International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-1, October 2012

Estimate Ripeness Level of fruits Using RGB Color Space and Fuzzy Logic Technique

Meenu Dadwal, V.K.Banga

Abstract—In this paper, a general approach is developed to estimate the ripeness level without touching the fruit. The two techniques has been used for this purpose are - color image segmentation and fuzzy logic technique. Four images of a single fruit have been clicked from four directions and separate desired part from each image using color image segmentation. Now calculate mean values of primary colors (Red, Green and Blue) of segmented parts and give it as input to FIS (Fuzzy Inference System) editor 1. FIS editor 1 gives decision whether this part of fruit is ripe, under ripe, about to ripe, about to overripe or overripe. The same operation is applied on remaining three images. These four outputs have been given to FIS editor 2. This editor gives decision whether the whole fruit is ripe, under ripe, or overripe.

Index Terms—Color image segmentation, Fuzzy logic, RGB color space, Ripeness.

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 analyze 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 color images [2]. 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 II gives description about methodology we are using here. Section III gives experimental results. Finally, some conclusions are represented in section IV.

II. METHODOLOGY

To apply given methodology we clicked four images of apple from four different directions. As the whole methodology is mainly concerned with colures so color image segmentation plays an important role in developing this system. The methodology can be divided in 5 steps – A, B, C, D and E. The flow of processing levels is explained in Fig. 1.

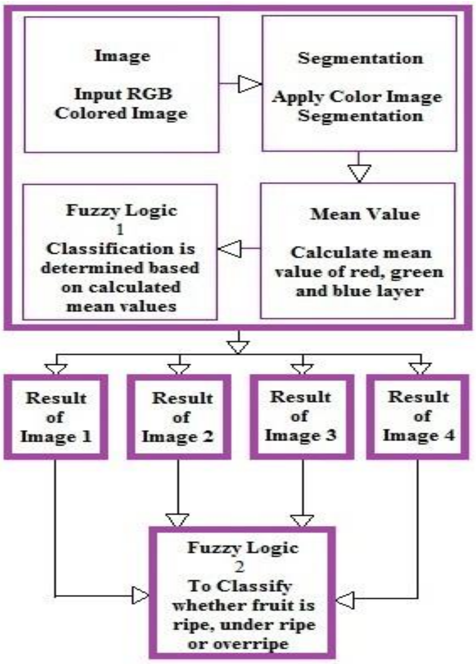


Fig. 1

Manuscript published on 30 October 2012.
***** Correspondence Author (s)
Meenu Dadwal, Department of Electronics and Communication, PTU University/ Amritsar College of Engineering and Technology, Amritsar, India.
Dr. V.K.Banga, Head of Department of Electronics and Communication, PTU University/ Amritsar College of Engineering and Technology, Amritsar, India.

A. Input RGB Colored Image

As we know, each color is made up of combination of three primary colors- red, green and blue. To represent a color in colored image each pixel has a fixed value of red, green and blue components. In RGB color space pixel p (i) is defined by ordered triplet of red, green and blue coordinates (r(i),g(i),b(i)),which represents the intensities of red , green and blue light respectively. The intensity value varies from 0 to 255. According to [11], it is an M*N*3 array of pixels, where each color pixel is a triplet corresponding to the red, green and blue components of an RGB image at a specific spatial location. The given Fig 2(a), 2(b), 2(c) and 2(d) are showing four images of an apple from four directions.

