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GRADING OF CASHEW NUTS ON THE BASIS OF TEXTURE COLOUR AND SIZE

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Abstract : *The cashew nut industry faces significant challenges in quality control due to reliance on manual segregation processes. Manual methods are labor-intensive, prone to errors, and time-consuming. This report presents a Raspberry Pi-based smart conveyor system for automated cashew nut segregation. The system integrates a camera to capture images of cashew nuts, a Raspberry Pi for processing, and a servo-controlled robotic segregator for sorting nuts into good, bad, or broken categories. The YOLOv5 algorithm is employed for real-time object detection and classification, ensuring high accuracy and efficiency. With its compact design, the system is cost-effective and scalable, making it suitable for small to medium-scale industries.*

1. INTRODUCTION

Cashew nut processing is a critical industry in many regions, especially in agricultural economies. Quality segregation of cashew nuts is a vital step in ensuring that the final product meets market standards. Traditional methods rely on manual sorting, which is not only time-consuming but also susceptible to human error. Automation offers a promising solution to improve efficiency, reduce labour costs, and enhance product consistency. This report details the design and implementation of a smart conveyor-based cashew nut segregation system. The integration of Raspberry Pi and YOLOv5 enables real-time image processing and precise classification of nuts, while servo motors ensure accurate physical segregation.

Numerous studies have explored automation in agricultural processing. Vision-based systems have been implemented for fruit sorting, grain quality analysis, and defect detection in food products. Convolutional neural networks (CNNs) have demonstrated exceptional performance in object detection and classification tasks, paving the way for automated solutions. YOLO (You Only Look Once) models, particularly YOLOv5, have gained prominence due to their speed and accuracy in real-time applications. In conveyor systems, Raspberry Pi has been employed for low-cost automation in small industries. However, there is limited research on applying these technologies to cashew nut segregation, highlighting the novelty of this project.

Cashew nuts (Anacardium occidentale) are one of the most popular and widely consumed nuts globally, known for their rich nutritional content and diverse applications in the food industry. The grading of cashew nuts plays a crucial role in ensuring high-quality products for consumers while also impacting pricing and marketability. Traditionally, grading has been a manual process, relying on human inspection to assess the size, texture, and color of the nuts. However, manual grading is time- consuming, subjective, and prone to inconsistencies. Therefore, automating the grading process has become essential to improve efficiency, accuracy, and consistency in the cashew nut industry.

The grading of cashew nuts is based on several key factors, such as texture and color. Texture refers to the surface characteristics of the nut, such as smoothness, firmness, and presence of cracks or imperfections. Texture is often an indicator of freshness and quality, with smoother and more uniform textures being preferred. Color is another important criterion, as cashew nuts with consistent, light golden or cream-colored surfaces are considered higher in quality, while discoloration or dark spots might suggest aging or poor processing.

2. EXISTING SYSTEM

The existing system for grading cashew nuts based on texture, color, and size is predominantly manual and relies on human expertise. Workers visually inspect and sort the nuts into categories, which can be time-consuming, labor-intensive, and prone to human error. This traditional approach lacks consistency and efficiency, leading to variations in quality. Some semi-automated systems use basic mechanical sieves or color detectors, but they fail to address complex grading criteria like texture accurately. Additionally, these systems often lack advanced technology for precise sorting and quality control, limiting their ability to meet industry standards and consumer expectations efficiently.

3. PROPOSED SYSTEM

The proposed system for grading cashew nuts integrates advanced technologies like computer vision, artificial and automation for precise, efficient sorting. High-resolution cameras and sensors capture detailed images of cashew nuts, analyzing their texture, color, and size. Machine learning models classify the nuts based on predefined quality standards, ensuring consistency and accuracy. Automated conveyor belts streamline the process, reducing manual labor and increasing productivity. The system also includes real-time monitoring and data logging for quality assurance. This approach minimizes human error, enhances grading efficiency, and meets industry demands for high-quality, standardized cashew nuts.

