



Robust Color image segmentation using efficient Soft-computing techniques: A survey

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Abstract: Images have always been very important in human life. Images are considered as one of the most important medium of conveying information, in the field of computer vision, by understanding images the information extracted from them can be used for other tasks for example: navigation of robots, extracting malign tissues from body scans, detection of cancerous cells, and identification of an airport from remote sensing data. This paper presents a survey on soft-computing techniques applied for color image segmentation. Further, this paper includes future research directions in the area of color image segmentation using soft-computing techniques.

Key words: Color Image Segmentation, Fuzzy, Edge Detection.

I. INTRODUCTION

People are more interested in certain parts of the image in the research and application of the image. These parts are frequently referred as a target or foreground (other part is called background), they generally correspond to the image in a specific and unique nature of the area. It needs to extract and separate them in order to identify and analyze object, on this basis it will be possible to further use for the target.

A digital image is composed of a finite number of elements called pixels, each of which has a particular location and value. One of the most fundamental features of digital image and the basic steps in image processing, analysis, pattern recognition and computer vision is the edge of an image where the preciseness and reliability of its results will affect directly on the comprehension machine system made objective world. Several edge detectors have been developed in the past decades, although no single edge detectors have been developed satisfactorily enough for all application. Now a day the medical field is growing enormously to diagnose and give treatment to the patient. One of the fast growing and important tool to diagnose functional or structural change on soft tissue is Magnetic Resonance Image (MRI). The MRI of head scan contains eyes, nose, ear, neck, scalp, brain tissue and some non-brain tissues. So doctors need some clear perception of MRI head scan to diagnose the disease on brain. For that we need some segmentation process. It may be performed manually, but it takes more time to segment the brain portion. Therefore, an automated method is necessary to segment the brain portion.

II. DIGITAL IMAGE PROCESSING

Digital image processing plays a vital role in the analysis and interpretation of remotely sensed data. Especially data obtained from Satellite Remote Sensing, which is in the digital form, can best be utilized with the help of digital image processing. Digital image processing refers to processing of digital images by using digital computers. Image enhancement and information extraction are two important components of digital image processing. Image enhancement techniques help in improving the visibility of any portion or feature of the image suppressing the information in other portions or features. Information extraction techniques help in obtaining the statistical information about any particular feature or portion of the image. Early 1920s Bartlane cable picture transmission system used to transmit newspaper images across the Atlantic. Images were coded, sent by telegraph, printed by a special telegraph printer. It took about three hours to send an image, first systems supported 5 gray levels. 1964 NASA's Jet Propulsion Laboratory began working on computer algorithms to improve images of the moon. Images were transmitted by Ranger 7 probe. Corrections were desired for distortions inherent in on-board camera.

Now there is a need of a method, with the help of which, we can understand images and extract information or objects, image segmentation fulfill above requirements. Thus, image segmentation is the first step in image analysis. Some time image denoising is done before the segmentation to avoid from the false contour selection for segmentation to segment the image without loss of information for medical diagnosing purpose is a challenging job.

III. IMAGE SEGMENTATION

Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an image. Practical application of image segmentation range from filtering of noisy images, medical applications (Locate tumors and other pathologies, Measure tissue volumes, Computer guided surgery, Diagnosis, Treatment planning, study of anatomical structure), Locate objects in satellite images (roads, forests, etc.), Face Recognition, Finger print Recognition, etc. Many segmentation methods have been proposed in the literature.

A boundary in an image is a contour that represents the change from one object or surface to another. This is distinct from image edges, which mark rapid changes in image brightness, but may or may not correspond to salient boundaries. Image segmentation is a procedure that partitions an image into disjointing groups with each group sharing similar properties such as intensity, color, boundary and texture. In general, three main image features are used to guide image segmentation, which are intensity or color, edge, and texture. In other words, image segmentation methods generally fall into three main categories: color-based, edge-based, and texture-based segmentations.

Color-based (or intensity based) segmentation assumes that an image is composed by several objects with constant intensity. This kind of methods usually depends on intensity similarity comparisons to separate different objects. Histogram thresholding, clustering and split-and-merge, are typical examples of intensity-based segmentation methods. Edge based segmentation has a strong relationship with color-based segmentation, since edge usually indicate discontinuities in image intensity. Widely used methods in edge-based segmentation include Canny, watershed, and snake.

Texture is another important characteristic used to segment objects from background. Most texture-based segmentation algorithms map an image into a texture feature space, then statistical classifications methods are used to segment different texture features. Co-occurrence matrix, directional gray-level energy, Gabor filters, and fractal dimensions, are frequently used methods to obtain texture features. Besides intensity, color, contour and texture: object density is another attribute to be used when image analysis is requested to find appropriate features on microscope measurements. For instance, in pathological tissue images, pathological diagnosis relies on accurate separation of different cells.

