



## Full Length Review Article

### A Survey On Various Segmentation Methods In Medical Images

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Accepted 02<sup>nd</sup> February, 2015; Published Online 31<sup>st</sup> March, 2015

#### ABSTRACT

This paper makes a review on various segmentation methods for automatic extraction of images from CT and MR images in medical field. Precise segmentation of medical images is a key step in contouring during radiotherapy planning. Computed topography (CT) and Magnetic resonance (MR) imaging systems are the most widely used radiographic techniques in identification, clinical trails and for treatment procedure. For the past years, many image segmentation techniques have been proposed by various researchers. These segmentation techniques can be classified into three types, (1) characteristic feature threshold or clustering, (2) edge detection, and (3) region extraction. This survey paper encounters some of these techniques. In biomedical image segmentation, most commonly used techniques fall into the categories of characteristic feature threshold or clustering and edge detection. This paper gives details of automatic segmentation methods, specifically for CT and MR images. The aim is to discuss the problems meet in segmentation of CT and MR images, and the relative advantages and disadvantages of those methods currently available for segmentation of medical images.

**Key words:** Edge based, Region based, Artificial intelligent, CT, MRI.

#### INTRODUCTION

For the past few years, the uses of Computed topography (CT) and Magnetic resonance (MR) imaging for identification of diseases, treatment procedure and clinical trials, it has become more important to use super computers to help the radiological experts in clinical diagnosis, treatment planning. So that segmentation method and algorithms are needed for the automatic extraction of anatomical structures and regions of interest (ROI). Various aims to automatic extraction are:

- To handle large number of images automatically.
- To achieve fast and exact results.
- To support faster communication.

Segmentation of medical images is very specific to medical application, imaging quality and type of body parts to be examined. When selecting a segmentation algorithm the following problems must be considered.

- Partial volume effect
- Different artifacts and
- Noise due to electronic system

While using segmentation, there is no universal algorithm for segmentation for every medical image. Each system has its own clearly defined merits and demerits. For example, in CT images one has to take care of bias field noise.

Some methods are more common as compared to specialized algorithms and can be applied to a wider range of data. This paper discuss about various segmentation method for automatic extraction of CT and MRI images.

#### SEGMENTATION

Image segmentation is the method of dividing a digital image into more than one segment. The main aim of segmentation is to clearly represent an image into meaningful and easy to analyze. Image segmentation is mainly used to identify the target and partition in images. Image segmentation is the method of allocating a tag to every pixel in an image and each tag that share certain characteristics with those pixels. The result of this is a collection of segments that describe the entire image.

Similar pixels in a region with respect to some characteristic such as color, intensity, or texture. Adjoining regions are different with respect to the imaging characteristic. When applied to medical images, the resulting segmented image can be used to create 3D reconstructions with the help of interpolation algorithms. Automatic segmentation of medical images is very difficult and different task, because medical images more complex than gray level images in nature. The output of segmented images can be affected by volume, intensity, presence of artifacts and gray level of different tissues. Even though various algorithms have been proposed in medical image segmentation, it still remains to be a difficult problem to researchers. From the image processing point of view, segmentation method can be classified based on gray scale level and textural feature.

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## METHODS BASED ON GRAY LEVEL FEATURES

The following method describes various segmentation methods based on gray scale level features:

- Amplitude based segmentation
- Edge based segmentation
- Region based segmentation

### Amplitude Based Segmentation

Segmentation of an image based on threshold features and gray level threshold is the simplest example of this segmentation method. This is mostly applicable for an image with region of unique brightness placed against different gray scale level. A threshold value can be calculated to segment the image. The threshold value can be calculated as follows.

$$r_{i,j} = \begin{cases} 1 & p_{i,j} \geq T \\ 0 & p_{i,j} < T \end{cases}$$

Where  $r_{i,j}$  is the resulting pixel at co-ordinate (i, j),  $p_{i,j}$  is the pixel of input image and T is the value of threshold.

This equation gives better results for segmenting an image with uni-modal histogram and fails in the case of an image with multi-modal histogram. Threshold value can be calculated by the above equation is very simple and works, when the target have unique brightness of different gray scale values. This threshold operation does not work well at segmentation of images with multiple objects each having different gray scale level value. To solve this disadvantage, band threshold equation can be applied as follows:

$$r_{i,j} = \begin{cases} 1 & T_1 < p_{i,j} \leq T_2 \\ 2 & T_2 < p_{i,j} \leq T_3 \\ 3 & T_3 < p_{i,j} \leq T_4 \\ \dots & k \\ 0 & T_k < p_{i,j} \leq T_{k+1} \end{cases}$$

otherwise Here, the  $K^{\text{th}}$  band is corresponding to object/region having pixel values in the range of  $T_k$  to  $T_{k+1}$  where  $T_k$  is the lower limit of gray level and  $T_{k+1}$  is the upper limit of Gray level band. To achieve accurate segmented results, the correct threshold value must be applied. The bar graph of an image is particularly used to identify the threshold value.

