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Color Image Segmentation Using Fuzzy Masking Methods

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ABSTRACT: Color Image Segmentation separates the image into distinct regions of similar pixels based on pixel property. It is the high level image description in terms of objects, scenes, and features. The success of image analysis depends on segmentation reliability. This article presents a novel approach for color image segmentation using two different algorithms with respect to color features. Here presented an adaptive masking method based on fuzzy membership functions and a thresholding mechanism over each color channel to overcome over segmentation problem, before combining the segmentation from each channel into the final one. Our proposed method ensures accuracy and quality of different kinds of color images. Consequently, the proposed modified fuzzy approach can enhance the image segmentation performance by use of its membership functions. Similarly, it is worth noticing that our proposed approach is faster than many other segmentation algorithms, which makes it appropriate for real-time application. According to the visual and quantitative verification, the proposed algorithm is performing better than existing algorithms.

KEYWORDS: Color Segmentation, Fuzzy Membership Functions, Edge Detection, Region Growing

I. INTRODUCTION

Image segmentation is one of the most important steps most important to the analysis of processed image data, which refers to grouping of similar pixels together and separating the particular portion of the image for the purpose of identification. Main goal of segmentation is to partition an image into regions that have strong correlation with objects or areas of the real world contained in the image. In computer vision, Segmentation is the process of partitioning a digital image into multiple segments. The main aim of segmentation is to simplify and/or change the representation of an image into something that is more meaning and easier to analyze and is to cluster pixels into relevant image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects easy to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, points, etc.,) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such as that pixel with the same label share certain image characteristics. The result of image segmentation is a set of segments that collectively cover the entire, or a set of contours extracted from the image. If an image has been pre-processed appropriately to remove noise and artifacts, segmentation is often the key step in interpreting the image. Image segmentation is a process in which regions and features sharing similar features are identified and grouped together.

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. The same problem of finding discontinuities in 1D signal is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction. Edge detection is a type of image segmentation techniques which determines the presence of an edge or line in an image and outlines them in an appropriate way. The main purpose of edge detection is to simplify the image data in order to minimize the amount of

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data to be processed. Generally, an edge is defined as the boundary pixels that connect two separate regions with changing image amplitude attributes such as different constant luminance and tri stimulus values in an image.

Edge Based Approach

Edges of an image are considered as a type of crucial information that can be extracted by applying detectors with different methodology. The task of edge detection requires neighborhood operators that are sensitive to changes and suppress areas of constant gray values. In this way, a feature image is formed in which those parts of the image appear bright where changes occur while all other parts remain dark. Only if it can formulate a model of the edges, can determine how accurately and under what conditions it will be possible to detect an edge and to optimize edge detection. Edge detection is always based on differentiation in one or the other form. In discrete images, differentiation is replaced by discrete differences, which only approximate to differentiation. The errors associated with these approximations require careful consideration. They cause effects that are not expected in the first place. The two most serious errors are: anisotropic edge detection (edges are not detected equally well in all directions), and erroneous estimation of the direction of the edges. While the definition of edges is obvious in scalar images, different definitions are possible in multi component or vectorial images. An edge might be a feature that shows up in only one component or in all. Edge detection also becomes more complex in higher-dimensional images. In three dimensions, volumetric regions are separated by surfaces, and edges become discontinuities in the orientation of surfaces.

The paper is organized as follows: Section 2 discuss about the related works carried out in the field of color image segmentation. Section 3 discuss about the modules to be proposed. Section 4 highlights discussion on the experiments to be done. Section 5 finally concludes the paper with future enhancement.

II. RELATED WORK

In present days digital image processing plays vital role in all fields and it contains flexible options to satisfy the user needs. Segmentation is one of the fundamental steps in digital image processing. In that, edge detection is one of the concept which gives exact position of the object which is located in the given input image. Detection of edges gives an exact result of objects which is searching by the user. There are various concepts which are introduced to find edges. Here are some related works done by various researchers in the field of color image segmentation. Habibur Rahman states that combination of two different methods produce some better results. In their work Thresholding and masking methods were proposed. For Thresholding, adaptive Thresholding is suggested and in the mean time masking with watershed algorithm also proposed to get the results as enhanced color image. Their experimental results were obtained using image quality assessment (IQA) metrics such as PSNR, MSE, PSNRRGB and Color Image Quality Measure (CQM) based on reversible YUV color transformation.

