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An overview: Image segmentation Techniques for Brain Images.

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***Abstract*— Brain segmentation is an important part of Medical imaging. Imaging plays a central role in the diagnosis and treatment planning of brain tumor. Traditionally, segmentation is performed manually in clinical environment that is operator dependent and very tedious and time consuming work. Brain Magnetic Resonance Image (MRI) segmentation is a complex problem in the field of medical imaging despite various presented methods. MR image of human brain can be divided into several sub-regions especially soft tissues such as gray matter, white matter and cerebrospinal fluid. In this paper, different segmentation algorithms are considered**.

***Index Terms*—Magnetic Resonance Imaging (MRI), segmentation**

I. INTRODUCTION

Medical images are complex in nature and rarely have any simple linear feature; this makes segmentation of MR images a difficult task. In this paper MRI images are considered. Magnetic Resonance Imaging uses magnetization and radio waves, rather than x-rays to make very detailed, cross-sectional pictures of the brain. It has many advantages over conventional imaging techniques, such as high spatial resolution, excellent discrimination of soft tissues and rich information about anatomical structure. Segmentation of brain from three dimensional (3D) magnetic resonance (MR) head images has many important research and clinical applications. The objective of segmenting different types of soft-tissue in MRI brain images is to label complex structures with complicated shapes, as white matter, grey matter, CSF and other types of tissues in neurological conditions.

The advantages of magnetic resonance imaging (MRI) over other diagnostic imaging modalities are its high spatial resolution and excellent discrimination of soft tissues. MRI provides rich information about anatomical structure, enabling quantitative pathological or clinical studies, the derivation of computerized anatomical atlases, as well as pre and intra-operative guidance for therapeutic intervention. Such information is also valuable as an anatomical reference for functional modalities such as PET, single photon emission computed tomography (SPECT), and functional MRI. Advanced applications that use the morphologic contents of MRI frequently require segmentation of the imaged volume into tissue types [4].

There are also many conventional Methods of MRI segmentation that uses image processing techniques such as region growing, edge detection, and histogram Equalization, etc. The problem with all these methods is that, they need human interaction for accurate and reliable segmentation. Human interaction is in terms of providing some initial knowledge externally for segmentation. This knowledge is in terms of a small amount of labeled data for some or all classes. This is usually time-consuming and expensive. The second fundamental aspect that makes segmentation of medical images difficult is the complexity and variability of the anatomy that is being imaged. It may not be possible to locate certain structures without detailed anatomical knowledge. This makes general segmentation a difficult problem, as the information must either be built into the system or provided by a human operator [2].

Some of techniques for segmentation of MR images are stated in this paper.

II. STRUCTURE OF BRAIN

The three major parts of the brain control different activities:

• *Cerebrum*: The cerebrum uses information from our senses to tell us what is going on around us and tells our body how to respond. It controls reading, thinking, learning, speech, and emotions. The cerebrum is divided into the left and right *cerebral hemispheres.* The right hemisphere controls the Muscles on the left side of the body. The left hemisphere controls the muscles on the right side of the body.

• *Cerebellum*: The cerebellum controls balance for walking and standing, and other complex actions.

• *Brain stem*: The brain stem connects the brain with the spinal cord. It controls breathing, body temperature, blood pressure, and other basic body functions.

Fig. 1 gives the basic structure of brain. [5]

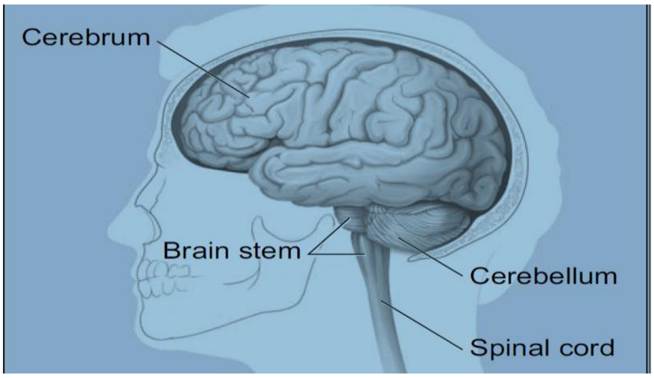

Fig.1. Structure of Brain.

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Brain MR Images can provide detailed information about Structure and pathological changes inside the brain area like Cysts, tumors, developmental and structural abnormalities. Fig. 2 gives a sample MR Image of brain used for diagnosis of brain tumor.

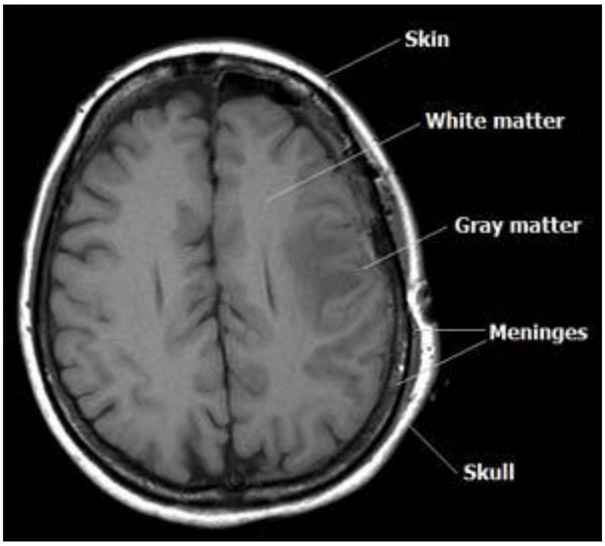

Fig.2. Brain MR Image

III. TUMOR GRADES AND TYPES

In normal condition for a human, cells grow old or get damaged, they die, and new cells take their place. Sometimes, This process goes wrong. New cells form when the body doesn't need them, and old or damaged cells don't die as they should. The buildup of extra cells often forms a mass of tissue called a growth or tumor.

