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Identification of Defects in Fruits Using Digital Image Processing

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***Abstract*—** Image Processing is a technique which converts an image into a digital image to obtain some enhancement or to select some effective information from it. Classification of fruit quality or grading is helped by detection of defects present on fruit peel. As there is a great demand for high-quality fruits in the market, the task of defect detection in fruit is very vital in the agricultural industry. However, defect detection by the human is labour-intensive and time-consuming. The proposed methodology is useful in supermarkets for automatic sorting of fruits from a set of different kinds of fruits. This system minimizes error and also speeds up the time of processing. The objective of this work is to present a novel method to detect surface defects of fruit using RGB images. The proposed method uses pre-processing, segmentation, edge-detection and feature extraction to classify the fruit as defected or fresh.

***Keywords*—**Image Processing, Defect detection, Pre-processing, Filtering, Background subtraction, Binary image

I. INTRODUCTION

In image processing, an input image is given and the output of image results into an image or features of an image. Image processing can be used for different objectives such as image recognition, recognition of pattern, image sharpening and image retrieval. The main four types of digital images include a binary image, indexed image, grayscale image and true-colour image. In processing the digital image, various phases are to be followed in order to extract the required information from the digital image. The phases of image processing are Pre-processing, Segmentation, Feature Extraction and Classification [1] [10].

For deciding the overall acceptance quality for customers, the uniformity in size, shape and other quality parameters of fruits are required. Labour shortages and a lack of overall consistency to the process resulted in a search for automated solutions. [6]. The important aspects for the inspection of fresh fruits are colour, size and number of defects. The defect or damage usually occurs in fruits due to various factors such as rotting, bruising, scab, fungal growth, injury, disease etc. Proper care should be taken after the post harvesting of the fruits. These defects must be removed in order to prevent cross-contamination and reduce subsequent processing cost.

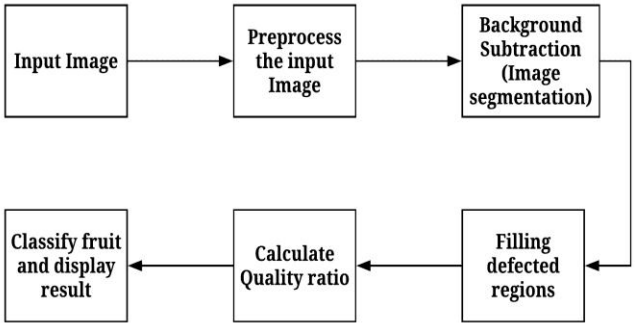

Figure 1. Generalised block diagram

Generally, human experts perform the quality inspection of fruits. The manual sorting by visual inspection is labour-intensive, time-consuming. It suffers from the problem of inconsistency and inaccuracy in the judgement of humans. With the advent of fast and high precision technology, automation of the defect detection process is expected to reduce labour cost and improve the efficiency of the sorting process. We can find the quality of fruits by various algorithms using image processing [2] [3].

The primary objective of this work is to design an algorithm that can identify the defect and classify the fruit based on digital image analysis.

Section I contains a brief introduction of identification of defects in fruits and the process. In Section II, some related

work is discussed. Section III discusses the methodology of pre-processing, background subtraction, feature extraction, classification of fruit and the algorithm for fruit detection. In Section IV, experimental result of proposed work is discussed. Finally, Section V contains the conclusion and future scope of this work.

II. RELATED WORK

To propose and implement the present work, different methodologies are being investigated. The reviewed literature has been classified into primary heads which helps in comprehensive analysis study. Literature as per their context can be studied by such an analysis. The computer vision systems and image processing have been widely used for classification, identification, quality evaluation and grading and in the agriculture area [4] [9]. Some of the important implementation techniques of image processing in agricultural produce are:

- For the classification of fruit, one of the techniques used is Speeded Up Robust Feature (SURF). The image is described based on the result and the local features extracted. Features extracted from each input image is compared with the database images and the result is generated. Square shaped filter is used in this system. It is an approximation to Gaussian smoothing. Hessian matrix is used to find surf points of interest [8].

