MRI Classification Using fuzzy membership

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ABSTRACT- MRI classification has proven to be useful in many science fields mainly because of its tight association with human healthcare where research has been focused in the past decade. This paper will discuss the classification of brain tumors MRI and classify them using Fuzzy logic into two classes depending on the type of tumor while taking into consideration the two cases of the tumor being malignant or benign. Using these four input membership functions, the system concludes an output, (Area of the segment), (segment color variance) as well as the location of the segment in the MRI by using the two input membership functions (Upper left) and finally (Lower Right). The outputs are used by the system to produce one result and eventually come up with a final decision that the MRI classification is based on.

To measure the system's efficiency, the results were compared to a radiologist diagnosis and were found to be 100% identical in all the experiments in which the cases were diagnosed by both the system and the radiologist.

Keywords: Segmentation, Fuzzy logic, MRI, Feature, FM

INTRODUCTION

Image classification is the second important step after segmentation; any image analysis must go throw image segmentation first to extract the useful information from the image. Then these useful information must be classified into decisions the segment is being clarified according the previously extracted information in this paper the features are the area of the segment which represent the whit matter in the MRI that is considers the tumor, other features collected from image is that position of the tumor and color variance. Each study is different from each other when sometimes we need to find the darkest spot, edges, boundaries, lighter spots, lines or curves etc [1].

There are so many studies on cancer MRI in general and on brain cancer in particular the aim of these studies most of the time is to find cure or to know the reason of this fatal disease till these days the progress is very weak therefore this studies should keep going. This paper is to implement a system that helps the doctors and physicians to gives very give a critical diagnose about the type of tumor. Brain tumors is on the top of the worst type of cancer list regarding to the critical location, this type of cancer came as tumor take place in the brain tissue or the surrounding area [2][3].

This paper introduce several memberships to obtain the optimal classification since it is a critical topic involving human health and after the process of segmentation methods and the method that being used. In this paper a classification method will be proposed to classify the tumor wither its benign or malignant to obtain the best result so the patient will have some kind of therapy or surgical interference [2].

IMAGE CLASSIFICATION [1]

Digital images obtained a very high place in all sciences, classifying images regarding to what type of data they carry very important that will make retrieving image a lot easy along with storing and study them. Classifying image is also useful to help the researchers to develop their work and extract useful information from the images, classifying image mostly about study pixels and categorize them in digital images. That means categorize data according to the spectral of the land cover in an image. Most of the time multispectral data are being used to perform the classification then, the spectral pattern is presented in each data pixel that used as a numerical basis for categorizing the advantage of classifying digital images is to identify and describe as a very identical gray level or colored feature in the digital image [13].

The most important thing about digital image analysis is that classification in common perspective people love to store a beautiful image without knowing anything about it but that means nothing without knowing that each image showing a magnitude of many colors that form the image and there useless. If didn't know what do these colors mean, there are two main classification for digital images that are described in the next section [1].

CLASSIFICATION USING FUZZY SYSTEM

Fuzzy logic and fuzzy set of theory give multi solutions to the mathematical morphology algorithm regarding processing the gray scale images. It's the group of all methods that understand process and represent digital images. For their segments and also their features as fuzzy sets that representation depends on the technique of fuzzy logic that been selected and also depend on the problem to be solved, fuzzyfication of an image data (coding) and defuzzification (decoding)

THE PROPOSED FIS FOR DIAGNOSING BRAIN TUMOR

In this the section, the proposed approach for diagnosing brain tumor using FIS technique has been discussed in more details. The general block diagram of the proposed FIS is shown in figure (1). This system includes four input MFs and single output MF.

FUZZY LOGIC IMPLEMENTATION

The proposed classification system for diagnosing the MRI images is fussy system; the input parameter for the algorithm is four parameters area, upper location, lower location and the color variant of the segment, a four membership function used to give the decision

whether the tumor is benign or malignant the input of the member ship function was the results collected from the segment using the five step mentioned previously. The output is the decision either malignant or benign.

Algorithm Diagnosing Brain Tumor based on Fuzzy Inference System
Input : 4 parameter Area , Variance Color, Percentage of Brain Tumor Position in Up , Down, Right , and Left Side
Output: Decision

BEGIN
Step1:
if (Input1 is not Variance) and (Input2 is not Area)
and (Input3 is MinDownLeft) and (Input4 is MaxUpRight) then
the MRI segment is Benign
Step2:
if (Input1 is Variance) and (Input2 is Area)
and (Input3 is not MinDownLeft) and (Input4 is not MaxUpRight) then
the MRI segment is Malignant
END

