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Automated Apple Harvester using Open-CV Algorithm

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***Abstract*:**

This paper sheds light on the advancements made in the agricultural industry. Digital image processing techniques are now widely used for the ripening estimation of fruits. This work focuses on the study and analysis of the various algorithms and feature extraction techniques that are used for the extracting features from the captured digital images. In countries like India one of the main challenges faced by the farming industry is the lack of labour. The system is proposed to inspect an Apple's ripeness based on colours. The algorithm is implemented using RASPBERRY PI development board. A cost-effective embedded system prototype is proposed for the determination of colour of the fruit. A real time object detection algorithm is implemented to demonstrate the harvesting step, wherein it detects ripe fruits for plucking.

Keywords: *Raspberry Pi, Digital Image Processing, Embedded.*

I. INTRODUCTION

This paper describes how the ripeness of fruit is determined using Raspberry Pi and a true time object detection algorithm. In countries like India one amongst the most challenges faced by the farming industry is that the lack of labor. Automation of the farming process may be a perfect solution to beat this problem. This project will detect the ripeness of fruits using raspberry pi. The recent application and development of image analysis results in quality evaluation of products within the field of agricultural and food. The proposed system starts the method by capturing the fruit image by using Raspberry Pi. Then, the image is transmitted to the processing level where the fruit's characteristics like color, size are extracted by artificial neural networks Color and size are the most significant aspect of agricultural and food products because high-quality products are significant for achievement in today's highly competitive market. In agricultural applications, the standard of a product especially fruits are often classified by their texture, shape, and color. These elements utilize human's vision especially as part of deciding the standard or ripeness of fruits. The method of evaluating is completed manually, repetitive and at risk of human error. In recent years, image processing techniques are discovered progressively helpful within the fruit industry, especially for applications in grading or ripeness of fruits Therefore the prototype is developed using a true time object detection algorithm which demonstrates the harvesting step by detecting ripped fruits for plucking.

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II. LITERATURE SURVEY

An Automatic fruit harvesting system is combination of a low-cost stereo-vision camera and a robotic arm. The stereo-vision camera is employed to detect the color, distance, and position of the fruits, whereas the robotic arm is employed to mechanically cut or pluck the fruits. The harvesting robot is predicated on a prototype. Combining the harvesting robot and moving platform demonstrated the potential for autonomous harvesting within the 2-dimensional area. [1]. Further work proposes "fruit localization and Detection" and fruit harvesting by using a robot manipulator with a hand which can reach the fruit without damaging the fruit and its tree to perform an automatic fruit harvesting by using a robot. Single Shot Multi Box Detector (SSD)is used to detect 2_dimensional (2D) position of the object (fruit). The SSD is one in every of the final object detection methods that use Convolution Neural Network (CNN). The SSD can exactly judge from color and shape. A three-dimensional (3D) position must be obtained to send a command to the robot arm. [2]. Various techniques are described to test the speed of ripeness for various fruits and vegetables. The various techniques used are histogram matching, clustering algorithm supported segmentation, relative value of parameter-based segmentation and image segmentation. The clustering algorithms used for segmentation are k means, fuzzy c means and GK-B. The process uses color image as input and that they have set some threshold values. Then by comparing the computer file images with the threshold values the maturity level of a vegetable or fruit is found [3]. The identification of normal and defective fruits supported quality using OPENCV/PYTHON successfully with adequate accuracy. The utilization of image processing for identifying the standard is often applied not only to any fruit [4]. Image processing method to accurately detect individual in conjunction with machine learning approaches. The proposed method in the study consists of three steps. At the primary step, pixel-based segmentation was conducted to roughly segment the pixels of the photographs into classes composed of fruits, leaves, stems and backgrounds. Blob-based segmentation was then conducted to eliminate misclassifications generated at the primary step. At the third step, X-means clustering was applied to detect individual fruits during a fruit cluster. [7]. Another research discusses different apple harvesting systems to return up with an appropriate system design. There are two ways in automated apple harvesting are one being bulk and the other being apple by apple. Mechanical apple harvester could be a mass harvester system that's designed for a narrow-inclined trellis which needs uniform ripeness row inclined trellis which needs uniform ripeness [8].

