

IMAGE SEGMENTATION TECHNIQUE FOR IDENTIFICATION OF DEFECTS IN FRUITS

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The Image Processing technique have been extensively used for the detection of defects, classification, quality evaluation, and grading in the agriculture field. External defects and infections in fruits have reasonable economical losses in the agricultural production worldwide. Identification of defects and continuous monitoring of fruits are important for sustainable agricultural business. In modern days' image processing technology and computer vision-based procedures have been useful progressively for fruits defect identification. Researchers have proposed and used many image processing methodologies and tools for the detection of defects in fruits; every algorithm and tool has a different accuracy level. In this paper, a computerized tool is developed, which can identify defects and grade the different types of fruits based on color, figure, and size features by digital image processing procedure. MATLAB was used as the programming tool for visible defects detection and grading of fruits.

Keywords: Postharvest losses, shelf life, image processing, computer vision, K-means clustering, fruit defects.

INTRODUCTION

Fruits have a vital role in keeping the human body healthy but face high postharvest losses due to short shelf life. Agriculture continues to play a major role in economic growth of the world especially the developing countries of South Asia. The presence of defected fruits on the shelves of numerous market shops is a regular phenomenon. Customers remain unsatisfied with agriculture goods they purchase even after paying a lump sum amount. It's impossible to keep track of skin defects and diseases in fruits. Farmers must be capable of detecting defects early in order to prevent incurring unnecessary financial losses.

Farmers and professionals use the standard approach of singlehanded eye observation to identify skin defects in fruits. The old retail assessment of fruits quality is a time-consuming process that needs more human power and is vulnerable to human error. Several types of fruit and vegetable defect identification work using pattern recognition and image processing technology have been investigated in recent years to accelerate the process and minimize human error, yielding a number of significant results.

The proposed technique is used in image processing for automated classification of fruits, as well as identifying defects and detecting the quality of various types of fruits based on shape, height, and facial feature (Sahu and Potdar, 2017). Bacterial foraging optimization algorithm, also known as a global optimization algorithm (GOA), is used in defected fruit image analysis. Similarly, a variant of the Advanced Bacterial Foraging Optimization Algorithm (ABFOA) method and RGB decomposition is used to segment the defected portion of fruits into various color frameworks based

on color characteristics (Devi, 2013). Red, green, and blue color are used to break the original picture into three planes.

The hierarchical technique for fruits grading and classification is developed which identify good and defected fruits using MATLAB Programming Tool. The various features from the fruit image have been extracted and methods like Thresholding, segmentation, and k-means for getting preferred databases have been used. This technique can also be used to identifying the quality of fruits with more precision (Sudhir *et al.*, 2017). Desai *et al.* (2016) used the K-means clustering methods to segment the image, which accompanied by feature extraction from the segmented image classify into one of the disease groups. Gabor filter technique has been developed by Yogesh *et al.* (2018) to segment the pome fruits images and external defect detection. The Gabor filter breaks down the original input image into several smaller images, which are then mixed with non-linearities. As opposed to other approaches such as the watershed, K-means, and Otsu Thresholding methods, the Gabor filter system yields very reliable and effective performance. The Otsu Process and Color-Based Segmentation are two of the techniques for better definition of defected regions of fruits (Jude Rozario *et al.*, 2016). The Otsu approach is used to separate contaminated areas and delete the context from the image, whereas K-Means Clustering is used for segmentation. However, the Otsu Thresholding approach provides much better performance outcomes.

The purpose of research was to design an automated framework that is effective in market stores for classification of the faulty area of fruit using image processing and machine vision techniques, consisting of various kinds of fruits that

consumers only get the absolute best food items for the price they spend.

METHODOLOGY

The image processing method is a non-invasive technique that enables farmers to handle nutrients and contaminants with greater precision, accuracy, cost-effectiveness, and speed. In this study photographs of different fruits were recorded using an external optical camera device. After that the entire method of identifying and segmenting defected regions as well as grading was divided into three phases: pre-processing, segmentation, and grading.

Image acquisition: The method of acquiring an image from a hardware-based source, such as a digital camera, for continued processing is known as image acquisition. The most critical aim of image acquisition is to provide an input image that can be monitored and evaluated to identify defected regions. In this paper, on various views of fruits image database was used.

Pre-processing: Pre-processing is one of the disciplines of image processing where the color reproduction can be increased by changing the illumination and saturation improvement to the optimal image quality. The input camera model for the image segmentation and feature extraction then processed images of fruits.

Segmentation and background subtraction: The image segmentation were used to classifying the images of fruits into the meaningful region. Image segmentation's key goal was to collect information from image datasets that are viewed in the form of data. Background subtraction, target edge detection, and segmentation of defected regions in fruits and vegetable images were all part of this process that is define in the given bellow equation.

$$g(x,y) = \begin{cases} 0, & \text{if } |f(x,y) - b(x,y)| \leq T \\ f(x,y), & \text{otherwise} \end{cases} \quad (1)$$

The $f(x,y)$ in the equation are the original image, $b(x,y)$ is the background image and T is the threshold, Where $g(x,y)$ is the image after its background has been removed.

