Color Image Segmentation for Fruit Ripeness Detection: A Review

Meenu Dadwal, V. K. Banga

Abstract- In this paper, we are representing different techniques to detect the rate of ripeness of fruits and vegetables. This paper reports techniques like histogram matching, clustering algorithms based image segmentation and relative value of parameter based segmentation. Each technique uses coloured images of fruits and vegetables as input data. In these techniques we set some threshold levels. By comparing the input data image with these threshold levels we can find the maturity level of given fruits and vegetables.

Keywords-- Image Segmentation, Ripeness, Clustering Algorithms, Histogram Matching.

I. Introduction

IN older days, human depends upon its vision qualities to differentiate between ripe and unripe fruits. But this method had high rate of errors because of illness, distraction and other factors during working hours [6]. This also may effects the working speed of system. So to decrease this failure rate human started to invent new methods.

These days, there are various methods to detect the ripeness of fruits and vegetables. In some methods we apply chemicals on fruits and sometimes we use machines. As we know, chemical may effects human health so usually machines are used for this purpose. Machine use their visual-based colour classification system that provide reliability, high speed and repeatable operation. Hence the production increases and reduces its dependency on manpower.

In machine vision system computer uses different method to analyse the given image of fruit and vegetable. Previously, computer systems were not robust enough to operate on large and real colours of images, so mostly gray scale images had been the main focus for researchers. But today, computer system has been developed enough to work on large and true colour images [2].

Meenu Dadwal is pursuing M. Tech (Electronics and Communication Engineering) in Department of Electronics & Communication Engineering from Amritsar College of Engineering and Technology, Amritsar, Punjab, India (Email: er.meenudadwal@gmail.com).

Dr. Vijay Kumar Banga is working as a Professor and Head of the Department of Electronics & Communication Engineering, Amritsar College of Engineering and Technology, Amritsar, Punjab, India (Email: vijaykumar.banga@gmail.com).

To increase the efficiency of computer system different researchers perform various experiments on different fruits and vegetables to check their maturity levels. In 2004, F. Mendoza, et al converted the RGB image of bananas into CIELAB format and accuracy reaches to 98% [4]. In 2003 and 2008, author uses average values of RGB to evaluate maturity levels of peaches, apples and oranges [5].In 2010, Zhi-yuan Wen, et all used machine vision to detect the maturity of citrus fruits. B. Ojeda-Magana, et al used different partitional clustering algorithms to detect ripeness level of bananas and tomatoes [1]. Fatma Susilawati mohamad and Azizah Abdul Manaf used histogram matching method to find ripeness of oil palm fruits. Scanlon proposed an approach to quantify colour of potato chips [3] and Choi used Colour image analysis to detect tomatoes maturity rate [8]. In 2011, Chiunhsiun Lin, et al proposed a method to check the maturity rate of tomatoes [2].

This paper is organized as follows; section 2 gives description about colour image segmentation. Section 3 depicts the outline of some techniques used to find the maturity levels of fruits and vegetables. Finally, some conclusions are represented in 4.

II. Colour Image Segmentation

Colour image segmentation is a process of partitioning an image into meaningful regions with respect to colours. Firstly monochromatic images are used to perform image segmentation operation. But in these images intensity is the only information source. It has been said that human eye can recognize thousands of colour shades and intensities but in case of gray scale images it can recognize only two dozens of gray shades. So segmentation of colour images has been more preferred as compare to gray scale images. It is easy to segment image on basis of colours as compare to texture, shape and size. The main reason behind this colour images provide more information, more capacity and high speed to process the information [1].

With the development of technology, the research work in field of colour image segmentation also increases. So according to techniques applied, this research work can be categorized as: 1. Image domain based, 2. Physics based, 3.Feature space based [9].

Image domain based techniques are mainly used to provide image segmentation for closely connected regions [9]. In first type of approach we try to develop regions until an homogeneity constrain is held. This development of region can be done with neighbouring pixels or by merging and splitting regions. In second type of approach we detect image discontinuities, so regions are limited by the pixels

containing the colour boundary. The resulting segmentation may or may not be homogeneous region in feature space.

