Automated Fruit Picking Robot

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***Abstract*—The present project report involves the designing, developing, and implementation of an Automated Fruit Picking Robot. The robot is an automated system capable of identifying and picking ripe fruits automatically. This system makes use of a TCS3200 color sensor for detecting the ripeness of the fruit and uses a multijointed robotic arm actuated by servo motors for picking the fruit and placing it in a designated location. As compared to sophisticated vision-based detection systems which make use of cameras and machine learning techniques, the current project is solely dependent upon real-time color sensing for fruit detection, which reduces cost and effort. An Arduino Uno board processes sensor values, identifies fruit ripeness and commands servo movements. A multi-jointed robotic arm along with an end effector is designed and implemented to grab the ripe fruits, which are later placed in the basket. In this report, different hardware components (Arduino Uno board, TCS3200 sensor, breadboards, power supply, and servos) as well as software implementation (Embedded C/C+)**

I. INTRODUCTION

Project Description: In the following project report, we will discuss the design, development, and implementation of an Automated Fruit Picking Robot. In essence, the robot is a fully automated system capable of detecting and picking ripe fruits automatically. This system employs the use of a TCS3200 color sensor to detect the ripeness of fruits whereas the fruits are grabbed using a multi-jointed robotic arm actuated by servo motors. In contrast to sophisticated systems that employ camera based and machine learning techniques to detect the ripeness of fruits, the proposed approach focuses only on color detection, which makes this system less expensive and easier. For instance, an Arduino Uno board will be employed in processing sensor values.

1.1. Motivation for the design of this robot

Is that of making a cheap and robust robot with readily available components. In fact, this project makes use of just a color sensor and servo motors (not a camera and no machine learning techniques), thereby proving to be highly reliable and easy. Through the use of RGB value thresholds, the robot proves that it can identify the ripeness of fruit effectively. With a robotic arm, the fruit can be picked by gripping it. A breadboard will also prove useful in setting up the.

1.2. The motivation behind designing this robot;

Is to come up with an affordable and durable robot using easily accessible parts. Actually, in the designing of this project, only a color sensor and servos (and not a camera or any kind of machine learning algorithms) have been used. This makes this robot very reliable and simple. The use of RGB threshold values shows how well the robot can detect ripened fruit. Using a robotic arm, the fruit can be plucked by simply holding it Role of this platform

1.3. Benefits of the Proposed System for Farmers

- Saves time and labour
- Reduces fruit damage
- Increases producctivity

For Consumers

- Better quality fruits
- Lower fruit prices
- More consistent supply

Platform Benefits

- Easy farm monitoring
- Improve resource management
- Scalability

1.4. The Automated Fruit Picking Robot has some benefits:

In relation to the sphere of intelligent agriculture and automated picking of fruits. Firstly, the robot will

automate the fruit detection and picking process, thereby saving time and human efforts. Secondly, it uses the TCS3200 color sensor for identifying ripe fruits due to their specific colors. Thirdly, the gripping technology of the robot will help reduce the probability of damaging the fruits while collecting them. Finally, this project will be more profitable due to lower farming costs This system is designed with an Arduino platform that employs servo motors, sensors, and breadboards. Hence, this system is affordable, easy to apply, and useful for educational and small-scale agriculture use cases. Moreover, this technology showcases how robotic engineering and embedded systems can be applied in agriculture, and in the coming days can further be improved by using more sophisticated technologies like AI.

II. LITERATURE SURVEY

Fruit picking machines in the earlier days made use of simple mechanical arms and color detection techniques to harvest ripe fruits. Color detectors such as the TCS3200 and RGB detector were often used in research due to their affordability, light weight, and ease of integration with controllers such as the Arduino microcontroller. The systems make use of color intensity to detect the maturity of the fruit. Such systems work efficiently when used in controlled lighting environments.

2.1. Early Development in farmer equipment rental Expert Systems

Automated fruit harvesting systems have seen their earliest form of development through the application of simple automation procedures in the agricultural sector, which intended to minimize the involvement of human efforts during fruit harvesting. Early fruit harvesters only included the use of simple mechanical systems and sensors that could accurately recognize fruits and harvest them with some degree of success. Simple robotic arms, conveyors, and color sensors were some of the equipment used in automating the fruit harvesters.

