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AI BASED FRUIT SORTING ROBOT BASED ON RIPNESS USING RASPBERRY-PI

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Abstract: This project focuses on the development of a fruit sorting system utilizing Raspberry Pi and machine learning techniques. The primary objective is to implement an automated system capable of detecting and sorting tomatoes based on their ripeness. The system utilizes a Raspberry Pi for object detection using the Haar Cascade algorithm and analyzes the color of the detected tomatoes to determine their ripeness. The determined data is then transmitted to an Arduino, which controls a servo motor to sort the tomatoes accordingly. This abstract provides an overview of the project's methodology, key components, and anticipated outcomes.

Keywords: Raspberry pi, Haar cascade algorithm, Arduino uno

I. INTRODUCION

In the agriculture and food processing industries, the need for efficient fruit sorting is paramount to ensure the quality and freshness of produce. Traditional sorting methods are labour-intensive, time-consuming, and prone to human error. The system employs a Raspberry Pi as the central control unit, a camera for image acquisition, and motors for the physical sorting process. By analyzing the ripeness of fruits through image processing, the robot effectively separates fully ripe fruits from those that are only partially ripe, optimizing the sorting process and reducing waste. The aim of this project is to develop an automated fruit sorting system specifically tailored for tomatoes. By utilizing computer vision techniques and machine learning algorithms, we aim to create a system capable of accurately detecting and sorting tomatoes based on their ripeness.

The proposed system consists of two main components: a Raspberry Pi and an Arduino. The Raspberry Pi serves as the primary processing unit, responsible for tomato detection and color analysis. The Haar Cascade algorithm is employed for tomato detection, allowing the system to identify tomatoes within the captured video feed. Once a tomato is detected, its color is analyzed to determine its ripeness. This analysis involves segmenting the tomato's color space and classifying it as ripe or unripe based on predefined criteria. Upon determining the ripeness of the tomato, the Raspberry Pi communicates this information to an Arduino microcontroller. The Arduino is connected to a servo motor, which is responsible for physically sorting the tomatoes. Depending on the ripeness classification provided by the Raspberry Pi, the servo motor will either push the tomato to the right (if it is ripe) or to the left (if it is unripe).

The integration of Raspberry Pi and Arduino allows for a seamless interaction between the software and hardware components of the system. This collaborative effort enables real-time data processing and precise control of the sorting mechanism, ensuring efficient and accurate sorting of tomatoes.

II. LITERATURE REVIEW

- Muhammad HanifTunio; Li Jianping, Muhammad Hassaan Farooq Butt, Imran Memon; YumnaMagsi(2022), **"Fruit Detection and Segmentation Using Customized Deep Learning Techniques".**

In this model, They have used the U-Net architecture to cope and investigate this challenge. U-Net is based on semantic segmentation used for object detection and localization. U-Net's contraction path encodes and extract the features from the source object (mango pictures), while the expansion path decodes the image by recovering the resolution for better localization.

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- AngJin Xiang; Aqilah BaseriHuddin; Mohd Faisal Ibrahim; FazidaHanimHashim (2021),"**An Oil Palm Loose Fruits Image Detection System using Faster R CNN and Jetson TX2 2021 International Conference on Electrical Engineering and Informatics (ICEEI).** This work proposes a system for oil palm loose fruits detection using Faster R-CNN, a deep learnin algorithm and NVIDIA Jetson TX2 hardware. In their study, 500 images of loose fruits were collected from an oil palm farm at Bukit Bangkong, Selangor during the harvesting process. The data were pre-processed using few techniques such as image resizing, cropping, data augmentation and data labelling. Faster R-CNN, a deep learning algorithm is used to train the model of the detection system by using 400 images from the acquired sample. The trained model was validated and tested with the remaining 100 images from the sample.

MdKhurramMonirRabby; Brinta Chowdhury: Jung H. Kim(2018). "**A Modified Canny Edge Detection Algorithm for Fruit Detection & Classification**" 2018 10th International Conference on Electrical and Computer Engineering (ICECE). In this study, an image processing method has been done using Canny Edge Detection (CED) algorithm to identify and sort the fruits. In addition to that modified Canny Edge Detection (MCED) algorithm is proposed to develop a fruit recognition method using color and shape of the fruits.