- Blob detection technique for defect detection in fruit is implemented in which the specific region is detected. The colour or brightness is compared with the properties of neighbouring regions. The defects in the fruit are highlighted with circles. Major axis calculation is involved in fruit size detection. When image processing results are obtained, the palette changes its direction which is used for sorting [7].

- In another method for external defect detection of fruit, the image is segmented using various methodologies in MATLAB [5]. The first segmentation method used is K-means clustering. In this, the n-observations are partitioned into K (<n) sets which is obtained from the image. The best solution from the cluster of sums of squares is selected through initial centroids. The second method of segmentation which is used is marker-controlled watershed segmentation. It is based on simulation of the flood. The third method that is used for segmentation of image is Otsu's method which is based on thresholding of clusters. Then edge detection is used which is based on optimization techniques. The fifth method for image segmentation uses the Gabor filter which involves decomposition of an input image [2].

- Another approach is using RGB and HSV colour space model for automatic fruit defect detection. In this method, application of computer vision system and image analysis is used to detect the defect on the fruit surface. A method is implemented for the quantification of the standard colour of the fruit in HSV (Hue, Saturation, Value) colour spaces to achieve fruit segmentation. A comparative study between the HSV and RGB colour space is done and the results are obtained [1].

III. METHODOLOGY

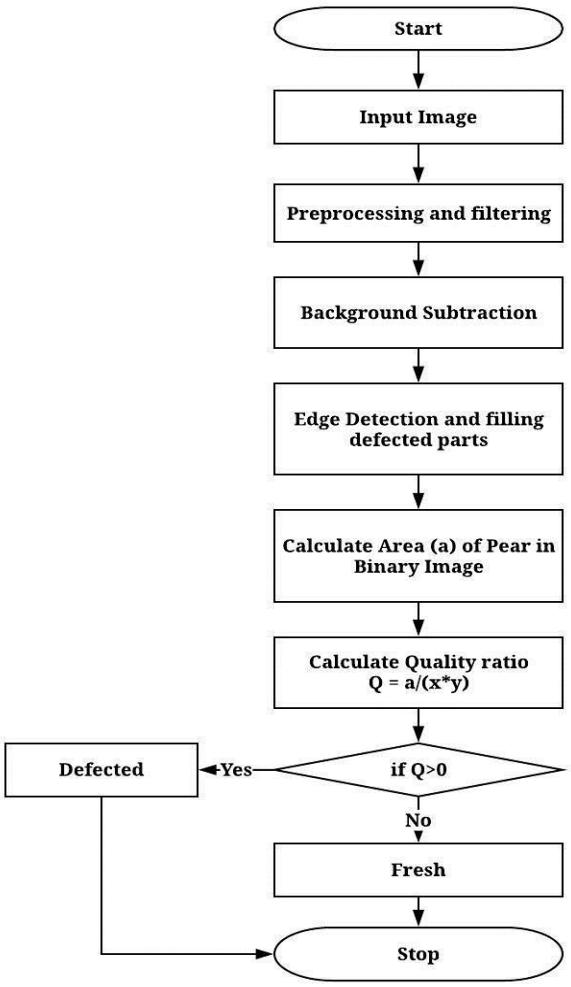

Figure 2. Flowchart

1) **Pre-processing**: The images obtained during the image acquisition phase may not be appropriate for the identification and classification purpose. The captured image is an RGB image (true-colour image) and the captured image contains noise and noise produces some blurring, to remove the noise we perform pre-processing activities. Steps involved in this activity are described as follows:

- **RGB to Grayscale conversion:** The captured image has three matrices of sizes with respect to the format used to store the images (TIFF, JPEG, BMP, etc). The three

matrices indicate that how much of the three colours red, green, and blue a certain pixel should use. This RGB image is converted to a grayscale image, in which the pixels have one colour which is a shade of grey in various ranges in between.

- **Image Binarization:** The grayscale image (monochrome image) is converted to a binary image by thresholding with the help of a threshold value. If the value of a pixel is greater than or equal to the threshold value then set 1, and if it is less than the threshold value set zero. This indicates that each pixel is stored as a single bit (0 or 1).

- **Filtering:** The binary image (digital image) is then filtered using a median filter which reduces noise and improves the visual quality of the image. Filtering is also referred to as smoothing. Value of a pixel gets replaced by the grey levels in the neighbourhood of that pixel. It is used for the detection of edges [8].

