A Review of Volume Estimation Techniques of Fruit

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Abstract— **Image processing is a process of understanding, analysis and modification on the image. Based on image processing some of the techniques were developed for volume estimation of fruits like as lemon, orange, mango etc. Volume estimation of fruit is use in packaging industries. This paper review different type of methods like as Monte Carlo method, water displacement method and color image segmentation technique and algorithm like as Image analysis algorithm and Canny Edge Detection algorithm for volume estimation of fruits. This paper includes advantages and disadvantages of the all methods of volume estimation of the fruits and also describes comparison of all methods. Volume estimation of fruits has some of the problems like it is time consuming process and accuracy of result.**

Keywords— Fruit, Volume measurement, Segmentation.

I. INTRODUCTION (*HEADING 1*)

India is the largest producer of fruits in the world. Huge post harvest losses (25-30%) occur in fruits in the period between harvesting and consumption [8]. Thus, there is an urgent need to adopt proper post harvest management practices by adopting improved packaging, handling and efficient transportation methods. Packaging is required to keep the mangoes in good condition until these are sold and consumed. The package should also protect the produce from rotting.
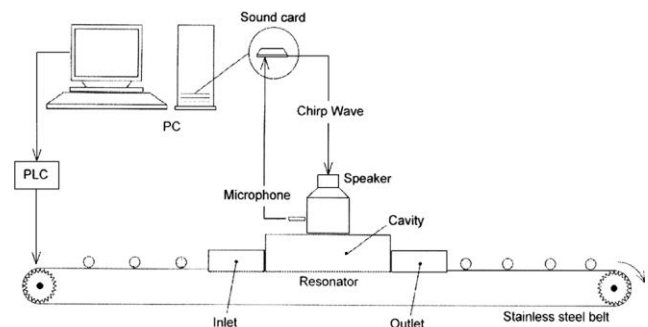

Figure 1 Packaging System [16]

If you want to find the volume of the fruit you can use many different methods. Standard digital camera was used to capture images of the fruits. You can get height and width from 1D image but you want to get diameter of mango that time use 2D image and you want to get surface of mango that time use 3D image. 2D to 3D image conversion is a very hard process.

The purpose of the study was to learn an image-processing algorithm that can help in automating the process of volume calculation of fruit.

The specific objectives were to try knowing image analysis algorithm that can measure the volume of a fruits using the extracted features.

In section 2, we have define literature review of volume estimation techniques of fruits and after this section define methods and algorithms of volume calculation of fruits and the last we describe the conclusion of our review..

The specific objective is to review an image analysis algorithm that can measure the size and weight. The purpose of the study was to propose an image-processing algorithm for volume calculation..

In [10], traditional approach water displacement method was used for volume calculation. But these methods have two disadvantages.
1. It is a time consuming process.
2. It will use impractical under field conditions.

They are concluding that the actual volume and result volume are not same and result is not accurate.

Some year ago, labor work is costly for sorting and grading the mango so farmer needs alternative option for automation of the sorting and grading of mango. Now a day farmer use automation system. The use of automation system is quality inspection, classification, sorting, and grading agricultural products become more interest.

The used of Monte Carlo Method in [2] this method describe size can be measured from 1D image like as length and width. Diameter can be measured from 2D image and the surface of fruit can be assessed from 3D image.
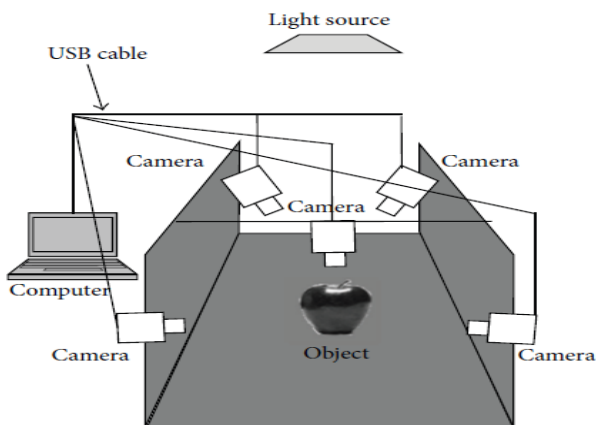

Figure 2 Camera Calibration systems [2]

The object was located at the center of a computer vision system as shown in Figure 2. Five images of the mango were acquired using five cameras. This image is used to extract Length, height, surface and diameter of the mango. Using this variable we can easily get the volume of fruit.