Physics based techniques use models based on the physical properties of light and of objects in an image. Such techniques attempt to find actual material boundaries and ignore boundaries due to illumination changes in an image [10].

In feature space based techniques algorithms are concerned with the presence of collective massive pixels within a features spectral space [9]. After determined relevant colour classes, the segmentation have been done according to regions of pixels corresponding to same colour class. But the final segmentation result is not so visible because of some limitations. These methods don't use its neighbourhood pixel information.

III. Different Techniques To Detect Ripeness Of Fruits

There are various techniques to detect the ripeness of fruits and vegetables. Three of them are following:

1)Clustering algorithms

Clustering means to create groups of same elements whereas algorithm means a step by step procedure for calculation. Hence clustering algorithms are the step by step procedure to calculate clusters of similar colour pattern in image. In [1], there are many partitional clustering algorithms that are used for colour image segmentation like K- means, the Fuzzy c means(FCM), the Gustafson Kessel improved by Babuska(GK-B) and the Gustafson Kessel Possobilistic Fuzzy c Means(GKPFCM). The performance of these algorithms depends upon the amount or type of information and the distance measure it uses. In this case, distance is the squared or absolute difference between a pixel and cluster centre but the result can be improved if spatial information is also taken into account. This will improve the better identification and quantification of the objects in the partitioned region of image.

We can check the results of these algorithms after applying them on fig 1(a). This is the original image of ripe and unripe bananas. Fig 1(b) shows the result of K-means algorithm. Fog 1(c) shows the result of Fuzzy c-means algorithm.

Fig 1(a) Original image

Fig 1(b)

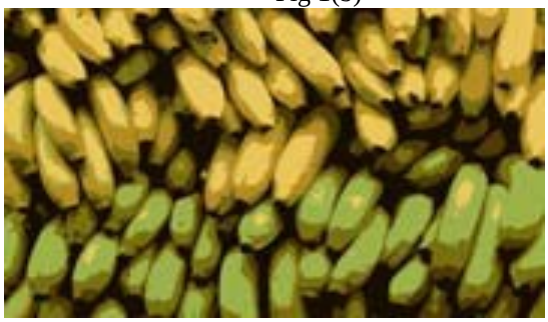

Fig 1(c)

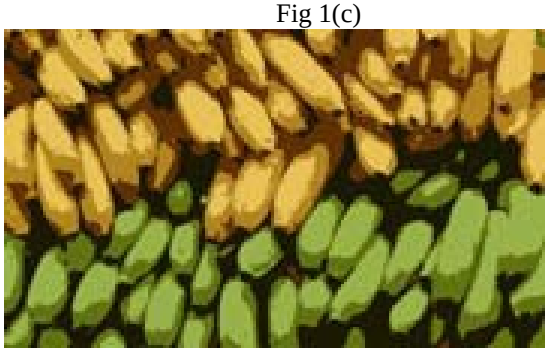

Fig 1(d)

Fig 1(e)

Fig 1(d) shows the result of GK-B (Gustafson-kessel-babuska) algorithm and finally fig 1(e) shows the result of GKPFCM (Gustafson-kessel Possibilistic Fuzzy c-Means) algorithm. At first sight we can see that the last algorithm shows the best result.

2)Histogram matching

In [14], according to author "Colour histogram represent the distribution or division of colours in an image". Global contrast of many images can be increases with this method, especially when the usable data of the image is represented by close contrast values. These adjustments help in uniformly distribution of intensities on the histogram. Hence the areas of lower local contrast can

gain higher contrast without affecting the global contrast [12].

In this method we convert the coloured image of fruits into gray scale image and find its histogram. After that we compare that histogram with the histogram of ripe fruit histogram sample and by this comparison we can easily find the ripeness of given fruit. According to [11], the colour histogram term is more often used for three dimensional spaces like RGB or HSV. But colour histogram use for all colour spaces. In [13] different histogram similarity measures are used to find most suitable and efficient one to check the ripeness of oil palm fruits.

