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A Comparative Based Review on Image Segmentation of Medical Image and its Technique

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Abstract— This paper presents a survey on Image segmentation. In Image segmentation dividing an image into many regions is the segmentation process. Segmentation Process provides a way to find a particular region of point inside an image. This process provides help in understanding the process in a meaningful way. In this paper, a survey of various techniques of image segmentation their algorithm that helps in finding Medical images.

Index Terms—Fuzzy C Means (FCFS); MRI; Region based segmentation; Line detection

I. INTRODUCTION

In the research community digital image processing is one of the most important areas for research. Image processing is a very [3] intellectual key that can modify outlooks of many designs. In digital image processing fundamental steps are image enhancement, image restoration, image acquisition, color image processing, image compression, image segmentation and recognition. In today time [2] image segmentation plays an important role in many tasks. Image segmentation is the first step towards an attempt to analyze or interpret an image automatically. Segmentation provides bridges the gap between low-level image processing and high-level image processing. An application involves for detection and recognition, make use of the image segmentation technique that provide measurement of object in the image. Application of segmentation includes Optical character recognition (OCR), Industrial inspection, Classification of terrains visible in satellite images, Tracking of objects in a sequence of images, Medical Image Detection their Measurement in bone, tissues and so on…. Image segmentation is the feature of image processing. Image segmentation [4] is the process of grouping pixels of homogeneous regions by the use of the common feature approach. These features can be represented as space of color, texture and gray levels, each with the similarities between pixels of a region. In Image segmentation [1] dividing an image into many regions is the segmentation process. The objective of segmentation is to simplify the structure of an image that is more meaningful and easier to understand. Image segmentation is used where to point objects and boundaries (lines, curves, etc.) in images. In current time world computer vision has become an important field and is used in many applications like remote sensing, electronics, medical, etc.…. Recently Image segmentation is applied to Fuzzy set, rough set and in genetic algorithm and all of these gained much more attention. The output of image segmentation is obtained from entire cover image and is a set of many regions, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic such as computed property, color, intensity, or texture.

FCM (Fuzzy c-means) is an unsupervised technique that has been successfully applied to future analysis, clustering, and classifier designs in the fields such as astronomy, geology, medical imaging, target recognition, and image segmentation. An image can be represented in various feature spaces, and the FCM method classifies the image by grouping similar data points in the feature space into clusters. The use of the Fuzzy segmentation method has gained more interest, which obtained more information from the original image than hard segmentation process (e.g. Bezdek et al. [7], Udupa et al. [8], Pham [9]). Fuzzy C means technique (FCM) can result a segmentation via fuzzy pixel classification. Apart from hard classification methods, where pixels only belong to one class exclusively, FCM allows multiple classes pixels with varying degrees of membership. This technique allows additional flexibility in application areas and has recently been used in processing of magnetic resonance image (MRI) [10].

II. LITERATURE SURVEY

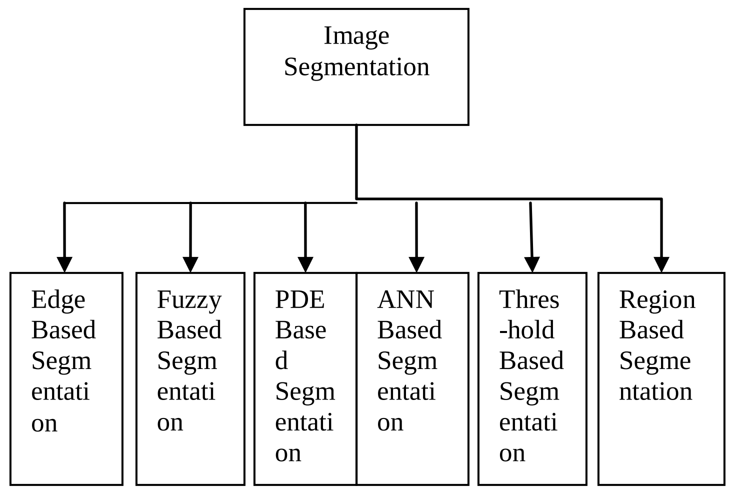
Xing Zhang (2014) [24], central of human experience is Facial expression. The main issue is efficiency and valid measurement that automated facial image inquiry seeks to the location. Posed and un-posed facial expressions differ along several dimensions in which including timing and including complexity, well-annotated video of un-posed facial behavior is needed.