Develop equipment to measured volume of mango base on acoustic resonance technique [3]. This tool is generating frequency that is use extract shape of mango. This tool have pipe of polyvinyl chloride (PVC) pipe in cylinder shape. At the bottom of the tool have one plastic plate and the speaker is installing at the top of the tools. The microphone was mounted

On the cylinder wall at a height of 15 cm from the base. Sound card of a personal computer and the speaker was connected with the audio output of the sound card. The response signals are sense by the microphone and come into sound card of personal computer. The MATLAB program convert receive signal into frequency using fast Fourier transform (FFT).
The mango put on resonator then frequency are measured. Mangos are put on this resonator with different position and size.
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Additionally three keywords use Mango Grading, Fuzzy System and RGB Color Sensor [4]. The use of mango grading is divided in to different parts based on color of fruits.

The color of the fruit is the most important part. RGB color sensor model use is it is sense the color of mangos and collects different frame or index. RGB color sensor in LED light source separately used to acquire data from mango skin and use one of the amplifiers the use of amplifier is converting 16bit data receive. They were developed RGB Color sensor model in RGB Sensor, Amplifier.

There is another segmentation technique in [9] that is important for mango grading is mass of mango. For that one research is conducted among 1050 mangos harvested between 2004 and 2007, were measured in an Experimental orchard at Mae Jo University, Chiang Mai in Thailand. Mangos are measured with different parameters like mass, density, max width, and max thickness with accuracy of 1.0mm.after this process original mangos are weighted with digital machine with accuracy of 0.1g.for digitally mass calculation all images are taken under static rules in which the vertical distance of surface is 45cm.now the value of L and wmax are taken form plotted graph of all views. The graph is greeted from frequency and from that mean is applied. Although mango shape is not approximated by some standard geometrical graphs but this method is able to define some co-relations between the characteristics demotions of size to mass. As per with different type of mango is considered than this method is not able to find correlation.

Here, we learn lots of algorithm or method of volume estimation of mango but all this not have same result of input values. Some method provide high accuracy, other method provide low accuracy of result. But we want to high accuracy of method or it will require low time. So it will be used in packaging industries.

Due to non-uniform background in image some problem occurred during shape extraction process [17].Most probably the problem is occurs in dark or light image using technique of segmentation, edge detection and other image processing algorithm based on region of interest means the region is more than actual region. The region of interest may be same as either background or neighboring pixels. They have use below equation in [21],

$$V_{S=D}{}^{3\pi/6}$$

Where Vs is a sphere volume and D is its diameter. This equation is use both fruit diameter and fruit length. They are conclude that using equation the accuracy of result may be increase. They are get actual volume using water displatement method and compare both actual result and estimated result.

For predict the volume of banana fruit in [22], they was develop an electronic system for tested the volume calculation of banana fruit. An electronic device based on capacitive sensor was developed to predict the volume of banana fruit. This system, which is used for volume measurement has four components are rectangular parallel plate capacitor, electronic circuitry, microcontroller, and display unit [22]. The capacitive sensor method is reliable for measuring the volume of banana and it needs to be calibrated for measuring other fruits volume.

Grading systems give us more information about size, color, shape, defect, and internal quality. They presented a review for development of a sorting system for grading lemon based on color and size [23].

In [24], Volume of three types of apple varieties was based on physical attributes like dimensions, surface area, mass and round by nonlinear regression analysis. In this research paper they use GMD (Geometric Mean Diameter) model which is better than other dimensional parameters.

Develop a scanner set algorithm for non-destructive measurement of surface area of cylindrical fruit [25]. A specific algorithm was represented to determine surface area of cylindrical fruits like melon. They conclude that size of fruits does not have a meaningful Performance on external surface area.

1. *Methods and Algorithms*
   1.1 Methods:
During Our dissertation work we learn the basic method for the segmentation, volume estimation method. Some of the methods are describe bellow:

A. **Monte Carlo Method with Heuristic Adjustment for Irregularly Shaped Food Product Volume Measurement.**

We can get shape of fruits using computer vision system. This system required some of hardware and software like as camera calibration, image acquisition, image processing. Using cameras get image of fruit from different position like as top view and surrounding view. Cameras are connecting to the computer using USB cables. In the image acquisition, capture image from different direction. These images describe RGB color space, dimension, and resolution in both vertical and horizontal direction. We can get the RGB color space into HSV color space. Using HSV we can easily separate background of the fruit. A grayscale image was constructed from the weighted sum of H, S, and V components using in [2]

$$Gr = w_h H + w_s S + w_v V$$

The values of the weights were chosen such that the optimum segmentation result would be obtained. Gr was then normalized to range

[0, 255].

After this process done segmentation on image for get the shape of image.

B. **Water displacement.**

It is a traditional method for volume calculation. This method required some type of hardware like as bowl. The fruits are put on bowl which also has water then we can easily guest volume of fruit. But the result of method is not accurate and it is required to use hardware. It will use impractical under field conditions.

