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Robotic Arm for Segregation Using Image Processing

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Abstract

The recent surge in industrial expansion can be attributed significantly to the advancements in automation technology. For better performance of industrial processes, automated systems are used. Image processing has played a great role in the applications of robotics and embedded systems. Sorting of objects is usually done by humans which takes a lot of time and effort. By employing image processing methods alongside appropriate sensors, object detection becomes feasible, enabling the utilization of robotic arms for sorting diverse items. This reduces human effort and improves the time to market the product. The model includes the conveyor system, capturing and detecting the objects and placing the objects. Using image processing techniques, the captured image is compared with its texture and color. Based on image processing, the robotic arm will be controlled and place the objects in desired locations. An Arduino model is used to process the captured image. The captured image is other than a pre-specified object, it involves the conveyor belt starting to move and the object is collected at the end of the conveyor system.

Keywords: *Conveyor belt; Image Processing; Pick and place; Smart bot; Sorting of object.*

1. Introduction

Significant advances have been made in robotics in the last two years. In the coming years, they will appear in space research and many activities in daily life. A robot is a mechanical device that performs tasks and acts according to a predefined set of general instructions and human control. Table 1 shows Literature Survey Analysis. These activities replace or support human activities such as the manufacture, operation, or transportation of heavy or hazardous substances. Robots are an important electronic and flexible product in high demand today. Robots are now more than machines, as labor costs and customer demand increase, robots are becoming the solution of the future. Robotic arms are used only for industrial automation and working in hazardous environments. Many robot controllers are expensive due to the special machining of high-precision drivers and components. In this report, a smart robotic arm received a command from a driver to pick up a specific object and then place it first. Figure 1 shows The Robotic Arm Setup [1].

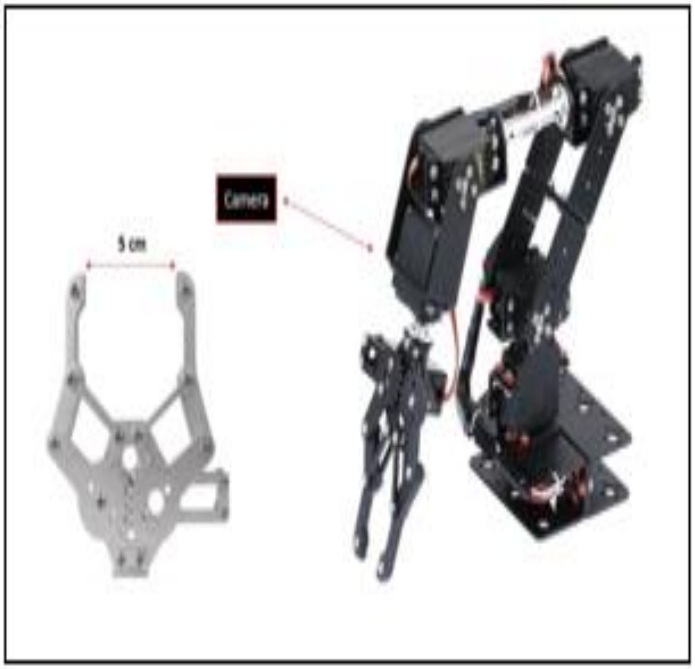

Figure 1 Robotic Arm Setup

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Table 1 Literature Survey Analysis

