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A Comparative Analysis of Different Image Segmentation Methods using Fuzzy Rules

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***Abstract*— Color Image Segmentation and Retrieval plays a major role in various scenarios and it is being a most challenging field in Image Processing. More works on this field had laid path to a prominent growth in color image segmentation as well as in image retrieval and the effectiveness differs with each other while applied in a real time scenario. Different strategies like Region growing, Fuzzy c means Algorithm, Edge detection mechanism, Clustering method are implemented in the recent works on Color image Segmentation and Retrieval. The ultimate intention of this Survey is to provide an idea to implement Fuzzy Rule Based approach in several image segmentation methods. There are various Fuzzy Rules available which can be used to segment the input color image and those segmented images can be referred as a data set in order to retrieve the images from the data set Fuzzy Rules can be applied. The end result will be the color image which satisfies the given input Fuzzy query based on Fuzzy Rules.**

***Keywords*—Segmentation; Fuzzy C means; Edge detection; Fuzzy rule; Fuzzy query.**

I. INTRODUCTION

An Image can be explained as a continuous function of the brightness values. Each point on the developed film can be related with a gray level value in which it represents how bright that particular point is. To store images in a computer sampling and quantization of the image function have to be processed. Sampling refers to considering the image only at a finite number of points. And quantization refers to the representation of the gray level value at the sampling point using finite number of bits. Each image sample is called a pixel. One of the simpler schemes is sampling on a regular grid of squares. We can visualize the process as overlaying a uniform grid on the image and sampling the image function at the center of each grid square. Finer the grid, better the resolution of the image; coarser the grid, the more is the observed ``pixelization''. At each pixel (or at each grid square) we usually represent the gray level value using an integer ranging from 0 for black to 255 for fully white. Color images are constructed from three intensity maps. Each intensity map is projected through a color filter (*e.g.,* red, green, or blue, or cyan, magenta, or yellow) to create a monochrome image. The intensity maps are overlaid to create a color image. Each pixel in a color image is a three element vector. There are two parts to the image formation process they are, the geometry of image formation, which determines where in the image plane the projection of a point in the scene, will be located and the physics of light, which determines the brightness of a point in the image plane as a function of illumination and surface properties. Image digitization Sampling means measuring the value of an image at a finite number of points. Quantization is the representation of the measured value at the sampled point by an integer. Image compositing is a process of combining parts from separate images to form a new image. It requires relative positions, orientations, and scales to be correct. Lighting of objects must be consistent within the separate images. Brightness, contrast, color balance, and saturation must match. Noise color, amplitude, and patterns must be seamless.

II. OVERVIEW OF IMAGE SEGMENTATION

Image segmentation [2] is the operation of partitioning an image into a collection of connected sets of pixels. The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application. The segmentation is based on measurements taken from the image and might be grey level, color, texture, depth or motion. Usually image segmentation is an initial and vital step in a series of processes aimed at overall image understanding. It also refers to the decomposition of a scene into different components. Segmentation [2] is a hypothetical middle-level vision task performed by neurons between low-level and high-level cortical areas. Segmentation is done based on regions, which usually cover the image also on linear structures, such as line segments and curve segments or on 2D shapes such as circles, ellipses and ribbons (long, symmetric regions). Segmentation [3] is typically associated with pattern recognition problems. It is considered the first phase of a pattern recognition process and is sometimes also referred to as object isolation. An application of image segmentation includes Identifying objects in a scene for object-based measurements such as size and shape. Identifying objects in a moving scene for object-based video compression (MPEG4).Identifying

objects which are at different distances from a sensor using depth measurements from a laser range finder enabling path planning for a mobile robots.

III. OVERVIEW OF FUZZY LOGIC

Fuzzy logic provides a method to formalize reasoning when dealing with vague terms. Traditional computing requires finite precision which is not always possible in real world scenarios. Not every decision is either true or false, or as with Boolean logic either 0 or 1. Fuzzy logic allows for membership functions, or degrees of truthfulness and falsehoods. Or as with Boolean logic, not only 0 and 1 but all the numbers that fall in between.

Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth -- truth values between "completely true" and "completely false". It can also be referred as a type of logic that recognizes more than simple true and false values. With fuzzy logic, propositions can be represented with degrees of truthfulness and falsehood. For example, the statement, today is sunny, might be 100% true if there are no clouds, 80% true if there are a few clouds, 50% true if it's hazy and 0% true if it rains all day.

Fuzzy logic has proved to be particularly useful in expert system and other artificial intelligence applications. It is also used in some spell checkers to suggest a list of probable words to replace a misspelled one. Fuzzy generally termed as a form of knowledge representation [9] suitable for notions that cannot be defined precisely, but which depend upon their context. It enables computerized devices to reason more like humans. There are generally two types of sets they are: Classical set and Fuzzy set. Classical set are those which contain objects that satisfy precise properties of membership. For example, Set of heights from 5 to 7 feet. While fuzzy set [11] are those which contain objects that satisfy imprecise properties of membership. For Example: The set of heights in the region around 6 feet.

Advantages of fuzzy logic are, Mimicks human control logic, Uses imprecise language, inherently robust, Fails safely, Modified and tweaked easily. Some of the applications of fuzzy logic includes: Simple Proportional Temperature Control, Determining the Input and Output relationships, Segmentation of images into pixels of varying sizes.

IV. DIFFERENT METHODS OF IMAGE SEGMENTATION USING FUZZY RULES

Recently many research efforts have appeared in the past few decades to explore various image segmentation techniques. The interpretation of pictures in motion [1], which are taken from the surveillance camera, plays a vital role in segmentation. The system consists of three different components such as a pre-processing module for feature extraction of image, static model for identifying the object and dynamic temporal model for identifying the action. The following are few image segmentation techniques using fuzzy rules.

A. Blobworld Image Segmentation Technique

Blob is highly defined as the group of pixel clusters moving between the given images. The blob in each individual image can be efficiently segmented from the image background. This Image segmentation [2] process does not remove the noise available in the image background. A Mechanism that can be applied for image perpetual integration is fuzzy inference process of basic visual clues. The linguistic variables used in the fuzzy set theory such as close, far, very close etc., are greatly helpful in replacing the existing crisp mechanism which involves mathematical description.

The main goal of this system is to develop a prototype for understanding and describing an image in natural form using fuzzy expert system. Domain expert knowledge is the fuzzy rules used to understand an image, object location, description of an object and its behavior. This system is developed for understanding an image in a higher level.

B. Fuzzy Rule based Image Segmentation Technique

Rule based techniques used for image segmentation [8], incorporates domain expert knowledge and can be able to manipulate linguistic as well as numerical data. It uses fuzzy IF –THEN rules for partial inference of image. Because of these reasons they are used mainly in medical imaging but these rules are specific to domain application. Fuzzy image segmentation has more advantages than classical methods since they can handle imprecise data. In the early days fuzzy IF- THEN rules were mainly used in control engineering but now they are used mainly in image segmentation technique. The main difficulty in fuzzy image segmentation is to determine parameter and shape of the membership functions. The main advantages of fuzzy rule based segmentation compared with other techniques are as follows.

a) Human can understand the linguistic problem easily.

b) It is less expensive than fuzzy clustering techniques.

c) It has the capability to potentially integrate domain experts knowledge.

In general fuzzy rule based image segmentation technique is application dependent and contains predefined membership functions and in some rare case parameters are determined manually. The overall result is that the performance is very sensitive to the parameter value. This problem is addressed by introducing this generic fuzzy rule based image segmentation algorithm. It is application independent and uses inter-pixel spatial relationship. This method approximates the key factor and threshold value automatically. This method incorporated inter-pixel spatial relationships. It also has a capability to incorporate any image attribute in any type of special applications by defining a new membership function in a simple way. So this technique is both application and image independent. The components of this technique are as follows,

a) A common databse to maintain to store relative rules. Example: Face database system.

b) Fact based system which specifies the present state of the world in which it contains the facts and declarative knowledge.

c) An interference engiene in which it operates and manipulates the processing facts and rules.

