Vision-Based Size Evaluation and Box Selection System

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***Abstract*—In many small-scale and medium-scale packaging industries, the process of selecting an appropriate box for a product is still performed manually. Workers typically measure the product dimensions using simple tools and then choose a suitable packaging box based on estimation or experience. This traditional approach often leads to inaccurate measurements, improper box selection, material wastage, and increased processing time. Oversized boxes result in unnecessary use of cardboard and packaging fillers, while undersized boxes may damage the product or require repackaging. These issues reduce operational efficiency and increase overall packaging costs. To address these challenges, this project proposes a vision-based size evaluation and box selection system that automates the measurement and decision-making process. The main objective of the system is to accurately determine the dimensions of an object and automatically recommend the most appropriate box size for packaging. The proposed solution uses a Raspberry Pi- controlled edge detection system, where a camera captures the image of the object placed on a platform. Image processing techniques, particularly edge detection algorithms, are applied to identify the boundaries of the object and calculate its dimensions such as length, width, and height. Based on these calculated dimensions, the system evaluates the required packaging size and classifies it into predefined box categories such as small, medium, or large. The results are then displayed through a web- based interface for easy monitoring and verification. By automating the size evaluation and box selection process, the system significantly reduces manual effort, minimizes packaging material wastage, and decreases the time required for packaging operations. Additionally, it improves accuracy and consistency in box selection, thereby enhancing overall efficiency in the packaging workflow. The implementation of such an automated vision-based system can support industries in optimizing packaging resources, reducing operational costs, and improving productivity. Therefore, this project provides a practical and scalable solution that can greatly benefit the modern packaging industry.**

***Index Terms*—Raspberry Pi, Edge Detection, Computer Vision, Size Evaluation, Box Selection System, Packaging Automation, Image Processing, Industrial Packaging Efficiency.**

I. INTRODUCTION

The packaging process plays a crucial role in protecting products, ensuring safe transportation, and maintaining product quality during storage and delivery. In many small-scale and medium- scale industries, packaging operations are still carried out using manual methods. Workers typically measure the dimensions of products using simple tools and then select a suitable box based on experience or visual estimation. This approach is not only time-consuming but also prone to human errors, which can result in inaccurate measurements and improper box selection. As a consequence, industries often face problems such as excessive use of packaging materials, increased operational costs, and reduced overall efficiency in the packaging process. Vision-based systems have the capability to analyse images, detect object boundaries, and extract important dimensional information in real time. This project proposes a vision-based size evaluation and box selection system that uses edge detection techniques to determine the dimensions of objects and recommend an appropriate box size.

II. RELATED WORKS

As there are no efficient automated systems available for accurate size evaluation and box selection in many small-scale packaging industries, there is a need for smart vision-based techniques to improve the process.

In [1], Yang Liu and Thanh Vinh Vo proposed a fast machine vision system for automated packaging robots. The system uses image processing and pattern recognition techniques to detect and track products in real time. A grayscale image-based pattern matching method is used to improve processing speed and reduce computational complexity. Experimental results showed that the system achieved reliable detection with precision.

In [2], S. Comari and M. Carricato presented a vision-based object detection system for industrial automation. The proposed method uses image processing techniques to identify objects and estimate their dimensions from captured images. Experimental results demonstrated that the vision-based approach can reliably detect object dimensions and assist automated systems in efficient sorting and packaging operations.

In [3], L. Zhou, L. Zhang, and N. Konz presented a comprehensive study on the application of computer vision techniques in manufacturing industries. The authors discussed how image processing and vision-based algorithms can be used for object detection in automated production systems. Experimental analysis shows that computer vision systems significantly enhance automation and accuracy in modern manufacturing environments.

In [4], M. Babic, M. A. Farahani, and T. Wuest reviewed image- based inspection techniques used in smart manufacturing and packaging systems. The authors analyzed different computer vision methods for product detection and quality verification. The study explains how cameras and image processing algorithms can automatically identify packaging defects and product dimensions. Machine vision systems were shown to improve reliability and reduce inspection time.

III. BLOCK DIAGRAM

The block diagram represents the working process of a vision- based size evaluation and box selection system used in automated packaging applications. The process begins with image capture, where a camera captures the image of the object to be packaged.