III. PROPOSED SYSTEM

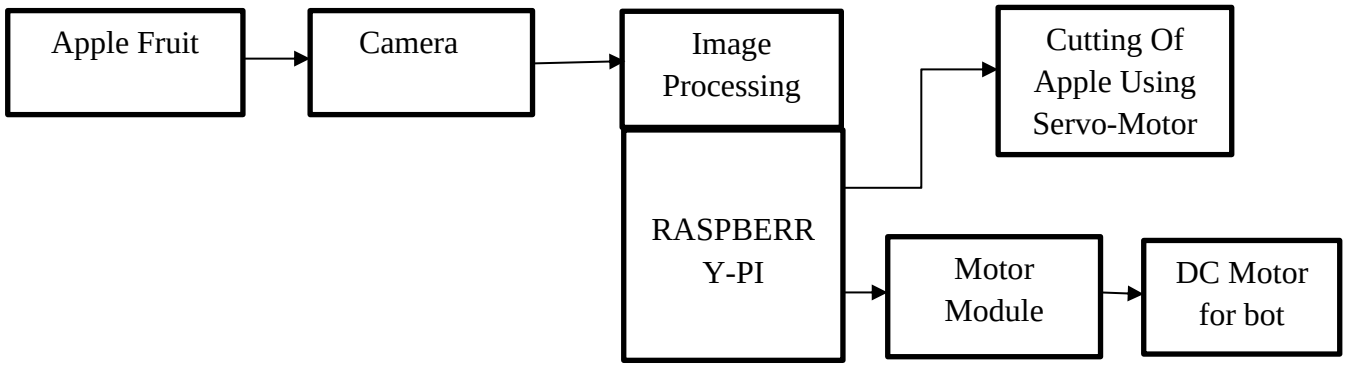

Fig. 1 Block Diagram

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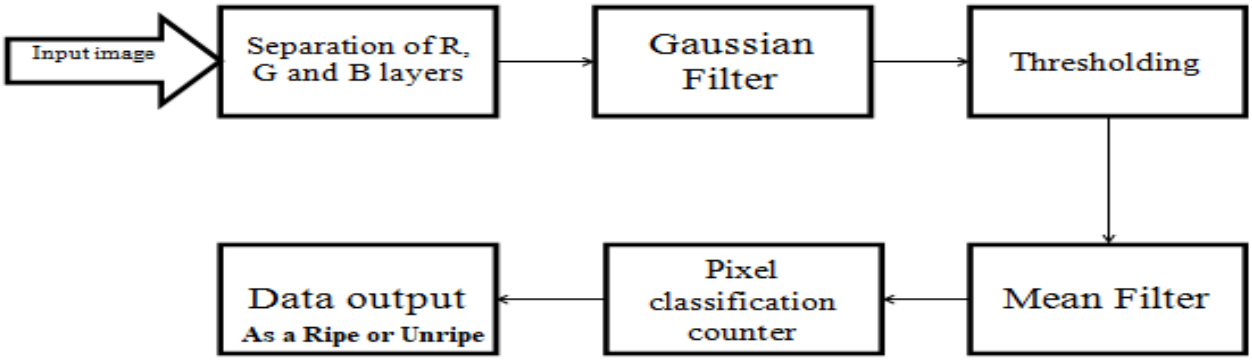

Fig. 2 Proposed System IMAGE processing.