Hence retrieval of image is based on the textual queries using rule based system in generic database which depends on colors. In face database the spatial properties are indexed with information like color of the cloths background area color of the hair. Most of the face parameters are extracted automatically and some of them are measured semi automatically.

C. Fuzzy expert system

Fuzzy expert system [5] is specifically for segmenting the low level images more effectively. In traditional methods, many thresholds and parameters are used. These have to be reduced. In this approach, these parameters were reduced by redesigning the system from the scratch. The results of the fuzzy system will produce generality and robustness of image. But the main drawback of fuzzy system is that more number of parameters which are usually thresholds for finding and determining the actual function and behavior of the fuzzy system.

Finally different classes use different sets of parameters. The main advantage of this system is that it brings solution to the sensitivity of the thresholding values by using the number of proper rules defined. The other solution is through restating the rules to obtain more robust fuzzy system [8]. The complex system will be vaguer and contains incomplete knowledge and this in turn implements set of linguistic rules, fuzzy implication and the rules of inference to reproduce the behavior of human expert's fuzzy system automatically.

D. Edge detection Image Segmentation Technique

Edges are the basic image features includes various image information which are very important for measuring the characteristics of an image through the process of image recognition. Edge detection [4] is defined as the process of identification and location of sharp discontinuity of image. Hence, edge detection plays a vital role in image analysis and act as a key factor for solving various complex issues. The main challenge in the image extraction and detection methods includes the following facts.

a) Variation in the lightening effect and the dynamic background.

b) Geometrical and the luminance feature.

c) Great impact of noise volume on edge shaping.

d) False edge detection and dislocating edges.

It is very difficult to evaluate the results of edge detection determined by different detector [7] with various parameters. The efficiency of edge detector is commonly compared to other algorithms like Robert and Canny Sobel's edge detection algorithms. A wide research had been done by creating different algorithm and methods for image segmentation. But still there is lot of difficulties in determining which algorithm produces accurate segmentation than other methods. The basic method for measuring the effectiveness of image segmentation is subjective evaluation in which manual comparison of human segmentation. In addition to that unsupervised method produce result for each individual image and images whose functionalities may not be well known till the time of evaluation. Most of the present image retrieval [10] based system performs primarily on low level image features. Images can be retrieved based on photometric and spatial relationship across various image regions a small or no image segmentation is made [11]. The regions are obtained from the low resolution images. The retrieval can be performed which is mainly based on iconic matching. The segmentation process is not made fully automatic because it need some parameters for tuning and hand pruning. Most of the research is done to reduce the dimensionality. This is made using the histogram analysis. This survey mainly focuses on indexing the whole image or certain user defined regions. This is not based on indexing, regions are created automatically. The image is said to be effective based on three main factors such as the time taken to perform a query, quality of the resultant query, ease of analyzing query results and refining query.

E. Fast Multilevel Fuzzy Edge detection Image Segmentation Technique

This Fast Multilevel Technique [12] was specially used for the detection of fast and accurate edge detection of blurry images efficiently. It enhances the contrast of images through the process of Fast Multilevel Fuzzy Enhancement algorithm with the implementation of simple transformation function based on two image thresholds. After that, the edges are extracted using the two stage edge detection operator that identifies the edge candidates based on the local characteristic of the image. The initial stage is fuzzy rule based in which memberships are assigned to pixels, classification of the pixels that have only one high membership and estimation of the initial conditions for the next stage.