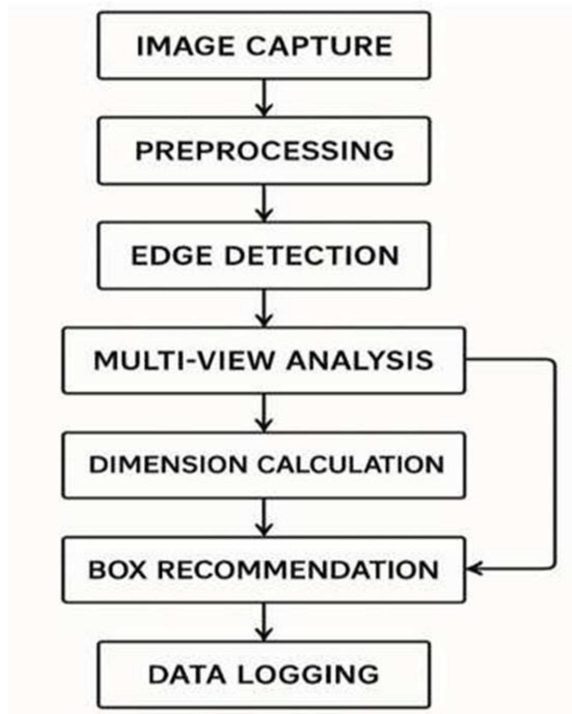

Fig. 1. Block diagram of the Vision-Based Size Evaluation and Box Selection System.

The captured image then undergoes preprocessing, where noise is removed and image quality is enhanced for better analysis. Next, edge detection is performed to identify the boundaries and shape of the object using image processing techniques. After this, multi-view analysis is carried out to analyze the object from different perspectives to improve measurement accuracy. Using these calculated dimensions, the system performs box recommendation to select the most suitable box for packaging. Finally, the system performs data logging, where the obtained information and results are stored for monitoring, tracking, and improving the efficiency of the packaging process.

A. Raspberry Pi 5

Raspberry Pi acts as the main processing unit that controls the entire system. It captures images from the connected camera and processes them using computer vision algorithms implemented in Python with libraries such as OpenCV. The Raspberry Pi performs image preprocessing, edge detection, and object size calculation based on the captured image. After calculating the object dimensions, it analyses the data to determine the most suitable box for packaging. It also manages system communication, controls the workflow of the packaging process, and stores the processed data for logging and analysis. Thus, the Raspberry Pi functions as the central controller that integrates image acquisition, processing, decision-making, and data management in the project.

Fig. 2. Architecture of Raspberry Pi.

B. Raspberry pi Camera (Module v1)

The camera serves as the primary image acquisition component responsible for capturing the visual information of the object to be analyzed. It continuously acquires images of the object placed within the inspection area and transfers them to the Raspberry Pi for further processing. The captured images provide essential data for subsequent stages such as preprocessing, edge detection, feature extraction, and dimension estimation. The accuracy of the overall system largely depends on the quality, resolution, and positioning of the camera, as these factors directly influence object boundary detection and measurement precision. Thus, the camera plays a vital role in enabling non-contact object analysis and supports accurate box selection in the automated packaging process. The camera enables real-time visual monitoring of objects, which improves the speed and responsiveness of the system during packaging operations. It helps in capturing consistent object views under controlled lighting conditions, thereby reducing errors caused by shadows or background noise.

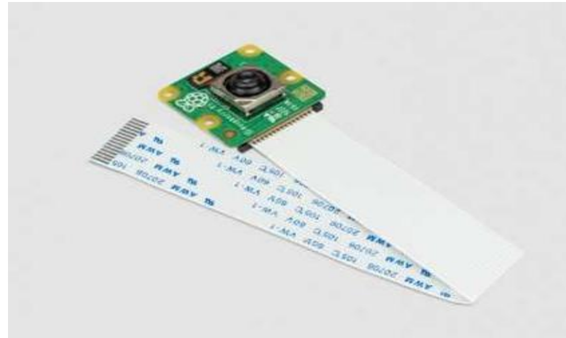

Fig. 3. Raspberry pi Camera (Module v1)

