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Improved K-Means Clustering with Colour Classification for Segmentation of Fruit Images

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ABSTRACT

In this paper we are proposing an improved clustering algorithm along with colour classification technique to segment the fruit images. This algorithm will provide more precise image segmentation for irregular shaped fruits such as banana, papaya, mango etc captured under natural illumination. Earlier segmentation methods are not suitable for fruit images captured in natural light; as they were sensitive to various colour intensity predisposed by the sunlight illumination. Natural illumination tempt uneven amount of light intensity on the surface of the object, resulting in low quality image segmentation. This improved algorithm will deal with problem of light effect due to natural illumination for irregular fruit images.

Keywords: Clustering, Colour Classification, Fruit Images, Image Normalization, Segmentation

I. INTRODUCTION

Quality control is an essential part, in agriculture and food industries, which helps to grade and export fruits. Since, manual inspection is tedious and vague; it was necessary to replace this manual method with an automated one. A machine vision substitutes this manual method with machine in which captured fruit images are used. Identifying only fruit part from available picture and ignoring background or noise, becomes significant, which is taken care of by means of image segmentation to isolate required object of interest from its background.

Segmentation method divides an image into different regions, and gives all the relevant data required for analysis and grading of a digital image. Segmentation methods like thresholding, clustering, color based and texture methods such as texture filters are in existence. An effective approach to perform image segmentation includes tools, and a comprehensive environment for data analysis, visualization, and an algorithm development. For segmentation of images, clustering and threshold based approaches are mostly preferred. Threshold based segmentation technique has received extensive interest from researchers for many years. Image thresholding is the most preferred method to partition background and foreground for images having high contrast levels. Clustering based approach separates out groups of objects. The most well-known and recognized crisp clustering method is K-means. This method is simple because it can easily classify given data set

or pixels through certain number of clusters. Although there are many enhanced segmentation methods that have been developed over the past years, however these extended methods were not usually applied on fruit images (which are taken under natural illumination) as these methods are sensitive to variations in color intensity which are a result of natural illumination.

Some modified methods have been developed to segment fruit images under natural illumination.

II. Related Work

This paper elaborates various segmentation approaches. Segmentation is classifying or clustering an image into several regions as per the features of image (the frequency response or the pixel value). Segmentation methods can be categorized as thresholding [1, 2, 3, 4], Color based segmentation [5] i.e. K-means clustering [6, 7, 8, 9, 10] and Fuzzy C-means Clustering [11], Region based segmentation [12], Edge based segmentation [13] i.e. watershed algorithm [14], Texture based segmentation i.e. texture filter [15]. Some are derived from above methods [12, 16 and 17] to attain more precise segmentation and to get rid of the drawbacks of existing methods.

I. Thresholding Method – Otsu Method

Otsu's thresholding iterates through all possible threshold values and calculates a measure of spread for the pixel levels on both sides of the threshold, i.e. for the pixels that either falls in foreground or background. This method is efficient as it operates directly on the gray level histogram.

In "Shape Characteristics Analysis for Papaya Size Classification" [3], thresholding is classifying grayscale pixels into two categories, for foreground and for background resulting in a binary image; since intensity values are different in each image, but global threshold value of images could not perform precise segmentation. In "Segmentation Of Natural Images Using An Improved Thresholding-Based Technique" [4], Otsu method is used to calculate threshold value automatically, and thus researchers are able to extract objects of interest from its background. "Quality Analysis and Classification of Bananas" [2], used thresholding for segmentation of bananas pictures as this is a simple method and also thresholding is more suitable for such type of segmentation.

II. Color based Segmentation – Data Clustering

The color based segmentation uses a centroid to represent each cluster and it classifies based on the similarity with the centroid of the cluster. Papers [6,7,8] used color based K-means clustering to identify defect in fruits using segmentation, as this is more acceptable method for images containing blur boundary. In "Segmentation of apple color images utilizing fuzzy clustering algorithms" [11], the author is using FCM clustering for segmenting an image of apple. K-means and FCM are very sensitive to find out initial cluster values and this may produce different segmentation results for those images captured in natural illumination. In "Adaptive K-Means Method for Segmenting Images under Natural Environment" [10], an improved clustering based segmentation is used i.e. adaptive K-means, which may overcome limitation of K-means and FCM. An approach used in adaptive K-mean clustering is to divide an image into sub-images and further these sub-images are segmented individually on the basis of local intensity values.