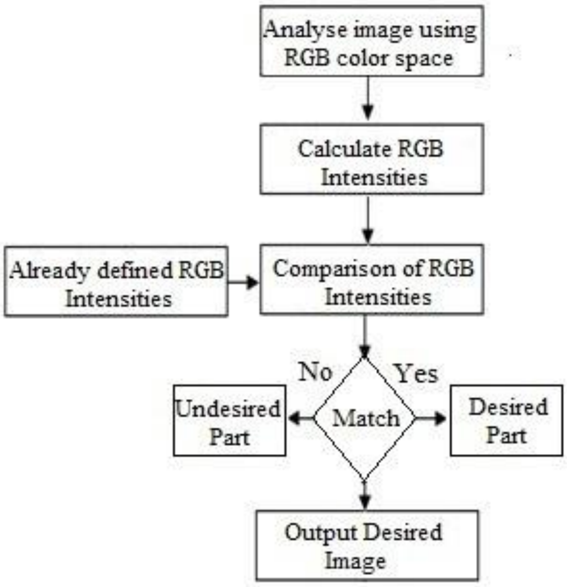
Fig 2(a) Fig 2(b) Fig 2(c) Fig 2(c)

B. Color Image Segmentation

Color image segmentation is a process of partitioning an image into meaningful regions with respect to colours. 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 are trying to detect ripeness level of apple by colour image segmentation. Firstly we studied pixel values of different shades of red colour for apple. From the observation we find that there is fixed range of r, g and b values which corresponds to same colour shades of apple. Therefore, we set the three basic rules according to which we detect the ripeness level of individual fruit.

1. r (i) > a: means that the primary colour component (red) should be larger than a .
2. g (i) < b: means that the primary colour component (green) should be larger than b.
3. b (i) < c: means that the primary colour component (blue) should be larger than c.

The value of “a”=80,”b”=83 and "c" = 95 are experimentally found to be satisfactory in the color segmentation. The first rule means that the value of r (i) - the intensity of red light should be larger than a. The second rule means that the value of g (i) - the intensity of green light should be less than b. The third rule means that the value of b (i) - the intensity of blue light should be less than c. In other words, if pixels of the input image satisfy the above 3 rules, then the pixels are regarded as desired part of fruit. You can give different values to a, b and c for distinct applications and the output will be altered. In flow chart 1.1 we describe the whole procedure in which way our scheme will perform. In first step we give input RGB image of fruit. Secondly, we calculate the intensity level of RGB values of input image. In third step, we compare our input image’s RGB intensities with already defined RGB values.



Flow Chart 1.1

In image, where these RGB intensities will match that is desired part and rest part is undesired part.

The resulted segmented images are showed in Fig 3(a), (b), (c) and (d).

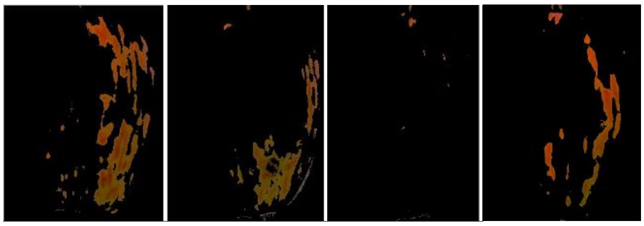


Fig 3(a) Fig 3(b) Fig 3(c) Fig 3(d)

C. Calculate Mean Values

To classify the fruit into under ripe, ripe and overripe categories, we need to obtain a range of mean value of red, green and blue layer for each fruit. These ranges values are used as a reference and a range input of fuzzy logic system. A total of 80 images are used in determining the range value of red, green and blue of each category. The mean values of red, green and blue layers are calculated using the following equations:

Mean R = R / No. of pixels
Mean G = G / No. of pixels
Mean B = B / No. of pixels

Where

Mean R = Mean value of Red layer
Mean G = Mean value of Green layer
Mean B = Mean value of Blue layer
R = Red pixel
G = Green pixel
B = Blue pixel

This step was individually performed on each image of apple. The range value (minimum and maximum) of RGB 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.

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D. Fuzzy Logic for Segmented Image

Here we are using Fuzzy Logic for classifying the apple into under ripe, ripe and override categories. Where the data is trained and the classification is made for given fruit We choose this technique because it represents a good approach when we want to interpret the decision making process of human to the computer. The Fuzzy Inference System works in 3 main steps: Define the input and output in Membership Function Editor, Set the fuzzy rules in Rule Editor and Get the output for each rule in Rule Viewer. The whole process is explained in Fig 4 to 6.