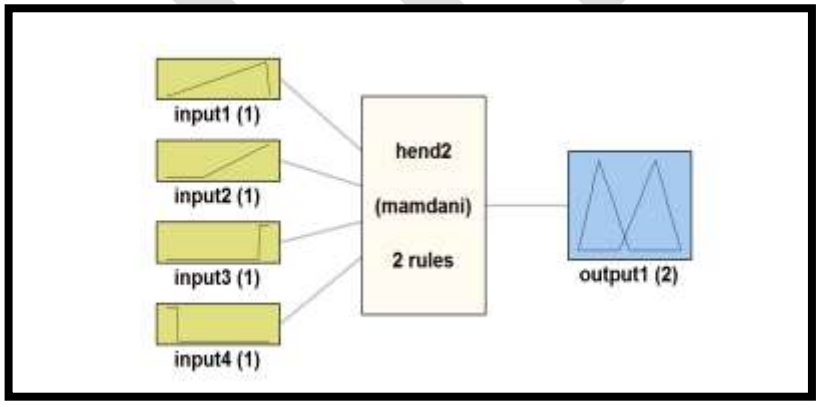

Figure 1: The General Block Diagram of the Proposed FIS for Diagnosing Brain Tumor.

The first input MF (input 1) is of triangular type which represents the variance color in tumor region. The structure of this MF includes three parameters (starting, middle, and end point). The desired values for these parameters in this MF are (500, 29000, and 30000), respectively as shown in Figure (2). The values of middle and end point are selected high because the determined values of variance color in many patients that are annotated by expert radiologists as a Malignant brain tumor are high (exceeds 22000), while the corresponding criterion in Benign brain tumor is low (less than 450), therefore the desired value of starting point in this MF is 500 which is slightly larger than lower limit of Benign patients [5].

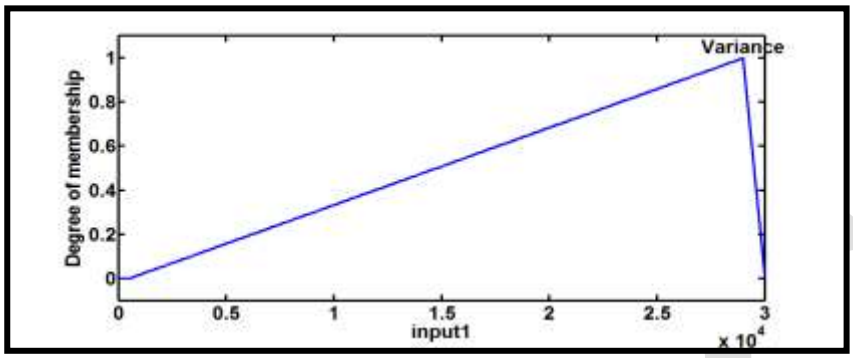

Figure 2: The Graphical Diagram of the first Input MF for the Variance Color in the Extracted Tumor Region.

Similarly, the second input MF take the same type of first input MF, but of course the desired parameters are different. This MF represents the area of the extracted shape that forms the tumor region. The simulation results of area for the tested patients show that the average value of area exceeds (8) for the Malignant cases, while the corresponding average value for Benign cases is about (7). Thus the desired parameters (start, middle, and end) point for this MF are (7, 20, and 20), respectively. The start point is selected to 7 to aggregate all area values above this threshold as a malignant patient while all values less than this threshold as a benign patient. The graphical structure for this MF is shown in Figure (3).

The third and fourth input MFs in the proposed FIS takes trapezoidal types which are different from the triangular type in first
and second MF. This MF has four parameters; first and second parameters represent the limits of left side in MF while the third and fourth parameters represent the limits of right side in trapezoidal MF.

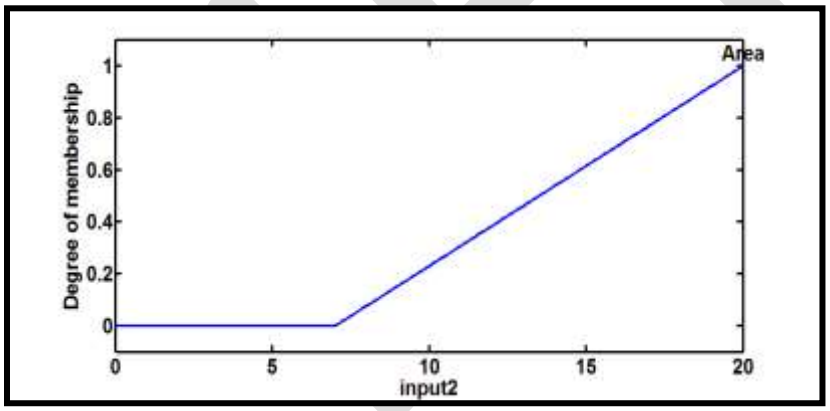

Figure 3: The Graphical Diagram of the second Input MF for the Area in the Extracted Tumor Region.