4. BLOCK DIAGRAM

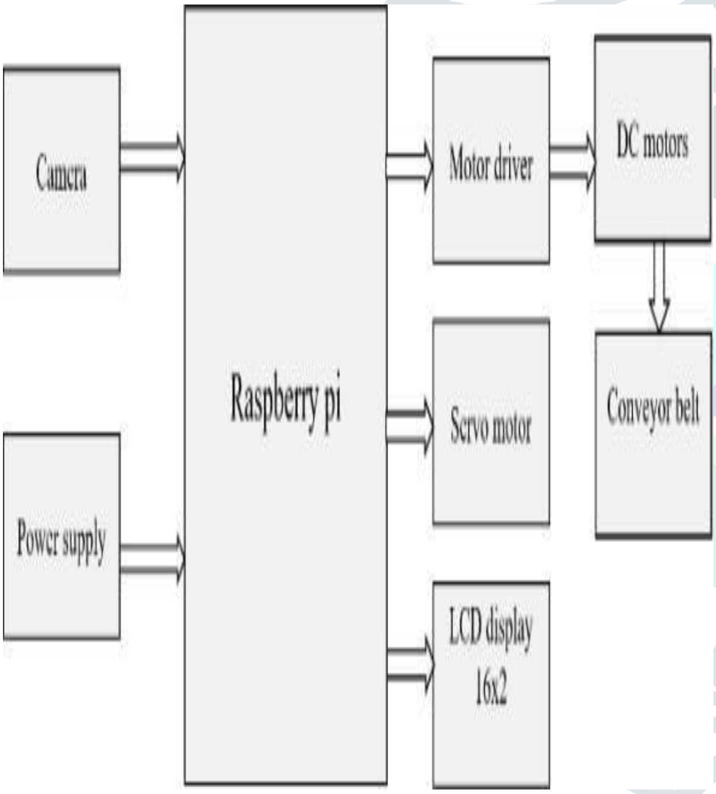

Fig. 4.1 Block Diagram

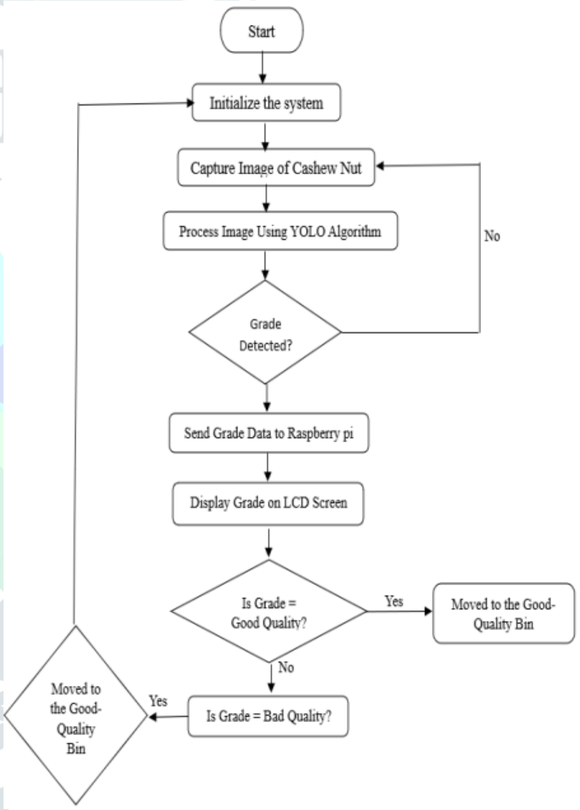

Fig. 4.2 Flow Chart

The cashew nut segregation system uses a Raspberry Pi as the central control unit. The process involves capturing images of cashew nuts using a camera, processing these images using the YOLO V5 algorithm to classify nuts, and segregating them into categories: good, bad, or broken. The workflow is as follows:

- Image Capture: A camera connected to the Raspberry Pi captures high-resolution images of cashew nuts on the conveyor belt.
- Image Processing: The captured images are processed in real-time using the YOLO V5 algorithm, which identifies and classifies the nuts into predefined categories based on quality and appearance.
- Conveyor Mechanism: A DC motor moves the conveyor belt, ensuring nuts are presented to the camera for classification.
- Segregation: Based on the classification results, the Raspberry Pi triggers a servo motor to direct the nuts to specific bins for good, bad, or broken categories.

- Servo Motor: Controlled by the Raspberry Pi to perform precise movements. Often used for positioning or handling objects on the conveyor belt.
- LCD Display (16x2): Displays information such as system status, object details, or process updates. Controlled by the Raspberry Pi to communicate with the user.
- Feedback Loop: The system continuously updates its classification parameters to enhance accuracy over time
- Hardware Integration connects components like the camera, motors, servo, LCD, and Raspberry Pi to work as a unified system. It ensures proper communication, power supply, and signal flow between devices for seamless operation. Data Processing.
- The camera captures images or videos and sends the data to the Raspberry Pi for analysis.
- The Raspberry Pi processes the image data using algorithms, such as Object detection/recognition using libraries like Open CV Classification or decision-making to determine the next action Based on the analysed data, the Raspberry Pi makes decisions, such as Activating the motor driver to move the conveyor belt. Controlling the servo motor for precise positioning.

5. METHODOLOGY

The methodology for grading cashew nuts based on texture, color, and size involves multiple steps. First, cashew nuts are collected and pre-processed to remove impurities. For size grading, mechanical sieves or digital imaging systems are used to categorize nuts by their dimensions. Texture analysis involves the use of optical sensors or machine learning algorithms to detect surface smoothness or defects. Color grading employs advanced image processing techniques or color sensors to classify nuts based on predefined color standards. Automation, such as computer vision and AI-based models, ensures precise, consistent, and efficient grading while minimizing human intervention and errors.

