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RESEARCH ARTICLE

IMAGE SEGMENTATION FOR TUMOR DETECTION USING FUZZY INFERENCE SYSTEM

V. Janani[1], P. Meena[2]

[1]Assistant Professor, Dept. of Biomedical Engg, PSNA College of engineering and technology, Kothandaraman nagar, Dindigul, Tamilnadu, India

[2]Assistant professor, Dept. of Electrical and Electronics Engg, Fathima Michael College of engineering and technology, Madurai sivagangai main road, Madurai, Tamilnadu, India

[1] jananim.tech88@gmail.com; [2] meena.sang14@gmail.com

Abstract— Image segmentation on surgical images plays a vital role in diagnosing and analyzing the anatomy of human body. The area of image segmentation has made an extensive ideology for classifying biomedical images. One such application for segmenting and classifying MRI brain images using fuzzy based control theory is proposed in this project. A special technique called FIS is used in brain image segmentation. The proposed FIS technique plays a promising part in identifying the tumor in brain image. In FIS technique, fuzzy rules are coined which helps in segmenting the image.

Key Terms: - MRI brain images; FIS technique; Segmentation; Tumor detection

I. INTRODUCTION

Image segmentation procedure adopted to analyze medical images is quite a challenging task. It refers to the process of partitioning a digital image into multiple regions. The goal of segmentation is to change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is used in order to locate objects and boundaries in images. The result of image segmentation occurs as a set of regions that collectively covers the entire image. Over the years, various image segmentation techniques have been proposed in order to analyze the image in an effective way. Brain tumor can be identified visually, but it is difficult to determine the location and volume of the tumor bounded by brain tissues. Using Fuzzy Inference System technique the tumor present in the brain is uniquely identified. The tumor classification is carried out using a neural network toolbox. To evaluate the performance of the classifier; accuracy, selectivity and specificity is calculated from the confusion matrix. A ROC curve is also plotted.

II. FUNDAMENTAL THEORY

Magnetic Resonance Imaging (MRI) helps in obtaining a structural three dimensional image of the internal parts of human body. It, based on the principle of Nuclear Magnetic Resonance (NMR), provides a better augmentation in analyzing heart, lungs, pelvis, abdomen and soft tissues in brain. Our human body is made of 80% hydrogen atoms. Hydrogen atom has a strong positive nucleus comprising proton particle. This proton has its own spin velocity, spin direction and axis of rotation. The parallel alignment of the hydrogen nuclei is set by a super conducting magnet cooled with helium liquid. The hydrogen nuclei, at this state, are subjected towards a radio frequency radiation. It disturbs the analogous alignment of the hydrogen nuclei. As the nuclei absorb some quantity of radio frequency signal, they shift from lower energy level state to higher energy level state. As soon as the radio frequency radiation is stopped the nuclei get back to their original position with some emission of relative energy. This emitted energy, from the shifting of nuclei from excited state of energy to ground state, is recorded and processed by using a signal processor. This procedure gives out a spatial image of the internal structure of human body. The same procedure is used repeatedly to obtain 3D (MR) brain images. In an MRI scanner two dimensional Fourier transform is done over the obtained image structures. On these obtained (MR) Images, segmentation is done by using Fuzzy Inference System for unique tumor identification. A simple setup of an (MRI) scanning system is shown in (Fig. 1).

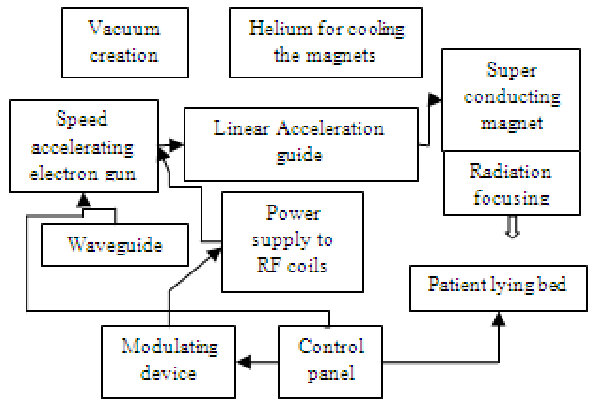

Fig. (1). A simple MRI system.

III. Related Works

Several authors have suggested various methodologies and algorithms for image segmentation. A brain tumor segmentation method has been developed by Rajeev Ratan et al (2009) and validated segmentation on 2D & 3D MRI Data. This method can segment a tumor provided that the desired parameters are set properly. This method does not require any initialization while the others require an initialization inside the tumor. The visualization and quantitative evaluations of the segmentation results demonstrate the effectiveness of this approach. Qilian Liang et al (2001) introduced the fuzzy c-means (FCM) method which is used to obtain the mean and standard deviation (std) of I/P/B frame sizes when the frame category is unknown. We propose to use type-2 fuzzy logic classifiers (FLCs) to classify video traffic using compressed data. A Gaussian MF with uncertain std is appropriate for modeling the frame sizes. We also used FCM to cluster and model the frame sizes when the frame category is unknown. We have classified video traffic using compressed data and have proposed type-2 FLCs to do this. Five fuzzy classifiers have been used for video traffic classification. Licheng Jioa et al (2011) designed a compression scheme for 2-D remote sensing images by using SA-RLT and object-based set partitioned embedded block coder. The new ROI compression scheme performs comparably even better than the JPEG2000-ROI scheme. An efficient ROI coding scheme based on SA-RLT and OB-SPECK has been designed. Experimental results confirmed the validity of the scheme. The main aim of this paper is to identify the tumor part present in the brain with a better efficient computer supported fuzzy algorithm designed by using image processing methodologies.

