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Research paper

Recognition of the unripe strawberry by using color segmentation techniques

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Abstract

In this paper, the efficiency comparison is displayed for recognize the unripe strawberry fruit using two different methods; color thresholding and K-means clustering. Color thresholding technique includes the following steps: color thresholding, morphological enhancement and draw mark for tracking. K-means clustering comprises filtering, transform the image to L*a*b color space, binary thresholding and extract the desired strawberry region. The results explained that color thresholding gets the better of K-means in the aspect of accuracy, effectiveness, and speed of code implementation. Both interested parties are written using MATLAB (R2018a) language.

Keywords: *Color Shade; K-Means Clustering; Morphology; Unripens Strawberry Fruit.*

1. Introduction

In ancient times, the differentiation between unripe and ripe fruits is done by human vision to examine its qualities. However, this way had high error rate because of distraction, illness and other of influential factors that occur during working for a long duration [1]. This may also influence the system speed so to minimize this failure rate human began to discover new invention. There are different ways to find the unripe fruits and vegetables. One of these ways is segmentation, which means to divide an image into various sections that are homogeneous with regard to some feature of an image. Image segmentation is the very important side of the human visual perception. Humans have used their sense of the vision to effortlessly division their environment, which surrounds into several scenes to support recognize them, lead their motion, and for nearly every other function in their lifetimes [1].
A difficult procedure contains many reactive components that are interested in the analyses of color, motion, shape, and structure of objects in images. Nevertheless, the visual system for human, the segmentation of images is an automatic, normal activity. Unluckily, it is not simple to innovate artificial algorithms whose efficiency is comparable to that of the visual system of a human. One of the big problems to success the growth of segmentation technique has been tending to disregard the complication of the problem completely because the performance of human is gone between the methods, which are in general involuntary. Because of this, images segmentation is weak by multiple types of uncertainty making most easy segmentations techniques inactive [1]. Image segmentation method is usually the first step of an image analyses process. All next steps, such as feature extraction and shape recognition depends heavily on the quality of the segmentation. Without a perfect segmentation algorithm, the target may never be recognizable. Over-segmenting an image will divide an object into various parts while under-segmenting it will collect different objects into one part. Finally, the segmentation process decides the success or failure of the analyses. For this reason, great attention is taken to upgrade the probability of successful segmentation [2].

2. Literature review

Image processing takes an important area in the study and analyses of immature fruit. Several researchers are interested in giving information and details about the color image segmentation to detect the fruit ripeness [3]. Another researcher described a comparative analyses of color and edge based segmentation and recognition for orange fruit [4]. Patel,Jain and Joshi presented an auto segmentation and yield computation of fruit depend on analyses of shape [5]. An automatic system of vision is presented on to obtain images of wine grape collections in vine-yard. A setup was applied to put an orange slice backwards the cluster to assist the segmentation procedures. A reference was put on the setup to get along with the image and executed size analyses. [6].
B.Kanimozhi and R.Malliga prepared to distinguish orange and red color fruits modification and divide the images out of Otsu type segmentation then trained data base images to estimate the execution rate by supervised and unsupervised learning models [7].
Automated K-means clustering using color image segmentation with RGB and HSV color models is presented by Rakib Hassan, Romana Rahman and Tajul Islam that attempted to detect the K automatically and so make segmentation with-out any hints that giving to the algorithm [8].
A modern segmentation algorithm was improved for directing a robot arm to select the mature tomato using a machine vision equipment. To reach this goal, a vision tool was utilized to get images from tomato shrub. The algorithm of recognition had to be adaptive control to the illumination cases of the greenhouse. Com-

pletely 110 color images of tomato were obtained under greenhouse light situations. The advanced algorithm works in these steps: (1) remove the background in RGB model and then extracts the mature tomato utilizing the combination of RGB, YIQ, and HSI color model and (2) localize the mature tomato using morphological characteristic of an image. Depending on the results, the total accuracy of the suggested algorithm was 96.36% [9].
Simran Bhagat and Priyanka Mehta Marker developed the controlled watershed algorithm for segmentation of infected parts of fruit have been implemented. execution time for the code also has been studied. The influenced area of fruit will also be calculated in terms of percentage [10].

