International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Apple Grading Using Fuzzy Logic

Kevin K. Prajapati[1],Prof. Kinjal B. Mistree[2]
[1]*Computer Engineering, CGPIT, Uka Tarsadia University Bardoli, India,*kevin07263@gmail.com
[2]*Computer Engineering, CGPIT, Uka Tarsadia University Bardoli,India,* kinjal.mistree@utu.ac.in

Abstract—In this paper, a general approach is developed to estimate the ripeness level of the Apple. Apple grading is done up to some extent on basis of knowledge, experience or some other technique but the efficiency can be improved by upgrading the grading process. Two techniques have been used for this purpose - image segmentation using OTSU method for thresholding and fuzzy logic technique for classification. For this, image of apple is taken as the input and desired part from each image is separated using image segmentation. For segmenting image, OTSU method is used. After that, min-max values of L, A and B channel of segmented parts are calculated and given as input to FIS (Fuzzy Inference System). FIS gives decision whether the apple is ripe, under ripe or overripe. The same operation is applied on other images.
Keywords-LAB color space, Image segmentation, Fuzzy logic classification, Ripeness.

I. INTRODUCTION

In older days, human depends upon hisvision qualities to differentiate between ripe and unripe apples. But this method had high rate of errors because of illness, distraction and other factors during working hours. This also may affect 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 apples and vegetables. In some methods we apply chemicals on apples and sometimes we use machines. As we know, chemical may effects human health so usually machines are used for this purpose. Machines use their visual-based color classification system that provides 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 analyze the given image of apple and vegetable. Previously, computer systems were not robust enough to operate on large and real colors of images, so mostly grey scale images had been the main focus for researchers. But today, Computer system has been developed enough to work on large and true color images.

Generally, quality of the food product includes outer parameters (size, color intensity, color homogeneity, bruises, shape, stem identification, surface appearance and mass), inner parameters (sugar contents, acid contents or inner diseases) and firmness. The most important factors, which influence the shopping behaviour, are taste/flavour, freshness/ripeness, visual appeal and cleanliness. In order to meet these criteria an apple sorting and grading algorithms are required for apple processing industries [1].

1.1 LAB Color Space

The LAB Color space [10] is defined by the CIE, based on one channel for Luminance (lightness) (**L**) and two color channels (**a**&**b**). LAB color space is better suited to many digital image manipulations than the RGB space, which is typically used in image editing programs.

II. METHODOLOGY

Apple grading process consists of thresholding and fuzzy logic methods. As the whole methodology is mainly concerned with colures so color image segmentation [2] plays an important role in developing this system. The methodology can be divided in 5 steps. The flow of processing levels is explained in Figure 1.

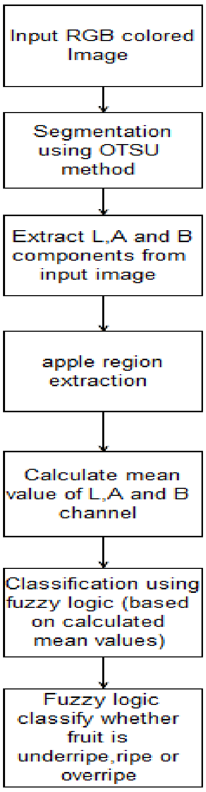

Figure 1. Flow Diagram

Step 1: Take input as RGB color image ofapple. As we know, each color is made up of combination of three primary colors- red, green and blue. To represent a color in color image each pixel has a fixed value of red, green and blue components. The intensity value varies from 0 to 255.

Figure 2. Input Images

Step 2: Convert RGB image to the LABcolor space. Extract the L, A and B components.
Step 3: Convert image into grey image andapply image segmentation using OTSU method thresholding. Image segmentation is a process of partitioning an image into meaningful regions with respect to colors. The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. In proposed scheme we have tried to detect ripeness level of apple by image segmentation [5].
OTSU thresholding technique [6] is one of the global thresholding methods and has been cited as an effective technique. OTSU's method is used to automatically perform clustering-based image thresholding, or, the reduction of a grey level image to a binary image. The algorithm assumes that the image to be threshold contains two classes of pixels like foreground and background.