Firas Ajil Jassim proposed a novel algorithm based on combining two existing methods to obtain a significant method to partition the color image into significant regions. On their first phase, the traditional Otsu method for gray channel image segmentation were applied for each of the R,G, and B channels separately to determine the suitable automatic threshold for each channel. After that, the new modified channels are integrated again to formulate a new color image. The resulted image suffers from some kind of distortion. To get rid of those distortion, the second phase is arise which is the median filter to smooth the image and increase the segmented regions.

Rafael Guillermo Gonzalez Acuna generalizes Otsu's binarization method towards reduction of color levels in color images. Color defines a multi-dimensional property vector at each pixel location, and this can be further generalized towards considering arbitrarily finite-dimensional property vectors at pixel locations.

Otsu's binarization method, originally already briefly discussed by Otsu for multi-Thresholding, was efficiently mapped earlier into a segmentation method for grey-level images by recursively applying the original binarization method. They generalize further by proposing a recursive algorithm for finite dimensional property vectors at pixel locations.

Navkirat Kaur presented color image segmentation algorithm in the form of color conversion. They convert RGB image to HSV because it gives the color according to human perception. Further three matrixes are made by three different planes. Firstly, a single new matrix is formed so as to see values of RGB at each pixel. If two rows are equal in a single new matrix then combine those rows. After that total number of colors existing in an original image is

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calculated. To see the exact color enter the number of colors wants to see and finally processed image is converted from HSV to RGB color space.

A.Kalaivani, Dr.S.Chitrakala represented K-Means Clustering algorithm which is the popular unsupervised clustering used for dividing the images into multiple regions based on image color property. The major issue of the algorithm is that the user has to specify the number of clusters-K, which is used to split the image into K regions. To overcome the issue, they focused on determining K automatically based on local maxima of gray level co-occurrence matrix.

Automatic generated K value is then passed to Fast K-means Clustering algorithm for segmenting color images into multiple regions.

A.Borji & M.Hamidi proposed a new method for color image segmentation using fuzzy logic membership functions. Sugeno type fuzzy inference system is used. Trapezoidal, Gaussian and bell shaped membership functions are investigated in their work and the results are compared. Trapezoidal membership function quotes better results among other functions. Md. Abul Hasnat, Olivier Alata and Alain Tremeau proposed an unsupervised method for indoor RGB-D image segmentation and analysis. Worked a statistical image generation model based on the color and geometry of the scene and it consists of a joint color-spatial-directional clustering method followed by a statistical planar region merging method. Evaluate their method on the NYU depth database and compare it with existing unsupervised RGB-D segmentation methods.

III. PROPOSED ALGORITHM

Many approaches to color image segmentation have been proposed over the years. Image edge detection is the simplest and widely used segmentation method to segment gray or color images into regions. A wide variety of color models used are RGB, YIQ, YUV, HIS, HSL, CIE, YCbCr. All the color models have their own applications of usage with its merits and demerits. RGB color model is good for color image segmentation while HSL color model finds wider applications in both image and video processing. The most common color image segmentation methods are histogram based and edge based segmentation. The promising segmentation techniques are spatial clustering method and region based segmentation method. In histogram based segmentation technique, a histogram is created based on the input image. Here edge based segmentation is taken for research and it can be implemented through fuzzy membership functions.