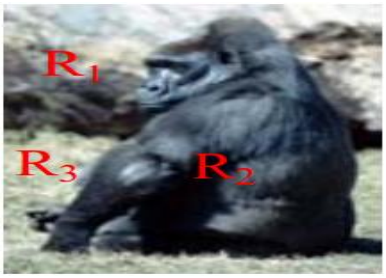
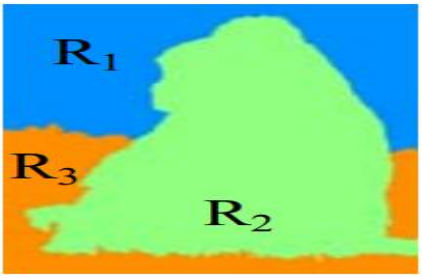
The second stage is the fuzzy c-means algorithm which organizes the undetermined pixels. Hence the Preliminary segmentation of the human brain MR images exposes the two-stage fuzzy system [13] [14] could determine white matter, gray matter, cerebrospinal fluid and HIV+lesion in an efficient and accurate manner. Hence there exists some two-stage system combining two techniques and dealing with different problem, so it indicates that different fuzzy segmentation techniques should be followed. The Systematic work flow of the fuzzy enhancement algorithm is as follows,

a) Load the image as an input to algorithm.
b) Set the 16 types of fuzzy templates.
c) Apply fuzzy templates prescribed.
d) Detect the maximum edge using derivate detection.
e) Finally apply the edge detection technique.

V. EXPERIMENTAL RESULTS OF IMAGE SEGEMENTATION TECHNIQUES

This section exposes the comparison of above mentioned image segmentation techniques which was applied over images through which the output extracted was tabulated. This empirical analysis have been done not to determine the best segmentation methods but to differentiate the techniques based on its performance and behavior. Hence this scrutiny helps the researchers to innovate more advanced image segmentation techniques for solving the existing challenges in hand.

TABLE I. IMAGE SEGMENTATION EXPERIMENTAL RESULTS

S.NO.	IMAGE SEGMENTATION PERFORMANCE		
	Name of the Technique	***Input***	***Output***
1.	BLOBWORLD IMAGE SEGMENTATION TECHNIQUE		
2.	FUZZY RULE BASED IMAGE SEGMENTATION TECHNIQUE		
3.	FUZZY EXPERT SYSTEM		
4.	EDGE DETECTION IMAGE SEGMENTATION TECHNIQUE		

S.NO.	IMAGE SEGMENTATION PERFORMANCE		
	Name of the Technique	*Input*	*Output*
5.	FAST MULTILEVEL FUZZY EDGE DETECTION IMAGE SEGMENTATION TECHNIQUE		

VI. DISCUSSIONS

The extraction of facial feature is based on intensity images because eyes and mouth are differ from the rest of the face. Even if the eyes are closed, the darkness of the eye sockets is sufficient to extract the eye regions. It detected in 86% of the regions. It assesses the robustness of 85% of the regions. The best-fit ellipse can be used to retrieve the image. By comparing with other body parts, the false positive can be occurred. It reduces the efficiency of the color segmentation and divides the face cluster into two or more distinct clusters. The other objects are connected to the face cluster and its shape can be modified. The efficiency of the color segmentation can be improved by including an adaptive thresholding algorithm. Blob world is one of the methods used to retrieve the image from the database. It is used to find the coherent image regions which roughly correspond to the object. Each image is segmented into regions with associated color and texture descriptors.

Querying is based on the attributes of one or two regions, rather than a description of the entire image. But the high dimensional feature space is computationally prohibitive. The main problem is that it takes time to run each individual query. It is complex to retrieve the image. The design of new pre-processing image techniques is done by Fuzzy inference system. It allows feature extraction and construction of input vectors for neural networks with aims of image recognition. FIS have been especially applied successfully in control and decision making system. The main advantage is the way they deal with the information related to some system variable allowing us to work with it. A fuzzy inference system is based on logical rules. It can work with numeric values or fuzzy input when the rules are evaluated.