3. Fruit segmentation

Fruit segmentation is a method of dividing an image into a significative area with respect to colors. Firstly, monochromatic images are used to execute the procedure of image segmentation. However, in these images intensity is the information source only. It has been said that eye of a human enables recognize thousands of color intensities and shades but in case of gray scale level, images can recognize two dozen only of gray shades. Therefore, color image segmentation has been more desired as compared to the images of grayscale. It is easy to segment an image on the base of colors as compared to shape, size, and texture. The important reason beyond this color images provides more capacity, more information and high speed to process [11-12]. With the advancement of technology, the researcher in domain of color image segmentation as well increases. In this paper, two techniques are discussed color thresholding and K-Means Clustering then compares the result to decide which one is more efficient than other.

3.1. Color conversion

The color images of the desired model are converted into an YCbCr model for two reasons. First, the intensity is the most of differences between images. Therefore, the process is centered on turning the greatest part of energy signal to a luminousness element. Weights utilized in the transformation process from RGB into YCbCr compatible with the prorated sensitivity of the visual system of human being and that process was implemented using more than one codecs. The transformation process equations are displayed as follows [11-13].

$$\left.\begin{array}{l} Y = (R + 2G + B)/4 \\ Cb = B - G \; Cr = R - G \\ Cr = R - G \end{array}\right\} \qquad (1)$$

Where Y, Cb, and Cr act as the Luma component, Blue difference, and Red difference Chroma elements, respectively.
Table 1 lists the red shades and corresponding decimal values of R, G and B intensities for each shade [14].

Table 1: Table of Green Shade

Green lights	HEX	RGB
	#EFFFCC	RGB(239, 255, 204)
	#E7FFB3	RGB(231, 255, 179)
	#DFFF99	RGB(223, 255, 153)
	#9DE600	RGB(157, 230, 0)
	#7AB300	RGB(122, 179, 0)
	#699900	RGB(105, 153, 0)
	#578000	RGB(87, 128, 0)

3.2. Color thresholding

Both of color thresholding and scalar thresholding are identical, for each pixel tag assign. When dealing with non-gray images, the aim focuses on detecting which pixels be a member of each of a group of interested colors. The thresholding of color produces an image of tags, where each tags corresponding to a color category. The computationally simple approaches utilized to associate rectangular box in the color coordinates with a color class. This corresponds to utilize a couple of thresholds for each element to realize the boundaries of the box over that element [15].
The use of RGB color space generally is not convenient for this unless the illumination is stable. A strong connection between the red, green and blue elements caused that, and all three colors will measure with illumination. This reveals as intensity changes, the container requiring being expansive while dots will move from corner to corner in RGB space. Based on that, only little different colors can be specified with gets a poor segregation between these colors [15-16].
Some advancement will give when changing over to YCbCr model that's because rectangular boxes lined up with the axes of the model that will be slanting in are of the RGB. Nevertheless, the elements of chrominance yet gauged with the luminance. Through alternatively scaling the chrominance elements through ultimate of the red, green and blue or by scaling the chrominance by the luminance may be acquired better differentiation [11]. The scheme in Figure (1) illustrates the band of a component of YCbCr model.

