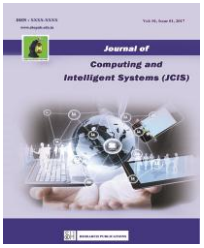
Original Research Article

J. Computing & Int. Systems (2017) 41–44

SACRED HEART RESEARCH PUBLICATIONS

Journal of Computing and Intelligent Systems

Journal homepage: www.shcpub.edu.in



ISSN: 2456-9496

Analysis on Multiple Sclerosis Lesion Segmentation in Brain Magnetic Resonance Images using Edge and Contour based Algorithms

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Received on 27th Dec 2017, Accepted on 5th Jan 2018

Abstract *— Multiple Sclerosis, shortly MS is persistent neural disease, which damages the neural system in the brain, spinal cord, and optic nerves. Sclerosis is scarring, and people with MS develop multiple areas of scar tissue in response to the nerve damage. Identifying MS by using Brain MR Images are widely accepted method. Normally MRI are Radio Gray-scale images. Recognising MS lesions in the brain nerves in the gray values is complicated task. So various segmentation methods are applied to locate the disease area in the brain. In this paper two major segmentation methods, Edge based and Contour based are used for the MS analysis.*

Keywords: Segmentation, Multiple Sclerosis, Magnetic Resonance Image.

I INTRODUCTION

Multiple sclerosis (MS) is a disease of the Central Nervous System (CNS) that is characterized by inflammation and neuroaxonal degeneration in both gray matter (GM) and white matter (WM) [1]. MS is the widespread immunity disorder affecting the nerve system, with estimated medical cases of 25 lakhs worldwide according to World Health Organization in the year 2008 and it was the reason for approximately 20,000 deaths in the year 2013. Many researches suggest there is a connection between autoimmune disorders and vitamin D deficiency, and it also observed that Genetics is also plays major part in this disease. The first experience a symptom of MS has very young age of 29.2 years average and interquartile 10 onset range of 25.3 and 31.8 years (World Health Organization, 2008). The major symptoms of MS are decline in memory skills, reduced vision, weakness in leg or arm joints, tiredness and loss of balance.

The advantages of MRI are: it can able to handle huge volume of medical cases good accuracy, and faster results. It also speed up computer-based processing in the medical field. MR imaging is most adaptable technology that allows analyst to get variety of images by using different signal flows and by altering the imaging parameters corresponding to Longitudinal relaxation time (T1), and Transverse relaxation time (T2)[6]. This paper presents segmentation methodologies for MS in the brain MR images.

II MULTIPLE SCLEROSIS LESION

Multiple sclerosis (MS) is a disease in the Nervous System where the myelin sheath of nerve cell axons is diminishing. The goal is to replace the labour-intensive identification of MS lesions using some computerized procedures. Still the Lesion identification is a significant research area in Image processing [2].

Mariano Cabezas et. al. provides a modified expectation-maximisation algorithm to fragment brain tissues (grey matter, white matter, and cerebrospinal fluid) and also a partial volume class containing fluid and grey matter. This method offers a primary segmentation, here the lesions have not detached from the tissue, so the next step is wanted to discover it. This stage includes the threshold of the FLAIR image, trailed by region based enhancement to remove false detections [8]. Enriched T1-w imaging system is very sensitive when identifying inflammations. This method detects infected areas five to ten times more regular than the manual identifications, telling that most number of Enhancing Lesions (EL) are medically not traceable. The two major imaging of MR, Longitudinal and cross-sectional reports are screening that the development of new MS signs are deeply related to the contrast enhancement, mostly happened in the severe and reverting phases of the disease [9].

In many circumstances, the critical black holes keeps same intensity for few months as inflammation declines, edema reconciles and repair processes like remyelination will happened. Only less than 40% of lesions develop into persevering or become black holes [10]. Lesions show up in the MRI as white or dark spots, according to the scan type.

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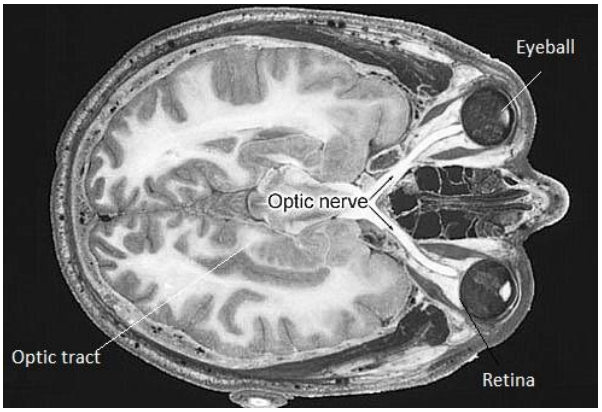


Figure 1 - MS affected experience optic neuritis (vision problem)

The Central Nervous System (CNS) controls all functions of the human body and mind. It consists of two major parts, one is the brain and the other is spinal cord. When Brain deals with thoughts, spinal cord holds the control of whole body. The fig. 1 depicts the top cut image of head, it shows central nerve system with white matter, gray matter, and optic nerves etc. the major MS happen in the two sides of the central nerve system.