Hongbing Liu (2014) [25], Color image segmentation algorithms are proposed based on granular computing clustering (GrCC). Firstly, the atomic hyper-spherical granule is represented as the vector including the RGB value of pixels of color images and radii 0. Secondly, the union operator of two hyper-spherical granules are designed to obtain the larger hyper-spherical granule compared with these two hyper-spherical granules. Thirdly, the granular computing clustering is developed by the union operator and the user-defined granularity threshold. Global Consistency Error (GCE), Variation of Information (VI), Rand Index (RI), and Loss Entropy (ΔEn) are used to evaluate the segmentations. Segmentations of the color images selected from the internet and BSD300 show that segmentations by grace, speed up the segmentation process and achieve the better segmentation performance compared with K-means and FCM segmentations.

Haida Liang (2014) [26], Portable Remote Imaging System for Multispectral Scanning (PRISMS) is created for in situ 3D topographic imaging of wall paintings and, high resolution spectral and another huge plot. In this they transverse the resolution of an image at tens of microns, from tens of meters distances remotely, and creating a high resolution imaging, which is likely from a fixed position on the ground in areas at heights that is challenging to access. A fully automated spectral imaging system, giving 3D topographic mapping at millimeter accuracy as a by-product of the image focusing process.

Bhuvaneswari (2014) [28], Automatic classification of lung diseases in computed tomography (CT) images is an important diagnostic tool for computer-aided diagnosis system. In this study, they presented a new image based feature extraction technique for classification of lung CT images. A novel fusion based method was developed by combining the Gabor filter and Walsh Hadamard transform features using median absolute deviation (MAD) technique and hence, it possesses the advantages of both models. The proposed system comprises of three stages. In the first stage, the images are preprocessed and features are extracted by novel fusion based feature extraction technique, followed by a second stage, in which extracted features are selected by applying genetic algorithm which selects the top ranked features. In the final stage, classifiers namely decision tree, K nearest neighbor (KNN), Multilayer perceptron Neural Networks (MLP-NN) are employed to perform classification of the lung diseases. A total of 400 data sets for the diseases, bronchitis, emphysema, pleural effusion and normal lung were used for training and testing. The classification accuracy of above 90% is accomplished by multilayer perceptron neural network classifier. The system has been tested with a number of real Computed Tomography lung images and has achieved satisfactory results in classifying the lung diseases.

III. VARIOUS SEGMENTATION TECHNIQUE



A. Segmentation using discontinuities:

Several techniques for detecting the three basic gray level discontinuities in a digital image are points, lines and edges. The most common mode to look for discontinuities is by spatial filtering methods. Point detection idea is to segregate a point which has a gray level, notably different from its background.

m1	m2	m3
m4	m5	m6
m7	m8	m9

Figure 1. Point detection mask

m1=m2=m3=m4=m6=m7=m8=m9 =-1, m5 = 8.

The response is R = m1z1+m2z2…… +m9z9, where z is the gray level of the pixel. Based on the calculated response from the above equation, we can find out the desired points.

B. Line detection :

Line detection is the next level of complexity to point detection and the lines could be vertical, horizontal or at +/- 45 degree angle. Responses are calculated for each of the mask above and based on the value we can perceive if the lines and their orientation.

C. Edge detection :

The edge is a regarded as the boundary between two objects (two dissimilar regions) or conceivably a boundary between light and shadow falling on a single surface. To find the differences in pixel values between regions can be computed by considering gradients. The edges of an image, hold much information in that image. The edges tell where objects are, their shape and size, and something about their texture. An edge is where the intensity of an image moves from a value of low to a value of high or vice versa. There are numerous applications for edge detection, which is often used for various special effects. Digital artists use it to create an impressive image outlines. The results of an edge detector can be added back to an original image to enhance the edges. In Image Segmentation the first step is Edge detection. Image segmentation, a field of image analysis, is used to group pixels into regions to determine an image composition. A common example of image segmentation is the "magic wand" tool in photo editing software. This tool allows the user to select a pixel in an image. The software then draws a border around the pixels of similar value. The user may select a pixel in a sky region and the magic wand would draw a border around the complete sky region in the image. The user may then edit the color of the sky without worrying about altering the color of the mountains or whatever else may be in the image. Edge detection is also applied in image registration. Image registration aligns two images that may have been acquired at detach times or from different sensors.