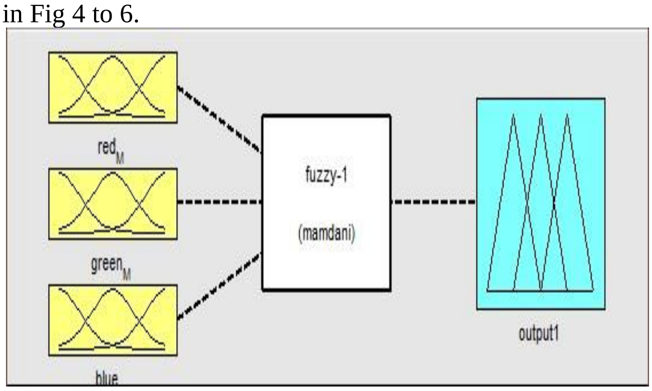

Fig 4: FIS editor 1 consist of three inputs and one output

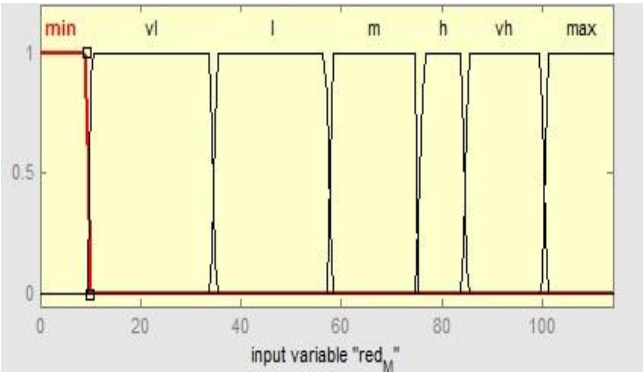

Fig 5(a): Membership function representation of red input

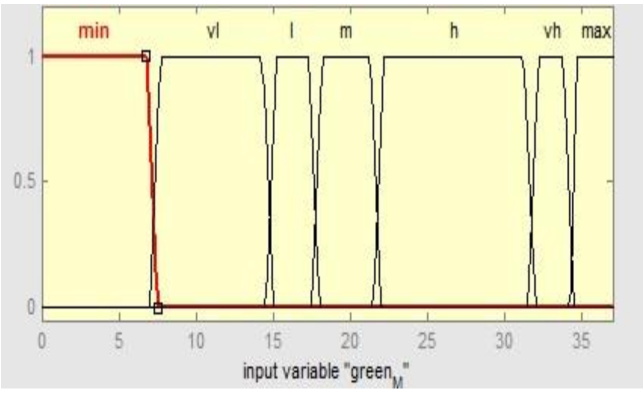

Fig 5(b): Membership function representation of green input

The three inputs are mean values of Red, Green and Blue layers and output1 is Category (ripe, under ripe, about to under ripe, about to overripe and overripe). The membership functions are builds using trapezoidal shapes since it gives the best result compared to other shapes. A total of 40 rules statements are created in order to classify the apple categories. Examples of the rules are illustrated as follows:

1. If (red is low) and (green is low) and (blue is low) then (category is under ripe)
2. If (red is high) and (green is high) and (blue is high then (category is overripe)
3. If (red is medium) and (green is medium) and (blue is medium) then (category is ripe)
4. If (red is very high) and (green is very high) and (blue is very high) then (category is overripe)

Above are some rules which describe the category in which an apple can lie. Figure 7 below shows the rule viewer of the system's input and output and the defuzzification result column. The first to third column is the inputs which are red, green and blue 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.