The third input MF represents a combined value which is determined from the left and down limits of tumor region that is extracted by the proposed diagnosing approach. The minimum value of left and down limits is the conditioning value in the 3rd input MF in the proposed FIS shown in Figure (1). The graphical diagram of this MF is shown in Figure (4). The desired parameters of this MF are (90, 90, 100, and 100). The simulation results of the combined value (minimum of the left and down side in tumor region) not exceed 90 in most Malignant patients, while the same combined value is greater than 90 for Benign patients. Thus the first and second parameters of 3rd MF in the proposed FIS take the same threshold value (90).

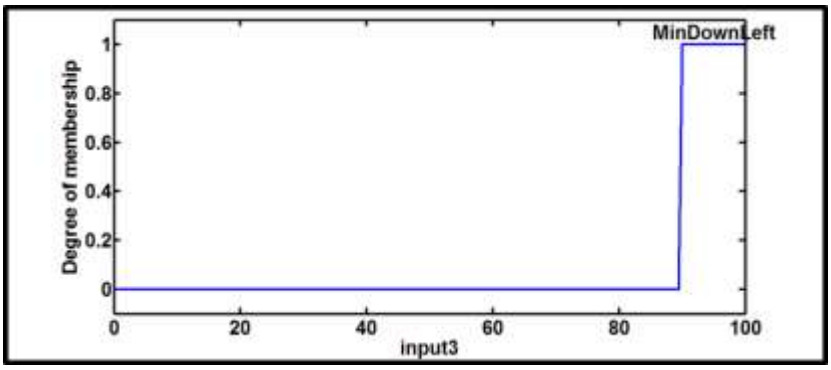

Figure 4: The Graphical Diagram of the third Input MF for the Combined Minimum Value of the Left and Down Side in Tumor Region.

The fourth input MF takes the same type of the third input MF except that the combined value that is determined is the maximum value of Right and Up sides in extracted tumor region. The desired parameters of this MF are (0, 0, 10, and 10). The aggregation value in this MF is the 3rd and fourth parameters (10), because most Malignant patients exceeds this threshold while the same combined value in Benign patients take a value less than this threshold. The graphical diagram of this MF is shown in Figure (5).

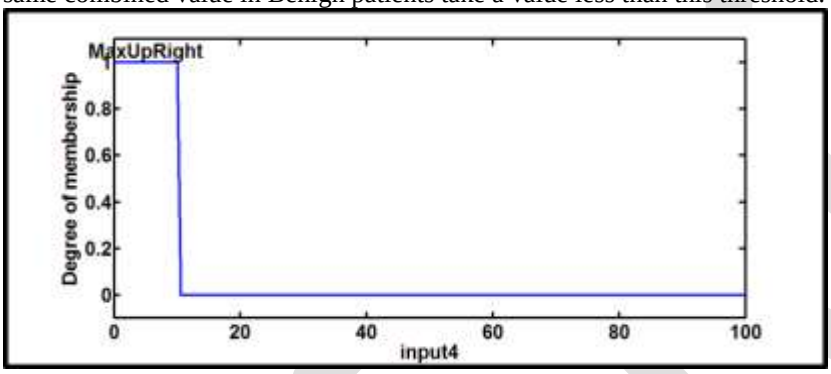

Figure 5: The Graphical Diagram of the fourth Input MF for the Combined Maximum Value of the Right and Up Side in Tumor Region.

The proposed FIS approach includes one output MF. This MF constructs from two sub-MFs, each one takes a trapezoidal type. As mentioned in first and second MFs, this type of MF has three parameters. The desired parameters of the first sub-MF marked with Benign are (-1 -0.6 0) and the parameters of the 2nd sub-MF marked with Malignant are (-0.19 0.5 1). The intersection point between these sub-MFs locates at (-0.5). Thus, the (-0.5) value represents the effective threshold to classify between Benign and Malignant. The graphical diagram of the output MF is shown in Figure (3.6).

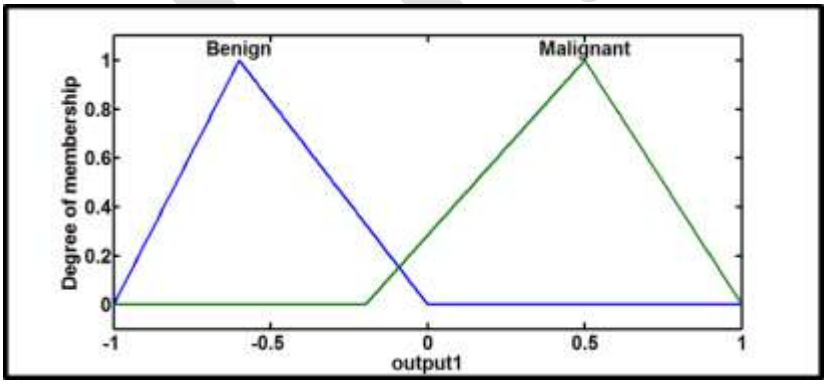

Figure 6: The Graphical Diagram of the Output MF for the Proposed FIS Approach Using Two Sub-MFs.