All the individual results extracted together which is known as the output fuzzy. Then a numerical value must be passed through a process of retrieval image. In fuzzy sets [6], once the membership function is defined in a concept which is based on the subjective opinion of one or more individuals. It shows no more than one value for each element of the universe. In doing so, it loses some of the ambiguity on some discussed concepts. Especially people may have a slightly different opinion that all are considered as valid. In the gradient magnitude method, it tries to replace the original image. In the results, the original image is changed. The output image shows the acquired image by gradient magnitude. It uses the pewit operator for transforming the image in to gray scale. This is especially done for low level images and normalization.

VII. CONCLUSION

Thus the Image Segmentation techniques using fuzzy rules and the retrieval process in various scenarios has been surveyed. And the Region growing, Fuzzy c means Algorithm, Edge detection method, fast multilevel fuzzy based edge detection segmentation method, and blob world segmentation method which are implemented in the recent works on image Segmentation and Retrieval are also keenly surveyed. Under this analysis the followers and researchers can examine that the Fuzzy Rule Based method can be implemented for the better segmentation of color images as well as the retrieval of those images from the database. The Color image segmentation and retrieval finds its major role in face reorganization system, satellite survey and also in the field of assistive technology. It is clearly proven that segmentation using Fuzzy logic results in acceleration convergence, clustering with robustness and reduced computational time. Fuzzy segmentation has good capability of handling noisy images possessing higher degree of variability. Thus the experimental results made with different images for each segmentation method is greatly helpful for the image processing researchers to discover more novelty segmentation techniques by rectifying the shortcomings in the traditional methods.

References

[1] Pal et.al, "A Review on Image Segmentation Techniques," Pattern Recognition Society, Britain, Vol. 26, No. 9, pp. 1274, 1993.

[2] Fue and Mui, "A survey on image segmentation," Pattern Recognition Vol. 13, 3-16, 1981.

[3] Haralic and Shaprio,"Survey, image segmentation techniques, Computer Vision Graphics Image Process," Vol. 29, 100-132, 1985.

[4] Zhiwei Ye, Zhengbing Hu, Xudong Lai, Hongwei Chen, "Image Segmentation using Thresholding and Swarm Intelligence", Vol. 7, No. 5, 2011.

[5] Yi-hua et.al. "A Novel Image Segmentation Method Based on Random Walk", IEEE Second Asia-Pacific Conference on Computational Intelligence and Industrial Applications, PACIIA, 978-1-4244-4607-0/09, 2009

[6] Orlando J. Tobias and Rui Seara, "Image Segmentation by Histogram Thrsholding Using Fuzzy Sets", Vol.11, No.12 , Article ID 140492, 15 pages doi:10.1155/2009/140492, 2009.

[7] Maia and Hongpeng, "A New Image Segmentation Method Based on Grey Graph Cut", IEEE Third International Joint Conference on Computational Science and Optimization, 978-0-7695-4030-6/10, 2010

[8] Harrabi and Braiek, **"**Color image segmentation using multi-level thresholding approach and datafusion technology", 2012.

[9] Hih-Cheng Hsu, Wesley W.Chu, Ricky K.Taira, "A Knowledge-Based Approach for Retrieving Images by Content", IEEE Transactions on

Knowledge and Data Engineering, Vol. 6, No. 4, August 1996, pp. 522, 523.

[10] Yong Rui, Thomas S. Huang and Shih-Fu Chang, "Image Retrieval: Past, Present and Future", Journal of Visual Communication and Image Representation, Vol. 10, pp. 1 - 23, 1999.

[11] H. J. Zimmermann, "Fuzzy Set Theory and its Applications", Allied Publishers Limited, 2nd Edition.

[12] Hoel Le Capitaine and Caral Frelicot,"A Fast Fuzzy C-means algorithm for fast fuzzy",Aix-lesBain,France.,July 2011.,EUSFLAT-LFA 2011.

[13] M.abdulghafour "Image Segmentation using Fuzzy Logic and Genetic Algorithm",Muscat oman.

[14] N.Senthilkumaran1 and R. Rajesh "Edge Detection Techniques for Image Segmentation"ACEEE 2009.