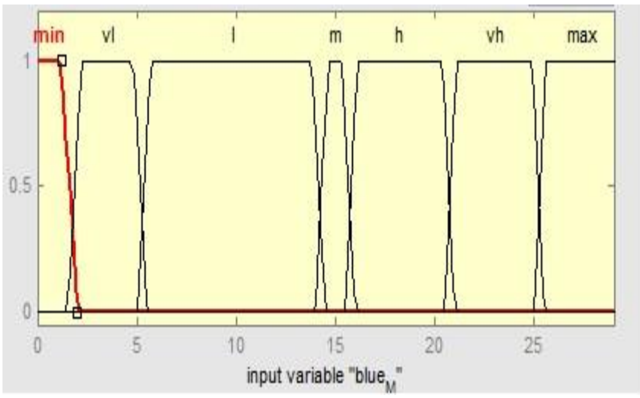

Fig 5(c): Membership function representation of blue input

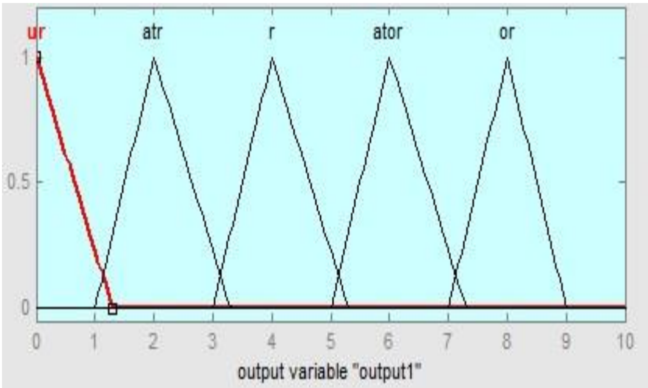

Fig 6:Membership function representation of output1

Based on the Defuzzification result from the Rule Viewer from Fig. 7, the apple fulfilled Rule 1 where red is low, green is low and blue is low. The value of the category is calculated by using the centroid method. The Defuzzification rules are:

1. If Defuzzification output is less than 1, Category is under ripe (ur).
2. If Defuzzification output lies between 1 to 3, Category is about to ripe (atr).
3. If Defuzzification output lies between 3 to 5, Category is overripe.
4. If Defuzzification output lies between 5 to 7, Category is overripe (or).

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5. If Defuzzification output lies between 7 to 9, Category is about to overripe (ator).

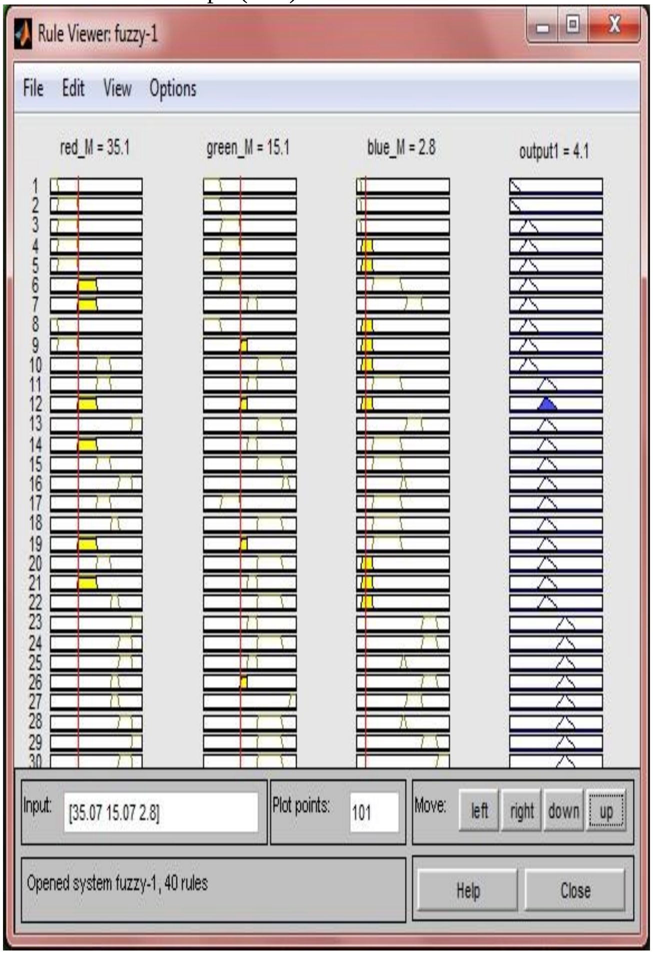

Fig. 7:Defuzzification result from Rule Viewer

E. Fuzzy Logic to Detect Ripeness Level of Fruit

Steps A to D are applied on four images of an apple. Calculated category values of each image are given as input to FIS editor 2 to estimate the ripeness level of apple from all sides.