IV. TECHNIQUES IN EDGE DETECTION

Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique. The edges identified by edge detection are often disconnected. To segment an object from an image however, one needs closed region boundaries. The desired edges are the boundaries between such objects. Segmentation methods can also be applied to edges obtained from edge detectors. Lindeberg and Li developed an integrated method that segments edges into straight and curved edge segments for parts-based object recognition, based on a minimum description length (MDL) criterion that was optimized by a split-and-merge-like method with candidate breakpoints obtained from complementary junction cues to obtain more likely points at which to consider partitions into different segments.

Soft Computing Techniques (Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic Models, and Particle Swarm Techniques) have been recognized as attractive alternatives to the standard, well established "hard computing" paradigms. Traditional hard computing methods are often too cumbersome for today's problems. They always require a precisely stated analytical model and often a lot of computational time. Soft computing techniques, which emphasize gains in understanding system behavior in exchange for unnecessary precision, have proved to be important practical tools for many contemporary problems. NNs and FLMs are universal approximators of any multivariate function because they can be used for modeling highly nonlinear, unknown, or partially known complex systems, plants, or processes. Genetic Algorithm and Particle Swarm Optimization Techniques have emerged as potential and robust optimization tools in recent years.

V. SURVEYED TECHNIQUES

In the image segmentation field, traditional techniques do not completely meet the segmentation challenges for color images. Fuzzy image processing is the collection of all approaches that understand, represent and process the images, their segments and features as fuzzy sets. The representation and processing depend on the selected fuzzy technique and on the problem to be solved.

A. *A Novel Method for Image Segmentation Using Fuzzy Threshold Selection*

In this paper a novel method based on fuzzy logic reasoning strategy is proposed for edge detection in digital images using 16 fuzzy edge templates that show the possible direction of the edge in the image and then calculating the divergence between the origins image and the 16 fuzzy templates. Calculation of the maximum

of the divergence value between the 16 templates and the original image of the same size. Set a threshold and applying the morphological operators.

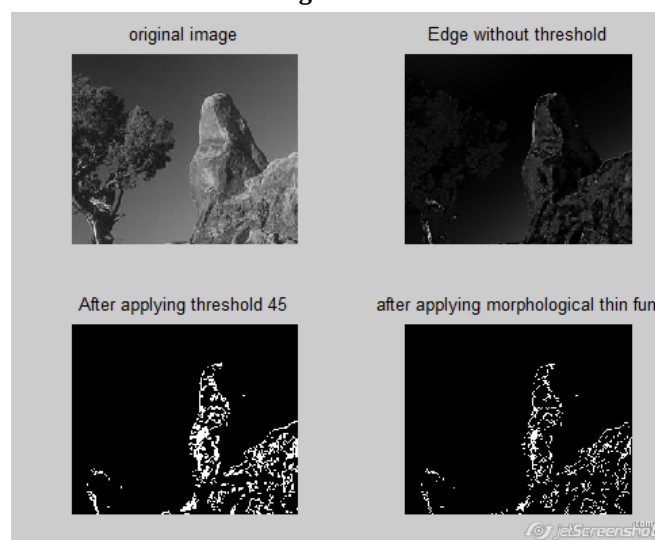
The general algorithm for image thresholding based on measure proposed above can be formulated as follows:

- (1) Reading the pixel of the image.
- (2) Number of row(n) and column(r) of an image is taken.
- (3) Selection of the 16 fuzzy templates.
 $a=0.3$; $b=0.8$;
 $t1 = [a \ a \ a; 0 \ 0 \ 0; b \ b \ b]$; etc., (distinct templates)
- (4) Converting into the fuzzy domain from the original image.
 All value in the interval of $[0 \ 1]$
 (ie maximum pixel/element of the image)
- (5) Finding Hesitation degree or intuitionistic fuzzy index 0.2 (assume)
 $Hpimage$ for each templates = $c*(1-pimage)$ for each templates)
- (6) Calculation of the maximum of the divergence value between the 16 templates and the original image of the same size let the original image denoted by this formed by taking the 3x3 matrix in the border matrix.
- (7) Finite iteration by Selecting the minimum divergence among the 16 divergence values and is positioned at the center of the templates position for the edge image.
 $Fuzzy\ domain\ image(i,j) = \max_n [\min_r Hpimage(i,j)]$
- (8) Edge image in the fuzzy domain matrix is transformed back in the image pixel domain i.e in the interval $[1 \ 255]$ domain (multiply by 255). Set a threshold, and applying the morphological operators of Matlab.

The proposed system was tested with different Images, its performance being compared the existing edge detection algorithms and it was observed that the outputs of this algorithm provide much more distinct marked edges and thus have better visual appearance than the standard existing one. Five 350 X 350 pictures are taken into consideration. Figure 1 shows the image which is used for testing purpose.

For various threshold value the pixels ranges are displayed in the Figure 2. The result of various pictures in Berkley dataset are shown in Figure 2 below.