Edge detection and contour filling: One of the most widely used techniques of image processing is edge detection. A discontinuity of grey level values defines an edge. In other words, an edge is a line that separates an object from its surroundings. The shape of an image's edge is determined by a number of factors. The object's optical and geometrical properties as well as the light and noise levels in the images. For the detection of proper edges of the fruit and vegetable objects, we used the canny method (Sharifi *et al.*, 2002) which the process is define step by step in the given bellow equations.

To minimize noise and unnecessary information and consistency, a Gaussian filter was used to smooth the image.

$$g(m,n) = G_\sigma(m,n) \times f(m,n) \quad (2)$$

Where

$$G_\sigma = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{m^2+n^2}{2\sigma^2}\right) \quad (3)$$

Compute gradient, $g(m,n)$

$$M(m,n) = \sqrt{g_m^2(m,n) + g_n^2(m,n)} \quad (4)$$

and,

$$\theta(m,n) = \tan^{-1}[g_n(m,n)/g_m(m,n)] \quad (5)$$

Threshold M :

$$M_T(m,n) = \begin{cases} M(m,n) & \text{if } M(m,n) > T \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

where T is chosen in such a way that all edge components are preserved and most of the noise is eliminated.

To thin the edge points, overpower non-maxima pixels in the edges in M_T were obtained. For this checked whether each non-zero $M_T(m,n)$ is greater than its two neighbors along the gradient route $\theta(m,n)$. If so, keep $M_T(m,n)$ unmoved, else, usual it to 0. Threshold the earlier result by two different thresholds t_1 and t_2 to obtain two binary images T_1 and T_2 . Reminder that T_2 with greater t_2 has fewer noise and fewer false edges but greater slits between edge divisions, when related to T_1 with smaller t_1 .

Linked edge divisions in T_2 to form unremitting edges. To do so, trace each division in T_2 to its end and then search its neighbors in T_1 to find any edge division T_1 to bond the gap till reaching another edge division in T_2 . After edge detection with canny method, we performed contour feelings using flood fill operation.

Classification and grading: The classification and grading of fruits were part of this method. Surface defects such as dark spots, scars, etc. have been used to classify the defected zone. Defected fruits and were graded by extracting the shape of the spoiled piece, then filling in the spoiled part to locate its position in the image as the basis for analysis, and finally graded the fruits based on the defective component.

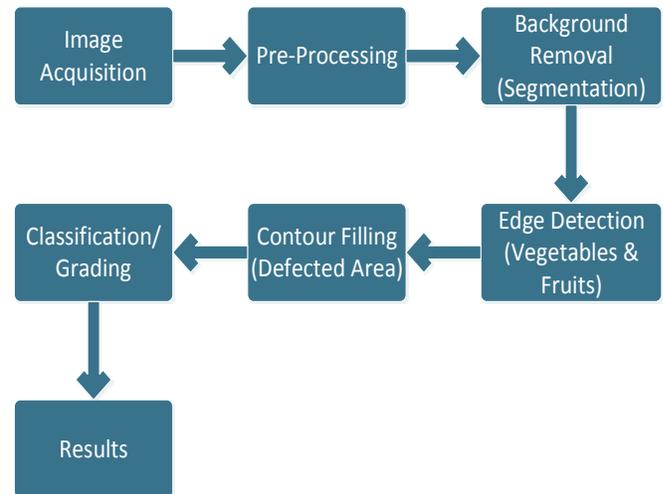


Figure 1. Process of image segmentation and identification of defects in fruits

RESULTS

Experiments were carried out with a set of apples, mangos and citrus images that are based on online available datasets “<http://www.cofilab.com/downloads/>”. Various phases of the Image segmentation technique for identification of defects are explored and shown in Figures 2, 3 and 4.

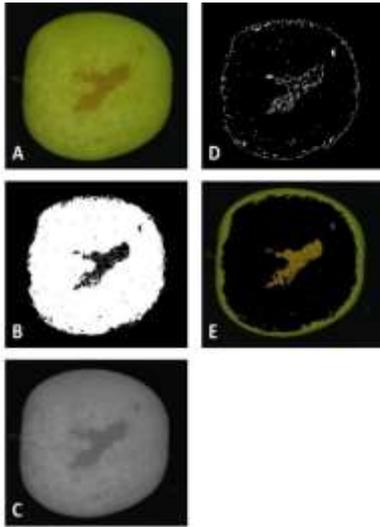


Figure 2. Image segmentation technique for identification of defects in apples. A) Original RGB image, B) Gray scale image, C) Background subtraction/segmentation, D) Edge detection and defects filling, E) Classification and grading.

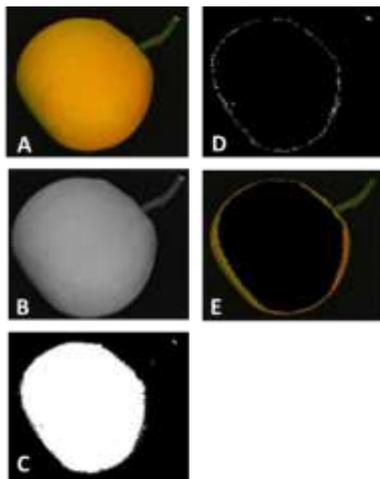


Figure 3. Image segmentation technique for identification of defects in citrus. A) Original RGB image, B) Gray scale image, C) Background subtraction/segmentation, D) Feature extraction defect identification, E) Classification and grading.