3)Parameter based segmentation

According to [2], in this technique RGB colour space is used and the whole processing is directly applied on original coloured images. Firstly we set the value of three parameters- red, green and blue colours to detect ripe fruits. For example we know the ripe tomato have red colour and unripe tomato have green colour. To detect the ripeness of tomato in given image we will set the values of RGB colours in such a manner that only red colour will be segmented. Consider r (i), g (i) and b (i)) represent the intensities of red, green, and blue light. So the three basic rules for colour image segmentation of tomatoes are:

1. $r(i)>\alpha$, means primary colour component red should be greater than α.
2. $\beta1<(r(i)-g(i))<\beta2$, means the primary colour component (red-green) should be between $\beta1$ and $\beta2$.
3. $\gamma1<(r(i)-b(i))<\gamma2$, means the primary colour component (red-blue) should be between $\gamma1$ and $\gamma2$.

The first rule means that the value of r (i) — the intensity of red light should be larger than α. The second rule means that the value of (r (i) – g (i)) — (the intensity of red light) - (the intensity of green light) should be between $\beta1$ and $\beta2$. The third rule means that the value of (r (i) – b (i)) — (the intensity of red light) - (the intensity of blue light) should be between $\gamma1$ and $\gamma2$.

So, to calculate the maturity level of tomatoes in [2] author set the values as: $\alpha=20$, $\beta1=0$, $\beta2=110$, $\gamma1=20$, $\gamma2=160$. At last we can calculate the rate of maturity level of tomato by formula R = (the number of maturity tomatoes colour) / (the number of NOT the maturity tomatoes colour). More values of R mean more maturity.

In Fig 2(a) the queue of tomatoes are arranged according to their maturity levels i.e. lest most tomato is ripe one and the right most is unripe. After applying this technique on original image 2(a), segmented image 2(b) is obtained.

IV. Conclusion

Clustering algorithms performance can be improved if we use more quantity of information. It also depends upon type of distance measure used. Histogram matching technique provides better result because it increases the global contrast of image so that intensities can be better distributed on histogram. But both clustering algorithms and histogram matching needs colour space transform whereas parameter based segmentation don't use any colour space transform. So the last technique is also very effective to find maturity levels of fruits and vegetables without difficulty by partially changing the values of parameters (α, $\beta1$, $\beta2$, $\gamma1$, $\gamma2$).

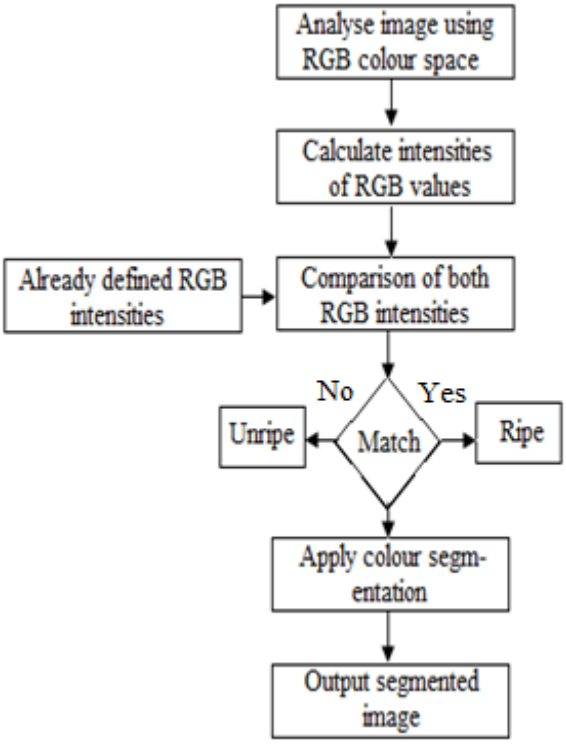

Fig. 2 Block diagram of Parameter based Image segmentation

Fig 2(a)

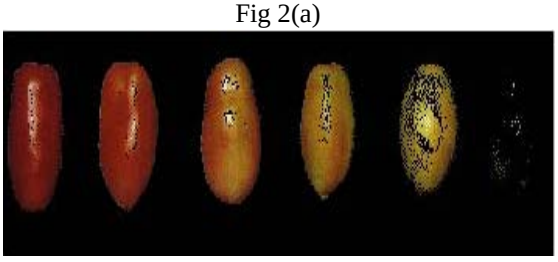

Fig 2(b)

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