IV. METHODOLOGY

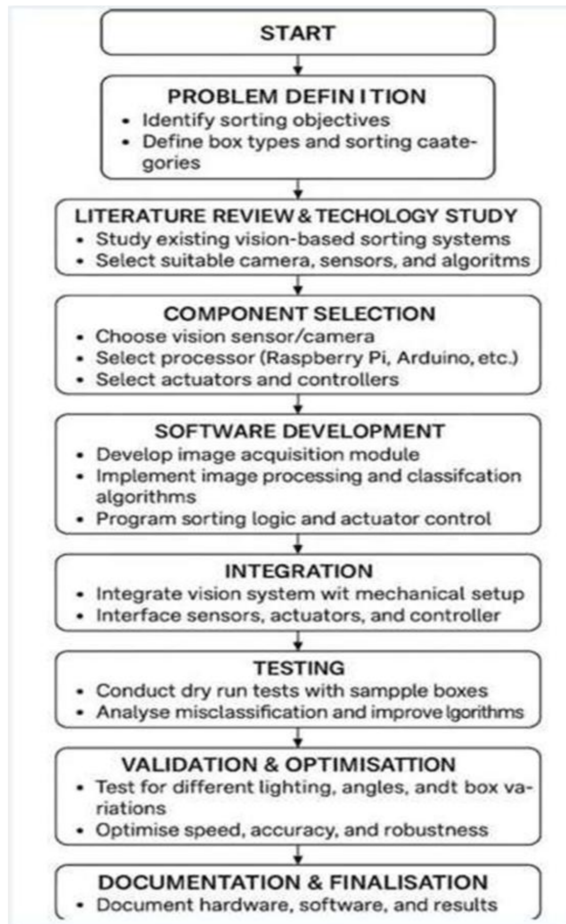

Fig. 4. Methodology to be adopted

V. IMPLEMENTATION OF ALGORITHM

STEP 1: Start

The system is powered ON, and all hardware components such as the Raspberry Pi, camera module, and display or output interface are initialized for operation.

STEP 2: Image Acquisition System Initialization
The camera module is activated and positioned to capture the image of the object placed in the detection area. The Raspberry Pi checks the camera connection and prepares the system for image capture.

STEP 3: Capturing the Object Image
When the object is placed in front of the camera, the system captures its image in real time for further analysis.

STEP 4: Preprocessing the Captured Image
The captured image is processed to improve quality by removing noise, adjusting brightness, and converting it into a suitable format such as grayscale for easier analysis.

STEP 5: Edge Detection of the Object
The system applies edge detection techniques to identify the boundaries and outline of the object clearly.

STEP 6: Object Dimension Analysis
Based on the detected edges, the system calculates the dimensions of the object such as length, width, and height using image processing algorithms.

STEP 7: Box Size Evaluation and Selection
The measured object dimensions are compared with the available box dimensions stored in the system. The most suitable box is selected based on the best fit for packaging.

STEP 8: Displaying the Result
The selected box size and object measurement details are displayed on the output screen or user interface for verification.

STEP 9: Data Logging
The measured dimensions and selected box details are stored in the system for record keeping, monitoring, and future analysis.

STEP 10: Stop
After completing the size evaluation and box selection process, the system stops and waits for the next object to be placed for analysis.