Title	Authors	Year Of Paper	Work Done	Results
Implementation of deep learning methods to identify rotten fruits.[2]	Chakraborty Sovon	2021	This Project focuses on a mechanism based on the available deep learning model to determine the fruit fast and reliably in a complicated orchard environment.	Detected the deep characteristics of fruits using a stereo camera and an indoor fruit dataset, resulting in efficient identification of varied fruit sizes.
An advanced method of Identification of fresh an Rotten fruits using differ Convolutional neural Networks [4]	Miah Md Sohel Tayeeba Tasnuva Mirajul Islam	2021	In this project, a fruit classification system was made useful in a variety of areas, including autonomous agricultural robots and the production of smartphone apps for identifying unique fruit species on the market. In this study, they took a total of 5658 fruit images which are based on 10 classes. Using CNN, we can pick up design in the image, and is robust for computer vision.	By finding defects in agricultural fruits, the expense and time for processing may be minimized. In the proposed classification system, they have worked on five CNN models. The Inception V3 model has an effective of 97.34 %.
Design of fruit segregati and packaging machine.[	Ganesh Khekare Ajinkya Shende Aldrick Gonsalves Kaustubh Padalkar Vinit Rodrigues	2020	The Authors have published That automation in the agricultural sector increases and improves the standard, basic features, expansion and efficiency of the production of goods. The features Used in this were preprocessing, thresholding, segmentation, extraction, classification and detection.	The project is realized to sort and pack different types of fruits. The objectives are also achieved which include: sorting five different types of fruits, packaging five types of fruits, and weighing and labelling the fruits.
A Comparative Analysis Of Fruit Freshness Classification.[6]	Karakaya Diclehan Oğuzhan Ulucan Mehmet Türkan.	2019	This study comparatively analyses an image dataset containing samples of three types of fruits to distinguish fresh samples from those of rotten. The proposed vision-based the framework utilizes histograms, gray-level co-occurrence matrices, bag of features, and convolutional neural networks for feature extraction.	The classification process is carried out through well-known support vector machines-based classifiers. After testing several experimental scenarios including binary and multi-class classification problems, it turns out to have the highest success rates are obtained consistently with the adoption of convolutional neural networks-based features.

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2. Methodology

To create our data, we have chosen the fruit as “apples”. We have segregated them based on their redness (Color texture). After that, we compared the apples based on their color. We processed most apples into each group (ripe and unripe) and then put them into separate containers. The software part is implemented using [2] Arduino programming for controlling the hardware and Python programming for computer vision tasks. Figure 2 shows Block Diagram.

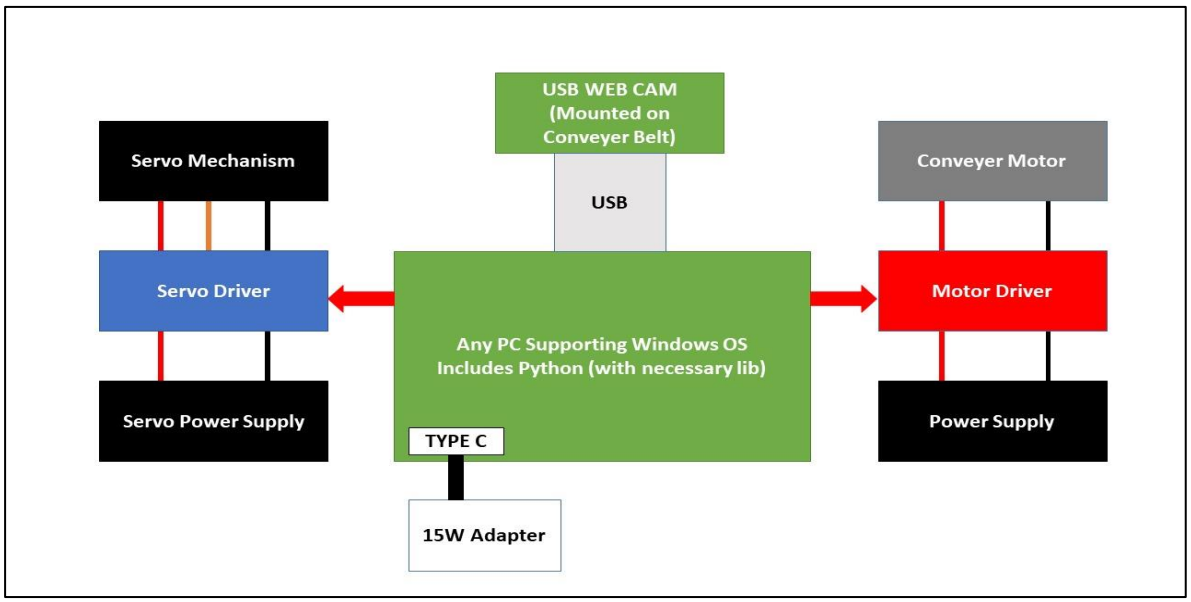

Figure 2 Block Diagram

Servo drives are electronic devices used to control servo motors. The servo drive receives feedback signals from the controller to indicate the desired position and speed. We use an arm-mounted RGB camera. The processor drives the 5 servo motors that make up the robot arm, and the camera is mounted on a bracket separate from the board. There are 2 boxes in the middle for storing [3] ripe and unripe fruits respectively. L298N is a motor controller that can control the speed and direction of two DC motors simultaneously. This module can drive DC motors. It is used to control two motor drivers, one for the conveyor belt and the other for the robot arm. We developed an application for a commercial robotic arm to sort, pick, and place fruits on a conveyor belt based on their physical state i.e. ripe vs. unripe. Figure 3 shows Circuit Diagram. This project involves the development of a system that can automatically sort apples based on their ripeness using computer vision and robotics.

