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Segmentation Using Fuzzy Membership Functions: An Approach

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***Abstract*— This article presents a novel approach for color image segmentation using two different algorithms with respect to color features. 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. 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*— Segmentation, Fuzzy Membership Functions, Fuzzy Inference System, Edge Detection, Region Growing and Thresholding**

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 artefacts, 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

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 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. 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

neighbourhood 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 process modules to be proposed. Section 4 highlights discussion on the experiments to be done. Section 5 finally concludes the paper with future work direction.

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 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. METHODOLOGY

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.

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. Trapezoidal membership function is the proposed method, in that 2x2 and 3x3 masks were created. Both masks results are compared with triangular functions mask results. After trapezoidal membership function process the resultant image can be further taken for Thresholding. Final results will be achieved after Thresholding module.

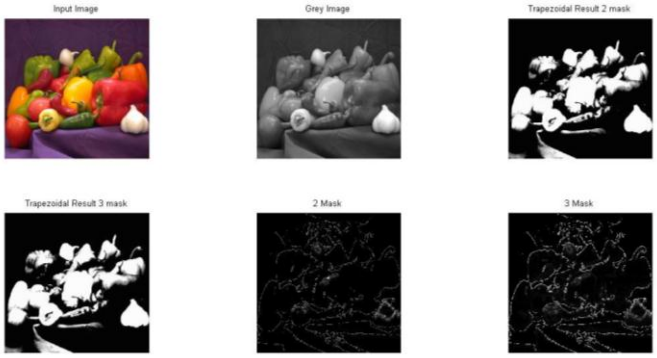

Figure 1: Vegetables a) Input Image b) Grey Image c) Trapezoidal 2x2 mask d) Trapezoidal 3x3 mask e) 2x2 Final Result f) 3x3 Final Result

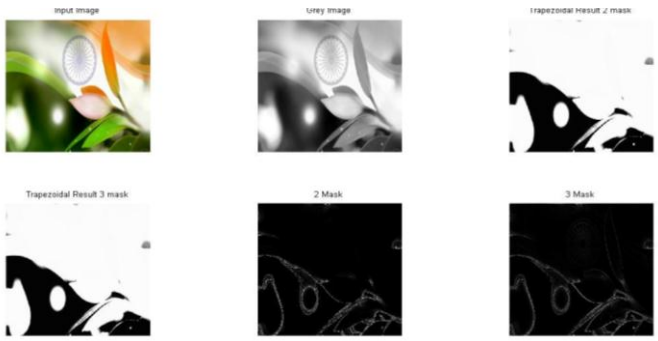

Figure 2: Flag a) Input Image b) Grey Image c) Trapezoidal 2x2 mask d) Trapezoidal 3x3 mask e) 2x2 Final Result f) 3x3 Final Result

Here colour image can be taken as input, further it can be converted to grey image and proceed to trapezoidal membership function masking. The resultant image will further taken for Thresholding.

IV. RESULTS AND DISCUSSION

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 [9] [10]. 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.

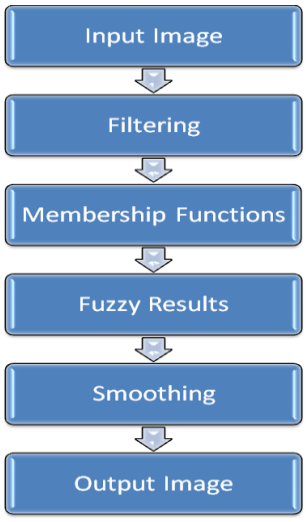

Figure 3: Work Flow of Future work

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

In this paper, segmentation algorithms for color images based on filtering and Edge detection were described. Additionally, fuzzy membership function's masking methods are 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, 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 again to formulate 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.

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