MEDICAL IMAGE SEGMENTATION USING VARIOUS TECHNIQUES: A SURVEY

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Abstract-The Perfect image segmentation of 2-dimensional, 3-dimensional and 4-dimensional medical images to separate functional for investigation that important in almost several computer-aided diagnosis system or other medical imaging applications. Numerous features of segmentation features and set of rules have been broadly discovered for numerous years in a host of journals. Though, the issue remains inspiring, with no distinctive explanation, reason behind big and continuously increasing figure of different substances of importance, large differences of their assets in images, different medical imaging modalities, and related changes of signal homogeneity, variability, and noise for each object. This paper overviews most prevalent medical image segmentation methods and deliberates their capabilities and simple advantage and limits. The present methods of the previous period are also presented.

Keywords- Image processing; Image segmentation; Image analysis; Image understanding; segmentation.

I. INTRODUCTION

Nowadays, Medical image exploration is a widespread idea which consider numerous processing and investigation approaches functional to a quantity of different imaging modalities. This image investigation can be separated into different topics such as: image enhancement, segmentation, registration, quantification and classification. Formerly every imaging modality contributes increase to a sum of different inspections that can change features. One of the main aims of image processing is to save compulsory info from the assumed image in a mode that will not affects the other features of that image. De-noising/augmentation of an image is the most significant stage compulsory to accomplish this requisite [16]-[17]. After eliminating noise from an image, we can achieve any operation on that image [18].

Image Segmentation is one of the foremost stages of image processing, in which some image is being split into numerous sections. Every section will signify several kinds of data to user in the form of color, strength, or quality. Later, it is significant to separate the confines of some image in the form of its sections [19]. This procedure of subdivision will allocate a single value to every pixel of an image in instruction to mark it easy to differentiate among dissimilar areas of any image. This difference among different parts of image is completed on the base of 3 properties of image, i.e., color, intensity, and texture of that image. Consequently the collection of one image segmentation method is completed next perceiving the problem area [20].

II. Advantage of image segmentation in medical image

The significance of image segmentation can’t be ignored for it is used in almost each area of science, i.e., eliminating noise from an image, medical images [6]-[10], satellite imaging, machine vision, computer vision, biometrics, military, Image Reerival [11]-[12], mining features and distinguishing substances from the assumed image. [13]-[15]
It is perceived that there is not a perfect technique for image subdivision, since each image has its particular altered category. It is similarly a very challenging task to invention a segmentation method for a specific kind of image. Meanwhile a technique useful to one image cannot continue successful to other category of images, then segmentation methods has been separated into three types, i.e. segmentation techniques based on traditional technique, AI procedures, and hybrid performances [16].

III. Methods for Image Segmentation

Image segmentation methods are categorized into 2 main groups Layer-Based Segmentation Methods and Block-Based Segmentation Methods [4, 10, and 21] see Fig. 1

3.1 Layer-Based Segmentation Approaches: The main purpose of Layered model to detect and image segmentation that fusions the output of a set of object indicators in order to describe shape masks and clarify the arrival, depth collection, and that appraises both class and instance segmentation [10, 21].

3.2 Block-Based Segmentation Methods: It is built on numerous structures which found in the image. This capacity is color information that is used to generate histograms, or information around the pixels that specify edges or borders or texture information [3]. Block-Based Image Segmentation approaches are considered on two things: incoherence and connection into three collections:

1. Region Based Methods: based on discontinuities.
2. Edge or Boundary Based Methods: based on similarity [14].
3. Hybrid Techniques [3].

These are the methods which were discussed in this paper, while there are two additional Block based Image

3.3 Segmentation methods or categories [6]:

a. **Pixel-Based** Segmentation: or Point-Based Segmentation [6, 7, and 11]. And

b. **Model-Based Segmentation**: The human vision scheme has the capacity to identify objects uniform if they are not entirely signified. It can be useful if the precise outline of the objects in the image is recognized [6, 7]. Segmentation is a procedure that splits an image into its areas or objects that have comparable structures or characteristics [2].