- Ruchita R. Mhaski; P.B. Chopade; M.P. Dale(2015), **"Determination of ripeness and grading of tomato using image analysis on Raspberry Pi**", 2015 Communication, Control and Intelligent Systems (CCIS). In this paper, we are inspecting the quality of tomato based on shape, size and degree of ripeness. An edge detection algorithm is used to estimate the shape and size of tomato and color detecting algorithm is used for the ripeness determination. All these algorithms are implemented on Raspberry Pi development board which will become independent and cost effective system.

III. BLOCK DIAGRAM

Block diagram of the project is shown in Fig.1. It consists of the following parts.

- Raspberry Pi: A Raspberry Pi board with sufficient processing power and memory to run the object detection and color analysis algorithms.
- Camera Module: A compatible camera module for Raspberry Pi to capture the video feed for tomato detection
- Arduino Microcontroller: An Arduino board to control the servo motor and facilitate communication between the Raspberry Pi and servo motor.
- Servo Motor: A servo motor capable of precise control for sorting tomatoes based on ripeness classification.
- Power Supply: Adequate power supply units for Raspberry Pi, Arduino, and servo motor to ensure continuous operation.
- Connectivity: Cables and connectors for connecting Raspberry Pi, Arduino, camera module, and servo motor.
- Step Down Inverter: The inverter reduces the total voltage from 8.2V to 5V, combining two 4.2V inputs.
- Sorting Plate: It segregate the tomatoes based on Ripeness.

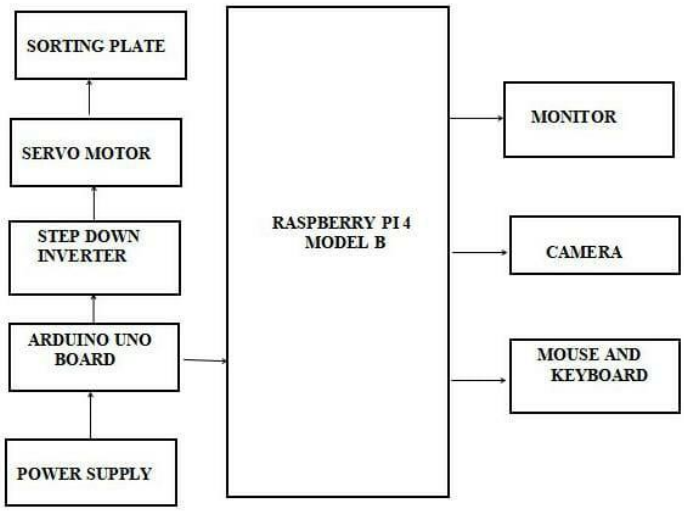

Figure 1: Proposed Block diagram

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IV. WORKING METHODOLOGY

1. Research and Planning:
Conduct a literature review to study existing fruit sorting systems, machine learning algorithms, and hardware components. Define the objectives, requirements, and constraints of the project.
Plan the hardware setup, including Raspberry Pi, camera module, Arduino, and servo motor.

2. Raspberry Pi Setup:
Install the required software libraries, including Open CV for Python, on the Raspberry Pi.
Configure the Raspberry Pi to communicate with the Arduino via serial communication.

3. Haar Cascade Tomato Detection:
Train a Haar Cascade classifier for tomato detection using labeled training data. Implement the trained classifier to detect tomatoes in the captured video feed. Fine-tune the detection parameters to optimize performance and accuracy.

4. Color Analysis for Ripeness Determination:
Extract the color information of the detected tomatoes using image processing techniques.
Implement algorithms for color segmentation and classification to determine the ripeness levels.
Define thresholds or criteria for categorizing tomatoes as ripe or unripe based on their color properties.

5. Arduino and Servo Motor Integration:
Program the Arduino micro controller to receive data from the Raspberry Pi via serial communication. Implement servo motor control logic to sort tomatoes based on the ripeness classification. Calibrate the servo motor mechanism for precise and accurate sorting movements.

V. COMPONENTS REQUIRED

5.1 ARDUINO UNO

Figure 2: Arduino UNO

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the micro controller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

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5.2 SERVO MOTOR

Figure 3: Servo Motor

It equips Carbon Fiber Gears which makes the servo motor much lighter than same metal gear motor. For small load applications using the metal gear servo motor adds on unnecessary weight, so we suggest using this lightweight plastic gear servo motors. The Tower Pro SG92R Mini Servo is 180° rotation servo. It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces. The good optimized performance and reliability of our servos have made them the favorite choice of many RC hobbyists.

