 90 degree and drop it in basket one. Again, all servos will reach their initial position, and again camera is enabled to detect the tomato.
- If the tomato is yellow when it is detected, the robot's locomotion is halted, the webcam is turned off, the gripper servo picks up the tomato, the base servo rotates the tomato's base to 0 to 180 degrees, and the tomato is dropped into basket2, after which all the servos return to their starting positions. The camera is turned back on to detect tomatoes.
- If the tomato is green in color, the robot's mobility will not stop until it finds a tomato that is red or yellow.

V. PROTOTYPE RESULT AND DISCUSSION

Fruit-Picking Robot System: The robot device for collecting tomatoes grown in greenhouses measures 1200 mm by 570 mm by 1150 mm and weighs around 1771 N. Figure depicts the tomato-picking robot's prototype mechanism. The end-effector and robot arm is controlled. For autonomous placement control, the robot carrier and its platform can move vertically and horizontally on the tracks. To identify the fruit, they can also automatically take and process images. The four tabs that make up the operating interfaces of the control system, produced by Lab VIEW Software, are the program's main menu, picture capture settings menu, robot arm settings menu, and robot carrier settings menu.

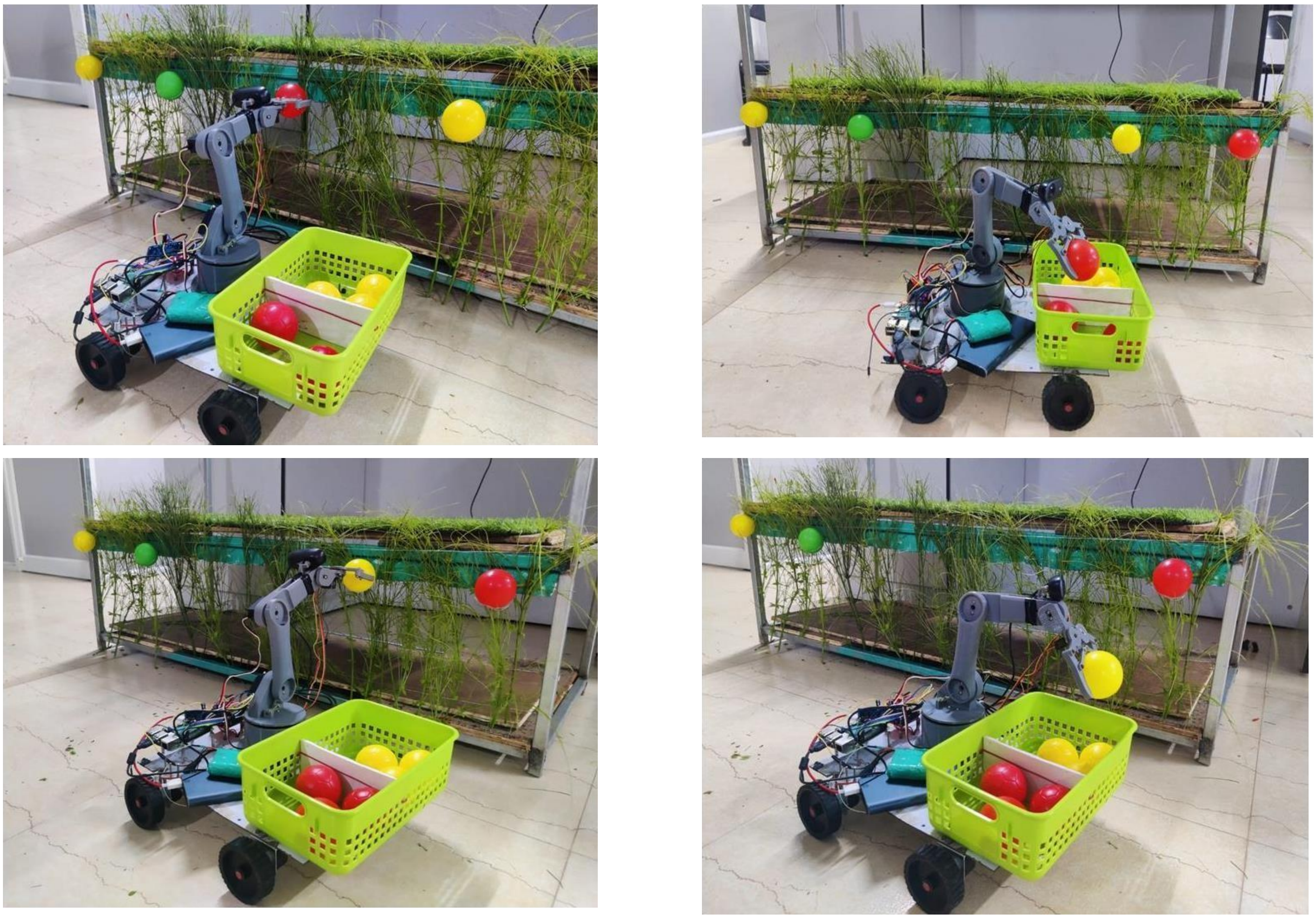

Figure 3: Robot Picking Test Balls

VI. CONCLUSION

In this project, a fruit-packing robot with a solar-powered agricultural foundation is created. We used solar panels, batteries, a Raspberry Pi, Bluetooth, a Dc motor, a robotic arm, and other technologies to construct this robot. Through data analysis and the use of a multi-sensor data fusion algorithm, the system may be able to produce intelligent decision data to control the roboticpicking arm, which can pick the fruits in place of farmers. The experiment was essentially practical and had the desired outcomes. It can lower power usage and cost compared to domestic and foreign items.

