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INSIGHT OF IMAGE SEGMENTATION TECHNIQUES

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Abstract: Image segmentation is a computer based analysis of image to get the details of object present in image. There are some certain steps in object recognition, representation and visualization. The basis of are pixel intensity, color or texture similarities, pixel continuity etc. The result of image segmentation provides set of regions that when combined together comprises the image space. Image segmentation can help the clinicians in the differentiation and visualization of organs and tissues, measurement and comparison of size of tissues and anatomies and finally to plan diagnosis and other treatment.

Keywords*:* Image Segmentation, Ultrasound Images, Thresholding, Edge-Detection, Region based Segmentation

1. INTRODUCTION

Image segmentation is a classic problem and most critical task in medical image analysis. Image analysis usually refers to processing of images by means of a computer with the aim of finding what objects are present in an image. Image segmentation can be defined as the division of an image space into meaningful structures.
An image can be defined as a two dimensional function f(x,y), where x and y are spatial coordinates and the amplitude of any coordinate at a specific point is known as the intensity of the image. When the intensity of f and the value of x,y are finite then the image is called digital image [1].

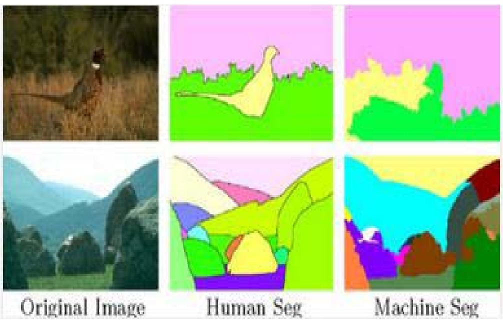


Fig.1: Results of a segmentation process [1].

It is often an essential step in object recognition, representation and visualization. Segmentation is usually performed on the basis of many factors such as pixel intensity, color or texture similarities, pixel continuity and higher level knowledge about the object models is required. The aim of segmentation could be simply separating the objects from the background or more complexly, extracting a particular object from the image space.
The result of image segmentation is set of regions that when combined together comprises the image space. Ideally, these regions represent the image components, of which the image space is consisted. The image can be defined by using a small number of well defined components instead of using a large number of unrelated pixels.
Challenges in ultrasound image segmentation:
Segmentation of Ultrasound images is strongly influenced by the quality of data. The inherent characteristic artifacts make the segmentation task complicated such as attenuation, speckle, shadows, and signal dropout. Due to the orientation dependence of acquisition, it can result in artificial boundaries. Ultrasound imaging or ultrasonography is an important diagnosis method in medical analysis. It is important to segment different types of tissues and organs in the ultrasound image for effective and correct diagnosis. But the characteristic drawbacks of ultrasound images can cause the processing of such images to run into complications and difficulties. Therefore, the implementation of many existing segmentation methods on medical ultrasound images yields no favorable results [2]-[4].
The basic block diagram of segmentation of an image is shown in Fig.2:

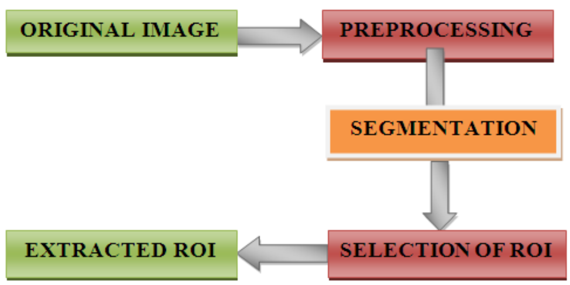


Fig.2 : Basic block diagram of image segmentation

2. CLASSIFICATION OF SEGMENTATION TECHNIQUES

In the past decades, a wide variety of segmentation methods has been proposed. Therefore, it becomes necessary to categorize the segmentation methods in order to present them properly [5]-[6]. The classification of different segmentation methods presented here is based upon the type of approach used to segment the images. These are categorized as:

2.1 Threshold based segmentation

Thresholding techniques are the most widely used for image segmentation. These are useful in separating the foreground from background. Any gray level image can be converted to binary image by selecting an optimum threshold value. The binary image should contain all the necessary information regarding the shape and position of the regions of interest (ROI). The benefit of obtaining a binary image first is to reduce the complexity of the information contained in an image and simplifies the recognition and classification of objects/foreground [7]. Any gray scale image can be converted to a binary image by selecting a threshold value. The pixels having intensities below the specified threshold are defined as black (0) and the pixels having intensities above the threshold value are defined as white (1). The problem which occurs in this type of segmentation is selection of the optimum threshold value. Histogram thresholding and slicing techniques are the examples of this type of segmentation approach. They may be applied directly to an image and can also be combined with pre and post-processing techniques.

2.2 Edge based segmentation

These techniques are based on finding the object edges or boundaries. an edge in an image may be a important local change in the image intensity, sometimes associated with a discontinuity in either the image intensity or the primary derivative of the image intensity. Discontinuities within the image intensity can be either step edge, wherever the intensity abruptly changes from one value on one side of the discontinuity to a different value on the opposite side, or Line edges, wherever the intensity abruptly changes value however returns to the starting value inside some short distance. Step and line edges are rare in real images. when the intensity changes are not instantaneous, however occur over a finite distance step edges become ramp edges and line edges become roof edges [8].

In edge based segmentation techniques, detected edges in an image are assumed to represent the object boundaries and accustomed identify the objects. In this, 1st the edges or boundaries of an object are known, and then the object is found by filling the boundaries in.