### Disadvantages

Calculation of threshold value is little difficult. Accuracy of an image is affected by noise and artifacts

### Edge Based Segmentation

Edge based mostly segmentation is that the most typical technique supported detection of boundaries that separate completely different regions. Edge detection technique is predicated on delineating of discontinuities in grey scale level, color etc., and sometimes these edges represent boundaries between objects. This technique segments a picture on the premise of boundaries of a picture. Number of edge police investigation operators supported gradient (derivative) operate are offered e.g. Prewitt, Sobel, Roberts (1st spinoff type) and Laplacian (2nd spinoff type), edge detector. Further, in edge based segmentation technique, it is make the border by joining the identified edges into edge chain.

During this method the spurious or faux edges are removed by threshold operation. The various edges based mostly segmentation algorithms are:

- Edge relaxation,
- Border detection technique,
- Hough remodel based.

The generalized formula for edge based mostly segmentation has the subsequent steps.

- Apply the spin-off operator to observe edges of the image
- Live the strength of edges by measurement amplitude of the gradient,
- Collect all edges having magnitude bigger than threshold T
- Realize the position of split edges; the split edge is either preserved or rejected supported the arrogance it receives from it precursor and successor edges
- Step three and four are continual with completely different values of threshold thus on resolve the closed boundaries; segmentation of a picture is achieved

The limitations of edge based mostly technique are:

- Performance is plagued by the presence of noise
- Noisy and weak edges can also be detected with in an image which can have a opposite influence on segmentation results.
- Edge detection techniques are used in conjunction with region- growing method for good segmentation result.

### Region Based Segmentation

Region primarily based ways square measure supported the principle of similarity- pixels with same properties square measure clustered along to make a regular region. the factors for similarity is most of the time grey scale level of pixels and this criteria will be such as by following conditions

$$R_1 \cup R_2 \cup R_3 \cup \dots \cup R_i = I$$

where  $R_1, R_2, R_3, \dots, R_i$  square measure the region within the image I, and  $R_1 \cap R_2 \cap R_3 \cap \dots \cap R_i = 0$

Region primarily based segmentation is any divided into 3 sorts supported the principle of region growing:

- Region merging
- Region cacophonous
- Split and merge

### Region Merging

- In this methodology some seeding points area unit needed to initialize the method, the segmentation results area unit smitten by the selection of seeds.
- Regions area unit full-grown iteratively by merging the neighboring pixels relying upon the merging criterion.
- This method is sustained till all pixels area unit assigned to their various regions as per merging criterion.

## Region Splitting

It is a method opposite to region merging and entire image is unendingly split till no additional cacophonous of a part is feasible.

## Split and Merge Method

This is the mixture of splits and merges uses the advantage of the two ways. This methodology is predicated on quad quadrant tree illustration of information whereby image phase is split into four quadrants provided the initial phase is non-unique in properties. When this the four neighboring squares area unit integrated betting on the uniformity of the region (segments). The split and merge method is suitable till no additional split and merge is applicable.

The algorithmic program for split and merge follows the subsequent steps.

- Outline homogeneity criterion. Break image into four sq. quadrants
- If any resultant sq is not unvaried split it additional into four quadrants
- At every level merge one or more additional adjacent regions satisfying the condition of uniformity.
- Continue this method till no additional split and merge of region is feasible

Apart from the preceding techniques watershed segmentation supported the construct of topography and oceanography is additionally a region-based segmentation. The limitation of region primarily based segmentation is that there are a unit probabilities of underneath segmentation and over segmentation of regions within the image. However, this downside are often corrected in 2 ways that

- By optimally choosing the criterion for segmentation, for this many algorithmic program utilizing computer science techniques are developed.
- By combining region approach with edge based segmentation method.

## Method Based on the Textural Features

Textural options of image area unit vital from image segmentation and classification purpose of read. Totally different researchers have used these options to realize image segmentation, classification, and each segmentation in addition as classification. The aim of texture based mostly segmentation technique is to dividing the image into regions having different texture properties, whereas in grouping the aim is to classify the regions that have already been metameric by one or alternative technique.

## Definition of Texture

Texture is outlined as one thing consisting of reciprocally connected components. A texture is also fine coarse, smooth, or grained relying upon its tone and structure. Whereas tone is predicated on component intensity properties, structure is that the spacial relationship between pixels. Any texture will be outlined because the spacial arrangements of texture

primitives or texture components, organized in additional or less periodic manner. Texture primitive could be a cluster of pixels representing the only or basic sub pattern and follows 3 main approaches for texture feature extraction supported the kind of approach used.