III. Region based Segmentation

Region-based segmentation mainly assumes that, neighboring pixels within one region have similar value; this is basically pixel based segmentation. The procedure regarding region based segmentation is to compare one pixel with its neighbors and if found identical, pixel can be set belong to the cluster as one or more of its neighbors.

In "On Plant Detection of Intact Tomato Fruits Using Image Analysis and Machine Learning Methods" [12], a method is developed which exactly detects individual intact tomato in mature, immature and at young stage on plant. This method comprised pixel based image segmentation to make a GUI application with which a color pixel and its 8-neighbour pixels are

automatically extracted with a label such as "fruit", "leaf", "stem" and "background".

IV. Edge based Segmentation

This method is generally based on edge in an image, which distinguishes object of interest from its background. Some techniques include edge detection method like gradient operators and Hilbert transform, and some are using watershed algorithm using concept of edge. In watershed algorithm, waterlines are found to separate out the distinct regions.

In "Image Segmentation and Maturity Recognition Algorithm Based on Color Features of Lingwu Long Jujube" [14], images are segmented based on features of Lingwu long jujubes; like shapes and colors. Based on color fusion technology, they have abstracted the red and non-red areas by summering the areas. As there would be the problem of adhesion and occlusion phenomena, watershed transformation was used to combine with distance and gradient algorithm; which deals with over-segmentation and under-segmentation. Marker approach which connects component belonging to image, is used for resolving the problem of over-segmentation occurred in the watershed algorithm. It consists of two markers internal and external, for area belongs to the object of interest and background respectively. The marker selection is based on pre-processing, in which image is filtered using smoothing filter; this filtering is useful in reducing the over segmentation, occur in watershed algorithm as shown in figure 2[18]. In "A Novel Approach to Image Segmentation" [13], image segmentation is used which is based on detecting the edges and performed some steps over the edge detected.

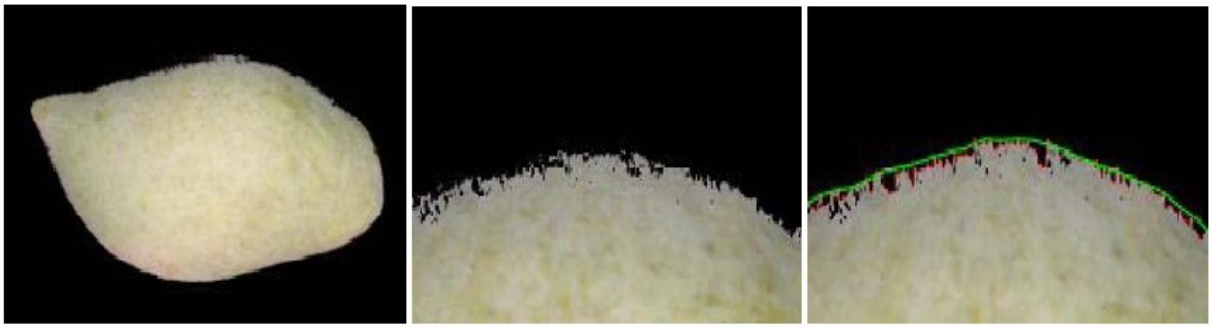

Figure 2: The filtering process in Marker method

V. Texture Method

For, segmenting highly textures images, Grey level or color pixel values are not sufficient; a spatial property of texture is used to characterize group of pixels. A local measure of texture is computed over a neighborhood. In "Estimation Of Mango Crop Yield Using Image Analysis - Segmentation Method" [15], A.B. Payne and K.B. Walsh brought an approach to count mangos of a tree. For this they had captured images for period of three days. These images were then segmented into fruit pixels and background pixels, using color segmentation in color ranges of RGB and YCbCr; further they have performed texture segmentation, based on adjacent pixel variability.

VI. Improved Algorithm

In last many years, several segmentation approaches are developed to get accurate segmentation of fruit images. These methods are not widely applied for fruit images captured under natural illumination; as some of the colours of fruit are very sensitive to the variation in colour intensity influenced by sunlight, and hence some improved approaches are brought to overcome this limitation.

In "Identification of red apples in field environment with over the row machine vision system" [17], a machine vision system which identifies red apples in RGB at outdoor environment in clusters is developed. In addition to the clustering algorithm, this approach is a

fusion of blob analysis and Circular Hough Transform (CHT) to identify apples in over the row sensor platform. "A Rule-Based Segmentation Method For Fruit Images Under Natural Illumination" [16], brought an improved clustering based approach TsNKm, which is combination of an improved Thresholding and Adaptive K-means; this algorithm works only on circular shaped fruit images captured under natural illumination.