6. IMPLEMENTATION

Yolo V 5 Training: There is an existing implementation using YOLOV5 in github however the model is incomplete and also doesn't support additional architectures due to which is not published. We used this as reference and built a YOLOv5 social distancing model which is capable of working on multiple architectures used in the YOLOv5 model as well on our custom architecture (modified backbone CSP). By doing this, we have successfully implemented the first working social distancing model based on YOLOv5 and other supporting architectures based on YOLOv5.

Fig 6.1: Train and Label image

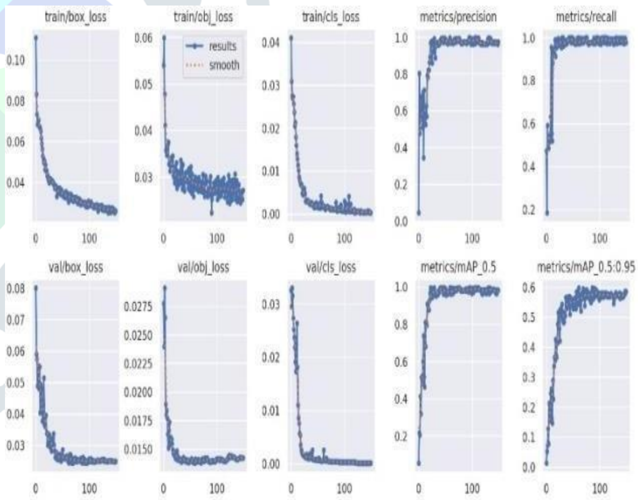

Fig 6.2: Training Metrics

Implementation of Social Distancing on YOLOv5 Models Our key objective is to implement a working YOLOv5 based social distancing model using YOLOv5s, YOLOv5s6, and YOLOv5s6 modified bottleneck CSP architecture. There is no existing social distancing working model based on the above YOLOv5 architectures. From the screenshots below the model's sample output can be seen which clearly indicates the risk category based on centroid distance calculations. Parameters for High, Medium, and Low risk: High Risk: Distance between people less than 200 units. Medium Risk: Distance between people between 200 - 250 units. 11 Low Risk: Distance between people more than 250 units.

7. RESULT

1) **Conveyor Belt**:

- A conveyor belt system is used to transport cashew nuts. The nuts move along the belt to pass through different analysis stages.

2) **Illumination and Camera**:

- A light source (visible in the setup) ensures uniform illumination, allowing a camera or sensor to capture clear images of the cashew nuts.
- The captured images are analyzed using computer vision techniques to assess the color, texture, and size.

3) **Sensors/Controllers**:

- Sensors or electronic boards (possibly microcontrollers like Arduino/Raspberry Pi) are visible. These components likely control the movement of the belt and the processing of data.

4) **Sorting Mechanism**:

- Once analyzed, the system could have a sorting mechanism to separate the cashew nuts into different categories based on their quality parameters (e.g., high-quality nuts, medium-quality nuts, or rejects).

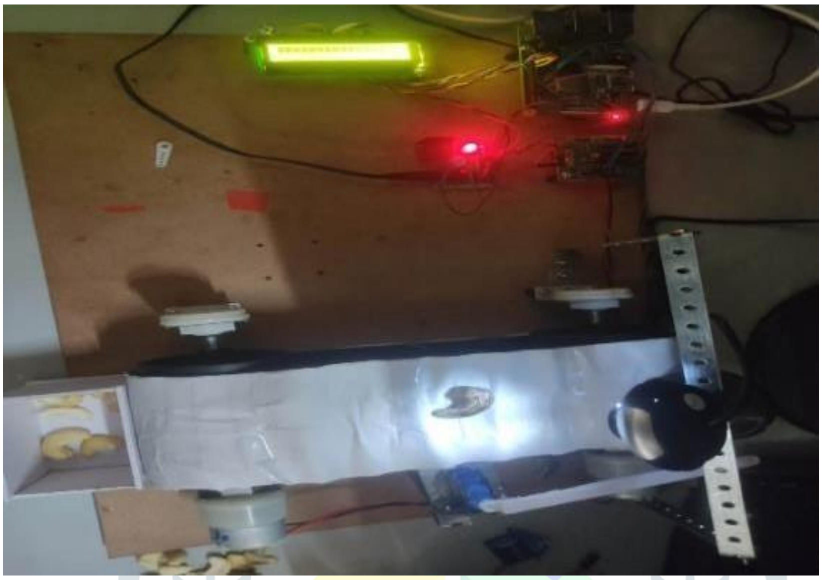

Fig 7.1: Gradig of Chsew Neat

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