- Applied math approach
- Syntactical or structural approach
- Spectral approach

In case of applied math approach, texture is outlined by a collection of statistically extracted options depicted as vector in four-dimensional feature house. The applied math options may well be supported 1st-order, 2nd-order or higher-order statistics of grey scale level of a picture. The feature vector thus generated from patterns is allotted to their specific category by probabilistic or settled call formula. Just in case of syntactical approach, texture is outlined by texture primitives that area unit spatially organized in step with placement rules to get complete pattern. In syntactical feature based mostly pattern recognition; a graph is drawn between the structural pattern and also the syntax of language. In spectral technique, textures area unit outlined by spacial frequencies and evaluated by autocorrelation perform of a texture. Some ways offered for textural feature extraction and classification supported the higher than approaches are: co-occurrence matrix technique supported applied math description of grey level of a picture, grey level run length technique, pattern texture description technique, syntactical technique and Fourier filter method. Texture based mostly ways as best fitted to segmentation of medical image, when put next to segmentation of medical image victimization straightforward grey level based mostly ways.

## OTHER APPROACHES OF SEGMENTATION

Apart from the higher than strategies, the subsequent 2 strategies of image segmentation also are out there.

- Model based segmentation
- Atlas based segmentation.

## Model Based Segmentation

This approach is that the formation of organs contains a repetitive style of pure mathematics and may be sculptural probabilistically for variation of form and pure mathematics. This may includes the following steps.

1. Register the coaching information.
2. Probabilistic illustration of variation of registered information.
3. Applied mathematics influence between model and image.

Model based strategies of segmentation involve active form and look model, deformable models and level-set based mostly models.

## Disadvantages

- They need manual interaction to position associate degree initial model and select acceptable parameters.
- Commonplace deformable models also can exhibit poor convergence to pouch like boundaries.

## Atlas Based Segmentation

Atlas based segmentation approaches square measure the foremost often used and powerful approaches within the medical image segmentation method. In this, info on anatomy, shape, size, and options of various, organs, soft tissues is compiled within the style of atlas or search table (LUT). Atlas target-hunting approaches square measure almost like correlation approaches and therefore purpose of atlas based mostly approaches is. Atlas based mostly segmentation approaches square measure among the third-generation algorithms. There square measure indications that sure atlas based mostly strategies will contend with manual segmentations though atlas choice, atlas registration procedure, and therefore the manual tracing protocol employed in atlas formation square measure factors that may have an effect on performance. But, they face limitations in segmenting complicated structure with variable form, size, and properties and professional data is needed in building the info.

## ARTIFICIAL INTELLIGENCE FOR SEGMENTATION AND CLASSIFICATION

Automatic segmentation strategies are supported computing (AI) based mostly techniques. AI techniques may be divided into supervised method and unsupervised method. Supervised segmentation needs operator interaction throughout the segmentation method whereas unsupervised strategies usually need operator involvement solely once segmentation is complete. Unsupervised strategies square measure most popular to make sure a reproducible result but, operator interaction remains needed for error correction within the event of associate degree inadequate result.

### Supervised Strategies

In the supervised class, we will place largely Artificial Neural Network (ANN) based mostly algorithms. ANN consists of huge range of interconnected process parts (artificial neurons) operating in unison to unravel specific issues. The most blessings of ANN are:

- Ability to find out adaptively, victimization coaching information to unravel complicated issues.
- Capability of self-organization; it will produce its own organization relying upon the data it receives for long time.
- Capability of performance in real time as a result of parallel configuration.

ANN has been wide used for segmentation and classification functions in each supervised and unsupervised modes. Though a spread of various neural network algorithms are developed for texture segmentation and classification with sensible classification accuracy, most of those texture classifier algorithms need intensive direction, coaching; their performance is sensitive to training parameters and is adversely affected within the presence of noise. Sometimes supervised image segmentation and classification strategies become terribly costly, tough and even not possible to properly choose and label the coaching information with its true class. Coaching is that the main demand of the many ANN based mostly algorithms wherever the classifiers have to be compelled to be trained before it may be applied to

segmentation and classification drawback. Further, for various information sets, analysis of various pictures of various sort and format, the total effort of choosing coaching information set and coaching is needed to be redone.