IV. Methodology

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The process of fuzzy inference involves developing membership functions, fuzzy logic operators and if-then rules. Mamdani-type and Sugeno-type are the two types of Fuzzy Inference Systems that can be implemented in Fuzzy Logic. In this case, framing the fuzzy rules and implementing them for image segmentation are done by Mamdani type controller exclusively. The Fuzzy Logic provides a number of interactive tools that allow accessing many of the functions through a graphical user interface (GUI). Here we use Fuzzy Inference System for image segmentation on (MR) brain images. The hierarchy of image segmentation process is shown in (Fig. 2).

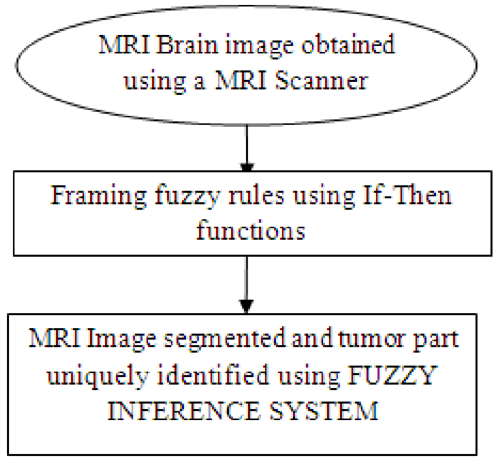

Fig. (2). Hierarchy of Image segmentation.

V. Fuzzy Rules for Segmentation

An input (MR) brain image for segmentation is given and processed using the image processing functions. A 256×256 grayscale (MR) image of brain is represented in (Fig. 3).

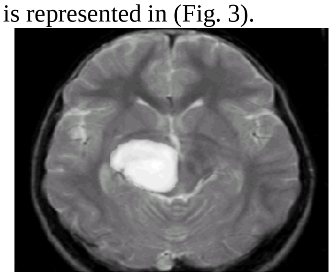

Fig. (3). 256×256 grayscale MR brain image.

Further with the processed image, fuzzy rules are framed and executed. The fuzzy rules are framed as,

FuzzySys.rule (1).antecedent= [1];
FuzzySys.rule (2).antecedent= [2];
FuzzySys.rule (3).antecedent= [3];

This is particularly developed for the antecedent part. For e.g., the basic fuzzy rule can be stated as if x is 1 and y is 2 then z is true. In this basic fuzzy rule 'x is 1' is said to be the antecedent and 'y is 2' is the consequent. The values 1 & 2 are said to be assigned fuzzy values. The coding mentioned above represents fuzzy rule assigned for the antecedent part [14].

FuzzySys.rule (1).consequent= [1 0 0];
FuzzySys.rule (2).consequent= [0 1 0];
FuzzySys.rule (3).consequent= [0 0 1];

This coding is developed for the consequent part with the fuzzy rule procedure.

VI. Implementation

- A input and output variables are introduced in Matlab's environment,
- A membership functions are defined using results from supervised classification,
- A Matlab's Fuzzy Logic Toolbox was used in definition of fuzzy logic inference rules,
- These rules are tested and verified through the simulation of classification procedure at random sample areas and at the end,
- A SPOT (Tumor) image segmentation was conducted.

Classification is conducted by the matlab's m-file. Resulting image is shown in (Fig.4)

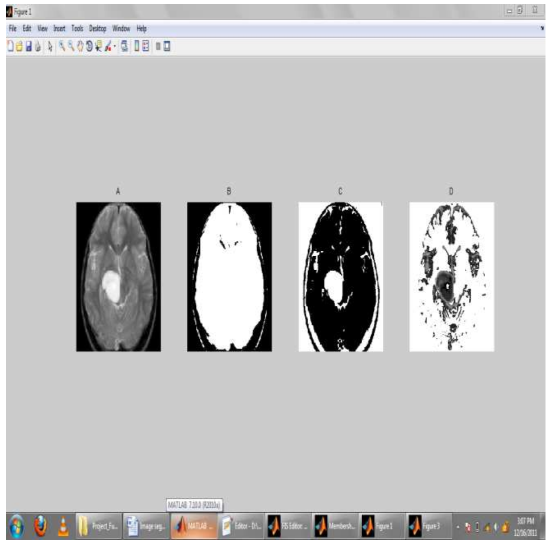

Fig. (4). (a). Input MR Brain tumor image. (b). First segmentation with the outline of brain tissues. (c). Tumor part identified in second segmentation. (d). Tumor extraction.

VII. CONCLUSION

This paper mainly focuses on identification of brain tumor in an efficient manner with lesser rate of similarity by using Fuzzy Inference System. A surgeon can have a clear knowledge about the tumor and its location in the brain. The clear anatomical structure of the brain tumor is identified using the proposed fuzzy based algorithm. And the performance of the confusion matrix and ROC curve can be improved by increasing the number of samples. The proposed system can be extended for diagnosis of other types of diseases.

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