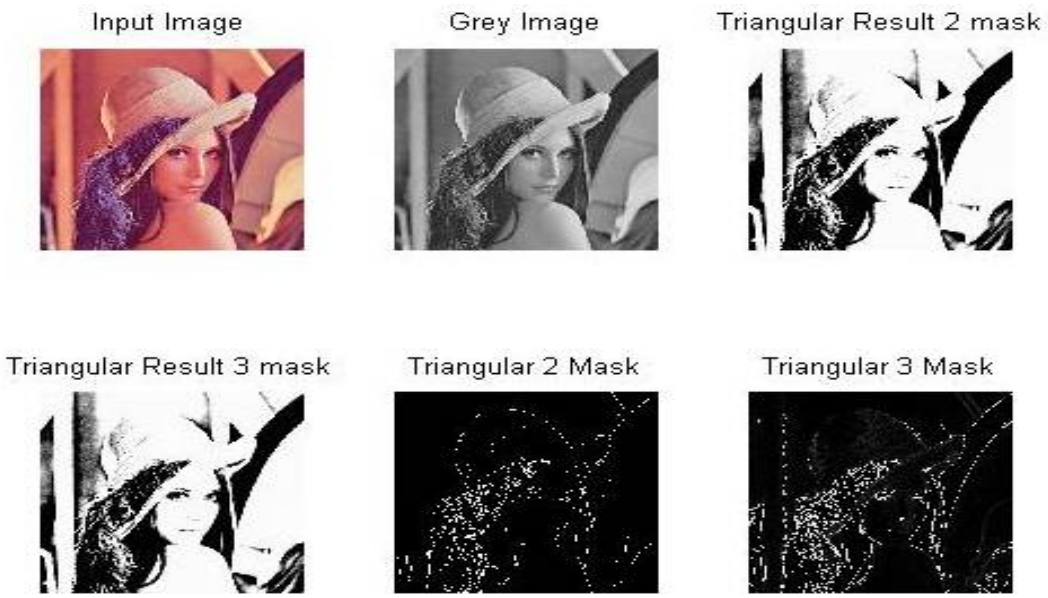

Figure 1: Results of Triangular Membership Function using 2X2 and 3X3 Masks

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Previously edge based segmentation is proposed with grey level images with different masking properties through fuzzy logic membership functions. Triangular membership function is taken as existing work and the proposed methods results are compared with triangular membership function. Triangular membership function is the proposed method, in that 2x2 and 3x3 masks are created. Both masks results are compared with triangular functions mask results. Color is perceived by humans as a combination of tristimuli *R* (red), *G* (green), and *B* (blue) which is usually called three primary colors. From *R, G, B* representation, we can derive other kinds of color representations by using either linear or nonlinear transformations.

Several color spaces, such as *RGB, HSI, and CIE* are utilized in color image segmentation, but none of them can dominate the others for all kinds of color images. Selecting the best color space still is one of the difficulties in color image segmentation. Red, green, and blue components can be represented by the brightness values of the scene obtained through three separate filters (red, green, and blue filters). Any color can be expressed by these three color bases. *RGB* is the most commonly used model for the television system and pictures acquired by digital cameras. Video monitors display color images by modulating the intensity of the three primary colors (red, green, and blue) at each pixel of the image. *RGB* is suitable for color display, but not good for color scene segmentation and analysis because of the high correlation among the *R, G,* and *B* components. By high correlation, we mean that if the intensity changes, all the three components will change accordingly. Also, the measurement of a color in *RGB* space does not represent color differences in a uniform scale; hence, it is impossible to evaluate the similarity of two colors from their distance in *RGB* space. Color image has been recognized that human eye can discern thousands of color shades and intensities but only two-dozen shades of gray. It is quite often when the objects cannot be extracted using gray scale but can be extracted using color information.

Compared to gray scale, color provides information in addition to intensity. Color is useful or even necessary for pattern recognition and computer vision. Also the acquisition and processing hardwares for color images have become more available and accessible to deal with the computational complexity caused by the high-dimensional color space. Hence, color image processing has become increasingly more practical. As mentioned before, the literature on color image segmentation is not as extensively present as that on monochrome image segmentation. Most published results of color image segmentation are based on gray level image segmentation approaches with different color representations. Texture is considered to be the major problem for all segmentation techniques, thus much more discussion was made on texture analysis than on color representation, and the problems of feature extraction in images with textural variations are discussed particularly.

Segmentation approaches are categorized into four classes: pixel based segmentation, area based segmentation, edge based segmentation and model based segmentation. A brief conclusion is drawn based on the analysis of the literature available. Most gray level image segmentation techniques can be extended to color images, such as histogram thresholding, clustering, region growing, edge detection, fuzzy approaches and neural networks. Gray level segmentation methods can be directly applied to each component of a color space, and then the results can be combined in some way to obtain a final segmentation result. However, one of the problems is how to employ the color information as a whole for each pixel. When the color is projected onto three components, the color information is so scattered that the color image becomes simply a multispectral image and the color information that humans can recognize is lost. Another problem is how to choose the color representation for segmentation. Each color representation has its advantages and disadvantages and there is no single color representation that can surpass others for segmenting all kinds of color images. In most of the existing color image segmentation approaches, the definition of a region is based on similarity of color. This assumption often makes it difficult for any algorithms to separate the objects with highlights, shadows, shadings or texture which cause in homogeneity of colors of the objects' surface.