Figure 1



It can be observed that the output that has been generated by the fuzzy method has found out the edges of the image more distinctly as compared to the ones that have been found out by the “threshold” edge detection algorithm. Thus the Fuzzy rule based System provides better edge detection and has an exhaustive set of fuzzy conditions which helps to extract the edges with a very high efficiency.

VI. TRENDS IN SURVEY AREA

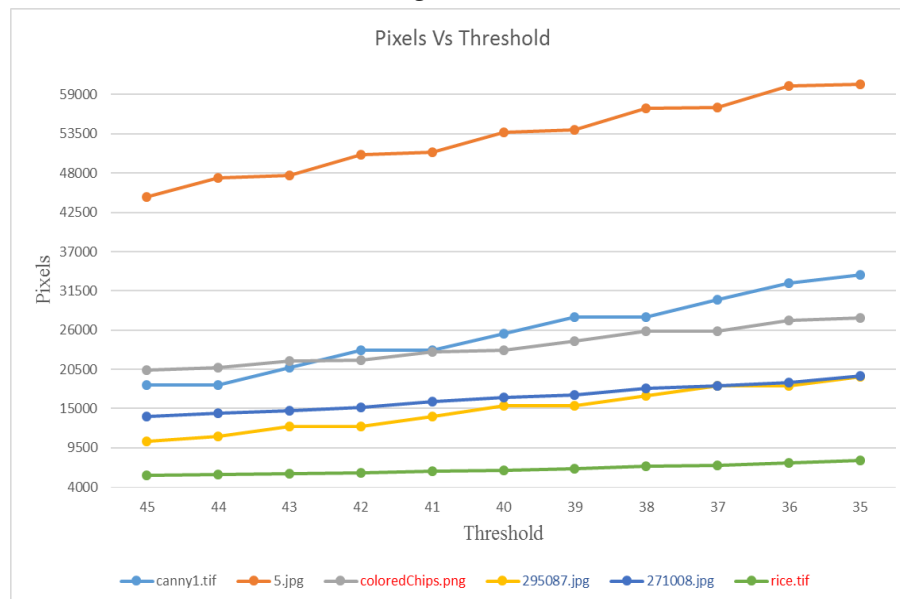
Clustering: Three phases in the color images Segmentation:

Phase 1: preprocessing: Morphological methods are applied to remove the noises away from images which applied to smooth some spots on uniformed patterns.

Phase 2: Transformation: Color space transformed methods are used to transform other color space to RGB. The average intra-cluster distance based method is a traditional method applied for transformation.

Phase 3: Segmentation: Applying clustering algorithm like K-means algorithm for finding the appropriate cluster numbers and segment images in different color spaces. The cluster with the maximum average variance is split into new clusters.

Figure 2



Neural networks: Neural networks can be a useful tool for edge detection. Since a neural network edge detector is a nonlinear filter, it can have a built-in thresholding capability. Thus the filtering, thresholding operation of edge detection is a natural application for neural network processing. An edge-detection neural network can be trained with backpropagation using relatively few training patterns. The most difficult part of any neural network training problem is defining the proper training set. A simple method is given for the edge detection training problem. Not only can neural networks be trained to detect edges, they can also be designed from scratch, without the necessity for training. The weights of the network can be selected to match the characteristics of your favorite linear edge detection filter. The addition of a bias, and a sigmoid non-linearity on the output produces an “engineered” neural network

Segmentation approach: Watershed model based on mathematical morphological operators is another budding technology with respect application in remote sensing image segmentation. Further, research on this approach is required. The selection of segmentation approach depends on what quality of segmentation is required. Further, it also depends on what scale of information is required. Fuzzy model would be good choice to represent ambiguity of region boundaries. Neural model would be good choice no prior distribution can be assumed and not very high quality object information is required. Among homogeneity measures, spectral, shape, size, scale, compactness and texture should be concerned when complex landscapes are to be analyzed.

VII. CONCLUSIONS AND FURTHER RESEARCH DIRECTIONS

Soft computing deals with approximate models and gives solution to complex problems. Color image segmentation is an important and is used in many image processing applications. Color image segmentation increases the complexity of the problem. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. The main aim is to compare the various conventional algorithms and soft computing approaches i.e. fuzzy logic, neural network and genetic algorithms for color image segmentation. Finally, some nice and elegant results are expected to follow which will be having a natural and valuable application in the field of image processing.

The edge detectors in question are especially the Sobel and Canny edge detection operators, as well as the 5x5 median, mean and α -trimmed mean edge detectors. These edge detectors were developed with the Euclidean distance in mind. They have shown good performance in the presence of noise. However, their performance on a wide range of color images is not known. Using the Euclidean distance as the similarity measure, one could use the principal eigenvector as the class prototype.

For color clustering, it is necessary to devise a way to effectively combine the benefits of k-means/Euclidean distance and Mixture of Principal Components / vector angle algorithms. Furthermore, more experimentation is needed to determine practical applications of this work in the color domain.

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