### Unsupervised strategies

Most of the unsupervised algorithms square measure cluster based mostly and not obsessed with coaching and coaching information. The 2 unremarkably used algorithms for cluster square measure K-mean or laborious C-mean and Fuzzy C-means. K-means algorithmic rule produces results that correspond to laborious segmentation whereas fuzzy C-mean produces soft segmentation which might be reborn into laborious segmentation by permitting the pixels to possess membership of cluster during which they need most price of membership coefficients. In cluster, the aim is to construct call boundaries supported unlabelled coaching information. Cluster is that the method of finding natural grouping clusters in flat feature area. It is tough as a result of clusters of various shapes and sizes will occur in flat feature area. Variety of practical definitions of clusters is proposed: Patterns at intervals a cluster square measure a lot of almost like one another than patterns happiness to totally different clusters. Image segmentation could also be thought-about a clustering method during which the pels square measure classified into the attribute regions supported the feel feature vector calculated round the pixel native neighborhood. Fuzzy cluster could be a sensible technique of classifying assortment of information purpose to reside in multiple clusters with totally different degrees of membership. However, the most limitations of fuzzy cluster algorithmic rule are: (a) sensitivity to initial partition matrix (b) stopping criterion (c) resolution could stand still at native minima. Hence, cluster techniques might not end in optimum resolution and there's no best cluster algorithmic rule for a specific application. Variety of various algorithms square measure needed to be tried to seek out the most effective one.

## SEGMENTATION OF CT AND MR IMAGES

Segmentation of CT and man pictures involves 3 main image connected problems; noise that may alter the intensity of a constituent specified its classification becomes unsure, intensity irregularity wherever the intensity of one tissue category varies bit by bit over the extent of the image, and pictures have finite constituent size and are subject to partial volume averaging wherever individual constituent volumes contain a mix of tissue categories so the intensity of a constituent within the image might not be in keeping with anybody category.

Some ways obtainable for CT image segmentation are:

- Threshold based
- Region based
- Deformable models based
- Fuzzy based
- Neural network based

MR imaging is specifically employed in brain imaging and therefore ton of analysis work has been done notably within the areas of man brain image segmentation. The most goals in

brain man phaseation is to segment gray substance, nervous tissue and humor. Segmentation is additionally accustomed determine the regions similar to lesions tumors, cyst, edema, and alternative pathologies and for this largely T1- weighted pictures are used. Most of the segmentation ways obtainable for CT and MRI pictures segmentation are intensity based mostly i.e. grey level based mostly hence; the segmentation results are tormented by (1) intensity in-homogeneities and (2) partial volume effects. Consequently, totally different researchers have planned ways for correction of those issues.

### Intensity In-Homogeneity Correction

In tomography intensity, irregularity artifacts cause shading result to seem over the photographs. As a result, they have an effect on the segmentation result whereas victimization straightforward grey level based mostly segmentation techniques. A way to rectify these intensity irregularity artifacts is by victimization image sweetening techniques. For this segmentation, techniques supported applied math methods and fuzzy ways, which supplies soft segmentation results, are notably helpful in overcoming the higher than mentioned limitation. A review of ways for correction of intensity irregularity unit in man pictures has been given by Vovk et al.

### Partial Volume Result Correction

When multiple tissues contribute to single constituent or voxel the resultant image is blurred at boundaries of the various region or object and this result is termed as partial volume result. To affect partial volume result, soft segmentation could be a sensible possibility. In soft segmentation we have a tendency to enable the region or categories to overlap i.e. pixels are allowed to possess multiple memberships with varied degree of membership constant in numerous regions. In onerous segmentation, we have a tendency to do not enable overlapping of the divided region and also the pixels are forced to reside within the region during which they are having most membership. Therefore soft segmentation retains additional info regarding the initial image by permitting the constituent to possess membership within the multiple regions. Fuzzy bunch is a super technique for soft segmentation and also the most generally used unsupervised rule for segmentation of each CT and MR pictures. Soft segmentation based mostly membership will be regenerate to onerous segmentation by permitting the constituent to possess worth of membership perform one similar to the region that it is highest membership value.

### Conclusions

Computer-aided segmentation may be a key step finding application in laptop assisted designation, clinical trials, and treatment designing. In recent years a large form of approaches are projected to phase CT and adult male pictures having their own deserves and limitations. This review provides the fundamentals of segmentation approaches and their various options. The approaches for image segmentation mentioned during this review may be hierarchal on the idea of pertinence, suitability, performance, and procedure price. Segmentation techniques supported grey level techniques like threshold, and region based mostly techniques are the only techniques and realize restricted applications. However, their performance may be improved by group action them with

computer science techniques. Techniques supported textural options utilizing atlas or look-up-table have glorious results on medical image segmentation. However, they have professional information in building the atlas. The disadvantage of atlas based mostly technique is that underneath sure circumstances it becomes troublesome to properly choose and label data; has difficulties in segmenting advanced structure with variable form, size, and properties. In such things it is higher to use unsupervised strategies like fuzzy-c-means algorithmic rule. A variety of various neural network-based algorithms are accessible for texture-based segmentation and classification having smart accuracy. However, most of those neural network-based algorithms need intensive management and coaching and their performance depends upon the coaching methodology and knowledge utilized in coaching. Finally, it is desired from medical image segmentation and classification algorithms that they have to have the subsequent features: a) accuracy, b) reliability, c) repeatability, d) hardness.

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