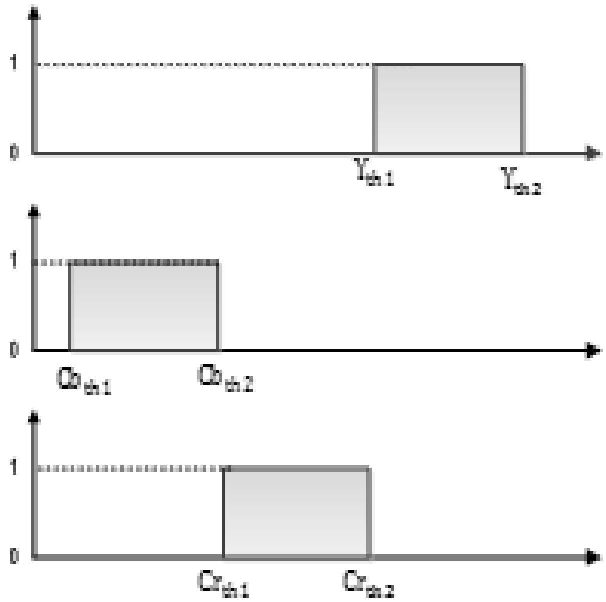

Fig. 1: Color Thresholding.

4. Algorithm for K-means clustering

The clustering usage for image processing is an active method. Clustering mechanism groups the objects into different classes, or in another meaning, breaking of a set of data into clusters (subsets), so that each data in cluster shares some general feature often according to some known measurement of distance. Where the usual method of statistical data analyses is data fractionating, which is applied in many scientific fields, including data extraction, pattern recognition, image analyses, bioinformatics and automated learning. Usually, the computational task of fractionating the set of data into k subsets indicated to unsupervised learning. There are numerous techniques of clustering prepared for a large range of purposes. K-means is a typical-clustering algorithm [17].
K-means is applied at all events to locate the natural pixels groupings introduce in an image. It is important in practice because it is simple and it is mostly so fast. It splits the input data-set into k-clusters. Each cluster is represented by an adaptively changing center (additionally called center of cluster), beginning with some primary values called seed-points. K-means clustering calculates the distances between the inputs (also called input data points) and

centers and allocates inputs to the closest center. K-means is an unsupervised clustering technique that asserts the input data objects into various classes depending on their mileage from each other [17].
Clustering technique supposes that the vector space consists of the data features and tries to distinguish natural clustering in them. The targets are clustered around the center μi∀i = 1..k which are calculated by minimizing the following aims [16]:

$$V=\sum_{i=1}^{k}\sum_{xj\in Si}(xj-\mu i)^{2} \quad (2)$$

Whereas k is the number of clusters, Si, i = 1, 2, . . . , μi and k are the centroid or mean point of all the points xj ∈ Si. As a section of this work, we performed K-means algorithm. This algorithm demands input as a color image. K-means clustering algorithm steps are as follows:

1) Read the image from the acquisition camera.
2) Transform Image from RGB to L*a*b color model. There are three colors in the image that case of the study: white, red, and green. By using eye sense, it can simply identify these colors from other. The L*a*b color model can fix this visual variance. The L*a*b* model formed from a luminosity-layer 'L*', chromaticity layer 'a*' indicating where the color falls down along the red-green axis, and chromaticity-layer 'b*' indicating where the color falls down along the blue-yellow axis. The 'a*' and 'b*' layers have all of the color information. Using the Euclidean distance metric the difference can measure between two colors.
3) By using k-means clustering classify the colors in 'a*b' space. The clustering that purposed is a technique to split up objects groups. K-means clustering algorithm managing every item as hold a place in space. It detects partitions such as that objects inside every cluster are nearest to every other as possible, and as far from objects in other clusters as possible. K-means clustering algorithm necessitates assign the number of clusters to be splitted and a distance metric to quantify how close two objects are to every other.
4) Make images that segment the unripe strawberry by color feature.
5) Result:

The smart unripe strawberry system consisted of a camera for image acquisition that takes the scene from conveyor belt for strawberries and a computer for saving data, image pre-processing and the recognition the fruitiness. The system is clarified in Figure 2.