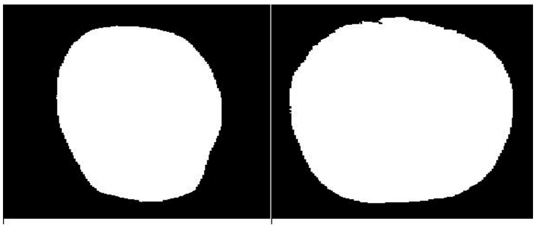

Figure 3. OTSU's Method Thresholding

Step 4: Calculate the minimum-maximum ormean value of segmented LAB image for each component. To classify the apple into under ripe, ripe and overripe categories, we need to convert RGB image into the LAB color space and obtain a range of mean value of L, A and B layer for each apple. These ranges values are used as a reference and a range input of fuzzy logic system. Total of 3 images are used in determining the range value of L, A and B of each category. The mean values of L, A and B layers are calculated using the following equations:

Mean L = L / No. of pixels,
Mean A = A / No. of pixels,
Mean B = B / No. of pixels,
Where Mean L = Mean value of L layer,
Mean A = Mean value of A layer,
Mean B = Mean value of B layer.

This step was individually performed on each image of apple. The range value (minimum and maximum) of LAB value for each category (under ripe, ripe and overripe) is obtained from the above calculation.

Step 5: Values are given as input to the FIS(Fuzzy Inference System) tool [8]. Rules are added into the rule editor. FIS classifies whether the apple is ripe, underripe or overripe. This range value is used as a reference for the fuzzy logic system in order to classify the category of apple. Fuzzy logic is a method that depends upon truth values rather than the Boolean logic of the given system. The fuzzy logic has three steps to process such as Fuzzification, Defuzzification and Fuzzy Inference System with the Fuzzy set or conditions for truth values.

To implement above algorithm & to classify whether the apple is ripe, underripe or overripe. FIS (Fuzzy Inference System) tool is used which allows different arithmetic operations, fuzzification and defuzzyfication methods.

Sugeno model is used to classify the inputs A and B channel because it is a more compact and computationally efficient representation than Mamdani system, the Sugeno system lends itself to the use of adaptive techniques for constructing fuzzy models.

The two inputs are mean values of A, and B layers and output is Category (ripe, under ripe, about to under ripe and overripe). The membership functions are built using trapezoidalshapes since it gives the best result compared to other shapes. A total of 6 rules statements are created in order to classify the apple categories. Examples of the rules are illustrated as follows:

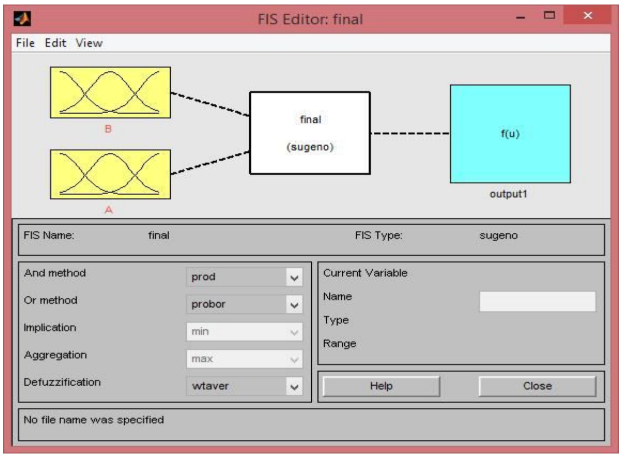

Figure 4. FIS Editor Consist of Two inputs and one output

1 If (B is high) and (A is medium) and then (category is under ripe).
2 If (B is medium) and (A is medium) and then (category is overripe).
3 If (B is low) and (A is medium) and then (category is ripe).