In computer vision, image segmentation separates the area of interest from its background image in the form of pixel. Conventional segmentation methods are more accurate when pictures are captured under artificial uniform illumination; whereas, when the image is captured under non uniform i.e. natural illumination, it is difficult to isolate the area of interest from its background. Some enhanced methods, such as Adaptive K-Means clustering technique, have been introduced, where illumination is not an issue while capturing images. These methods are capable of isolating the area of interest from its background correctly using modified algorithms [6, 7, 1, 13, and 19]. In some cases, artificial illumination may be provided by placing a light source to eliminate the effect of camera flash and to have consistent illumination [8, 20, 12, 2, 11, 9, 3 and 5]. Hence, it may be noted that, at certain intervals, segmentation techniques are modified to eliminate the light effect on captured image.

III. PROPOSED METHODOLOGY

In this paper we are using the hybrid segmentation approach which uses the K-means clustering for different cluster generation as per cluster index. In clustering technique the objects of different groups classify particularly a data set which partitions into clusters in order that the data in every one cluster shares some common defined distance measurement. For a wide variety of purposes, different approaches of clustering are used in which K-means clustering algorithm is renowned approach which has many advantages over the others. K-means clustering is an unsubstantiated clustering method in which the input data objects are classified into multiple classes on the basis of their intrinsic distance from each other.

A. Problem definition

Image segmentation is performed to separate out the object of interest and background. Image attainment is an important task in image segmentation, according to "On-line fruit grading according to their external quality using machine vision"[13] the movement problem exists while capturing an image hence proper arrangement is required to provide uniform illumination so that this movement problem can be solved. In "Infected Fruit Part Detection Using K-Means Clustering Segmentation Technique"[2] while segmenting the captured image using k-mean clustering, the selection of proper centroid becomes difficult. For getting uniform illuminated fruit image artificial illumination need to be provided. In such a case FCM gives accurate segmentation. In both these approaches initial cluster value is required, but both are sensitive to find the initial cluster. "A Rule-Based Segmentation Method for Fruit Images under Natural Illumination" [14] is able to perform segmentation of circular shaped fruit images captured under natural illumination but the same approach cannot be used for irregular shaped fruit images.

In general the segmentation is difficult for the images captured in outdoor environment; still many segmentation techniques are developed to get proper segmented fruit images. But all these methods are sensitive to various colour intensity influenced by illumination of the sunlight and hence reduces the quality of segmented images. As compare to the other segmentation techniques K-means clustering gives more accuracy. Hence in this paper we are using improved K-means clustering for cluster generation with colour classification.

B. Image processing methods

Otsu, K-means and FCM are three basic methods for segmenting an image in different parameters. Image Attainment, Image pre-processing and Image segmentation are essential in every segmentation method, to have an accurate

and correct segmented image. Fig 1 shows system flow of Image Segmentation.

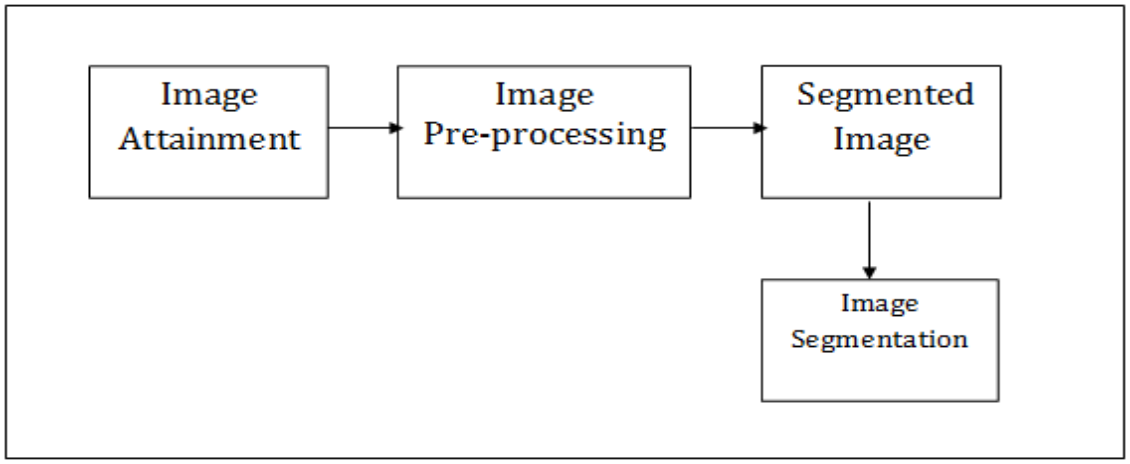

Fig 1: System flow of Image Segmentation

a. Image Attainment

Good quality pictures of fruits (e.g. Banana, Papaya, and mango) would have to be captured, with high resolution digital camera in image attainment. These images are being captured under any illumination condition to get realistic data and finally RGB values of these images would be stored.