DIAGNOSIS RESULTS USING PROPOSED FIS MEMBERSHIP FUNCTION

In this section, the results of Brain Tumor diagnosis which are obtained by the proposed (Fuzzy Inertias System) FIS for some patients are presented. The structure design of the proposed FIS illustrated in Chapter three is implemented using fuzzy graphical user interface (GUI) editor by a MATLAB environment. One MRI case for brain tumor patients were selected and tested as the validation data in this implementation. MRI of patient (BRATS_HG0001) were selected and pre diagnosed with Malignant Tumor. Another patient (BRATS_HG0012) was selected and pre-diagnosed with Benign Tumor. The final diagnosis in the proposed FIS takes the form of activating one output MFs based on the conditional results of fuzzy rules that are considered in the proposed FIS. Moreover, the results of these rules are varied according to the desired entry values by input brain tumor patient.

One output MF with two sub- MF s is considered in the proposed FIS, the first is Benign, which denotes the decision of benign diagnostic for the tested brain tumor; the second is Malignant, which denotes of malignant diagnostic for the tested brain tumor.

In the 1stbrain tumor patients (BRATS_HG0001), the first input MF Input1 which represents variance of colors in the brain tumor region and the second input MF Input2 which represents the area of the segment activated, while the third input MF Input3 which represent minimum color value in the left and down halves in the brain tumor region are not activated as shown in the rule viewer diagrams in Figure (7). According to these output MFs results, the final diagnosis is malignant brain tumor.

The concept of having the final call which determines case type is to have one input at a time and see the result then comparing with other input result with the pre-diagnose images that collected from the radiologist the final output the same for both system and doctor if we use the same slice number that we fixed before.

In the second image case (BRATS_HG0012), the first input MF Input1 which represents variance of colors in the brain tumor region and the second input MF Input2 which represents the area of brain tumor are not activated, while the third input MF Input3 which represent minimum color value in the left and down halves in the brain tumor region are activated as shown in the rule viewer diagrams in Figure (8). According to these output MFs results, the final diagnosis for the MRI segment is malignant brain.

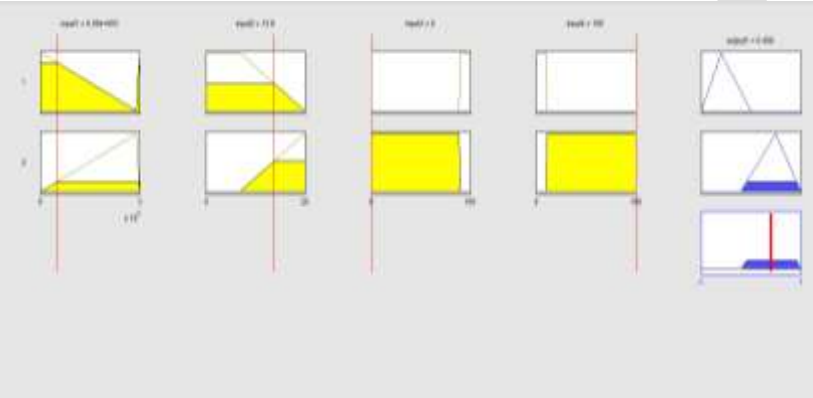

Figure (7) Generated Rule Viewer Diagram by Proposed FIS on BRATS_HG0001

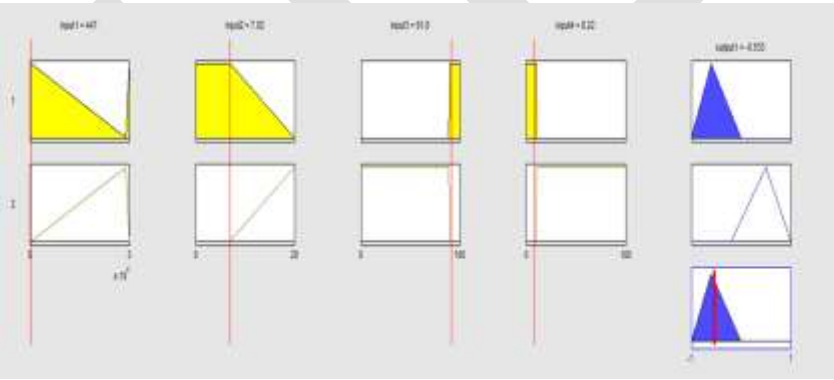

Figure (8) Generated Rule Viewer Diagram by Proposed FIS on BRATS_HG0012

CONCLUSION

This paper describe classification tumors MRI using the fuzzy role result shows the classification depend on the area of the segment and color variation, classification performed using MATLAB software.

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