There are two types of Primary brain tumors as benign and malignant:

1) Benign brain tumor:

This type of tumor generally do not consist cancer cells and can be removed. Benign brain tumors usually have an obvious border or edge. They don't spread to other parts of the body. However, benign tumors can cause serious health problems.

2) Malignant brain tumor:

This consists of cancer cells and hence also called as brain cancer. They are likely to grow rapidly and can affect nearby healthy brain tissues. This type of tumor can be a threat for life.

Now, depending on what is type of cell of tumor, doctors group brain tumors by grades. There are four grades as grade I to grade IV. Cells from low-grade tumors (grades I and II) look more normal and generally grow more slowly than cells from high-grade tumors (grades III and IV). Over time, a low-grade tumor may become a high grade tumor. However, the change to a high-grade tumor happens more often among adults than children.

Regardless of the type of tumor, it is often clearly visible in The MR image. Fig. 3 presents MRI brain image with brain tumor detected in it.[5]

Fig.3. MRI of brain tumor

IV. SEGMENTATION TECHNIQUES

1) Histogram thresholding:

Histogram thresholding is easiest method of segmentation because thresholding is fast and economical in computation. In thresholding, histogram of an image is subdivided using a threshold which is nothing but a gray level. Band thresholding, local thresholding, multi thresholding and semi- thresholding are some of the modifications of this technique. Single thresholds that can differ in image elements are known as local threshold whereas Single thresholds that can be applied to the complete image are known as global threshold. Then depending on value of this threshold, image pixels are assigned with two gray levels.

Thresholding can be accomplished with preprocessing like filtering. Generally a median filter is used for preprocessing.[1]

2) Region growing:

In region based segmentation, pixels with same properties are grouped together. The property that is taken in to consideration is intensity of pixels. There are two types of segmentation, region growing and region merging. Pixels are examined with their neighborhoods and are grouped together. Region growing technique can be applied in brain tumor diagnosis. In region growing, we start with similar pixels and go on grouping with pixels having same intensity. One of the drawbacks of this method is that dissimilar starting points may not result growing into identical regions.[1]

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3) Edge based segmentation:

In edge based segmentation technique boundary on an image or an edge is defined by the local pixel intensity gradient. An estimation of the first order derivative of the image function is called a gradient. Gradients in directions x and y are expressed as Gx and Gy. Edge-based techniques are fast in computation and usually in this approach a priori information About image content is not required. The most general problem of this approach is that often the edges do not enclose the object completely. In this segmentation technique the direction and magnitude can be presented as images. A post processing step of linking or grouping edges is required to structure closed boundaries neighboring regions. Weighed summation of the pixel intensities in a small neighborhood can be represented as a numerical array in this method which Is called as kernel/ window/mask. In a two 3X3 mask the following matrices are used.

4) Mean shift:

Mean shift method is a non-parametric technique to examine a complex multi-modal feature space and to classify feature clusters. Size and shape of the region of interest are the only free parameters in this method. In mean shift segmentation in order to estimate the density gradient, the density estimation is changed. A two step sequence of discontinuity preserving filtering and mean shift clustering is utilized in this segmentation technique. In mean shift process for each point in data space first, the region of interest is obtained like a spherical window. Next, the mean shift is calculated. [2]

5) Watershed Algorithm:

The Watershed transformation is a powerful tool for image Segmentation. Watershed segmentation classifies pixels into regions using gradient descent on image features and analysis of weak points along region boundaries. It uses analogy with water gradually filling low lying landscape basins. The size of the basins grows with increasing amounts of water until they spill into one another. Small basins (regions) gradually merge together into larger basins. Watershed techniques produce a hierarchy of segmentations, thus the resulting segmentation has to be selected using either some prior knowledge or manually. Hence by using this method the image segmentation cannot be performed accurately and adequately, if objects not constructed as desired be detected.

6) Gray Level Co-occurrence Matrix:

Gray level co-occurrence matrices are used to define of textural features. The values of the co-occurrence matrix elements present relative frequencies with which two neighboring pixels separated by distance d appear on the image, where one of them has gray level i and other j. Such matrix is symmetric and also a function of the angular relationship between two neighboring pixels. The co-occurrences matrix can be calculated on the whole image, but by calculating it in a small window which is scanning the image helps reducing the computational complexity. As we have to compute a matrix of size as same that of image size, it is obvious that such matrices are too large and their computation becomes memory intensive. Therefore, it is justified to use a less number of gray levels, typically 64 or 32.

V. Conclusion

Image processing has become a very important task in today's world. Today applications of image processing can be found in number of areas like medical, remote sensing, electronics and so on .If we focus on medical applications, image segmentation is widely used for diagnosis purpose. Thus, to find a appropriate Segmentation algorithm based on application and the type of inputted image is very important. In this paper, we have stated some of the techniques that can be used for segmentation of brain MR Images. For proper output using these techniques, type of image should be also considered.

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