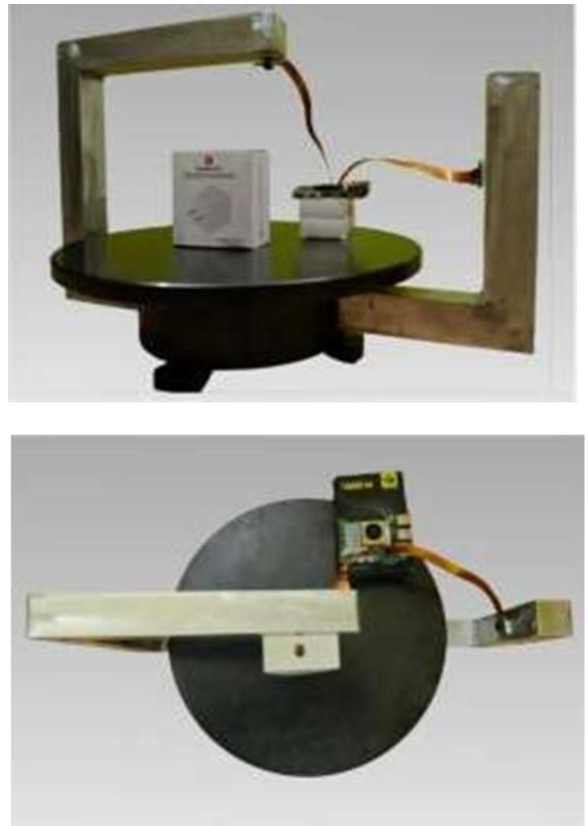

Fig. 5. Vision-Based Size Evaluation and Box Selection System

VI. RASPBERRY PI CAMERA INTEGRATION

The integration of the Raspberry Pi and camera module plays a crucial role in the proposed Vision-Based Size Evaluation and Box Selection System. The camera is interfaced with the Raspberry Pi to capture real-time images of the object placed in the inspection area. Once the image is acquired, the Raspberry Pi processes it using image processing algorithms to perform preprocessing, edge detection, and dimension analysis. This integration enables the system to convert visual input into useful measurement data for box selection. The Raspberry Pi acts as the central processing unit, while the camera serves as the image acquisition device, together forming the core of the vision-based automation system. Hence, the successful integration of these two components ensures accurate object detection, efficient size evaluation, and reliable packaging decisions.

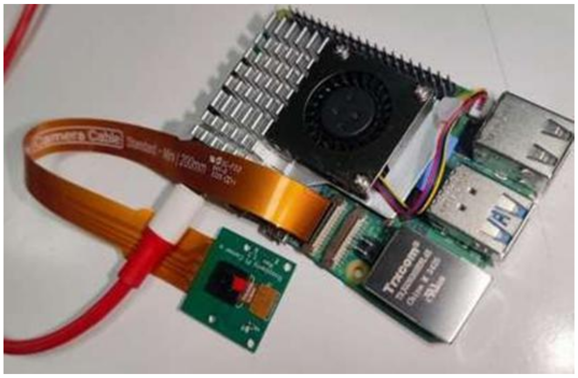

Fig. 6. Camera interface

A. Raspberry PI Edge detection process

Raspberry Pi uses the image captured by the camera to find the boundaries of the object. First, the Raspberry Pi receives the image and converts it into a suitable form, usually grayscale, to simplify processing. After that, an edge detection algorithm like Canny edge detection is applied to identify sudden changes in pixel intensity, which represent the outer edges of the object. These detected edges help the system clearly separate the object from the background. Based on these boundaries, the Raspberry Pi can calculate the object's dimensions and use them for selecting the most suitable box. Thus, edge detection is an important image processing step that allows the Raspberry Pi to recognize the shape and size of the object accurately.

The edge detection process in Raspberry Pi is an important stage in the proposed vision-based system, as it helps in identifying the exact outline of the object from the captured image. After receiving the image from the camera module, the Raspberry Pi performs initial preprocessing operations such as grayscale conversion and noise filtering to enhance image quality. It then applies an edge detection technique to highlight the regions where there is a sharp change in intensity, which usually corresponds to the object boundaries. These boundaries are essential for separating the object from the background and obtaining its geometric shape. The detected edges are further used for dimension estimation, allowing the system to measure the object accurately and support proper box selection for packaging applications.