VII. REFERENCES

[1] Ratnadip S. Patil, Shubham S. Patil, Design and Development of Multipurpose Solar Powered Ag-Robot International Journal of Research in Engineering and Science (IJRES) ISSN (Online): 2320-9364, ISSN (Print): 2320-9356 www.ijres.org Volume 9 Issue 8 ‖ 2021 ‖ PP. 63-67 www.ijres.org .

[2] Bhukya Venkatesh Naik, R. Raman Goud , Design and fabrication of a Solar Powered Autonomous Agricultural Robot, 2nd International Conference on Manufacturing, Material Science and Engineering 2020 AIP Conf. Proc. 2358, 050005-1–050005-8; https://doi.org/10.1063/5.0057867 Published by AIP Publishing. 978-0-7354-4114-9.

[3] Ranjitha B, Nikhitha M N, Aruna K, Afreen 'Solar Powered Autonomous Multipurpose Agricultural Robot Using Bluetooth/Android App ' Proceedings of the Third International Conference on Electronics Communication and Aerospace Technology [ICECA 2019] IEEE Conference Record # 45616; IEEE Xplore ISBN: 978-1-7281-0167-5.

[4] Yi-Chich CHIU*1, Suming CHEN*2, Jia-Feng LIN "Study of an Autonomous Fruit Picking Robot System in Greenhouses .' Partly presented at the 6th International Symposium on Machinery and Mechatronics for Agriculture and Biosystems Engineering (ISMAB)

Jeonju, Korea in June 2012.

[5] Wang Z H, Xun Y, Wang Y K, Yang Q H. Review of smart robots for fruit and vegetable picking in agriculture. Int J Agric & Biol Eng, 2022; 15(1): 33–54.

[6] Jieqiong Han '' Design and Implementation of Intelligent Agricultural Picking Mobile Robot Based on Color Sensor'' l 2021 J. Phys.: Conf. Ser. 1757 012157.

[7] Prof Chandrakant D. Bhos1, Shrutika M. Deshmukh2, Prajakta A. Bhise3, Shweta B. Avhad "Solar Powered Multi-Function Agri-Robot" International Research Journal of Engineering and Technology (IRJET)- e-ISSN: 2395-0056, Volume: 07 Issue: 06 | June 2020.