![Figure 1. Methods of Image Segmentation](image-url)
3.4 Region Based Methods: Distribute the whole image into sub regions or clusters, e.g. all the pixels with same grey level in one region. [3].

a. Clustering: K-mean: separations an image into K collections or clusters through addition points, p, to the cluster where the alteration among the point and the mean is minimum. [3, 12, 19, 22]. Hard clustering undertakes sharp limitations between clusters [5].

b. Fuzzy clustering: shape-based image segmentation set of rule [3, 5].

Applications: medical imaging and security systems. Advantages: shape-based image segmentation. Disadvantages: certain clustering set of rules like K-means clustering doesn’t promise incessant areas. This disadvantage is overcome by Split and Combine method [3].

c. Split and Merge: Two parts: Originally the whole image which is occupied as a single region is frequently split till no more splits are probable, Quad tree is a splitting data structure, then two regions are compound if they are adjacent and comparable, integration is frequent up until no more merging is probable [3, 5, 7].

Three steps: using Quad Tree (IQM), 1st unbearable the image, 2nd modifying neighbors list and the 3th step is merging splitted areas. Advantages: associated regions are definite and IQM decreases long† neighbour problems during merging. Disadvantages: the location and direction of the image prime to blocky ultimate segmentation and ordered separation leads to over segmentation (more regions) by intense [3]. This disadvantage can be overcome by using Regulated cuts [3, 18, and 20].

d. Normalized Cuts: Normalized cuts goal at optimal splitting by decreasing number of regions. This process is based on graph theory. Each pixel is a vertex in a graph, edges link nearby pixels. Weights on the edge are allocated allowing to correspondence, distance, color, grey level or textures and so on among two consistent pixels [3, 5, 18, and 20].

Applications: medical images [3, 18, 20]. Advantages: no necessity to combine regions after intense, better edges meaning, new optimality condition for separating a graph into clusters and different image structures like strength, color texture, contour stability are preserved in one unchanging network. Disadvantages: multipart computational [3].

e. Region Growing: Region growing is one of prevalent approaches. Starts with a pixel and will go on calculation the pixels based on correspondence, to the region, recurrence until all pixels fit to certain region [3, 5 … 7].

Applications: fragment the quantities of human body. Advantages: associated regions are definite; multiple principles at the same time and give very good consequences with less noisy. Disadvantages: over segmentation when the image is noisy or has intensity differences, cannot differentiate the protecting of the real images and power and time consuming [3].

3.5 Threshold: is extrication forefront or object from the training [3...14] into no overlying sets [13].
Threshold subdivision methods grouped in classes:

- **Local** methods are based on the local possessions of the pixels and their areas.
- **Global** procedures fragment an image on the basis of evidence acquire totally (e.g. by using image histogram; worldwide texture properties).
- **Split, merge and growing** methods use both the concepts of homogeneity and geometrical proximity in instruction to get good segmentation consequences [8].

**Fuzzy C-means**: is set of rule and approaches that can expand remote sensing image threshold segmentation with less iterations times and good immovability and robustness [5, 8, 22]. A fuzzy set of class range points of association marks with no sharp border [11] see Fig. 2.

![Multimodal image histogram and the characteristic functions for the seed subsets.](image2.png)

**Figure 2. Multimodal image histogram and the characteristic functions for the seed subsets.** [13]

**Gray –level** images are transformed to binary images by picking a single threshold value (T), so the binary image should cover information about the position and shape of the objects, center [5, 8].

In threshold **regions** categorized on the base **range values**, useful to the amount values of the image pixels [3, 5].