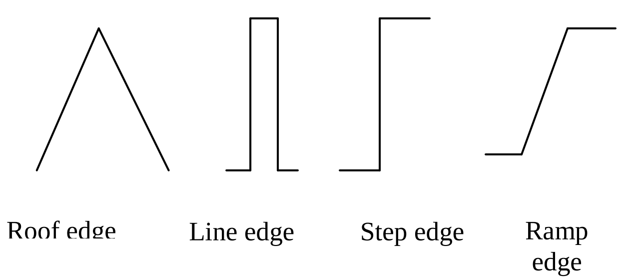


Figure 2. Different edge profiles.

There are an infinite number of edge orientations, widths and shapes (Figure 2). Some edges are straight while others are curved with varying radii. There are many edge detection techniques to go with all these edges, each having its own strengths. Some edge detectors may work well in one application and perform poorly in others. Sometimes it takes experimentation to determine what the best edge detection technique for an application is. The simplest and quickest edge detectors determine the maximum value from a series of pixel subtractions. The homogeneity operator subtracts each 8 surrounding pixels from the center pixel of a 3 x 3 window. The yield of the operator is the maximum of the absolute value of each difference. Similar to the homogeneity operator is the difference edge detector. It operates more quickly because it requires four subtractions per pixel as opposed to the eight desired by the homogeneity operator. The subtractions are upper left -lower right, middle left - middle right, lower left - upper right, and top middle - bottom middle.

D. Segmentation using Thresholding :

Thresholding is based on the hypothesis that the histogram has had two dominant modes, like for example light objects and a dark background. The method to extract the objects will be to select a threshold F(x, y)= T such that it separates the two modes. Depending on the kind of problem to be solved, we could also have multilevel thresholding [29]. Based on the region of thresholding we could have global thresholding and local thresholding. Where global thresholding is considered as a function of the entire image and local thresholding involves only a certain region. In addition to the above mentioned techniques that if the threading function T depends on the spatial coordinates, then it is known as the dynamic or adaptive thresholding. Let us consider a simple example to explain thresholding.

E Region based segmentation

We have seen two techniques so far. One is dealing with the gray level value and another with the thresholds. In this section we will concentrate on regions of the image. Formulation of the regions: An entire image is divided into sub regions and they must be in accordance to some rules such as

- Union of sub regions is the region
- All are connected in some predefined sense.
- Not to be sane, disjoint
- Properties must be satisfied by the pixels in a segmented region P (Ri) =true if all pixels have same gray level.
- Two sub regions should have a different sense of the predicate.

F ANN Based Image Segmentation:

An Artificial Neural Network, every neuron is corresponding to the pixel of an image. Image is mapped to the neural network. Image in the form of neural network is trained using training samples, and then the connection between neurons, i.e., pixels is found. Then the new images are segmented from the trained image [30]. Some of the most used neural networks for image segmentation are Hopfield, BPNN, FFNN, MLFF, MLP, SOM, and PCNN.

Segmentation of an image using neural network is performed in two steps, i.e., pixel classification and edge detection .

G Fuzzy Theory Based Image Segmentation :

Fuzzy set theory is used in order to analyze images, and provide accurate information about any image. Fuzzification function can be used to remove noise from an image as well . A grayscale image can be easily transformed into a fuzzy image by using a fuzzification function. Different morphological operations can be combined with a fuzzy method to get better results [31]. Fuzzy k-Means and Fuzzy C-means (FCM) are widely used methods in image processing.