[8] Sachin Bharat Jagtap , Saurabh Mohan Bhosale, Vishal Atul Deshmukh, Navin Madhukar Deshpande,Prof. Adhapure D.U "A Review On Solar Operated Multipurpose Agriculture Robot" International Research Journal of Engineering and Technology (IRJET)- e-ISSN: 2395-0056, Volume: 04 Issue: 10 | Oct -2017.

[9] A. J. Scarfe, R. C. Flemmer, H. H. Bakker and C. L. Flemmer "Development ofAn Autonomous Kiwifruit Picking Robot" 978-1- 4244-2713-0/09/$25.00 ©2009 IEEE

[10] Andreas De Preter ∗,† Jan Anthonis ∗ Josse De Baerdemaeker "Development of a robot for harvesting strawberries" 405-8963 © 2018, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd. All rights reserved. Peer review under responsibility of International Federation of Automatic Control. 10.1016/j.ifacol.2018.08.054.

[11] Yaguchi H, Nagahama K, Hasegawa T, Inaba M. Development of an autonomous tomato harvesting robot with rotational plucking gripper. In: 2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Daejeon, Korea: IEEE, 2016; pp.652–657. doi: 10.1109/IROS.2016.7759122.

[12] Chen X Y, Chaudhary K, Tanaka Y, Nagahama K, Yaguchi H, Okada K, et al. Reasoning-based vision recognition for agricultural humanoid robot toward tomato harvesting. In: 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Hamburg, Germany: IEEE; 2015; pp.6487–6494. doi: 10.1109/IROS.2015.7354304.

[13] Tanigaki K, Fujiura T, Akase A, Imagawa J. Cherry-harvesting robot. Computers and Electronics in Agriculture, 2008; 63(1): 65– 72.

[14] Ji C. Vision information acquisition for fruit harvesting robot and development of robot prototype system. PhD dissertation. Beijing: China Agricultural University, 2014; 101p. (in Chinese)

[15] Liu J Z, Li P P, Li Z G. Hardware design of the end-effector for tomato-harvesting robot. Transactions of the CSAM, 2008; 39(3): 109–112. (in Chinese)

[16] Davidson J R, Silwal A, Hohimer C J, Karkee M, Qin Z. Proof-of-concept of a robotic apple harvester. In: 2016 IEEE/RSJ International Conference on Intelligent Robots & Systems (IROS), Daejeon, Korea: IEEE, 2016; pp.634-639. doi: 10.1109/iros.2016.7759119.

[17] Shamshiri R R, Weltzien C, Hameed I A, Yule I J, Grift T E, Balasundram S K, et al. Research and development in agricultural robotics: A perspective of digital farming. Int J Agric & Biol Eng, 2018; 11(4): 1–14.

[18] Hayashi S, Shigematsu K, Yamamoto S, Kobayashi K, Kohno Y, Kamata J, et al. Evaluation of a strawberry-harvesting robot in a field test. Biosystems Engineering, 2010; 105(2): 160–171.

[19] Xiong Y, Ge Y, Grimstad L, From P J. An autonomous strawberry-harvesting robot: Design, development, integration, and field evaluation. Journal of Field Robotics, 2020; 37(2): 202–224.

[20] Feng Q C, Zheng W G, Qiu Q, Jiang K, Guo R. Study on strawberry robotic harvesting system. In: 2012 IEEE International Conference on Computer Science and Automation Engineering (CSAE), Zhangjiajie, China: IEEE, 2012; pp.320-324. doi: 10.1109/csae.2012.6272606.

[21] Guo F, Cao Q X, Masateru N. Fruit detachment and classification method for strawberry harvesting robot. International Journal of Advanced Robotic Systems, 2008; 5(1): 5662. doi: 10.5772/5662.

[22] Flemmer R C, Flemmer C L. Innovations in fruit packing: a slow kiwifruit packing line and a robotic apple packer. International Journal of Postharvest Technology and Innovation, 2011, 2(2): 120–130.

[23] Kahya E, Arm S. Research on robotics application in fruit harvesting. Journal of Agricultural Science and Technolog, 2014; 4(5): 386–392.