Membership Functions

A Membership Function (MF) is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The input space is sometimes referred to as the universe of discourse, a fancy name for a simple concept. One of the most commonly used examples of a fuzzy set is the set of tall people. Here Triangular Membership function is taken for experiment and the curve is altered as per the function.

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IV. DISCUSSION

Recently, there are a large number of color image segmentation techniques. Basically it can be classified into four general categories: Pixel-based, Edge-based, Region-based, and Model-based techniques. Actually, the basic behaviour of these techniques can be divided into three concepts. The first concept is the similarity concept like Edge-based techniques. Alternatively, the second concept is based on the discontinuity of pixel values like Pixel-based and Region-based techniques. Finally, a complete different approach is the third concept which is based on a statistical approach like Model-based techniques. In the third concept, segmentation is implemented as an optimization problem. Different kinds of Segmentation techniques are introduced and several results are discovered under color images. Here we expect combining two or more techniques produce effective results compared to single technique. In that point of view, Otsu method is taken and further noise removal and Thresholding features are included.

Generally, Otsu method is one of the oldest methods in image segmentation and it is treated as a statistical method according to its probabilistic execution. It must be mentioned that the Otsu method is one of the best automatic thresholding methods and the basic principle in Otsu method is to split the image into two classes which are the objects and the background. The automatic threshold is obtained through finding the maximum variance between the two classes. Practically speaking, let I=[1,L] is the range of greyscale levels of image f(x,y) and pi is the probability of each level. The number of pixels with gray level i is denoted fi, giving a probability of gray level i in an image as: (1) Nf p i i. Then, the automatic threshold t that divides the range into two classes which are C0 = [1,…, t] and C1=[t+1, L]. It also revised for color images with some modified averages. After splitting the classes, noise removal and proposed techniques are recommended for Thresholding region.

In existing work, edge detection have been done by fuzzy's inference system's triangular membership functions. In that, 2*2 and 3*3 mask are examined with the help of various fuzzy inference rules. Different input and output fuzzy sets are declared. In present works, fuzzy's trapezoidal membership function is used and 2*2 and 3*3 masks are generated. The result of both masks are compared to previous works and find that proposed work works well by finding exact edges in the given input image. The analysis can be done through finding edge plot percentage. Same way color image are taken for segmentation with major changes in fuzzy membership rules. RGB color model is chosen for proposed method and the variables are declared in masking frame. Below figure represents the work flow of future work which will works on color images.

Basically, Region based methods are based on continuity in objects. These techniques divide the entire image into sub regions depending on some rules like all the pixels in one region must have the same gray level. Region-based techniques rely on common patterns in intensity values within a cluster of neighbouring pixels. The cluster is referred to as the region, and the goal of the segmentation algorithm is to group the regions according to their anatomical or functional roles. Using thresholding technique regions can be classified on the basis range values, which is applied to the intensity values of the input image pixels. Thresholding is computationally economical and fast, it is the oldest segmentation method and is still widely used in simple applications. Using range values or threshold values, pixels are classified using either of the thresholding techniques like global and local thresholding. Global thresholding method selects only one threshold value for the entire image. Local thresholding selects different threshold values for different regions. To segment complex images multilevel thresholding is required.

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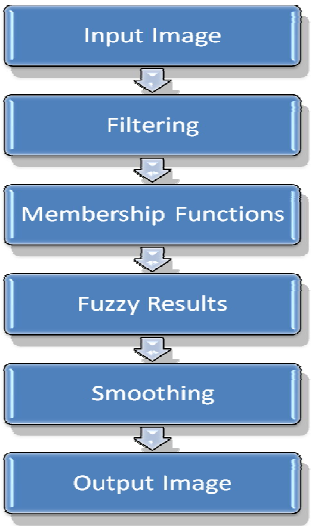

Figure 2: Work Flow

In first, image is taken as input and then it can be carried to filtering process. After filtering, image can be proceeding to fuzzy logic membership function. In that membership function is choose and mask is prepared. As mentioned earlier, two types of mask were generated to test gray level images. 2x2 and 3x3 masks are generated and it tested through various set of images. Evaluated results show better performance than previous works.

