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An Image Segmentation comparison approach for Lesion Detection and Area calculation in Mangoes

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Abstract: Over the past decades, the demand for digital information has increased dramatically. Even in food industry, consumers are using the digital information to better inform themselves. As a result they have started expecting lesion free, good quality fruits, vegetables and other items at lower cost. In food industry external quality of fruits play an important role which is evaluated by their colour, texture and visual lesions. Manual inspection is time consuming, expensive and non consistent, therefore machine visions approach is adopted for lesion detection. Here in this paper mangoes are selected as a case study where different segmentation techniques are used for detection of lesion areas in mango. Recommendation of the best suited segmentation method for defect tracking is adopted. The proposed system is evaluated using defected mangoes. About 100 samples of mangoes examined and about 30 lesion mangoes were selected for the segmentation process.

Keywords: *Lesion, Detection, Segmentation, Defected Mangoes, Food Industry, Quality.*

1. INTRODUCTION

Digital images are used widely as one of the key medium for conveying information. Extracting and understanding the information from digital images and using it for several tasks is one of the most important characteristic of machine learning, this process of automatic inspection and analysis of images is called as machine vision[1].

Quality and safety of products are some of the major contributors in food industry. Quality usually defines the degree of excellence, a value or high standards of products. Particularly in food and health sector the knowledge of quality demands the research activities, which involves production and preservation of quality therefore, determining the possible damage to fruits and vegetables is extremely extensive and it is often an important criterion of quality determination. The quality of fruits can be described by the following attributes, colour, appearance, flavour and texture etc. The appearance of fruit decides whether it is accepted or rejected by consumers therefore it is the most critical attribute.

Mango belongs to the genus Magnifera and family Anacardiaceae. , the name Magnifera Indica refers to Indian Mangoes [2]. South Asia is the largest cultivator of mangoes and distributed worldwide and about 57% of the world's mangoes are from India.

In machine vision, the process of dividing image into sets of pixels that is multiple segments is called as image segmentation.. The goal of this process is to simplify the representation of an image so that it would be much easier to analyse. It is one of the initial steps in understanding the image characteristics and identifying different constituent objects in them.

2. PROBLEM DEFINITION

Quality analysis of fruits is accomplished based on appearance, texture, shape and sizes. Manual analysis is based on traditional visual quality inspection performed by human operators, which is time consuming, slow, non-consistent and expensive. It has become increasingly difficult to hire personnel who are adequately trained and willing to undertake the tedious task of inspection. A cost effective, consistent and accurate detection of lesion area is possible using machine vision. In image processing various segmentation algorithms are being tested and a best suitable algorithm is selected to identify and to calculate the lesion areas in mango fruit.

3. LITERATURE SURVEY

The important concerns with respect to modern food industry are quality and safety. Computer vision technologies are applied in order to determine various features, traits and natures that have impact on the

quality of the product Clustering algorithms can provide an efficient mean of differentiating the defects from the required regions. One of the tedious approaches in order to save time and energy would be to reduce human interaction for the inspection of agricultural goods; hence an automated approach comes into picture [3].

One of the most rapidly growing consistent and object oriented inspection technologies that can be invariantly applied to various sectors is computer vision technology. This technology has contributed to the development of entirely automated systems. Single colour, multicolour and multiple spectral imaging find significant emphasis on grading and sorting systems. As India is an agricultural country this technology can widely benefit the economy since it provides an efficient way for grading of agricultural products or more precisely fruits. Higher accuracy, Stability of the product is an added advantage of this approach [4].

In grading and sorting of fruits, detection of bruises and damage of skin is critical. In Computer vision, textual feature detection technique can be efficiently applied in this regard. This collected information can be used to isolate the defected fruit [5].

In computer vision technology when a image is captured it is greatly affected by noise and other disturbances, median filtering helps in reducing the noise and retaining the edges in an image [6].

Complimentary elements are one of the important constituents of soft computing. This can be applied for edge detection to segment images. Edge detection plays a vital role by determining the change in intensities and detects it as an edge. It can also be described as a boundary that distinguishes two homogenous regions of an image. The method of discriminating and locating sharp obstacles in an image is referred as edge detection [7].

In this paper an algorithm for the sorting of mangoes is discussed .The first step would be to extract the mango area from the background. The most important significance of thresholding is its simplicity and is one of the simplest techniques which can be adopted .The result is then eroded to remove the background pixels from the foreground defected area, which can be determined by setting up a particular threshold for a particular image. The defected portion is then filtered and enhanced to calculate the area [8].