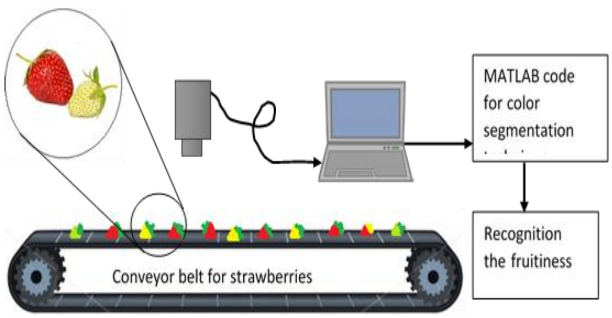

Fig. 2: The Smart Unripe Strawberry System.

Each one of the images despite in result part is acquired using MATLAB (R2018a) and the specifications of the laptop are core i5 processor and random access memory (RAM) 8 gigabyte. The source code applied for unripe strawberry fruit segmentation techniques, Color thresholding and K-means clustering are written in script file without using existed MATLAB functions and then find the elapsed time. The input strawberry fruit images were having various illumination circumstance. Two techniques are utilized in this paper, color segmentation and K-means clustering.
Color segmentation as shown in Figures (3) to (8) steps are filtering that the first pre-processing stage.The Gaussian Low Pass (GLP) filter has been used to average out the difference in the circumstance of brightness.
The discovered pixels were represented by number "1" while the other pixels were represented by number "0". This resulted in the binary image where the strawberry fruit regions are appeared as white and the other parts was appeared by black color. Firstly, the unripe strawberry can be separated from the entire image by using color segmentation technique that depends on the threshold of color shads.
While (Fruit_Yuv(i, j, y) > 1 && Fruit_Yuv(i, j, y) < 20)
Color thresholding range (1 to 20) can be selected by using try and error technique to get the desired color. Morphological procedures were exercised to improve the binary image. The "erosion" operation was used to clear the separated pixels and then the morphological "dilation" operation was applied to get a fully white region, which represents pure strawberry fruit region, then as shown below

Fig. 3: Original Image.

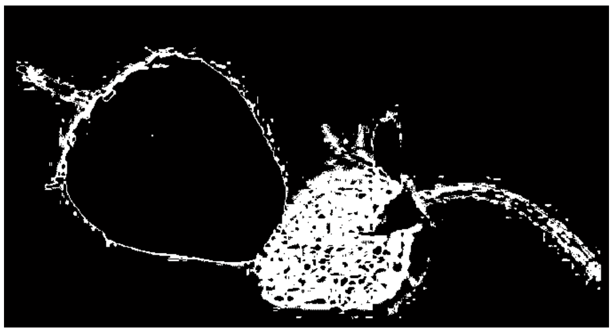

Fig. 4: Raw Segmentation Result.

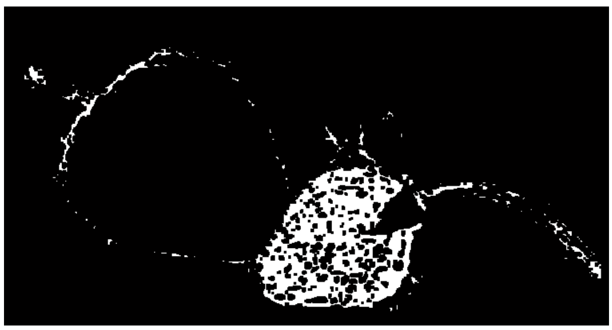

Fig. 5: After Erosion.

Fig. 6: Filled Reign.

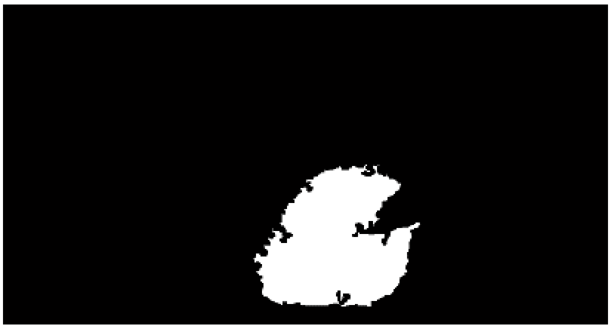

Fig. 7: Final Result.