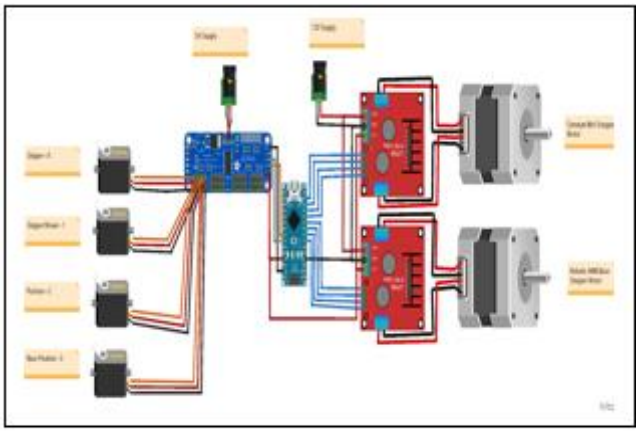

Figure 3 Circuit Diagram

The system consists of hardware [4] components like an Arduino Nano microcontroller, a stepper motor with a conveyor belt, a robotic arm for picking and placing apples, and a USB camera connected to a Windows system. Figure 4 shows Actual Model Setup.

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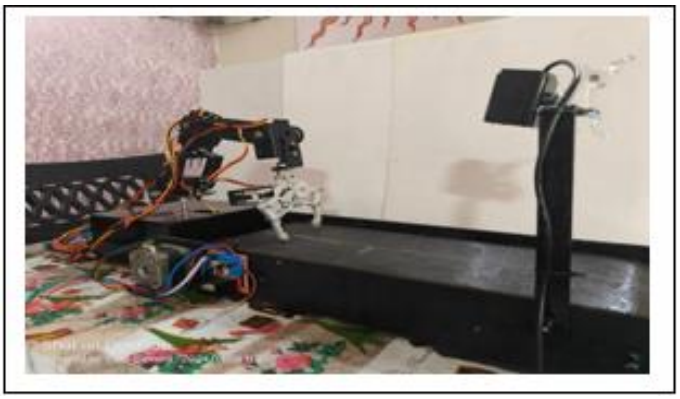

Figure 4 Actual Model Setup

Workflow Model:

Apple Detection: The Python script continuously analyzes the video feed from the USB camera to detect apples [5].

Ripeness Detection: After detecting an apple, the script calculates the percentage of red and yellow-green pixels in the apple's region of interest (ROI) to determine its ripeness. Figure 5 shows Workflow Model.