In this work 3x3 mask is applied to locate the edges. Nine masking variables are included in this mask and as usual P5 act as output variable. After scanning the resultant image can be further carried out to smoothing process to remove the noise if any present. In final segmented image is taken further to process analysis.

V. CONCLUSION AND FUTURE WORK

Segmentation algorithms for color images based on filtering and Edge detection were described in this article. Additionally, fuzzy logic membership function's masking methods were proposed which is based on rules and that gives some likely results. A brief introduction to color image segmentation and fuzzy segmentation approach is discussed. The development based on IF-THEN rules is predicted as a promising research area in the near future. Suitable membership functions are chosen based on the parameters likely to assign for the variables. It concludes that triangular membership function must satisfy all the conditions which suits for implementation. Generally, implementation process can be done through two phases. On the first phase, the fuzzy membership function based edge detection for gray channel image segmentation were applied for each of the R,G, and B channels separately to determine the suitable automatic threshold for each channel. After that, the new modified channels are included with channel wise and again to form a new color image. The resulted image suffers from some kind of alteration. To get rid of this warp, the second phase is arise which is the median filter to smooth the image and increase the segmented regions. Experimental results were presented on a variety of test images to support the proposed algorithm.

REFERENCES

1. Rafael C Gonzalez and Richard E Woods (2013), "Digital image processing", ISBN 978-81-317-2695-2, Pearson Education.
2. Rafael C Gonzalez, Richard E Woods and Steven L Eddins (2011), "Digital image processing using MATLAB", ISBN – 13: 978-0-07-070262-2, Tata McGraw Hill Education.
3. Firas Ajil Jassim, Fawzi H. Altaani, "Hybridization of Otsu Method and Median Filter for Color Image Segmentation", International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-2, May 2013.