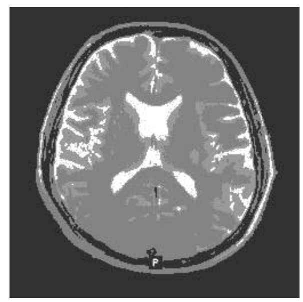
IV. FUNDAMENTAL THEORY

4.1 Magnetic Resonance Imaging:

Magnetic Resonance Imaging (MRI) is a technique that is primarily used to produce high quality medical images of the soft tissues inside the human body. In this section we give a brief description of the principles of MRI, which are referred to [15]. In MRI, the image is a map of the local transverse magnetization of the hydrogen nuclei. This transverse magnetization in turn depends on several intrinsic properties of the tissue. MRI is based on the principles of nuclear magnetic resonance (NMR). The NMR phenomenon relies on the fundamental property that protons and neutrons that make up a nucleus possess an intrinsic angular momentum called spin. When protons and neutrons combine to form a nucleus, they combine with oppositely oriented spins. Thus, a nucleus with odd no. of protons and neutrons contain a net spin where as for even number no net spin. Hydrogen nuclei have an NMR signal since its nucleus is made up of only a single proton and possess a net spin. The human body contains fat and water, which have many hydrogen atoms. Medical MRI primarily images the NMR signal from the hydrogen nuclei in the body tissues. The net spin of the nucleus around its axis gives it an angular moment. Since the proton is a positive charge, a current loop perpendicular to the rotation axis is also created, and as a result the proton generates a magnetic field. The joint effect of the angular moment and the self generated magnetic field gives the proton a magnetic dipole moment parallel to the rotation axis. Under normal condition, one will not experience any net magnetic field from the volume since the magnetic dipole moments are oriented randomly and on average equalize one another. When placed in a magnetic field, a proton with its magnetic dipole moment processes around the field axis. The frequency of this precession, $v0$, is the resonant frequency of NMR and is called the Larmor frequency. The precession frequency is directly proportional to the strength of the magnetic field, i.e.

$$v0 = gB0 \qquad (1)$$

Where $B0$ is the main magnetic field strength, and g is a constant called gyro magnetic ratio, which is different for each nucleus (42.56 MHz/Tesla for protons). Given a specimen, the application of a magnetic field $B0$ would create a net equilibrium magnetization $M0$ per cubic centimeter, which is aligned with the $B0$ field. The $M0$ is the net result of summing up the magnetic fields due to each of the H nuclei and is directly proportional to the local proton density (or spin density). However, $M0$ is many orders of magnitude weaker than $B0$ and is not directly observable. By tipping $M0$ away from the $B0$ field axis with an appropriate RF pulse having a frequency equals to the Larmor frequency, a longitudinal magnetization component ML and a transverse magnetization component MT is produced. When the RF pulse is turned off, the longitudinal magnetization component ML recovers to $M0$ with a relaxation time $T1$, and the transverse magnetization component MT dephases and decays to zero with a relaxation time $T2$.



(a) Original MRI1 Brain image

(b) Segmented MRI1 Brain image

Figure 3. MRI1 Brain image

V. COMPARATIVE ANALYSIS TABLE

Proposed Technique	**Algorithm Used**	**Benefits**	**Accuracy**
Separation of WM, GM and CSF. Tumor detection and Bilateral symmetry analysis	Fuzzy Based Method	Robust tumor detection	93% Average detection accuracy and 4.5 minutes per image segmentation

Application of FCM on MRI brain Image to identify glioma and calculation of volume	Fuzzy C Mean Algorithm	No prior information on the images, the computation speed is fast with Less memory and in FCM less iterations are needed in clusters.	Accuracy estimation not performed
Application of FCM by modification of the Objective function	Modified FCM Algorithm	A fast clustering even in the presence of Gaussian noise	71% accuracy achieved compared to other FCM base methods
Modification of the cluster center and membership value updating criterion is used with FCM on image	Modified FCM algorithm	A reduced dataset to increase efficiency.	93.45% segmentation accuracy with 20 Sec average CPU time
Hybrid, semi-automatic, parallel boundary and region based approach using clustering and deformable model.	Clustering & Deformable model	Highly efficient and accurate in identifying the corpus callosum and brain cortex in three dimensions.	Performed by comparing with manual segmentation with high overlapping rate
Hybrid method using ACM for Skull stripping, K means for clustering into three regions and then training ANN with the data to generate model	ANN with ACM and K Means Clustering	Efficiently segments the brain region into 3 distinct region and performs skull stripping as well	Average Accuracy 98.86% with error rate of 1.14%

VI. CONCLUSION

In this paper, a survey presents various techniques detailed discussion on image segmentation. Recent reviews of various researcher works also present. In Image segmentation dividing an image into many regions is the segmentation process. Segmentation Process provides a way to find a particular region of point inside an image. In this paper, a survey of various techniques of image segmentation their algorithm that helps in finding Medical images. Also present comparative analysis table of various research work.

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