1) Input block: The input citrus image captured will be in color format i.e., it consists of Red Green and Blue (RGB) components. The input image is divided into different types depending upon its color. It provides information of ripeness of fruits that are given as the input. It is basically the collection of numerous citrus fruit images which are mainly used in future for the better grading in order to fetch enhanced revenue in national and international market. It includes ripe or unripe fruit.
2) RGB layer separation block: Each R, G and B layers of images are separated to which the citrus categorization scheme is applied separately.
3) Citrus categorization block: The categorization system, the citrus categorization system itself consists of Gaussian filter, Thresholding, Mean filter and a pixel classification counter.

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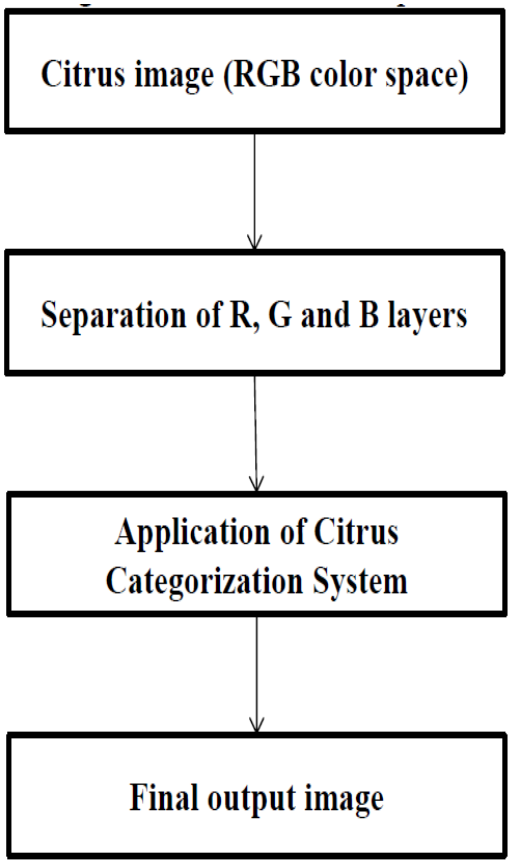

Fig. 3 Methodology

(1) The input image consists of noise; hence it removed using Gaussian filter.
(2) Thresholding- Binarization is that the operation of converting a grey-scale image into a binary image to spot the objects of interest from background. Binarization may be a widely applied pre-processing step for image segmentation. Often, the burden of segmentation has been on the edge operation, in order that a proper threshold image results in better segmentation. Within the proposed project, so as to stay the hardware as simple as possible, a world binarization method with a set threshold is to be performed. (3) Mean filter is used to remove additional noise and blur effect of the image. (4) A pixel classification is performed by counting the quantity of the pixel of the region of interest that belongs to each one in all the classes among four classes (raw, semi-Citrus image (RGB color space) Separation of R, G and B layers Application of Citrus Categorization System Final output image ripe, unripe). Finally the output image is obtained through which it easily classifies the various level of citrus.

1) Initially layer with maximum value between red and green layers of the image is considered and set as S.
2) It is to be right shifted by 1 bit to have an appropriate comparison between blue layer and the maximum of red and green layers.

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Fig.4 Red apple.

This the image inputted by the camera.

Fig.5 Green apple.

This the image inputted by the camera.

3) Two counters are maintained at this point where 1st counter holds the count in which the maximum value is more as compared to blue layer and 2nd counter holds the count in which the blue layer has more value as compared to the other when both are given as input to the comparator.
4) If the maximum value is more as compared to blue layer, then the fruit is in the good/ripe condition else bad/unripe condition.
5)The bot will move continuously in search of apple until the ripen apple is detected.
6) When the Python code for apple detection is executed, then if the apple is captured by the camera and the apple is ripen then the signal is sent to the raspberry-pi and the bot stops moving and the cutter is activated. This will pluck the fruit.
7) A motor driver and a 12V servo motor is used for bot wheels so that the bot can move in search of apple and capture continuous images with the help of a webcam.
8) The output of the code executed is as shown below.