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4. Song Gao, Chengcui Zhang, and Wei-Bang Chen, "An Improvement of Color Image Segmentation through Projective Clustering", IEEE IRI 2012, August 8-10, 2012.
5. Mrs. C. Mythili, Dr. V. Kavitha, "Efficient Technique for Color Image Noise Reduction", The Research Bulletin of Jordan, ACM, Volume 2, Issue 3, 2011.
6. Nikita Sharma, Mahendra Mishra, Manish Shrivastava, "Color Image Segmentation Techniques and Issues: An Approach", International Journal of Scientific & Technology Research Volume 1, Issue 4, May 2012.
7. Jan Puzicha and Serge Belongie, "Model–based Halftoning for Color Image Segmentation", UC Berkeley, Department of Computer Science, December 2002.
8. Soumya Dutta, Bidyut B. Chaudhuri, "Homogenous Region based Color Image Segmentation", Proceedings of the World Congress on Engineering and Computer Science, ISBN: 978-988-18210-2-7, Volume 2, October 2009.
9. E. Boopathi Kumar and M. Sundaresan, "Edge Detection Using Trapezoidal Membership Function Based on Fuzzy's Mamdani Inference System", IEEE, 2014.
10. E. Boopathi Kumar and M. Sundaresan, "Fuzzy Inference System based Edge Detection using Fuzzy Membership Functions", International Journal of Computer Applications, ISSN: 0975 – 8887, Volume 112, Issue: 4, February 2015.
11. M. Jogendra Kumar, Dr. GVS Raj Kumar, R. Vijay Kumar Reddy, "Review on Image Segmentation Techniques", International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882, Volume 3, Issue 6, September 2014.
12. Rozy Kumari, Narinder Sharma, "A Study on the Different Image Segmentation Technique", International Journal of Engineering and Innovative Technology (IJEIT), ISSN: 2277-3754, Volume 4, Issue 1, July 2014.
13. H.D. Cheng, X.H. Jiang, Y. Sun, Jingli Wang, "Color image segmentation: advances and prospects", Pattern Recognition 34 (2001) 2259-2281.
14. M. Borsotti, P. Campadelli, R. Schettini, "Quantitative evaluation of color image segmentation results", Pattern Recognition Letters 19 (1998) 741–747
15. Navkirat Kaur, V. K. Banga, Avneet Kaur, "Image Segmentation Based on Color", International Journal of Research in Engineering and Technology, Volume: 02 Issue: 11 | Nov-2013
16. Frank Y. Shih, Shouxian Cheng, "Automatic seeded region growing for color image segmentation", Image and Vision Computing 23 (2005) 877–886
17. Khande Bharath Kumar and D. Venkataraman, "Object Detection Using Robust Image", © Springer India 2015, L.P. Suresh et al. (eds.), Artificial Intelligence and Evolutionary Algorithms in Engineering Systems, Advances in Intelligent Systems and Computing 324, DOI 10.1007/978-81-322-2126-5.
18. Mihir Narayan Mohanty and Subhashree Rout, "An Intelligent Method for Moving Object Detection", © Springer India 2015 L.C. Jain et al. (eds.), Intelligent Computing, Communication and Devices, Advances in Intelligent Systems and Computing 309, DOI 10.1007/978-81-322-2009-1.
19. Emmanuel Joy and J. Dinesh Peter, "Tracking of Unique Colored Objects: A Simple, Fast Visual Object Detection and Tracking Technique", E.B. Rajsingh et al. (eds.), Informatics and Communication Technologies for Societal Development, DOI 10.1007/978-81-322-1916-3_15, © Springer India 2015.
20. Simranjit Singh Walia, Gagandeep Singh, "Color based Edge detection techniques– A review", International Journal of Engineering and Innovative Technology, Volume 3, Issue 9, March 2014.
21. Amiya Halder, Nilabha Chatterjee, Arindam Kar, Swastik Pal and Soumajit Pramanik, "Edge Detection: A Statistical approach", 3rd International Conference on Electronics Computer Technology, 2011.
22. Suryakant, Neetu Kushwaha, "Edge Detection using Fuzzy Logic in Matlab", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 4, April 2012.
23. Shikha Bharti, Sanjeev Kumar, "An Edge Detection Algorithm based on Fuzzy Logic", International Journal of Engineering Trends and Technology, Volume 4, Issue 3, 2013.
24. Mehul Thakkar, Prof. Hitesh Shah, "Edge Detection Techniques Using Fuzzy Thresholding", 978-1-4673-0126-8/ 2011, IEEE.
25. Anil K Jain (2014), "Fundamentals of Digital Image Processing", ISBN 978-81-203-0929-6, Pearson Education.
26. E.Boopathi Kumar and V.Thiagarasu, "Evaluation of Color Image Segmentation Novel Methods", IJIRCCE, ISSN: 2320 – 9798, Pages: 21323 – 21328, Volume 4, Issue 12, December 2016.
27. E.Boopathi Kumar and V.Thiagarasu, "Segmentation using Masking Methods in Color Images: an Approach", IJESRT, ISSN 2277 – 9655, Pages: 104-110, Volume 6, Issue 2, February 2017.
28. A.Kalaivani, Dr.S.Chitrakala, "Automatic Color Image Segmentation", International Conference on Science, Engineering and Management Research (*ICSEMR* 2014), ©2014 IEEE.
29. Md. Habibur Rahman, Md. Rafiqul Islam, "Segmentation of Color Image using Adaptive Thresholding and Masking with Watershed Algorithm", 978-1-4799-0400-6/13/ ©2013 IEEE.
30. Rafael Guillermo Gonzalez, Junli Tao, "Generalization of Otsu's Binarization into Recursive Color Image Segmentation", 978-1-5090-0357-0/15/, © 2015 IEEE.

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BIOGRAPHY

Mr E Boopathi Kumar is currently pursuing Ph.D. in PG & Research Department of Computer Science, Gobi Arts & Science College. He is a Life member of Computer Society of India, Indian Science Congress & Inventive Research Organization. He has published more than 9 research papers in reputed international journals including Thomson Reuters and conferences including IEEE and it's also available online. His main research work focuses on Image Processing, Data Mining and Networking.

Dr V Thiagarasu is currently working as Associate Professor in PG & Research Department of Computer Science, Gobi Arts & Science College. He is a Life member of Computer Society of India, Indian Science Congress & Operational Research Society of India. He has published more than 50 research papers in reputed international journals including Thomson Reuters and conferences including IEEE and it's also available online. His main research work focuses on Image Processing, Data Mining and Networking. He has 28 years of teaching experience and 16 years of Research Experience.