III MAGNETIC RESONANACE IMAGE

MRI is a non-invasive test that does not have the problem of ionizing radiation. It uses magnetic field and radio waves to transfer data to the computer, which translates the data into cross-sectional images. An MRI helps doctors to see lesions in Central Neural System. Lesions appear like white or dark spots, depending upon the scan type i.e T1, T2, etc. Image contains contrast intensity shows MS disease that is recognized as inflammation of active lesions. These lesions are tending to be new or bigger. The contrast images also show areas of permanent damage called "black holes." Basically MRI taken for brain, liver, chest, abdomen and pelvis to get structural change for medical diagnosis. The brain MRI taken to identify tumors, stroke, and infections in the brain.

MRI has been widely used for segmentation to find changes of central nervous system in medical neuro science studies [3]. So, segmentation of MR images of human brain into useful materials for clinical purpose such as white matter (WM), gray matter (GM), and cerebrospinal fluid (CSF) are vital task for measurement of acute lesion and the other disorders [4, 5].

Table 1- Types of tissue and its intensity

Feature	T1 image	T2 image
White matter	Bright	Dark
Fat	Bright	Dark
Solid mass	Dark	Bright
Blood	Gray	Dark

There are three major types of MRIs,

A. T1 weighted MRI

These images used to analyse for the longitudinal movement of protons. And these *T1* images check for basic structural details of human brain and it helpful when there is any change happened.

B. T2 weighted Images

These images look at transverse movement of protons. *T2* usually took at bodily fluids, because most diseased tissues have more water or liquid content than the normal matters.

C. STIR and FLAIR Sequence MRI

Short *T1* Inversion Recovery (STIR) is a fat subduing technique. It is useful for supressing the signal from typical fatty connective tissue to decrease the error in the human perception and improve the imaging. FLuid Attenuation Inversion Recovery (FLAIR) is a water suppression procedure. It is best method for capturing cerebral oedema, periventricular or cortical lesions that leads to multiple sclerosis.

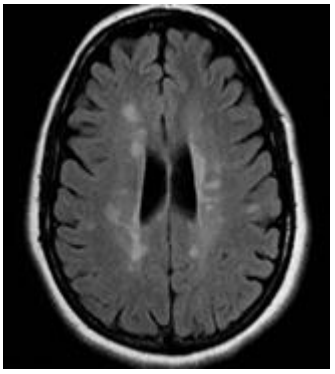


Figure 2 - MRI of multiple sclerosis lesions in the brain.

For analysis, a sample MR image has been taken. That is shown in the figure 2. T1 weighted MRI indicates white spots indicate active MSL in the central neural system. This fig. 2 is analysed in both the segmentation techniques.

IV EDGE BASED SEGMENTATION

Segmentation is the process of dividing into different regions and also clustering similar neighbouring pixels to find meaningful objects in the image based on the parameters of color, intensity, pattern etc. [7]. Edge based segmentation is the process that is initiated by the primary task of edge detection. An edge is an abrupt variation in the pixel density of an image. It includes important features of an image. An edge is also a border between an object in the image and its background. The major edge detection algorithms are Canny, Sobel, Roberts, and Laplacian. The edge based segmentation methods are, Edge relaxation method, Border detection method, and Hough transform based Segmentation method [6].

Step 1: Pre-processing like gray scale conversion (if any).

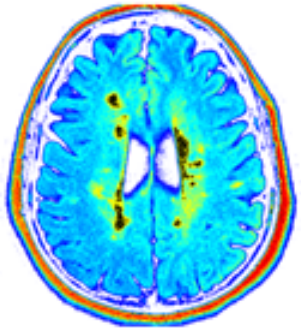
Step2: Edge detection using any major detector or specific algorithm.

Step3: Adjustment of edges based on the threshold defined.

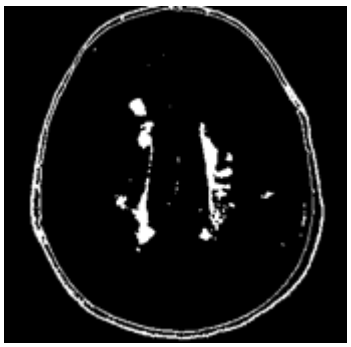
Step 4: Noise removal if any.