The process of image segmentation requires extracting features such as shape, colour, and texture etc.It is often the first step in any analysis and study of image for several image processing applications. Object recognition and filtering often requires image segmentation. HSI colour space is one of the widely used techniques for segmentation and is the best approach of segmentation of the images with uniform background. One of the advantages is that even though there are fluctuations in an image (in this case mango) the very high and very low intensity levels are not taken into account and hence it makes this approach a rather simpler and easier one. One of the major advantages is that the computational time required is very less and more desirable [9].

Major advantage of HSI over RGB is that it utilises both hue and intensity components. It finds application in the fields of medical imaging. When gray image is considered which has lost most of the colour information, it can be resort to I component so that the information can be retrieved. Considering the three components H, S and I, H and I were found to be more advantages [10].

Segmentation on the whole is one of the vital pixel based measurement in image analysis. It has been proved that it has a large impact on quantitative image analysis of an image. Similarly texture plays an essential role in segmentation and is categorised into four major groups, depending on those approaches the image can be partitioned or categorised. Four approaches are as follows structural, statistical, model based and filter based approach, out of these the most used and significant approach is the filter based approach [11].

K-means clustering approach is referred as one of the most functional and fruitful techniques to extract the transformations from an image. Even though colour doesn't depict the defect, it is used for discriminating regions. K-means usually works on converting an image to different colour spaces. It is basically an unsupervised algorithm, which is precise, fast and consistent [12].

Contrast augmentation techniques are one of the most advantages methods in image processing applications for extracting crucial information. Diverse techniques such as histogram equalisation, adaptive equalisation, and non-linear and linear contrast techniques are found to be effective in carrying out individual estimations in the pre-processing applications [13].

High contrasts in images usually tends to hide the detailed information and are found to be occurring in the images acquired in dark shadowed and bright light environmental conditions. Hence introducing a difficulty in the segmenting the darker and lighter areas,

introducing flaws in detecting and analysing the quality of the images [14].

4. IMAGE SEGMENTATION

Segmentation is the process subdivided into its constituent objects or groups. The objects once identified are analysed or subdivided to extract the information for high level machine vision activities. For any automated system various processes are required to segment an image into desired level. Such as in the automated inspection of electronic assemblies interest lies in analysing the images with the objective of determining the presence or absence of specific anomalies like missing components or broken connection paths therefore the segmentation stops when the objects or region of interest in an application has been identified. Therefore the segmentation termination depends on the type of application. It is one of the important tasks in machine vision applications and a quite difficult task in analysis applications. The success of machine vision and analysis applications depends on the success of segmentation. Therefore every image processing system should have robust image segmentation.

There are various segmentation algorithms which are based on two factors, one is based on discontinuity and other is similarity. In the first category, the aim is to partition an image based on abrupt changes in intensity or gray levels of an image such as edges, lines and points. The second category is based on partitioning the image into regions which are similar according to the predefined set of samples or criteria.

5. PROPOSED METHOD

In this paper mangoes are selected for case study, about 100 samples of mangoes examined and about 30 lesion mangoes were selected for the segmentation process. Around 500 images were captured using a digital camera (Nikon 8MP), among which 20 images of lesioned mangoes were selected for the process. Mangoes chosen were of two different verities. The proposed system shown in Figure-1 involves; image acquisition, followed by Pre-processing, segmentation, lesion detection and area calculation.

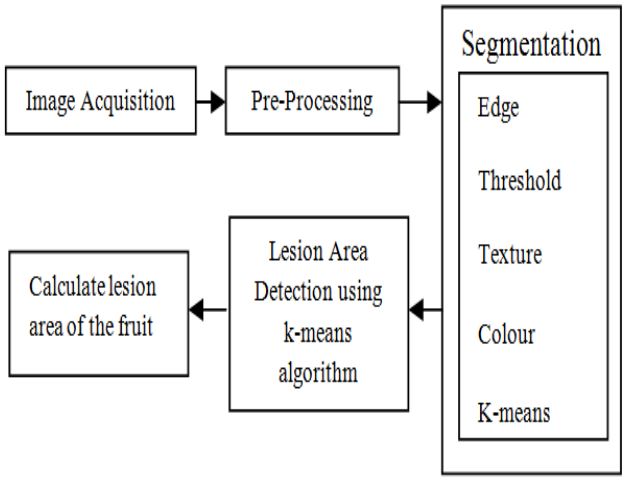


Figure-1: Block diagram for the proposed system

The processes are as follows

Image Acquisition: The images are captured using a digital camera with resolution of 8MP, which are the resized to 640x480 for faster computations.