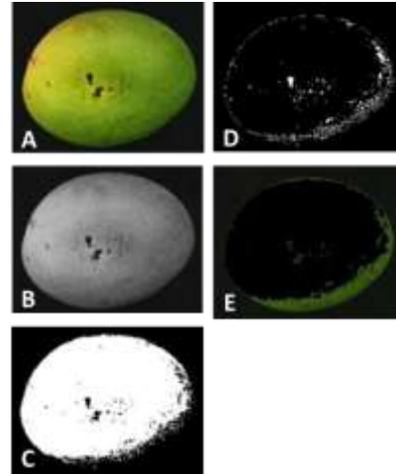


Figure 4. Image segmentation technique for identification of defects in mangoes. A) Original RGB image, B) Grayscale image, C) Background subtraction/segmentation, D) Feature extraction defect identification, E) Classification and grading.

Step by step defect identification method implementation details in MATLAB are as follow:

Pre-processing: First, different fruits raw images were read in MATLAB and then converted into gray-scale version. The *rgb2gray* predefined MATLAB function was used for RGB to gray conversion operation. The Original RGB image is shown in Figure 2A and grayscale image format is mentioned in Figure 2B.

Segmentation and background removal: After the pre-processing step, conversion of RGB color format to the gray-scale image was done, and further we used gray-scale image for background removal. We used *otsuthresh* predefined MATLAB function for calculating threshold value of the fruit images. This threshold value in *imbinarize* MATLAB function was used to convert the gray-scale image into binary image (background subtraction). The binary image format is shown in Figure 2C.

Edge detection and defects filling: To create a border, edge detection was used. Using the predefined function *edge*, created contours on a filtered fruit image. Canny method in *edge* function was used for detection of edges. The defected region in apple image was then filled with white pixels by using modified *imfill* MATLAB Function. The edge detected and defects filling images are shown in the Figure 2D.

Classification/grading: The contour (defects) filling image followed by the median filter was used to filter the image, and then used the predefined *sum* function for calculating the sum of total defected area white pixels. Finally, graded the fruits based on the sum of all (defected area) white pixels. Figure 2E represents the classification and grading process.

DISCUSSION

The proposed technique is tested using various apple, mangos and citrus images. Figure 2, 3 and 4 listed the results at various stages of an algorithm for apple mango and citrus images. The algorithm proposed in Figures 2, 3, and 4 easily and reliably calculates the consistency of fruits.

Step by step defect identification method implementation discussion using MATLAB are as follow:

Pre-processing: First, different fruits raw images were read in MATLAB and then converted into gray-scale version. With regards to the format used to store the images, the image data has three matrices of scales. The three matrices specify how often of each of the three colors red, green, and blue can be used for a given pixel. The “*rgb2gray*” predefine MATLAB function was used for RGB to gray conversion operation. The Original RGB image is shown in Figure 2A, 3A and 4A. The grayscale image format is mentioned in Figure 2B, 3B and 4B.

Segmentation and background removal: Segmentation is useful for two causes. Firstly, the rest of the background pixels have to be omitted to assess the rough areas of fruit. The second objective is to decide whether such a pixel intensity in the fruit are less than those in the background. We used “*otsuthresh*” MATLAB function for calculating threshold value of the grayscale fruit images. This threshold value in “*imbinarize*” MATLAB function was used to convert the gray-scale image into binary image (background subtraction). A front object is generated to reduce the quantity of data to be processed. The classifier's accuracy would increase as a result of this. The binary image format is shown in Figure 2C, 3C and 4C.

Edge detection and defects filling: To create a border, edge detection was used. Using the predefined function edge, created contours on a filtered fruit image. Canny method in “*edge*” function was used for detection of edges. The defected region in apple image was then filled with white pixels by using modified “*imfill*” MATLAB Function. The edge detected and defects filling images are shown in the Figure 2D, 3D and 4D.

Classification/grading: The contour (defects) filling image followed by the median filter was used to filter the image, and then used the predefined “*sum*” function for calculating the sum of total defected area white pixels. Finally, graded the fruits based on the sum of all (defected area) white pixels. Figure 2E, 3E and 4E represents the classification and grading process.

The total defected area white pixels of figure 2E (Apple) fruit was 5214 that automatically classified in to “Very Poor” quality category. In figure 3E (citrus) fruit the total defected area white pixels was 1514 that automatically classified in “Outstanding” quality category and figure 4E (mango) total defected area white pixels was 10356 that classified in “Dangerous” quality category.

Conclusion: An Image Processing-based method is worked out for detection of defective areas in fruits and grading them based on the defected area. After flooding the infected portion with white pixels and using the number of total defected white pixels for clear identification and grading, the suggested methodology produced precise and successful results for defining and segmenting the defected section of the fruits. This approach can also be used to diagnose diseases using machine and deep learning approaches, which is important for the proper plant protection.

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