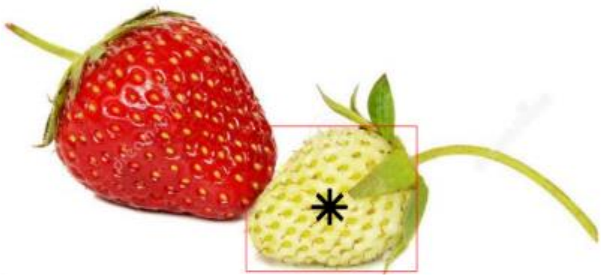

Fig. 8: Track the Unripe Strawberry Fruit.

Although it can be evidenced that the execution will always cut-off, the k-means method does not need to detect the perfect configuration, corresponding to the comprehensive objective function minimum. The methods are also significantly critical to the primary randomly selected cluster centers. The k-means methods can be run more than one time to minimize this effect. This, of course, demands much more time to execute.

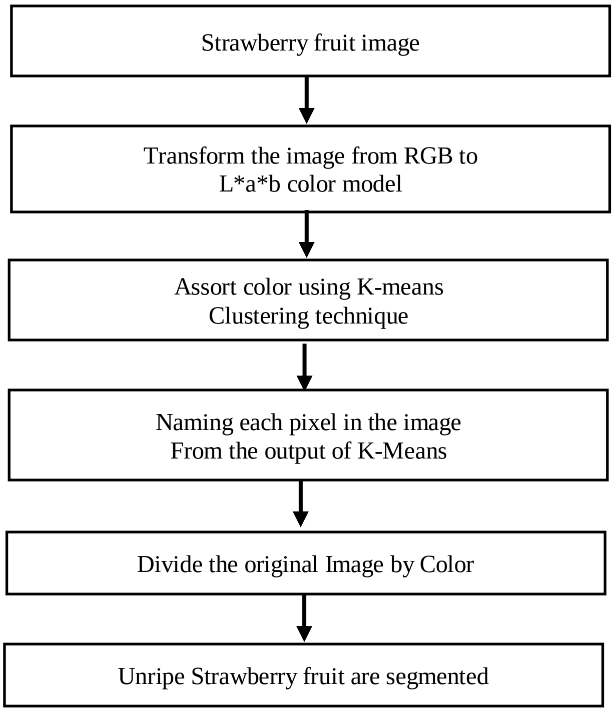

Fig. 9: Procedure of K-Means Clustering Algorithm.

Figure (9) illustrated the steps of K-means clustering algorithm, which begins firstly convert the color image of strawberry fruit to Lab model. Classify the color using k-means method, each pixel named from the output of the algorithm then separate the original image by color. Figures (10) to (13) are the result of that procedure.

Fig. 10: Input Image.

Fig. 11: Gaussian Filter.

Fig. 12: Binary Noise-Removed Image.

Fig. 13: Extracted Fruit Region.

Table 2 records the time of execution depend on both methods. The pair commands tic-toc has been applied to calculate the time of execution desired by each method. It is clear that the time exhausted by color thresholding is less than that needed by K-means clustering. This variation is referred to the easiness steps of color thresholding.

Table 2: Time Calculation

The technique	Elapsed time in seconds
Color thresholding	0.259367 seconds
K-mean clustering	1.942580 seconds

5. Conclusion

In this study, two methods have been used to implement fruit segmentation; color thresholding and K-mean clustering. Depend on the executed results one may focus on the following:

a) The color technique is easier than K-means; since the first one needs the intensity property in its detection procedure, meanwhile, the K-means clustering requires the learning algorithms that solve the well-known clustering problem.

b) When the environmental conditions changed, the k-means technique could find the desired color threshold, for the state of color methods, and one may find green color at another contrast band. This demands to redo the search steps for each varied condition.

c) Color thresholding is quicker than k-means for the purpose previously discussed.

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