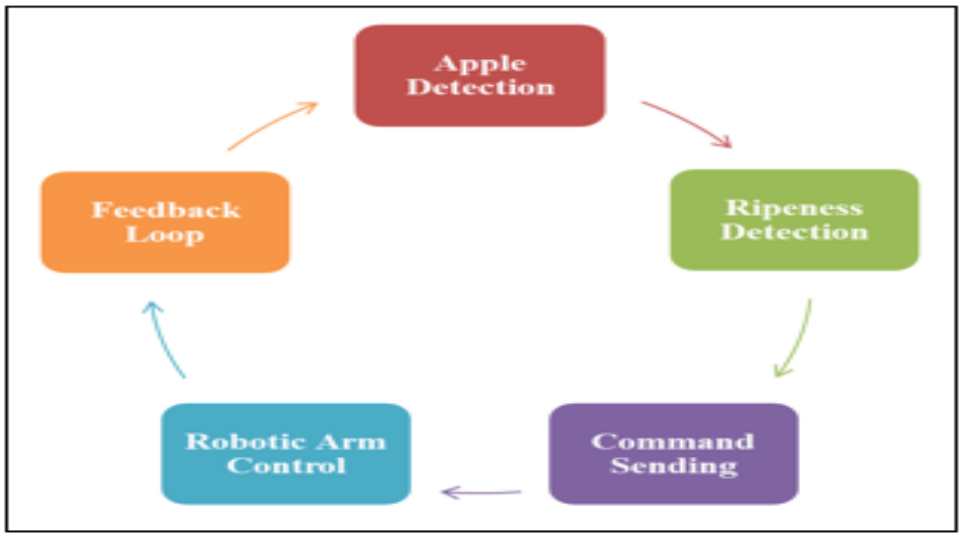

Figure 5 Workflow Model

Command Sending: If a ripe or unripe apple is detected, the Python script sends a corresponding command (1 for ripe, 2 for unripe) to the Arduino Nano via serial communication.

Robotic Arm Control: Upon receiving the command, the Arduino Nano controls the robotic arm to pick up the apple from the conveyor belt and place it in the appropriate bin.

Feedback Loop: The Arduino Nano sends feedback (e.g., "Finished") to the Python script after completing the sorting task for each apple. This feedback ensures synchronization between the computer and the hardware components. Figure 6 &7 shows the Detected fruits.

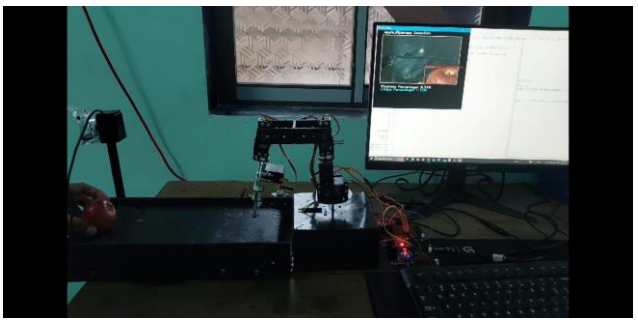

Figure 6 Detection of Fruit

The working of our project is:

1. First, we keep the apple in the initial position of the conveyor belt where the camera detects the apple.
2. The camera mounted on the start of the conveyor belt then detects the apple.

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3. Using the Windows algorithm the apple texture is detected.
4. The conveyor belt then starts to rotate i.e. it takes the calculated steps towards the arm.
5. Once it reaches below the arm gripper the arm starts picking up the apple.
6. As per detected the arm places it in the desired container.

Figure 7 Apple Detected

3. Implementation

Algorithm/ Working of the system:

- Initialize the Raspberry Pi and all connected components.
- Set up and configure the PCA9685 Servo Driver.
  3. Initialize and calibrate the servo motors.
- Initialize the Raspberry Pi Camera for image capture.
- Configure and set up the conveyor belt motor.

Main Loop:

- Continuously monitor the conveyor belt for the presence of an apple.
- Capture an image of the apple when detected.
- Process the captured image for ripeness detection.

Image Processing:

- Use image processing techniques to determine if the apple is ripe.
- Define the sorting action based on ripeness.
  1. If ripe, proceed to pick and sort into the ripe box.
  2. If unripe, sort it into the unripe box.

Robotic Arm Control:

Control the robotic arm's servo motors for picking and sorting.

1. Adjust the arm to pick up the apple.
2. Place it in the appropriate sorting bin based on ripeness.

Conveyor Belt Control:

- Control the conveyor belt motor to continue the process.
- Repeat the loop for the next apple on the conveyor.

Output Images:

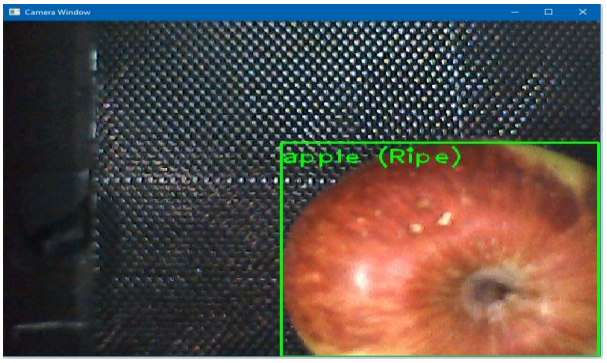

Figure 8 Ripe Apple

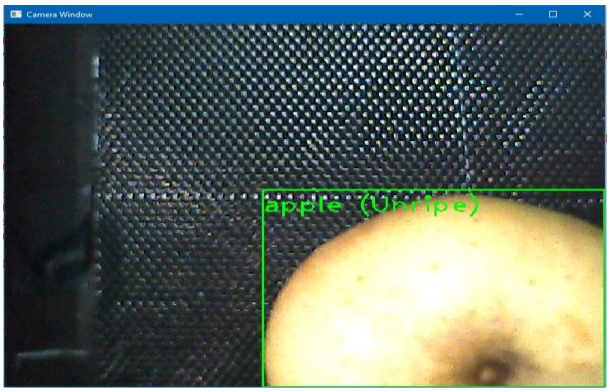

Figure 9 Unripe Apple

4. Results

Efficiency: Testing was performed with the help of 10 specimen apples. Out of the total apples 6 were picked and 4 were rejected by the griper. When the 10 apples were placed on the conveyor belt, the detection was done by the camera successfully which is riped or unriped simultaneously. The efficiency is decided of the model based on the acceptance of the gripper. So, we conclude the efficiency of the gripper is 60 percent. This percentage can be further increased to 80 percent by modifying the gripper specifications [6].

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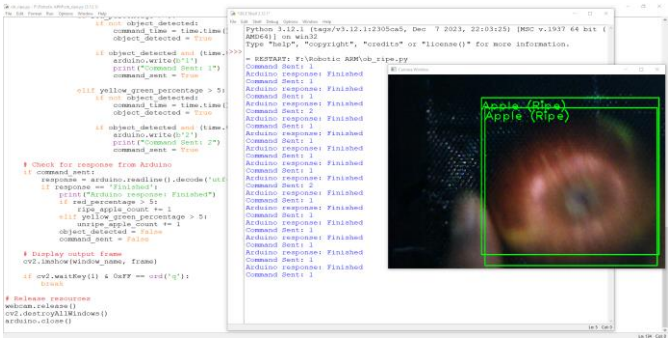

Figure 10 Results

Conclusion

In this work, an automatic segregation system for fruit using color sensors has been successfully developed. The process of segregation is based on the ripeness color of the fruit. This project has been performed by quantitatively separating the ripe and unripe fruits using RGB range value. This process was repeated several times, and the results were almost identical. Based on the RGB data series, the ripe fruit showed a value exceeding, while the unripe fruit showed a value less than all tests. The difference between the two characteristics of the fruit is very significant with a difference of the value which can be categorized as under-ripe. This indicates that the probability of an error to occur in determining the characteristics of the fruit is slim and thus makes this system more reliable and robust. In the future, a set of sensors is proposed to detect a bunch of the other fruits as well. This further can speed up the segregation process and be more suitable for adaptation to the industry. Furthermore, the image processing technology is also great to introduce to the segregation system.

References

[1]. Flexible control of robotic arms for amputees' patients Tejas. C, ECE Department, B.N.M., Tejaswini. V, ECE Department, B.N.M., Shuvankar Dhal, ECE Department, B.N.M., Sirisha.P. S, ECE Department, B.N.M.

[2]. [2] Chakraborty, Sovon, et al. "Follow the planting to know the ripe fruit." 2021 5th International Conference on Trends in Electronics and Informatics (ICOEI). TSE, 2021.

[3]. Enhancing fruit quality assessment through the integration of GLCM (Gray Level Co-occurrence Matrix) and multiclass support vector machines was a focal point of discussion at the 2018 International Conference on Advances in Computers, Communications, and Informatics (ICACCI).

[4]. Miah, Md Sohel, et al. "The best way to identify fresh and rotten fruits using different neural networks." 2021 12th International Conference on Computational Communications and Networking Technology (ICCCNT). TSE, 2021.

[5]. Khekare, Ganesh, et al. "Manufacture of fruit sorting and packaging machines". 2020 International Conference on Computer Performance Evaluation (ComPE). TSI, 2020.

[6]. Karakaya, Diclehan, Oğuzhan Ulucan, and Mehmet Türkan."Comparative analysis of fruit freshness classification". 2019 Intelligent System and Application Innovation Conference (ASYU). IEEE, 2019