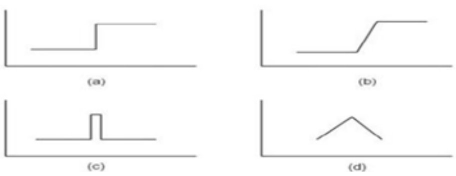
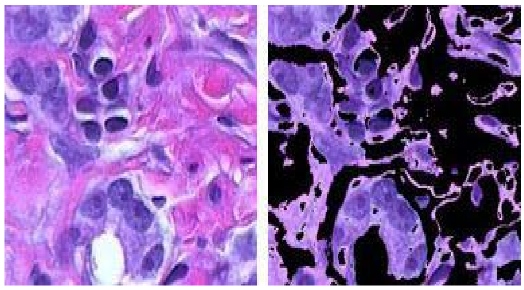


Fig.3: Types of Edges (a) Step Edge (b) Ramp Edge (c) Line Edge (d) Roof Edge [1].

2.3 Region based segmentation

An edge based technique tries to search out the object boundaries then locate the object itself by filling them in; a region based technique takes the opposite approach, by beginning in the middle of an object and then "growing" outward until it meets the object boundaries. In region based methods generally, an image is divided into regions which represents the relevant objects in best method in scene. Various region properties like area, shape, statistical parameters and texture can be extracted and used for additional analysis of data [9].

In region based method, first of all, image is partitioned into pattern cells. After partitioning, each pattern cell is compared with its neighboring cell to identify if they're similar, using a similarity property. If the cells are similar, then these are merged together to form a segment and the similarity property that is used for comparison is updated. The comparison process is repeated until there's no region to join remains. Further the segment is labeled as a completed region. This process is repeated till the labeling of all the cells [10].



(a) (b)

Fig.4: Region based segmentation a) Input Image b) Segmented Image [9].

2.4 Clustering techniques

These techniques are used in the grouping of similar patterns. Some clustering techniques can readily be applied for image segmentation. Clustering can be viewed as an attempt to determine which components of a data set belongs together. In this, pixels are replaced by clusters. These pixels can be clustered together on the basis of same color, texture etc [11]-[15].

2.5 Matching

When we know how an object in an image space, we wish to extract, looks like (approximately) we can use this knowledge to locate that particular object. This approach is called matching.The block diagram for classification of segmentation techniques is shown in Fig.5.

Segmentation algorithms utilized in medical image analysis ought to be able to avoid both over-segmentation and under-segmentation. In the first case, the pixels of an object are defined as the pixels that belong to other segments of the image. In other words, a single pixel is represented by 2 or additional segments. in the latter case, the pixels belonging to other segments are represented as the pixels belonging to the same object. therefore accurate segmentation of objects is needed. Once the region of interest is extracted, one can analyze the appearance, shape and other features of the region. This in turn can help the clinicians' in effective diagnosis and treatment of diseases [16]-[19].

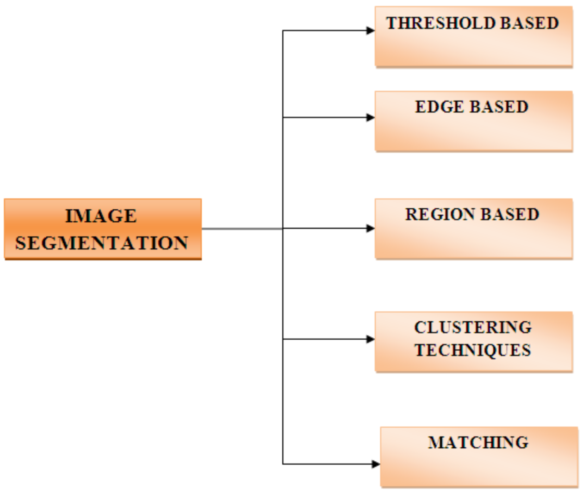


Fig. 5: schematic classification of various segmentation methods

Although development of image segmentation algorithms has drawn extensive and consistent attention, relatively little analysis has been done on segmentation analysis. Most analysis methods are either subjective, or tied to specific applications [20]-[22]. Some objective evaluation methods are proposed, however the majority of those are within the area of supervised objective evaluation, that are objective methods that require access to a ground truth reference, i.e. a manually-segmented reference image. Conversely, the area of unsupervised objective analysis, in which a high quality score is based exclusively on the segmented image, i.e. it doesn't need comparison with a manually segmented reference image, has received very little attention.

The key advantage of unsupervised segmentation analysis is that it doesn't need segmentations to be compared against a manually-segmented reference image. This advantage is indispensable to general-purpose segmentation applications, such as those embedded in real time systems, wherever a large variety of images with unknown content and no ground truth ought to be segmented. The ability to evaluate segmentations independently of a manually-segmented reference image not solely allows analysis of any segmented image, however also allows the distinctive potential for self-tuning [23]-[25].

3. CONCLUSIONS

Image segmentation has many applications in the field of biomedical image analysis. It can help the clinicians in the differentiation and visualization of organs and tissues, measurement and comparison of size of tissues and anatomies and finally to plan diagnosis and other treatment. Medical image segmentation is different from conventional image segmentation tasks. First, medical imaging techniques find limitations in revealing information relevant to clinical diagnosis. In most of the cases, it is difficult to separate the tissue or organ from its surrounding when they have similar intensities with other tissues and their boundaries lack strong edge information. Second, many imaging modalities, generate noisy and low contrast images due to their internal mechanisms. Also, artificial markers and tags added in some of the imaging modalities make the segmentation process even more difficult. Third, medical images appear complicated due to the anatomical structures. Therefore, medical expertise is needed to understand and interpret the images. And hence, segmentation algorithms are required that can fulfill the clinicians' needs. It is also required to validate the segmentation results by the experts.

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