Pre-processing: Images are processed before segmentation, various pre-processing algorithms such as converting to gray scale, which eliminates the saturation and hue components while retaining the luminance. Median filtering is used to remove noise, where the value of the pixel is replaced by the median of the intensity levels in the neighbourhood of that pixel and simultaneously retaining the edges .Contrast enhancing to adjust the contrast of the image to obtain better results.

Segmentation Block: Various segmentation techniques and algorithms such as edge based, thresholding, texture based, colour based and using K-means clustering are applied and tested for all the data sets, so that the results can be compared and a best suitable segmentation technique is adopted to detect the area of lesion in mango fruit.

5.1 Flow Diagram of Proposed System

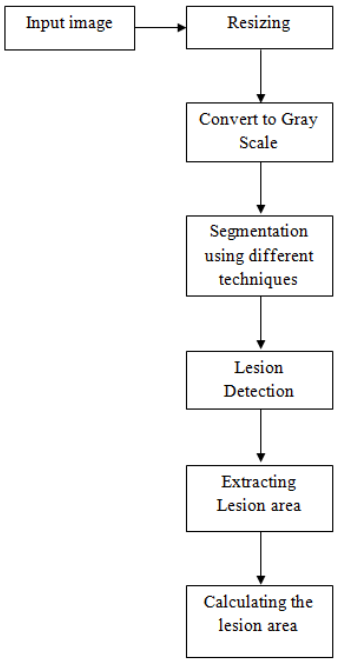


Figure-2: Flow diagram of the proposed system.

6. RESULTS

Figure-3: Data sets collected for mangoes each are of 640x480 dimensions.

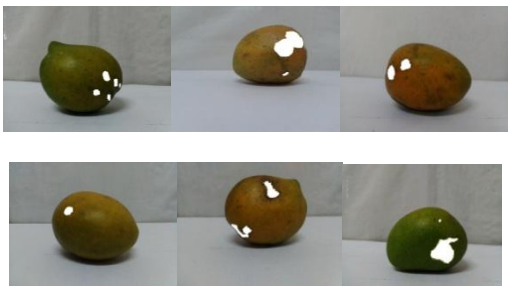


Figure-4: Data sets showing the lesion areas.

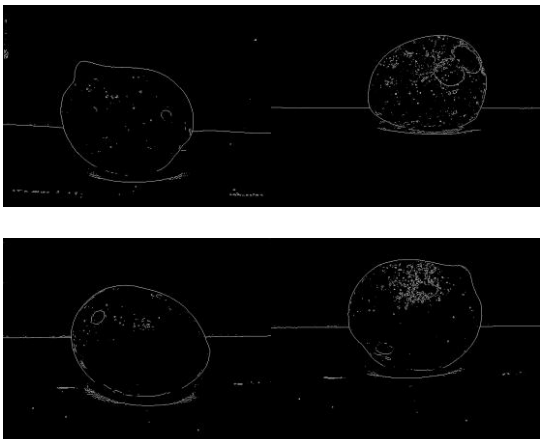


Figure-5: Results of edge detection using sobel operator for data samples1 to 4.

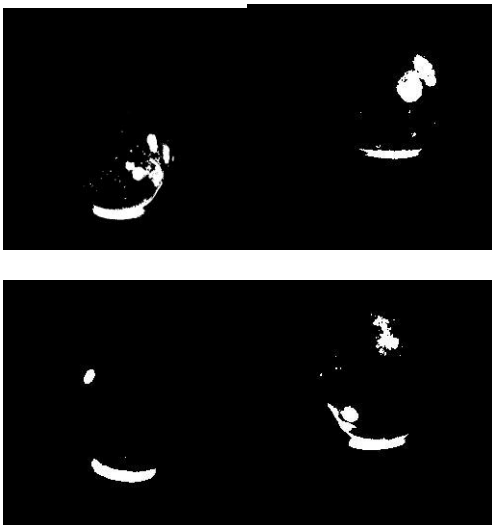
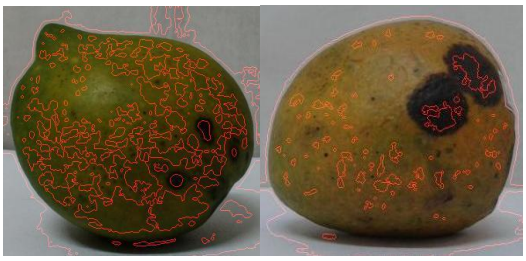


Figure-6: Results of thresholding using different thresholds (25, 30, 40) for data samples1 to 4.