5.3 BATTERY

Figure 4: Battery

This LG INR18650 M26 2600mAh Lithium-Ion Battery gives value for your money. It comes with a rated voltage of 3.7 volts and a capacity of 2600mAh. It is a single cell, compact, and powerful battery cell with 2600 mAh capacity. It is very convenient to install in your project to fulfill the 3.7 Volt requirement with high capacity. The battery terminals can use in any compatible battery adapter/holder or it can be permanently

5.4 RASPI CAM

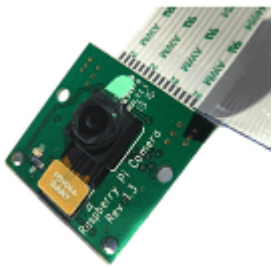

Figure 6: RASPI CAM

The 8MP Raspberry Pi Official Camera Module v2 can be used to take high-definition video, as well as stills photographs. It uses high quality 8 megapixel Sony IMX219 image sensor custom designed add-on board for Raspberry Pi, featuring a fixed focus lens. It is capable of 3280 x 246 pixel static images, and also supports 1080p30, 720p60 and 640x480p60/90 video.

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Raspberry Pi Camera V2 attaches to Pi by way of one of the small sockets on the board upper surface and uses the dedicated CSI interface, designed especially for interfacing to cameras. It is suitable for mobile or other applications where size and weight are important.

5.5 STEP DOWN INVERTER

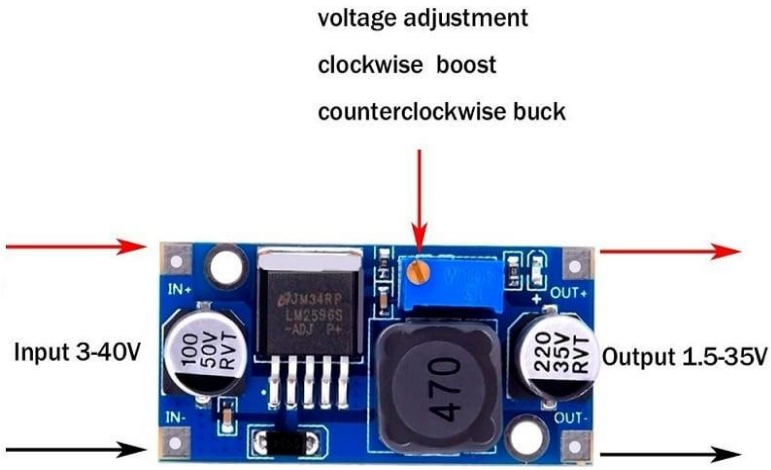

Figure 7: Step Down Inverter

DC-DC Buck converter step down module LM2596 Power supply is a stepdown(buck) Switching regulator, capable of driving a 3-A load with excellent line and load regultion. These devices are available in fixed output voltages of 3.3 V, 5 V,

12 V and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

5.6 RASPBERRY PI BOARD

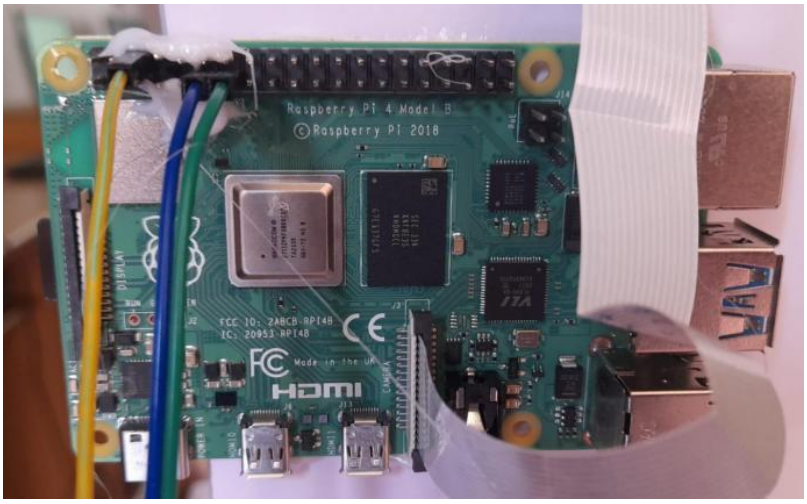

Figure 8: RASPBERRY PI BOARD

The Raspberry Pi 4 Model B builds upon the success of previous Raspberry Pi models, offering enhanced processing power, memory capacity, and peripheral connectivity in a compact and affordable package. It is designed to support a variety of applications, including education, prototyping, DIY projects, home automation, and embedded systems development. The Raspberry Pi 4 Model B is available in multiple configurations with varying amounts of RAM, including 1GB, 2GB, and 4GB options.

