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Fuzzy Logic Application in Analysis of Sonographic Images

Bhavna Gupta[1] and Kuldeep Singh[2]

[1]M.Tech Student, Electronics and Communications Engg. Baddi University of Emerging Science and Technology Solan, H.P.-173205
[2]Department of ECE, Baddi University of Emerging Science and Technology Solan, H.P.-173205
E-mail: [1]bhavnablp@gmail.com, [2]kuldeep.singh@baddiuniv

Abstract—*The theory of fuzzy sets offers a computationally feasible way of examining sonographic images. The objective of this paper is to develop an interactive method for presenting suggestions of sonographers or field experts with the help of fuzzy logic theory. In this approach the sonographic evidence of liver (largest body organ of human beings) is considered to presenting Radiologist/ sonographer's opinion regarding a disease on behalf of the sonographic images generated by USG machine. Here the liver parameters like liver size, and hepatic vein size is taken into deliberation to displaying the results in terms of opinion regarding disease. These two parameters become the two inputs to the FIS editor, and one output i.e. disease opinion, the corresponding membership functions have to be created. The potential benefit of using fuzzy logic is to increase the intelligibility and ease of report generation instantly with the sonographic images print outs. This will also save the time of expert to write the report separately.MATLAB software affords the elementary support to nurture such system.*

1. INTRODUCTION

Fuzzy logic achieves a way for representing reasoning about human knowledge that is vague in nature [1]. In fuzzy logic all truths are partial or approximate fuzzy systems are very useful in two general contexts: (1) in situations involving highly complex systems whose behaviors are not well understood and (2) in situations where an approximate, but fast, solution is warranted. [2]

Sonography allows evaluation of the anatomy of body organ in multiple planes; the field experts can precisely localize a lesion. When dealing with images of body organs like liver, membership functions are defined as an evaluating function for incorporating the specialist opinion in terms of diseases finding. [3]

The basic configuration of the logic system considered in this paper is shown in Fig. 1.

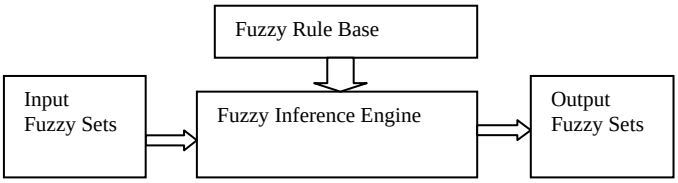

Fig. 1: Fuzzy logic system

The inputs for the proposed Fuzzy logic system are Lever size (mm) and Hepatic vein sizes (mm) which are respectively obtained from the five patients during sonography.Liver disease represents the fuzzy logic system output.

2. RELATED STUDY

This section discusses some applications of Fuzzy logic in analysis and diagnosis field. The literature is undertaken from various resources such as journals, conference articles, online sources, and reference and text books. All relevant information is studied to construct a precise summary. Fuzzy logic theory is a mathematical approach that permits partial membership. Fuzzy logic is applied to control the anesthesia given to the patients during surgical operation [4].For classifying the single channel surface electromyography signal, the parameters median and standard deviation gave best results for discriminating closing and opening hand movements [5].Fuzzy mathematical morphology is used to segment biological images having characteristics of vagueness and imprecision. In this paper an approach is introduced based on fuzzy morphology to segment images of human oocytes in order to extract the oocyte region from the entire image [6].Methodology is proposed for reflecting visual image presentation in medical diagnostics. Different aspects of the formation of image series (fuzzy, associative, and dynamic) are analyzed. The variants of building the frames that include linguist and image visual components are suggested. [7].Computation with words is possible, computerized systems can be built by implanting human expertise expressed in daily language. Such a system can perform approximate cognitive somewhat similar to but much more primitive than that of the human brain. Computing with words seems to be a slightly futuristic phrase today since only certain aspects of natural language can be characterized by the calculus of fuzzy sets [8].Fuzzy logic controller is well adapted to the processing of imprecise information. The fuzzy output for each single channel surface electromyography signal signal for opening, closing and no movement is achieved by using RULE SET [9].Fuzzy logic is a tool and can only useful and powerful when combined with analytic methodologies and machine

reasoning techniques and artificial neural network produces a artificial system capable of sophisticated computation similar to human brain [10]. With regard to medical philosophy, decision-making, and diagnosis; the framework of fuzzy sets, systems, and relations is very useful to deal with the absence of sharp boundaries of the sets of symptoms, diagnoses, and phenomena of diseases. The development of fuzzy relations in medicine and their application in computer-assisted diagnosis show that this fuzzy approach is a framework to deal with the ‘‘fuzzy mode of thinking’’ in medicine [11].