IV. RESULTS

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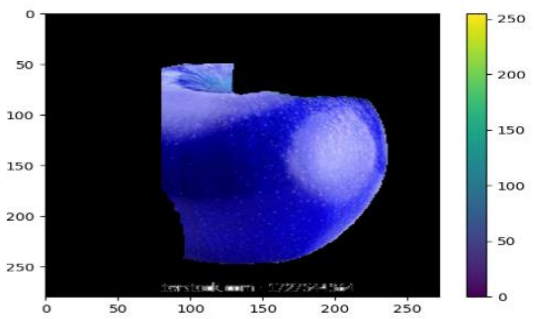


Fig.6 BGR image.

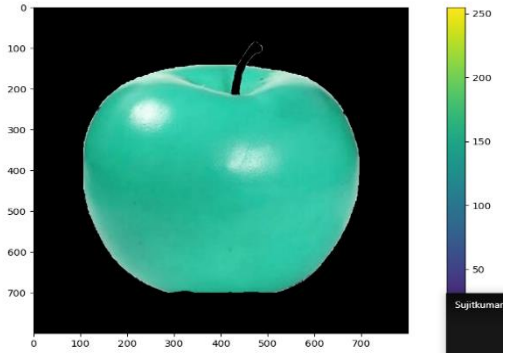


Fig.7 BGR image.

Fig.8 Grayscale image

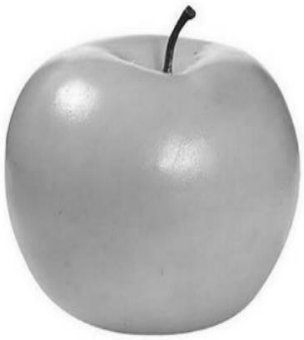
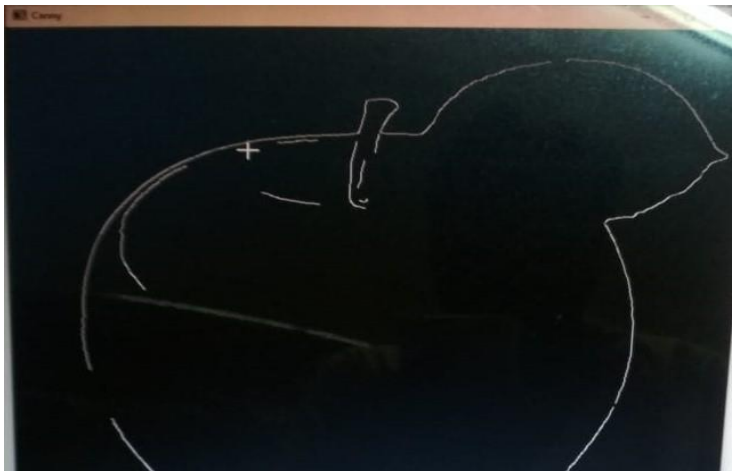


Fig.9 Grayscale image



The **Canny edge detector** is an EDGE DETECTION operator that uses a multi-stage algorithm to detect a wide range of edges in images.

The edges of the captured fruit is determined by using canny edge detection algorithm.

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Fig.10 Edge Detection

APPLE DETECTED IS UNRIPPEN.

COMMAND SEND TO MOVE FORWORD.When the apple detected is not rippen ,move forward command is sent which continues the search of another apple.

Fig .11 Detection of Unripen Apple

APPLE DETECTED IS RIPPEN.

COMMAND SEND TO CUT OUT APPLE.

When the apple detected is rippen the message sent is

For cutting the apple.

Fig .12 Detection of Ripen Apple

V. Conclusion

The implementation of a system for automatic apple sorting based on ripeness which will be detected on the color combination in the fruit image using Open-cv. This system can be applied for assisting for the automation process in sorting fruit based on the ripeness level. The implementation is validated on a Raspberry Pi that provide a compact design. Implementation of this project on Raspberry Pi yields faster results.

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