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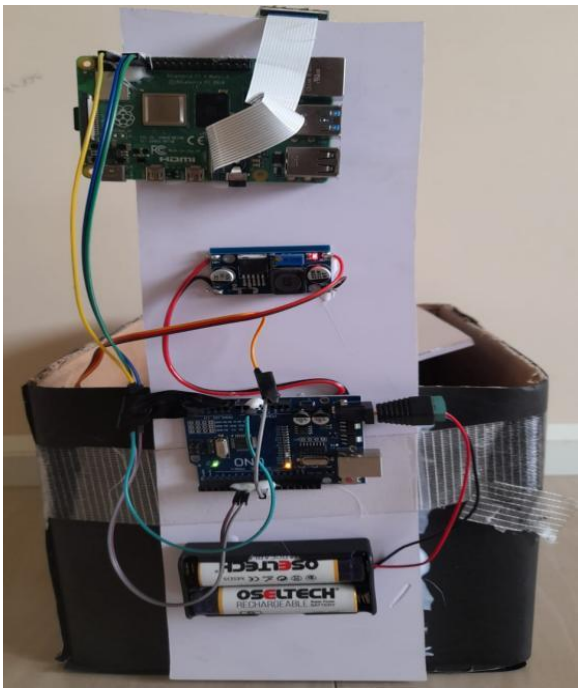
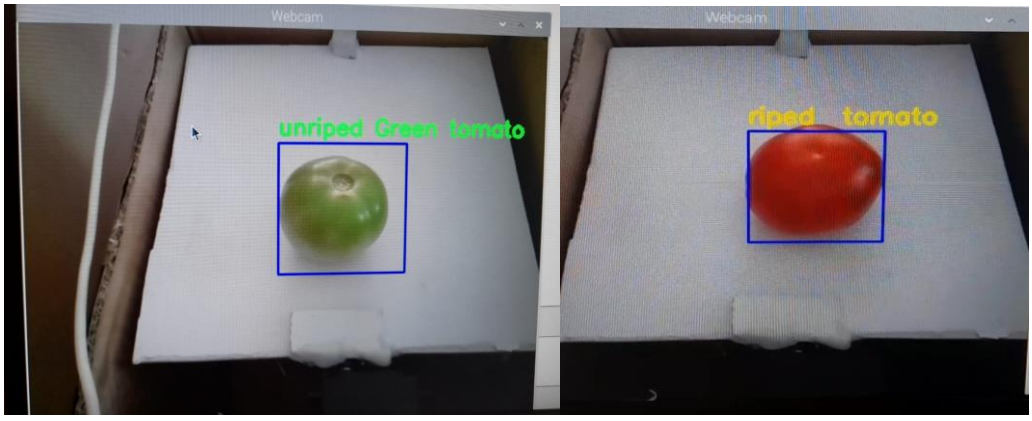
VI. RESULT



An AI Based Fruit Sorting Robot using Raspberry-Pi offers an innovative solution for automating the sorting of tomato based on ripeness. Equipped with a camera, the raspberry pi views the tomatoes which are analyzed using machine learning algorithms to determine the ripeness levels. This analysis relies on color and texture features, distinguishing between unripe ,ripe tomatoes with high accuracy. Once the ripeness is assessed, a servo motor is actuated to physically sort the tomatoes into their respective categories. This system not only enhances efficiency and consistency in sorting but also reduces the labor required for manual sorting, making it highly beneficial for agricultural applications and improving the supply chain process from farm to market.



Segregation of tomatoes based on ripeness.

VII. CONCLUSION AND REFERENCES

The Raspberry Pi 4 Model B with 1GB of RAM is a versatile and powerful single-board computer that offers enhanced processing power, memory capacity, connectivity, and multimedia capabilities compared to its predecessors. It serves as an ideal platform for a wide range of projects and applications, including education, prototyping, DIY projects, media center and entertainment, desktop computing, IoT, and home automation. With its compact size, low cost, and extensive community support, the Raspberry Pi 4 Model B continues to empower users worldwide to explore, experiment, and innovate in the field of technology.

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