b. Pre-processing of Image

RGB values of captured images would be resized in pre-processing. The resized value could be, 240 x 240, 320 x 320 or 640 x 640 pixels. This is required to keep even intensity of all pixel values, which will reduce required processing time.

c. Segmentation of Image

In this, various shaped fruit images is divided into two parts; one with unwanted background and other with exact fruit image.

The Framework of Image segmentation is shown in Fig 2 and steps carried out in performing segmentation of irregular shaped fruits images are as follows;

- Step 1: Read the input image of fruit captured in natural light.
- Step 2: Perform Image normalization which includes color space conversion and image preprocessing
- Step 3: Generate the Color cluster for image segmentation
- Step 4: Perform Segment Classification
- Step 5: Output the segmented images with various cluster.

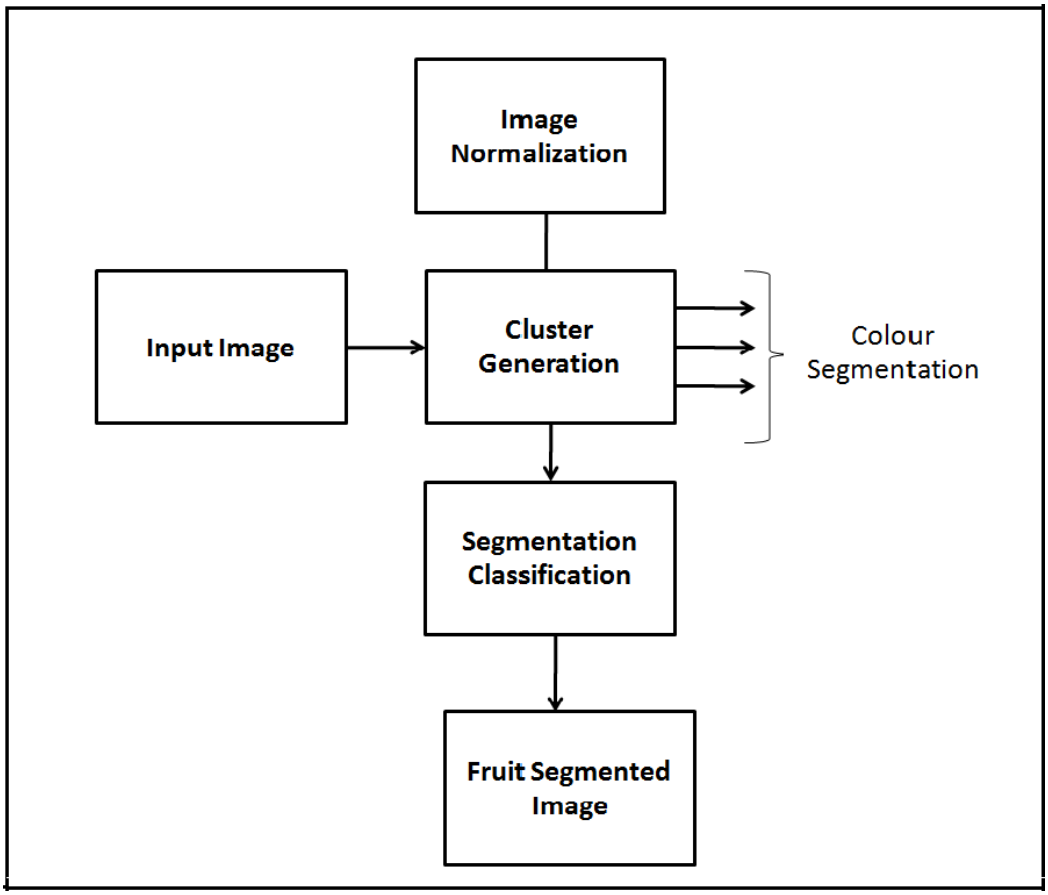

Fig. 2 Framework of Image Segmentation

IV. CONCLUSION

To develop an improved method which can segment various shape fruit images captured under the natural illumination, image normalization and colour classification are very important steps to be carried out. This paper has been proposed an approach using K-means clustering which form different cluster and colour classification for segmentation which can execute both the steps accurately and can provide the required segmentation of fruits.

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