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A Survey Paper on MRI Segmentation Algorithms to Identify Amyotrophic Lateral Sclerosis

[1]A Mary Priya, [2]D Peter Augustine and [3]V B Kirubanand,
[1,2,3]Department of Computer Science, Christ University, Bangalore, Karnataka, India

Abstract--Amyotrophic Lateral Sclerosis (ALS), which is also mentioned as Lou Gehrig's disease, is a continuous degenerative neuromuscular concern influencing both Upper Motor Neuron and Lower Motor Neurons and especially distressing people in their forties to seventies. In spite of the fact that the pathology of ALS has been obviously illustrated somewhere else, the exact reasons by which the sickness advances and the proficient ways of diagnosis through various tools such as MRI are still inadequately comprehended regions of the solution. In such scenario, there is a compelling need for right and accurate diagnosis of ALS to control the progressiveness of it. It is the motivation behind this survey article to talk about the most pertinent proposed MRI processing algorithms in the literature available from the past and present which have encountered changing degrees of achievement.

This is in no way a comprehensive survey of the current literature available; nevertheless, it should serve as an exhaustive analysis of the most significant points of MRI processing to diagnose ALS.

Keywords--*Amyotrophic Lateral Sclerosis (ALS),* Magnetic Resonance imaging (MRI), Segmentation, Self-organizing mapping, Kmeans, Fuzzy C-means

I. INTRODUCTION

ALS is a disease, belongs to the group of Motor Neuron Disease (MND) which affects both UMN and LMN. In some cases, it affects the brain and for some people spinal cord. But most of the patients are affected in both the regions which are controlled by the nerve cells (neurons). The neurons look after the control of muscle actions in the face, arm, and the leg. These nerve cells get degenerated and die in the progress of ALS. It generally occurs at the average age of 55 years. The probabilities are also there for the age group between 20 and 70.Men are more affected by ALSdiseasethan women by 20%.The expected lifetime of patients after diagnosis is 2 years, in some cases, it is 5 to 10 years.

ALS may occur due to various reasons like the disorganized immune response, chemical imbalance and mishandling of proteins. There may be some symptoms in the initial stage of ALS such as cramp, stiffness in muscles, muscle tightening, muscle weakness mostly in face or leg, or sometimes both intheleg, and face. The patients may face breathing problems, speech, chewing and swallowing difficulties. If the patients are diagnosed by these symptoms through clinical investigations, the physician may suggest for lab tests to confirm the presence of ALS in the patients. There are different tests used such as Electromyography (EMG) and Nerve Conduction Study (NCS). These tests are used to determine the electrical energy in the muscles which sends signals to nerves. Magnetic Resonance Imaging (MRI) also takes the major role in the diagnosis of ALS according to their symptoms. Paddock, Catharine (2017)[1] have said that Riluzole (Rilutek) is the drug which as an approval to give treatment to ALS patients by the association of Food and Drug Administration (FDA). This drug will react slowly for some patients and in most of the patients, it reduces glutamate levels in the body.

There are several cognitive therapies with medications suggested by the doctors to treat different symptoms of ALS. Depends upon the symptoms, different therapy is given to the ALS patients. The various therapies suggested by the different authors are Physical therapy, Occupational therapy, Speech therapy, Breathing therapy, Psychological and social support and Nutritional support.

Magnetic Resonance Imaging in Amyotrophic lateral sclerosis: ALS is a rapidly progressing neurodegenerative disorder which is incurable even today. There are many attempts and ongoing studies with a different section of therapeutic candidates. Magnetic resonance imaging (MRI) on the other hand has made substantial progress over last few decades and also it is a practical and noninvasive means or method to attain or derive some insights into the pathology of the sickness or disease.

One should distinguish the difference between structural and functional MRI techniques. Here the structural MRI presently mainly serves to rule out other diseases mimicking ALS. Moreover, it is also useful in finding cortical atrophy in ALS. Whereas functional MRI can detect cortical activations pertaining to a task performed by the Participant during scanning

The present available structural and functional MRI techniques, a combination of DTI and resting fMRI might provide the most promising early screening protocol to identify subjects which are at risk for developing ALS.

II. ALS THROUGH MAGNETIC RESONANCE IMAGING (MRI)

MRI Magnetic resonance imaging is an imaging model. To create useful diagnostic images MRI used non-ionizing radiations. Initially, MRI was called as nuclear magnetic resonance imaging after its early use for chemical analysis. MRI scanner has a large or huge powerful magnet. The patient should lie in the large powerful magnet that is MRI scanner. Radio wave antenna is used to send and receive signals from the body which it's converted into images by a computer connected to the scanner. Any part of your body can be imaged and obtained in any plane. ALS is quite dangerous and devastating disease coz it not only affects motor function but it involves extramotor systems. Therefore it is proposed to initiate longitudinal and multicenter studies so that we can analyze larger sample sizes by which the results can be optimized and MRI can become a more specific diagnostic tool in this regard.