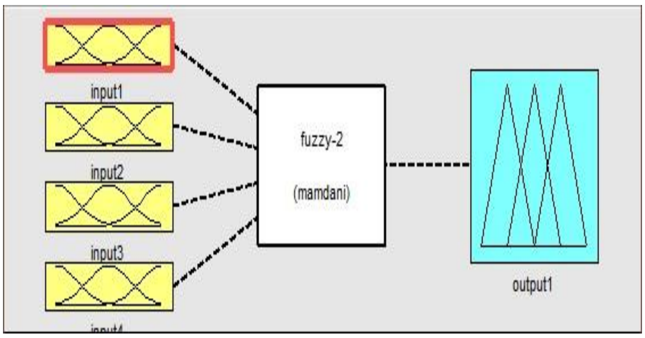

Fig 8: FIS editor 2 consist of four input and one output

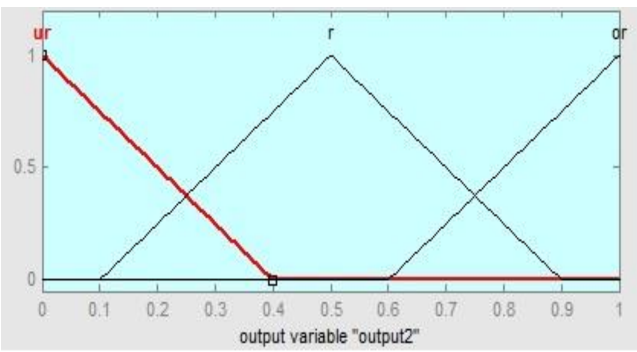

Fig. 9: Membership function representation of output 2

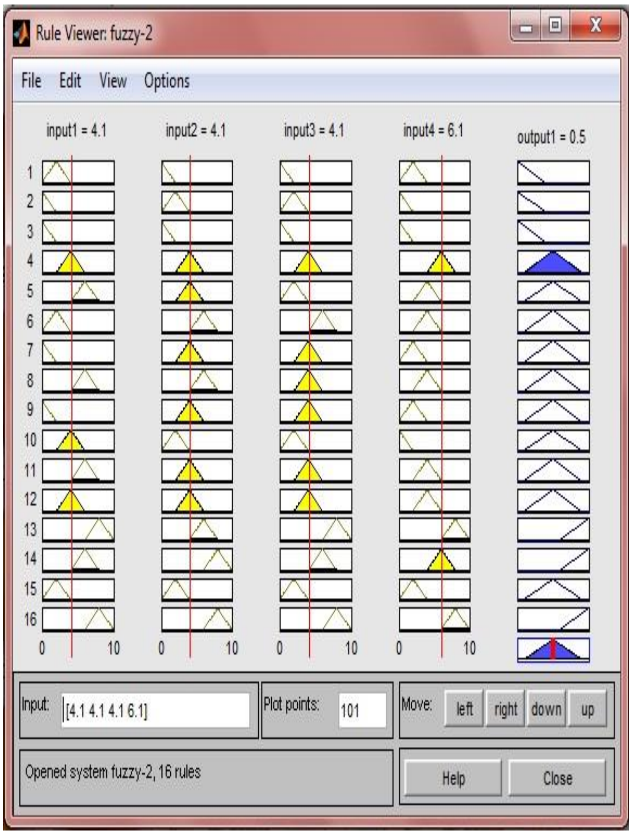

Fig 10:Defuzzification result from Rule Viewer

Figure 8 shows 4 inputs and 1 output value to FIS editor 2. These four inputs are the category values of Fig 2(a), 2(b), 2(c) and 2(d) and the output categories as shown in Fig. 9 are ripe, overripe and under ripe. As like in FIS editor 1, FIS editor 2 some predefined Defuzzification range have been used to get output as shown in Fig 10 but total 16 rules statements are created in order to classify the apple categories.