**Pixels** are ordered, using range values or **Threshold values** to: 1st **Global** threshold where a single threshold value is used in the entire image, 2nd **Local**, (adaptive) [8], threshold value is allocated to every pixel to control whether it fits to the forefront or the related pixel [3, 5, 6, 8], 3rd **Threshold value T** is designated by studying image **histograms** which can be one of two models: 1st **Bimodal** histograms present two peaks and a strong valley, T is the valley point [3, 8, 13], 2nd **Multimodal** histograms, see Fig. 1, are more composite, with numerous peaks and not clear valleys so it is not easy to select the value of T [8, 13].
IV. THRESHOLD TECHNIQUE FOR MEDICAL IMAGE

- **Mean** Method: usages the mean value of the pixels as the threshold value [8].
- **P-Tile** Technique: one of the initial threshold approaches, uses information about the area size of the object, based on the grey level histogram, undertakes the objects are brighter than the circumstantial and occupy a fixed percentage, known as P%, of the picture area. **Applications:** Suitable for all sizes of objects.
- **Histogram Dependent** Technique (HDT): Dependent on the success of estimating the threshold value that separates the two homogenous regions of the object and background. **Applications:** for image with large homogenous and will separate regions [8].
- **Edge Maximization** Technique (EMT): depend on the maximum edge, edge detection techniques, threshold to start segmentation and **Automatic threshold** performance becomes much better [5, 8, 15].
  **Applications:** for image with more than one homogenous region.

I. EDGE BASED

Segmentation can also be done through using edge detection methods. There are many methods and is labeled in Fig 7. In this procedure the border is recognized to section. Edges are sensed to classify the discontinuities in the image. Edges on the region are outlined by recognizing the pixel value and it is compared with the neighboring pixels. For this classification they use both fixed and adaptive feature of Support Vector Machine (SVM) [5]

In this edge based segmentation, there is no necessity for the detected edges to be closed. There are numerous edge detectors that are used to segment the image. In that Canny edge detector has some step by step process for subdivision is revealed in Fig 3, which is as follows:
1. To decrease the consequence of noise, the surface of the image is smoothened by using Gaussian Convolution.
2. Sobel operative is functional to the image to detect the edge strength and edge instructions.
3. The edge orders are occupied into deliberations for non-maximal destruction i.e., the pixels that are not connected to the edges are noticed and then, they are reduced.
4. Final stage is eliminating the destroyed edges i.e., the threshold value of an image is intended and then the pixel value is associated with the threshold that is gained. If the pixel value is high than the threshold then, it is measured as an edge or else it is excluded[4].

**Figure 7. Types of Edge Detection**

The Canny Edge Detection process is labeled in the flowchart. Edges are the discontinuities in the intellect of intensity, which gives us a design of an article. All substances in the image are outlined when the strengths are designed precisely [3].
Numerous Edge Detectors are labeled.

- The edges are noticed by computing the smallest and extreme of first imitative in gradient edge detector.
- Zero Crossing is found in second derivative to identify the edges in Laplacian edge detector.
- Sobel Edge Detector uses Convolution Kernel to detect the edges.
- Magnitude of the spatial gradient is calculated for edges in Robert’s Edge Detector.
- Canny Edge Detector also uses high spatial gradient but it takes more computation than Sobel and Robert’s Edge Detector. [21]

The method that is used for segmenting the isolated sensing image has high spatial determination. The two step measures for segmentation are mining the edge information from the edge detector and formerly the pixels are categorized. The advantage of this procedure is retrieving information from the weak border too [9]. Spatial resolve for segmentation expands positional accuracy [22]. Built on the edge flow, the image is segmented. It classifies the direction of the change in color and texture of a pixel in an image to segment [12]. Segmentation can also be done through edges. There will be some gap between the edges as it is not closed. So, the gap is filled by edge linking. The broken edges are extended in the direction of the slope for the link to get the connectivity for segmentation [14].

II. ANN based image segmentation:

It is neural net is an artificial representation of human brain that tries to simulate its learning strategies and can be used for decision making process. An artificial neural network is often called a neural network or simply neural net. In recent years, artificial neural networks have been widely used to solve the problem of medical image segmentation. Neural network that simulate life, especially the human brain's learning procedures, constitutes a large number of parallel nodes. Each node can perform some basic computing. The learning process can be achieved through the transferring the connections among nodes and connection weights [15]. Its main advantage is not dependent on the probability density distribution function. It can also prove the segmentation results when the data deviation from the normal situation.
Neural network can also reduce the requirements of expert intervention during the image segmentation process.