Two different types of MRI used to identify ALS structural MRI and functional Magnetic resonance imaging (fMRI). Katja Kollewe, Sonja Korner (2012)[2] said that diffusion tensor imaging (DTI) is the most favorable for structural MRI method to recognize ALS-which is comparable to get reform in primary motor cortex and pyramidal tracts and other regions in the brain beyond the motor parts. In this structural MRI, we do

segmentation to identify ALS some of the different process used to in segmentation and also some different algorithms are used.

Tomer Fekete, Neta Zach, et al (2013) [3]have said that brain starts to malfunction using MRI is not sustainable in ALS disease. Data of ALS patients will be observed from R-fMRI. The authors tested the hypothesis of a system-level seizing the core of ALS to treat the patient, in spite of its inherent clinical and prognostic heterogeneity, may be identified using R-fMRI data. The cerebral functional connectivity to the network analysis says that ALS has an influence on some outspread noncortical fields to do treatment.

III. SEGMENTATION

The major part of medical image processing is doing segmentation, it has different techniques some of them are threshold, edge based used to detect edges of a region in images, clustering, neural network based, among these types cluster based has different clustering methods the authors are K-means clustering(used to separate n number of clusters and its mean), Fuzzy C-means clustering(extracts one data to two or more different clusters), subtractive clustering method and mountain clustering method.

Norouzi, Alireza, et al (2014) [4]in this paper the authors said about some segmentation methods and the authors gave it's detailed by telling that how it works in medical image analysis and also the authors have given advantages and disadvantages of the algorithm. The authors described region based methods like thresholding and region growing, in Clustering methods k-means and Fuzzy C-mean is explained, in classification method K-nearest likelihood and the Maximum likelihood is given and in Hybrid method graph out is explained. All these methods are a famous method which is used for medical imaging to analyze the image and its features. Self OrganizingMap (SOM) is an exclusive of clustering network which sketches high assistanceto give high range of one dimension in most of the cases it usually gives two-dimensional discrete representation of input is called as map, Dan Tian and Linan Fan (2007) [5]In this paper the authors used two main methods: using pixel classifying image and doing feature extraction base on SOM neural network algorithm, the authors did feature extraction by calculating the variance of pixels using feature vector by the help of 8 nearest neighbors the authors reduced network size and speeded the network running each and every neuron stores it neuron weight, Euclidean distance is used to find the similar network in SOM. IN pixel classification the authors have added one new layer i.e. associative layer which helps to reduce the weight of neurons.

Nameirakpam Dhanachandra, et al (2015) [6] The authors have used different methods in that one of the famous methods is k-means clustering which is normally used to slice the ROI from image background. In this paper the authors have used partial stretching enhancement to improve the quality of the image after this the authors applied K-means clustering algorithm. Subtractive cluster method is used to create the centroid by the help of data points which is generated by data clustering.

So subtractive clusters will be used to generate the starting centers and these center positions will be used to do segmentation by the help of K-means algorithm. To the segmented images, the authors have used a median filter to remove unwanted features and noise.

IV. SEGMENTATION IN MRI IMAGES

Pappas, Thrasyvoulos N. (1992)[7] In this paper the authors used general K-means clustering algorithm recycled for local intensity variations to include spatial constraints in the image, it is based on the Gibbs random field model. Local intensity variations are calculated according to its procedure which involves its average over a sliding window; while processing algorithm its size will get decreased. with the help of an eight-neighboring Gibbs random field model, we will apply it to the pictures related to industrial, aerial photographs, printed text, buildings, and faces, this shows that Kmeans algorithm performs better and its nonadaptive extensions which combine with spatial constraints by the use of Gibbs random fields. A hierarchical implementation performance is faster than the regular speed while executing. The segmented images have caricatured from the originals which protect the most important features while eliminating some unwanted details. This segmented image can be represented as cruds of an image. The pictures are easy to display or print using some gray levels, which can be coded easily. Kapur, Tina, et al (1996) [8]have presented a method to segmentation the brain tissue from MRI by combining three different techniques: active contour models, expectation/maximization (E/M) segmentation and binary mathematical morphology. The authors have combined some methods which utilized gray level, topological and information in pictures. E/M is pre-owned for a group of intensity-based alteration and information, binary morphology, and accordance for adding of relative topological data and balloon-based disfigure profiles for the increment of spatial data to segmentation procedure.