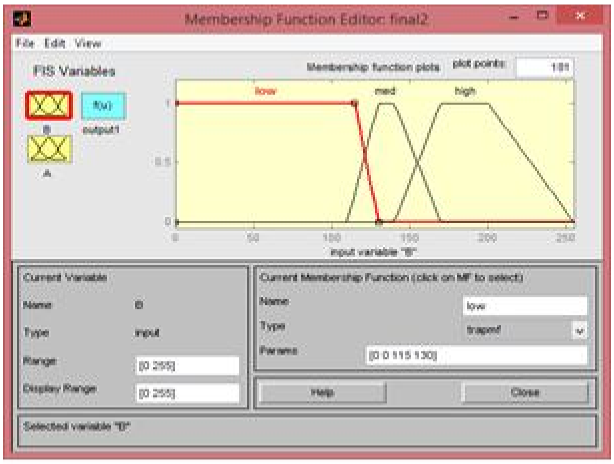

Figure 5. Membership Function Representation of B channel input

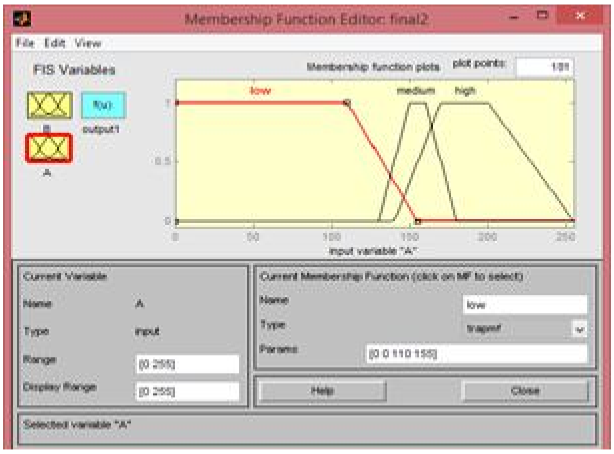

Figure 6. Membership Function Representation of A channel

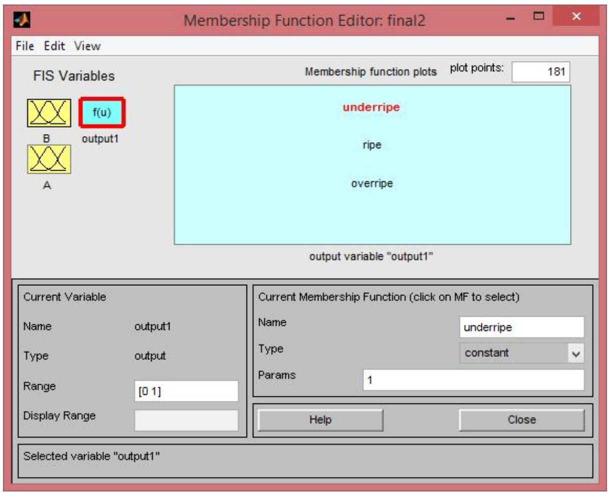

Figure 7. Membership Function Representation of Output

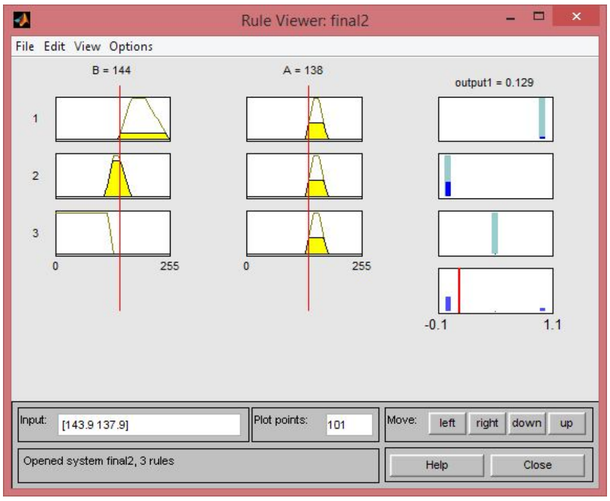

Figure 8. Defuzzification Result from Rule Viewer

Above figure 8 shows the rule viewer of the system's input and output and the defuzzyfication result column. The first and second column is the inputs which are B channel and A channel values, while the last column is the category column. The last row of the category column shows the defuzzification result where category of apple is obtained. The functions adopted to implement the "and" and "or" operations were the minimum and maximum functions, respectively. The sugeno method was chosen as the defuzzification procedure, which means that the fuzzy sets obtained by applying each inference rule to the input data were joined through the add function; the output of the system was then computed as the resulting membership function.

III. RESULTS

The system developed is managed to classify fruit in ripe, under ripe and overripe categories. Table 1 shows the ranges of L, A and B mean values to categorized given apple sample. This step was individually performed on each image of apple. The range value (minimum and maximum) of LAB value for each category (under ripe, ripe and overripe) is obtained from the above calculation. This range value is used as a reference for the fuzzy logic system in order to classify the category of apple.

Table 1. Results of LAB components

Category		L Component	A Component	B Component
Underripe	Min	80	82	139
	Max	195	156	196
Ripe	Min	136	127	127
	Max	255	194	175
Overripe	Min	34	134	158
	Max	143	176	254

CONCLUSION