V. LITERATURE SURVEY

Hakeem Aejaz Aslam et al. (2013) [1], In this paper the author offers a new method to picture segmentation the usage of Pillar okay-approach set of rules and the set of rule defined using that set of rules is recognized as Pillar k-mean s set of rule. This segmentation method includes a new instrument for grouping the factors of high resolution pictures so that it can expand accuracy and decrease the calculation time. This set of rules is capable to enhance the k-mean clustering for photo segmentation in the aspects of accuracy and computation time. This set of rules distributes all first centroids in line with the most cumulative distance metric. In this paper a new technique for image segmentation is established that compares the results of K-mean set of rule with Gaussian aggregate model. Experimental consequences make clear the effectiveness of our approach to improve the segmentation satisfactory and accuracy factors of computing time.

Khang Siang Tan (2011) et al. [4], In this paper a new histogram thresholding fuzzy C-method hybrid (HTFCM) method is obtainable that would find distinct software in sample approval in adding to in laptop creative and prescient, mainly in shade photo division. The histogram thresholding method that is planned in the paper is working to obtain all possible uniform regions within the pattern photograph. Then, the luxuriant C-manner set of rule is functional in the unchanging regions while cluster formation and that will improve the density of formed clusters. Investigational consequences have established that the low complexity of the proposed HTFCM method should obtain better cluster acceptable and segmentation consequences than other segmentation techniques that employing ant colony set of rules.

Dibya Jyoti Bora et al. (2014) [7], In this paper image segmentation is specified as a massive topic of research and optimal of large number of researchers by the author. The reason for the popularity of image segmentation is because of its importance in the area of image processing and processor vision. The prime task of the researchers working in the field is to develop a method for efficient and better image segmentation. The segmentation done using approaches of clustering are measured good for image segmentation. The advantage of using approaches of clustering in image segmentation is that this is a wide area and can be employed in other areas of manufacturing too. In this paper the author has developed a new technique for image segmentation keeping clustering as a base. K-mean set of rule is employed and distance parameter is considered for deciding the performance.

Rajiv Kumar et al. 2011 [9], In this paper the process of image segmentation is defined as the method via which we segment a given photograph into several parts in order that we can further examined every of these components present in the photo. The author states that it is possible to extract some records via analyzing them and this statistics is useful for excessive-stage gadget vision software. There are numerous techniques of photograph segmentation to be had in literature. In this paper, analysis is done to examine the discontinuity-primarily based approach for photo segmentation. The discontinuity-based totally segmentation may be categorized into 3 methods: factor detection, line detection, and aspect detection. The result of these numerous approaches is analyzed in MATLAB the use of IPT.

Amanpreet Kaur et al. (2012) [10] this paper present an image segmentation is described as in which we distribute the image into a couple of mechanisms in the form of pixels. In segmentation, without a doubt image is represented into greater understandable form. Segmentation basically used to hit upon the gadgets, obstacles and other applicable facts in the digital snap shots. There are exceptional tactics to
enforce segmentation like threshold, clustering and modify strategies etc. After appearing these processes, the ensuing segmented image is a cooperative pixel set of the complete photo. Pixels within the image correspond to some characteristics of picture like shade, texture and so forth.

Muhammad Waseem Khan et al. (2014) [11], In this paper the author states that image segmentation is an integral part of image processing. The author says that the steps of image segmentation are essential when it comes to area of image processing. The task of image segmentation is dividing the image into numbers of regions so that image could be analyzed easily. The numbers of objects in the image are also recognized easily when segmentation of image is done. To ease the process of evaluating and analyzing images various image segmentation techniques have been developed till date. In this paper the author has reviewed the techniques that have been developed till date for image segmentation and has also developed a new technique for image segmentation using the recent technology.

Rohan Kandwal et al. (2014) [12], In this paper, image segmentation is noted as the maximum important part in digital picture processing. Segmentation is nothing however a portion of any photo and object. In image segmentation, digital photo is split into a couple of set of pixels. Image segmentation is commonly required to cut out region of interest (ROI) from a photograph. Currently there are many distinct set of rules to be had for photograph segmentation. Each has their very own benefits and motive. In this paper, the author has reviewed different image segmentation set of rules with their possibilities.