Alirezaie, S. M. (1997) [9] here the authors proposed new techniques based on dual artificial neural network (ANN) architectures for tissue categorization of MR images and automatic partitioning of the human brain; Learning Vector Quantization (LVQ) artificial neural network is used for multispectral supervise categorization from MRI images. For better and accurate classification LV is modified. In this new method, automatic tissue segmentation Self-Organizing Feature Map (SOFM) was utilized to construct an unsupervised clustering scheme. To reduce congregated artifacts, an algorithm is elaborated for removing the cerebrum in advance to partitioning. The cerebrum is obtained by stripping SM pixels from the T2W image. There are three tissue types segmented: cerebrospinal fluid (CSF), white and gray matter. As further work, The Euclidean distance was used in LVQ and SOFM.

Pham, Dzung L., and Jerry L. Prince (1999) [10] have presented the fuzzy partitioning of twodimensional (2-D) and three-dimensional (3-D) multispectral MRI tainted by the power of inhomogeneity, as loss of signal strength in any part of the image. This method useful to the powerfulness of the inhomogeneity as an improvement range which causes the image to restore its smoothness and it gradually differs over its image area. It is completely automated except for some specified parameters; the authors are using 2-D Adaptive Fuzzy C-means for three-dimensional (3-D) multispectral images due to its potential range of 3-D image input. In this experiment the authors worked using, AFCM which provides solid distribution in the existence of intensity inhomogeneity and can be distributed straightly to the recent techniques like hard segmentations (overlapping is not done), soft segmentations (appropriate amount overlapping and transparency); gain field estimates, or inhomogeneity corrected images. Here the authors used AFCM in combination with misshape of surface algorithms to recreate the human cerebral cortex from MR images.

Yugander.P, SheshagiriBabu.J et al (2012) [11] here the authors recommended a several Multiple Kernel Fuzzy C-means

Clustering (MKFCM) on the level set scheme. MKFCM is used to create a basic contour arch to overcome the seeping border in the course of curve propagation. MKFCM provides for combining various reports of image pixels in segmentation algorithm. The other reports about various image pixels will be connected to the kernel space by using some kernel functions the author's explained it on specified in ordered field. Using the edge indicator function image segmentation is performed. The authors combined Multiple Kernel Fuzzy C-means Clustering algorithm and Adaptive Level Set algorithm. As a result, the objectis enhanced and performed well to achieve a good outcome while deriving the asteroids from an authentic figure.

There are disadvantages while working with MRI since it may cause artifacts like noise, low level of contrast between some tissues and the intensity of homogeneities and the disturbed density of a molecule during the segmentation task. A.Naveen and T.Velmurugan (2015)[12]have used K-means algorithm to apply the boundary detection and other techniques for MRI brain image, MRI brain image are analyzed using classification and some other techniques. The authors have used simple K-means algorithm for partitioning the pixel and also the authors proved that K-means algorithm performs well when the shape of an image is spherical by the different application, in this the amount of picture element will get vary when a number of pixels are eight and sixteen. P.TamijeSelvy, et al (2011) [13]have used different types of algorithms like K-means Clustering, Self-organizing maps(SOM), Hierarchical clustering and Fuzzy C-mean algorithm for MRI brain images these algorithms have been examined and the performance is calculated based on its execution time and exactness of an algorithm, while execution the Kmeans and SOM were compressed less by comparing to other two algorithms which are based on pixels, K-means and Hierarchical gave better result by achieving nearly 95% whereas Selforganizing and Fuzzy C-mean have reached up to 85%.

Zhang Yang, Ye Shufan, et al (2016)[14]have proposed an algorithm called the harmony searching (HS) algorithm the authors have modified the algorithm to improve the efficiency of an algorithm. Then, the optimal value was obtained using the improved HS algorithm. The optimal value of convergence was employed as the initial value of the fuzzy clustering algorithm for segmenting MRI brain images. The authors have proved that improved HS algorithm for MRI brain segmentation is more than random value, an initial value which gives a superior out come in the Fuzzy clustering algorithm.

Koley, S. and Majumder, A. (2011)[15]here the authors have tried using K-means clustering algorithm and Cohesion based Self-Merging (CSM). CSM is a method to find the exact location of the tumor in MRI of the brain image. The twophase clustering algorithm is used to detect the outliers, CSM whose performing time is arranged according to the size of an input data set in MRI. It is the simplest method to obtain the effective segmentation process which is done in less time comparing to different methods and also it is easier and simple.

CONCLUSION

In this paper, we discussed some of the common and frequently used segmentation techniques to diagnose ALS disease through brain MRI processing techniques. The various segmentation methods applied to MRI images by different authors in their research articles. K-means clustering, Fuzzy C-means clustering, Selforganizing map, Harmony search has been explained. Using these techniques researchers can apply their investigations to extract the significant features from the brain MRI data set for identifying ALS with an improved accuracy for better treatment.

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