In this paper, an image segmentation algorithm that can examine the ripeness level of apple using LAB color space and fuzzy logic is presented. This approach can operate directly on LAB color space without the need of color space transformation. Moreover, the system can be applied to different applications without any difficulty by merely changing the values of the channels L, A and B.

REFERENCES

[1] B. Ojeda-Magana, R. Ruelas, J. Quintanilla-Domingvez and D. Andina, "Image Segmentation by Partitional Clustering Algorithns", IECON 2010 - 36th Annual Conference on IEEE Industrial Electronics Society, 7-10 Nov., Glendale, AZ, 2010, pp.2828 -2833.

[2] Chiunheium Lin, ching- Hung Su,HsuanShu Huang and Kuo-Chin Fan, "Colour Image Segmentation Using Relative values of RGB in Various Illumination, Circumstances", International Journal of computers, vol.5(2) , 2011, pp.252-261.

[3] Scanlon, M. G., "Computerized video image analysis to quantify colour of potato chips", American Potato Journal, Vol. 71(11), 1994, pp. 717-733.

[4] F.Mendoza, J .M. Aguilera, "Application of Image Analysis for Classification of Ripening Bananas", Journal of Food Science. 69(9), 2004, pp.415-423.

[5] G.Maitre, H. Hugli, F. Tieche and J. P. Amann, "Range Image Segmentation Based on Function Approximation", published at ISPRS90, Zurich, and Sept. 1990.

[6] J.Blasco, N. Aleixos, E., "Molto. Machine Vision System for Automatic Quality Grading of Apple", Biosystems Engineering, vol. 85 (4), 2003, pp.415-423.

[7] Zhi- yuan Wen, Lu-mingShen, Hui-pngjing, Kui Fang, "Colour and Shape Grading Of Citrus Apple Based on Machine Vision with FractelDimention", 3rd International Congress on Image and Signal Processing (CISP2010),IEEE 2010,pp. 898-903.

[8] S. Romani, P. Sobrevilla, E. Montseny, "Obtaining the Relevant Colours of an image through Stability- based Fuzzy Colour Histograms", The IEEE International Conference On Fuzzy Systems , 2003 pp. 914-919.

[9] Rafael C.Gonzalez, Richard E. Woods and Steven L. Eddins,"digital image processing using MATLAB", pp.208-211.

[10] http://en.wikipedia.org/wiki/Lab_color_space