III. EXPEIMENTAL RESULTS

The system developed is managed to classify fruit in ripe, under ripe and overripe categories. Table 1 shows the ranges of red, green and blue mean values to categorized given fruit sample.

Table 1

Category	Red mean Min	Red mean Max	Green mean Min	Green mean Max	Bluemean Min	Bluemean Max
Underripe (ur)	0.0	9.3	0.0	6.45	0.0	4.09
Ripe (r)	35.0	118.4	14.0	33.3	2.8	16.0
Overripe (or)	72.1	100.8	17.7	31.9	21.0	28.0
About to Ripe(atr)	6.50	47.9	4.1	17.5	3.1	19.6
About to Overripe (ator)	83.4	113.8	17.6	36.6	14.7	25.5

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But in some cases these ranges do not give accurate results. Some value lies in overlapped regions in red, green and blue mean values. Hence sometimes provide unexpected results.

IV. CONCLUSION

In this paper, a novel color image segmentation algorithm that can examine the ripeness level of apple using RGB color space and fuzzy logic is proposed. This approach can operate directly on RGB 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 parameters a, b and c. This technique can be used to detect ripeness level of fruits, vegetables and in medical field to find different stages of diseases in human body on color bases.

REFERENCES

[1] B. Ojeda-Magana, R. Ruelas, J. Quintanilla-Domingvez and D. Andina, "Colour Imge 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,Hsuan Shu 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] J. Blasco, N. Aleixos, E., "Molto. Machine Vision System for Automatic Quality Grading of Fruit", Biosystems Engineering, vol. 85 (4),2003, pp.415-423.

[6] Ling Mei Chang, Rodney Tan, Gilbert Thio, "Design Of Visual- based Colour Classification System", Research papers, JASA 2, January 2007,pp. 30-33.

[7] Zhi- yuan Wen, Lu-ming Shen, Hui-png jing, Kui Fang, "Colour and Shape Grading Of Citrus Fruit Based on Machine Vision with Fractel Dimention", 3rd International Congress on Image and Signal Processing (CISP2010),IEEE 2010,pp. 898-903.

[8] Choi K. H., "Tomato maturity evaluation using colour image analysis", Transactions of the ASAE, Vol. 38(1), 1995, pp. 171-176.

[9] 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.

[10] Allan Hanbury, "Physics based Segmentation of Colour Images in Spherical Coordinates", Technical Report,23rd july, 2003, pp. 1-2.

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

[12] Wikipedia, the free encyclopedia. Color image segmentation, 2010

Meenu Dadwal is scholar in Department of Electronics & Communication Engineering in Amritsar College of Engineering and Technology, Amritsar, Punjab, India. She did his B.Tech (Electronics and Communication Engineering) from Punjab Technical University, Jalandhar. India. and pursuing M.Tech (Electronics and Communication Engineering) from Amritsar College of Engineering and Technology, Amritsar, Punjab, India. She has 4 national and 1 international conferences to her credit.

Vijay Kumar Banga is working as Professor and Head of the Department of Electronics & Communication Engineering, Amritsar College of Engineering and Technology, Amritsar, Punjab, India. He obtained his B. E (Electronics and Instrumentation Engineering) from Punjabi University, Patiala, Punjab, India, M.Tech (Electronics and Instrumentation) from Panjab University , Chandigarh, India and Ph.D. in Electronics (Artificial Intelligence) form Thapar University, Patiala., India. Presently, he has 13 years of research and UG & PG teaching experience. He has 35 research papers to his credit in various international journals and conferences. He is member of Board of Studies in Electronics and Communication Engineering of Punjab Technical University, Jalandhar, Punjab, India. His areas of research and interest include Robotics, Artificial Intelligence, automated control systems and Genetic algorithms.

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