VI. Advantage and Disadvantage of multiple segmentation method

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverse dynamics</td>
<td>• Data are very good.</td>
<td>• Many different EMG patterns can produce the same kinematic output</td>
</tr>
<tr>
<td>method</td>
<td>• Animation is of high quality.</td>
<td></td>
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<tr>
<td></td>
<td>• Using a nonlinear optimizer.</td>
<td></td>
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<tr>
<td>Active contour</td>
<td>• Use active contour models</td>
<td>• Should find strong image gradients to drive the contour.</td>
</tr>
<tr>
<td>method</td>
<td>• Preserves global line shapes efficiently</td>
<td>• Lacking accuracy with weak image boundaries and image noise</td>
</tr>
<tr>
<td>Watersheds Method</td>
<td>• Based on Mathematical Morphology</td>
<td>• Over segmentation</td>
</tr>
<tr>
<td></td>
<td>• Helps to improve the capture range</td>
<td></td>
</tr>
<tr>
<td>Novel edge-based</td>
<td>• Set of rule based on an Energy minimization procedure.</td>
<td>• depends on the assumption that the deformation and movement of the tracked Object is small between the frames.</td>
</tr>
<tr>
<td>Method</td>
<td>• Improve the filtration efficiency.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using linkage clustering.</td>
<td></td>
</tr>
<tr>
<td>Topological</td>
<td>• Pattern recognition fields used to perform the segmentation.</td>
<td>• Complicated.</td>
</tr>
<tr>
<td>Method</td>
<td>• The method used to model relationships between inputs and outputs.</td>
<td></td>
</tr>
<tr>
<td>Pattern Recognition</td>
<td></td>
<td>• Restrictions on shape parameters.</td>
</tr>
<tr>
<td>Method</td>
<td></td>
<td>• Complicated.</td>
</tr>
<tr>
<td>Threshold method</td>
<td>• Try to find edge pixels while eliminate the noise influence.</td>
<td>• The detected edges are consisted of discrete pixels and may be incomplete or discontinuous.</td>
</tr>
<tr>
<td></td>
<td>• Use gradient magnitude to find the potential edge pixels.</td>
<td>• Computationally expensive</td>
</tr>
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V. DISCUSSION

In this discussion, Image segmentation has a favorable future as the worldwide segmentation set of rules and has develop the emphasis of modern research. The numerous important segmentation methods have deliberated in above. There are different types of techniques available for segmentation process. But the paper focused on top five techniques used for segmentation. The paper demonstrations the detailed explanation about how the segmentation is done by using each technique separately. Thus there is no single method which can be considered good for all type of images but all methods are equally good for particular type of images. Due to all above factors, Image Segmentation faces a challenging problem in image processing and computer vision.

Image segmentation is the process of division of a digital image into multiple segments sets of pixels, also known as super pixels. The aim of segmentation is to simplify and change the representation of an image into something that is more meaningful, easier to analyze and easy to understand. Image segmentation is used to give the values of objects and boundaries of a selected image like lines, curves. Image segmentation is the most important field of image analysis and its processing which is mostly used in medical field to analyze the disease. It is also used in many scientific fields including, engineering and technology, face recognition and object. The major challenge of image segmentation is to remove the noise from image by using various methods and give the clear view of image. The main goal of this article is to propose methods improving image segmentation and give the clear object about image by using different techniques. This paper presents a brief outline on some of the most commonly used segmentation techniques like thresholding, Region based, Edge detection, fuzzy based and ANN based segmentation.

VI. CONCLUSION

From the previous review, we classify the current methods and summarize their features. Also each method has its suitable application fields, and researchers should combine the application background and practical requirements to design proper set of rules. Accuracy, complexity, efficiency and interactivity of a segmentation method should all be the considered factors. This paper makes a review on the current segmentation methods, and the main tendency of each method with their principle ideas, application field, advantages and disadvantages are discussed.

REFERENCES