C. *Color Image segmentation technique.*

There are lots of image segmentation method are available such as Clustering Technique, Edge Based Techniques, Region Based Techniques, Split and merge Techniques . All the methods are use different approach and strategy.

Region base technique is divide image in different region base on some rules like as the entire pixel in one region have same gray level.

Edge detection is a problem of fundamental in image processing. Edge detection techniques are generally used for finding discontinuities boundary in images. The major task is extract edge from image like as corners, lines, curves.

Split and merge technique follow two parts in the first part split the image base on some rule the merge the image. If too much variety occurs then the image is split into regions using thresholding. In merging phase, where two regions are merged if they are adjacent and similar. Merging is repeated until no more further merging is possible.

2. *Method Comparison*
All these methods have some feature and limitation which is define in the following table:

Method Name	Method Component	Advantages	Disadvantages	Refer-ence
Monte Carlo	Proposed Computer Vision System, Cameras	1.Provide better accuracy compare to water displacement 2. It is a flexible method. 3 .Easily understood by non-mathematicians. 4.Can generally be easily extended and developed as required.	1.the method not involving damage or destruction, especially of an fruits that is being tested 2.Investment in time and resources 3.Solutions are not exact, but depend on the number of repeated runs used to produce the output statistics. That is, all outputs are estimates.	2
Water displacement	Bowl, Water, Fruits	1.Easy to Implement 2.Low cost	1.It is a time consuming process. 2.It will use impractical under field conditions.	2
Color Image segmentation technique	Object's Image	1.Segmentation method is easy to use.	1.The result of all method is not accurate. 2.very difficult to assess and compare the performance of these segmentation techniques	6

3. Algorithm

During Our dissertation work we learn the basic Algorithm for volume calculation of fruit. Some of the algorithm is describe bellow:

A. Image analysis algorithm:

1. Capture acquire image.
2. After acquire image RGB and CB value of pixel are calculate using different method. Use CB and threshold values. CB value is optional.
3. After segmentation edge were detect from image.
4. Then remove not necessary regions from image. .
5. Identify pixel and regions from image.
6. Detect the roundness of each region and remove defective pixel from image. Other regions were removed so that the final segmented image will result to an image with one region only.
7. Then count the defective pixel and compute the % of defective pixel.
8. Identity quality and size of image.
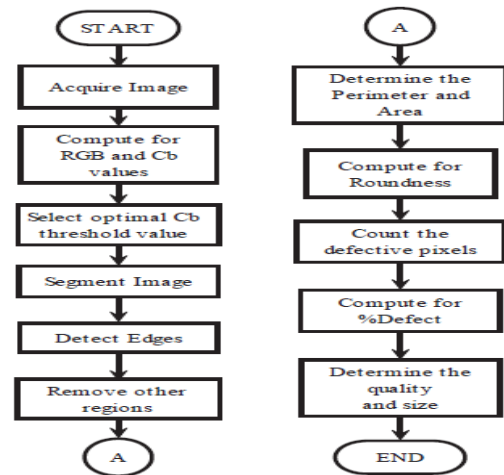
B. Canny Edge Detection Algorithm [6]

1. First remove all noise from the image before try to detect edge from image. Two dimensions Gaussian is approximate for edge detection. One is the X direction and second is a Y direction.
2. Gradient of the image is used to change in intensity which is indicating that presence of edges. It will give result in X direction gradient and Y direction gradient.
3. Non-maximal suppression. Edge will occurred when gradient is maximum and the gradient is computed at each pixel. Then for each pixel check if the magnitude of the gradient is greater at one pixel's distance away in either the positive or the negative direction perpendicular to the gradient. If the pixel is not greater than both, suppress it.
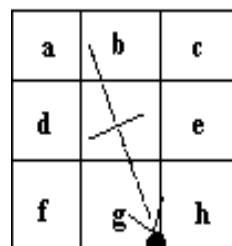
From central gradient value interpolate gradient value at ● from gradient values at e, g and h. Repeat in opposite direction. Suppress if non-maximum

[6]

4. The thresholding is used by the Canny Edge Detector is referred to as "hysteresis". It is refer both high thresholding and low thresholding. If pixel has a value above the high threshold then it is set pixel as edges.

If the pixel has a value above the low threshold then it is set as an edge Pixel as well. If a pixel has a value below the low threshold, it is never set as an edge pixel. (Algorithm based on description given in [6]).

CONCLUSION (HEADING 4)

This review paper analyze some problem like shape extraction, segmentation problem, edge detection and color sensing. Lots of methods and algorithms were developed for volume estimation of fruits but that have some problem in time and accuracy. These algorithms have gape between estimation result and actual result.

So, it is necessary to develop a new algorithm for volume estimation of fruits to overcome problem like time and accuracy.

We are in a channel to develop algorithm for volume calculation for fruit to solve the problem of time and accuracy.

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