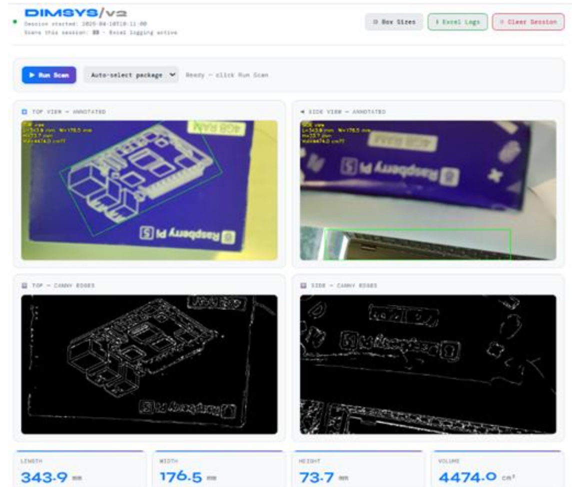

Fig.7. Edge Detection

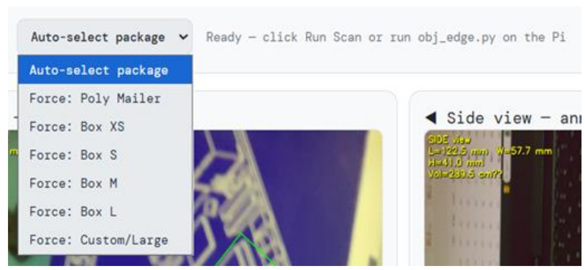

Fig. 8. Box Size Selection

B. Displaying Output in Web Page

The output of the proposed system is displayed through a web-based interface, which provides an interactive and user-friendly platform for monitoring the packaging process. The webpage presents the live video feed from the CSI camera, enabling real-time visualization of the object placed in the inspection area. Along with the live image, the interface also displays the measured dimensions of the object, such as length, width, and height, obtained through image processing on the Raspberry Pi. This integrated display system improves user accessibility, supports real-time decision making, and enhances the overall efficiency of the vision-based size evaluation and box selection process. The proposed system incorporates a webpage-based output display to present the results of the vision-based size evaluation process in a clear and organized manner.

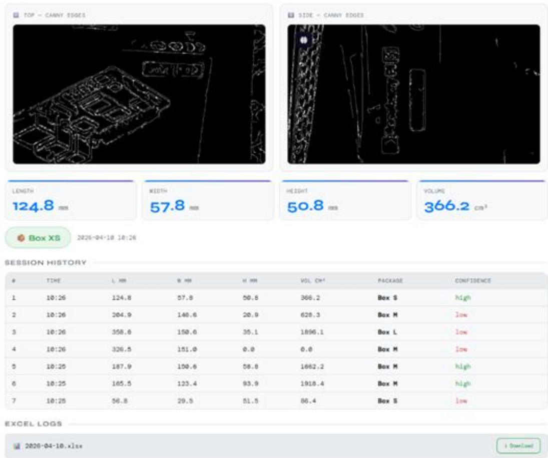

Fig. 9. Web Page for Output Display

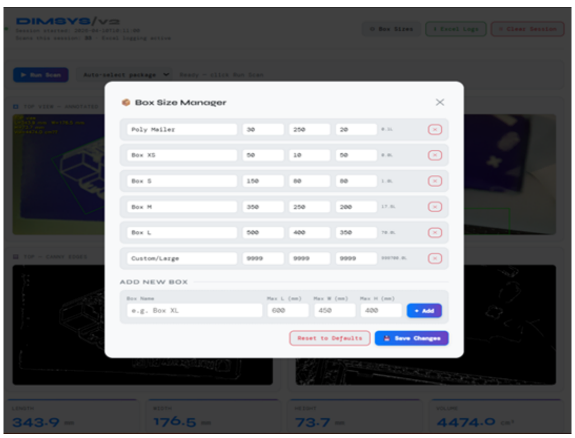

Fig. 10. Box Size Manager

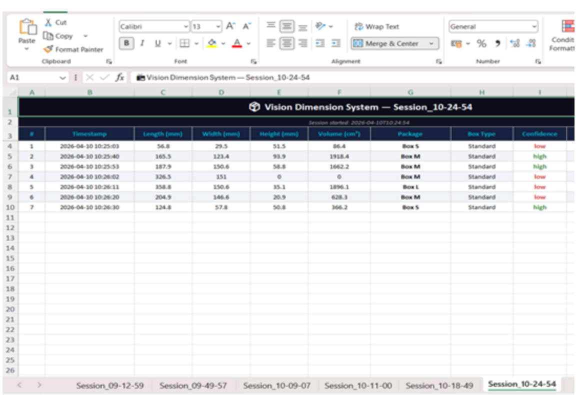

Fig. 11. Excel Logging Module

VII. CONCLUSION

The proposed Vision-Based Size Evaluation and Box Selection System provide an effective and automated solution for identifying object dimensions and selecting an appropriate box for packaging. By integrating a camera module, Raspberry Pi, and image processing techniques, the system is able to capture object images, analyze their boundaries, and estimate their size accurately. The use of preprocessing and edge detection improves the reliability of object measurement and supports non-contact evaluation. Based on the calculated dimensions, the system recommends the most suitable box, thereby reducing manual effort and improving packaging efficiency. Overall, this project demonstrates the practical application of computer vision in automation and offers a cost-effective approach for smart packaging systems.

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