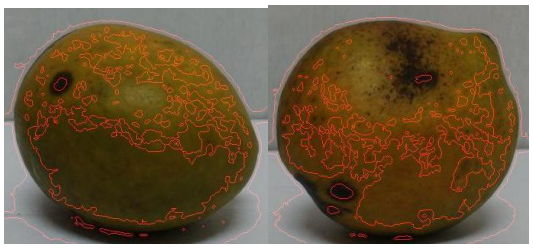


Figure-7: Results of Texture based segmentation for data samples1 to 4.

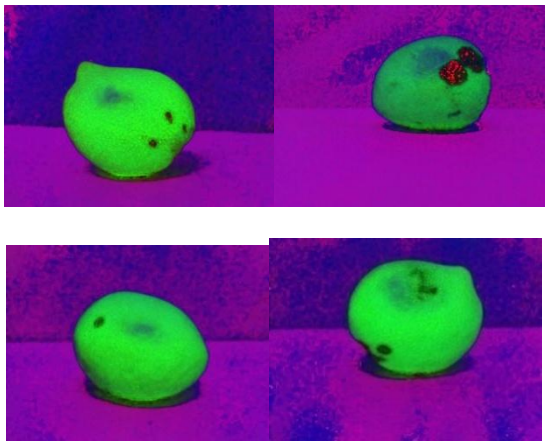


Figure-8: Results of colour based segmentation (HSI) for data samples1 to 4.

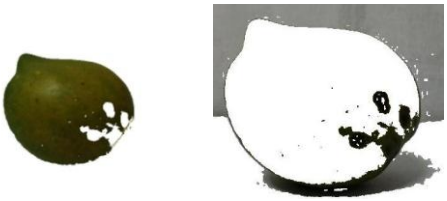


Figure9: Results of segmentation using k-means algorithm for data sample 1.

Figure-10: Results of segmentation using k-means algorithm for data sample 2.

Figure-11: Results of segmentation using k-means algorithm for data sample 3.

Figure-12: Results of segmentation using k-means algorithm for data sample 4.

Area calculation and Comparison

Data sample	Number of lesions	Edge based segmentation	Thresholding	Texture based segmentation	Colour based segmentation	Segmentation using k-means
1	3	Not detected	Detected (Over segmented)	Not detected	Detected	Detected
2	2	Detected(over segmented)	Detected	Not Detected	Detected	Detected
3	1	Detected (over segmented)	Detected	Not Detected	Detected	Detected
4	3	Detected (over segmented)	Detected	Not Detected	Detected	Detected
5	3	Detected (over segmented)	Detected	Not Detected	Detected	Detected
6	3	Not Detected	Detected	Not Detected	Detected	Detected

Table:-1 Comparison of lesion detection in different Segmentation.

Data samples	Area calculation in %		
	Thresholding	Colour based segmentation	Segmentation using k-means
Data1	45%	15%	98%
Data2	81%	93%	100%
Data3	94%	58%	93%
Data4	56%	75%	99%
Data5	89%	56%	99%
Data6	80%	66%	99%

Table:-2 Comparison of lesion area in different Segmentation Techniques.

7. CONCLUSION AND FUTURE SCOPE

This paper presents an automatic approach for segmenting lesion in mango fruit using various segmentation techniques and to calculate area of the lesion in each method. Segmentation using K-means algorithm was found to be more precise in detection of lesion areas .The area computed using k-means algorithm for segmentation was found to be accurate and efficient when compared with other segmentation methods. Hence it was possible to develop a fast, cost effective, consistent and accurate detection of lesion areas in mango fruit.

In this Paper a major step in computer vision based techniques is presented and can be further developed for classifying the defects based on their size and to detect the type of lesion which can be used for grading the quality of the fruit. Once the quality is defined it can be sorted accordingly. Yet another work is to develop a sophisticated algorithm for ripeness evaluation.

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