Figure 3 -Basic Edge based Segmentation Algorithm

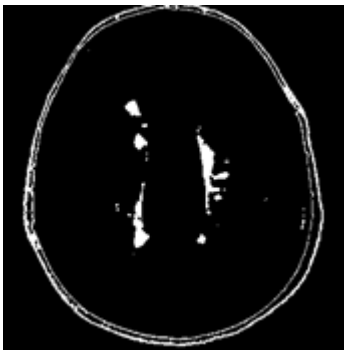
The figure 3 shows the universal outline of the edge based segmentation process. It may further consists some sub processes for the custom purposes.



(a)



(b)



(c)

Figigure 4 - (a) color mapped image for Fig.2 (b) Segmented image with lower threshold (c) Segmented image with hogher threshold than (b)

The figures 4 (a –c) shows that, the identified or segmented region of pixels in the image as Multiple Sclerosis lesion. The image 4 (a), indicates color mapped values for the gradient intensity of the figure 2. The dark matter on that figure is possible MS. Figure 4(c) is result of highest threshold value.

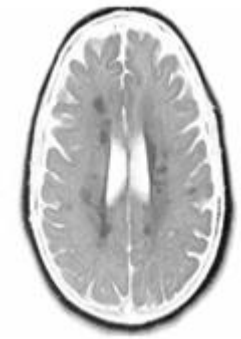
V. CONTOUR BASED SEGMENETATION

Connecting edges of a particular surface in the image to make a region boundary is called a contour. These contour lines are plotted on the boundaries or intensity deviations on the same image [11]. The contour can be drawn with open or closed boundaries. An open contour is sometimes a portion of the area border that is not showing a boundary. Closed contours are showing the region boundaries, the pixels inside the boundary may be found empty. The open contours are plotted by using single looping algorithm where the closed contour lines are drawn with multiple looping. Both the edge and contour identifies the boundary for segmentation, but contour provides additional detail about intensities. A contour characterized as a layers of sloped edges, that is each curve is separated by the intensity on the specific position where the curve plotted [12,13]. This method consist of Snakes model, Boundary model, Nonparametric Shape Prior Model, and Geodesic Active contour model [14]. The approach of this model is to segment an image based on rapid changes in grayscale intensity levels.

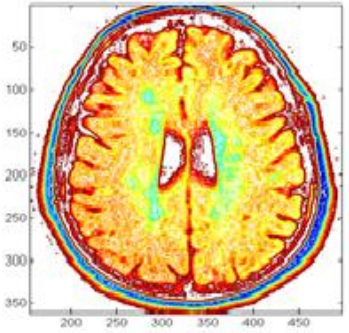
$$|C| = (\sum_{i=0}^{n-1} |v_i|^2)\frac{1}{2}$$

Where, $|C|$ is size of contours, and v indicates vector of n length.

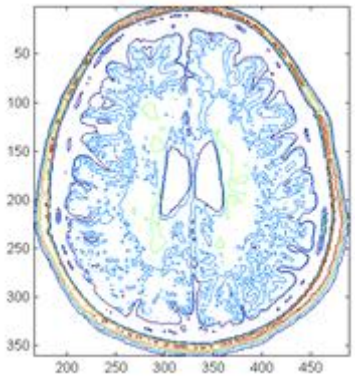
The active contours method without edges meanwhile the data term controlling the level set evolution is based on region features and not on the edges [2].



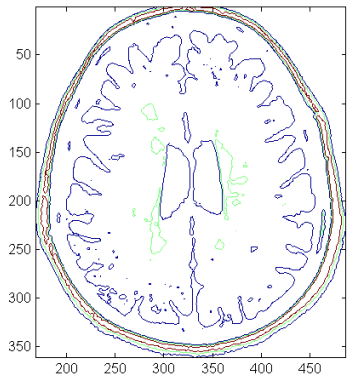
(a)



(b)



(c)



(d)

Figure 5 - (a) Inverse of the Fig.2 (b) Contour based image of Figure 5a - with 50 Contours (c) with 5 contours (d) with 3 contour segmentation .

The figure 5 shows the contour based segmentation of MS. The 5a depicts result of 50 contours i.e bounding with maximum fifty colors. The white region surrounded by green contours are MS. The figure 5d is the result of 3 contours, it shows green curves are MS.

V. CONCLUSION

The analysis for the MS segmentation in the Brain MRI experimented in two ways, Edge and Contour basis. Edge based segmentation first detects edges in the gradient image i.e gray scale using any one of the major edge detectors. Based on the threshold given, it finds MS according to the intensity. In contour based method, it segments MS based on the contour level. Even it is less number of contour curves provided, it can able to bound lesion in the MRI. The level of noise is less in the contour method. But, unlike edge model, it can only be used for the descriptive representations.

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