2.2. Rise of Machine Learning in farmer equipment rental

The rise of machine learning has significantly improved the performance and intelligence of automated fruit picking robots in modern agriculture. Cameras and AI algorithms are used for fruit recognition. Manage inventory

- Robots can identify fruits based on color, shape, and size.
- Improve platform performance

2.3. Problems in Traditional Vegetable Markets

The conventional method of fruit collection mostly relies on manual work. This process is slow, expensive, and inefficient. Farmers will have to employ many people for the task of collecting the fruits. Manual harvesting is associated with damage to fruits in the course of harvesting, especially if there is poor handling of the fruits. In cases where the fruits are situated at elevated positions, there is the risk of poor harvesting rates.

III. METHODOLOGY

Testing Components: Each individual component including color sensor, servos, and Arduino was tested. For example, we created an Arduino program where we simply blink the white LEDs in TCS3200 and print raw frequencies from OUT for different colored objects. Another test program involves sweeping the servos to their maximum ranges and to ensure correct connections and to see the amount of torque produced by them. Sensor calibration: This step included using some sample fruits (ripe and unripe). We kept the fruits at some particular distance below the sensor. Then we read red, green and blue values. We calculated red and green frequency values (e.g., by counting the pulses generated within 100 ms). Ripe fruits like red apples show significantly high red frequencies than green frequencies while the unripe (green) fruits show high green frequencies. From this, we get threshold or decision rule values. For example, (Red_count > 1.5 * Green_count) means ripe fruit.

3.1. Data Collection

- Fruit type data fruit ripeness level
- Fruit size and color
- Damaged or unhealty fruits
- Camera and sensor reading

3.2. Product Listing Process

Farmers upload:

- Fruit detection

- Ripeness identification
- Robotic arm movement
- Fruit picking
- Distance measurement

The system verifies and publishes listings

3.3. Testing & Deployment

The platform is tested for:

- Robotic arm testing
- Sensor testing
- AI model testing
- Grip strength testing

Deployment uses:

- Arduino IDE
- Arduino core library

IV. HARDWARE:

- Arduino Uno
- TCS3200 Color Sensor Module
- MG995 Servo Motors (×2)
- SG90 Servo Motors (×2)
- Robotic Arm Structure
- Robotic Arm Structure
- Breadboard (solderless)
- Power Supply
- Jumper Wires and Connectors
- Basket / Collection Bin

SOFTWARE:

- Arduino IDE
- Arduino core library
- Servo library

V. RESULTS AND OUTPUT

Automated Fruit Picking Robot was successfully developed and implemented for the demonstration of the basic idea of an automatic fruit picking system. The robot has successfully identified ripened fruits based on their color with the help of TCS3200 color sensor and executed the picking process with the use of robotic arm and the gripper mechanism. Servo motors were used for the controlled movement to different segments of the robot and its rotation in order to properly position the gripper towards the ripened fruit. Ripened fruits have been automatically distinguished from unripe fruits based on the specified colors and successfully tested under the simulated conditions with the use of colored balls.

Output of the whole project proved that the robot can be utilized for fruit picking process. Microcontroller based on the Arduino development board has successfully coordinated processes associated with the identification of colors and execution of the movements based on them.

This system has provided proof of the practical use of sensors, embedded systems and robotics in agricultural sphere.

VI. FUTURE SCOPE:

1. Mobility:

Mount the arm on a mobile base (wheeled or tracked) so it can navigate rows and reach multiple trees. Add sensors (ultrasonic/infrared) for obstacle avoidance.

2. Advanced Sensing:

Integrate other sensors: e.g., an infrared (IR) proximity sensor or LiDAR to detect fruit location/distance, or a camera for visual context (while still using color sensor for accuracy).

3. Multiple Arms:

Use two or more arms working in parallel to increase throughput.

4. Improved Gripper:

Replace the simple gripper with a more adaptive design (like soft grippers or suction cups) to handle fruits of different sizes and shapes.

5. Machine Learning for Calibration:

Although we avoid ML now, a small neural network could learn better ripeness distinctions from a color histogram, making the system more robust to varied lighting.

VII. CONCLUSION:

The design and implementation of an Autonomous Fruit Picking Robot through the use of TCS3200 color sensor and Arduino have been successful in achieving their intended purposes. As a result of the use of the color sensor to detect ripe fruits by their colors and

then picking them up through the servomotor-controlled actuators, the objectives have been achieved in an easy and affordable way without the use of cameras and AI.

The main lesson from this experiment is that simple and inexpensive technology can still help in automating certain processes including those in agriculture. Through experiments, it was proved that ripe fruits that had high red colors intensity could be easily detected and picked up. The use of the breadboard made the assembly process quite easy.

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