2) Background Subtraction: Background subtraction (segmentation) serves two purposes. The first purpose is to remove most of the background pixels for the determination of the coarse regions of the fruit. The second purpose is to determine whether pixels in the fruit have intensities less as compared to the intensities of pixels in the background [10]. If so, reverse, increase the intensities of pixels in the fruit as compared to the intensities of pixels in the background. A foreground object (fruit) will be created which reduces the amount of data to be processed. This will improve the performance of the classifier.

3) Feature Extraction: The area of fruit in the binary image is calculated which is the number of pixels in the white area total. Then, the total is divided by the pixel value (x*y) of the whole image, by which the area of the fruit relative to the image can be obtained.

4) Classification of the fruit: After feature extraction, the defect detection is performed based on surface defect such as scars, spots, etc. The defected fruit is identified by creating a boundary of contours of defective part on filtered fruit image and the contours are filled with white pixels to finds its area for the basis of judgement. After which the condition will be applied. If the ratio is greater than the set threshold value then the fruit is defected otherwise, the fruit is fresh.

Algorithm:

Step 1: Input the fruit dataset image to check the fruit.
Step 2: Pre-process the original image RGB by converting it into grayscale image and binary image by thresholding.
Step 3: Filter the image to remove noise.
Step 4: Subtract the background from the pre-processed image.
Step 5: Perform edge detection and fill the defected parts.
Step 6: Calculate area and quality ratio of fruit image.
Step 7: Apply the condition and display the result.

IV. EXPERIMENTAL RESULTS

Initially, the user will upload the fruit image on the graphical user interface (GUI) from the folder of the fruit dataset. In the dataset the collection of fruit images will be stored and each image will be given a unique number. This image will be accepted by the system and it will perform different operations on the fruit image and classify the fruit as defected or fresh. This output of classification will be made available to the user on the GUI.

Figure 3 shows the results of original image, grayscale image, binary image, edge detection, contour filling and filtered image.

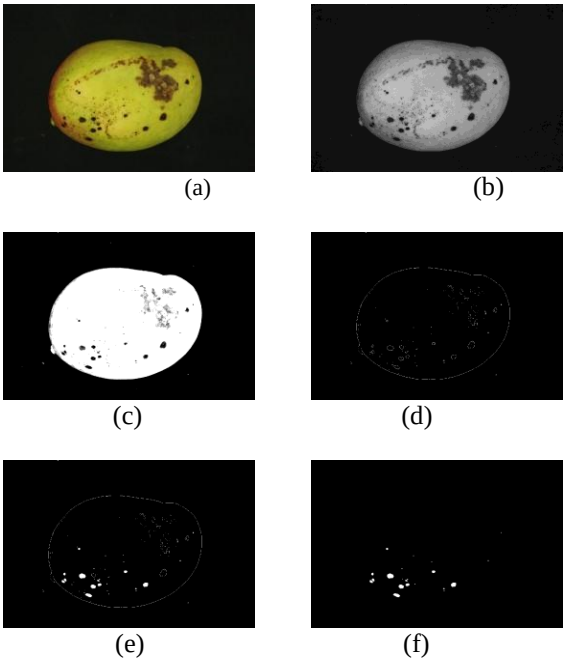

Figure 3. *(a) Original Image (b) Grey-scale Image (c) Binary Image (d) Edge Detection (e) Contour Filling (f) Filtered Image.*

V. CONCLUSION AND FUTURE SCOPE

Due to the increasing demand for quality fruits, a reliable mechanism to handle the bulk of data is implemented. Algorithms were developed to classify the fruit, based on a single view of fruit images. The fruits were differentiated into two classes based on the ratio computed.

Hence, using the proposed algorithm, sorting of fruits can be

done based on quality. The system will have a good prospect of application in fruit size detecting and grading areas. The colour, perimeter, roundness, and percentage of defect features can be utilized in the future to enhance the accuracy of the algorithm. Some other features such as display of diseases of fruit and analysis of statistical comparison of defects in various fruit can be implemented in addition to the proposed algorithm.

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