3. METHODOLOGY

In this section, an algorithm is established to recommend the disease opinion at the glassy of sonography.The basic parameters of liver are chosen to develop the algorithm. Lever size (mm) and Hepatic vein size (mm) are the input fuzzy variables to the fuzzy inference engine. Disease opinion is the output. The method of mapping from a given input to an output using fuzzy logic involves membership functions, fuzzy logic operators, and IF-Then Rules. The functional idea can be straightforwardly understood by Fig. 2.

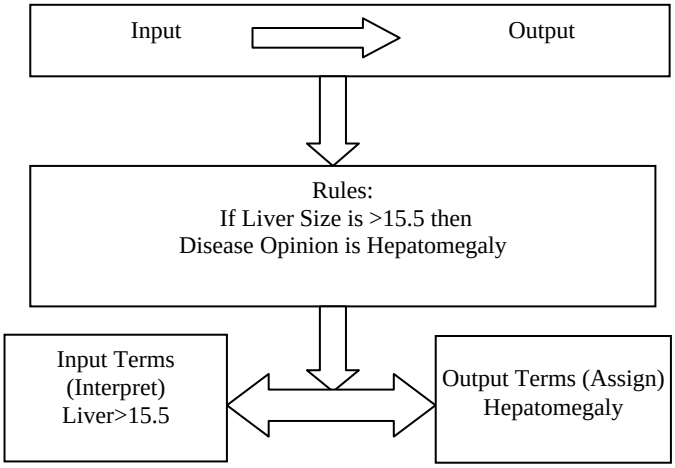

Fig. 2: Functional block diagram

MATLAB is used for enactment. By using If-Then type fuzzy rules, the inference engine converts fuzzy inputs to fuzzy output with the solicitation of mamdani FLC (AND method), the best popular inference engine [9].

The Fig. 3. Shows how the main components of a FIS and the three editors fit together. These GUI are dynamically linked.

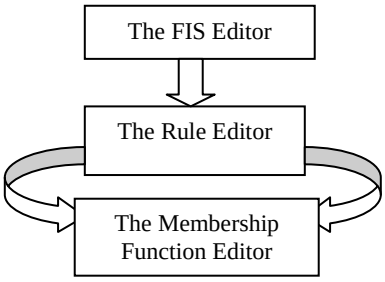

Fig. 3: Basic MATLAB GUI editors

The fuzzy controller has two inputs and one output. Three triangular membership functions are chosen for each input. First for normal liver, second for border line disorders and third for diseased liver.

Before defining the rules, the input and output data of controller are normalized. Each normalized variable is replaced by a set of linguistic variables. Table 1 shows the input variables for the fuzzy system.

Table 1: Input liver parameters

	Parameters	Normal liver	Border line disorders	Diseased liver
1	Liver size (mm)	< 15	15.5-16.5	> 15.5
2.	Hepatic Vein size (mm)	8	8-10	> 10

The corresponding output values which are required to be display after the analysis of data with the help of fuzzy logic system are given in Table 2, Table 3, and Table 4.

Table 2: Output values for normal liver

	Liver Parameters	Normal liver Values	Output
1	Liver size (mm)	< 15	Normal Liver Size
3.	Hepatic Vein size (mm)	8	Normal Hepatic Vein

Table 3: Output values for border line disorders

	Liver Parameters	Border line disorders	Output
1	Liver size (mm)	15.5-16.5	Mild Hepatomegaly
3.	Hepatic Vein size (mm)	8-10	Minimal Hepatic Congestion

Table 4: Output values for diseased liver

	Liver Parameters	Diseased Liver	Output
1.	Liver size (mm)	> 15.5	Hepatomegaly
2.	Hepatic Vein size (mm)	> 10	Hepatic Congestion

The membership function values for normal liver, border line disorders and diseased liver for each liver parameter are providing in Table 5.

Table 5: Membership values

Membership values	Input 1	Input 2
	Liver size	Hepatic Vein size
Mf1	<15	8
Mf2	15.5-16.5	8-10
Mf3	> 15.5	> 10

4. RULE SET

1. If input 1 is Mf1 then output is Normal liver size.

2. If input1 is Mf2 then output is Mild Hepatomegaly.

3. If input 1 is Mf3 then output is Hepatomegaly.

4. If input 2 is Mf2 then output is Mild Hepatic congestion.

5. If input 2 is Mf3 then output is Hepatic congestion.

5. RESULTS AND DISCUSSION

This analysis system is based on fuzzy logic model. It is designed for diagnosis the disease in Liver. This system consists of two input variables: liver size and hepatic vein size. The rule base of this system is used to determine the one output parameter value: Disease opinion according to two inputs.Mamdani Inference system shown in Fig. 4 is used to produce the results. Fig 5 represents the rule viewer for disease opinion hepatomegaly and fig 6 shows represent the surface view of the system.

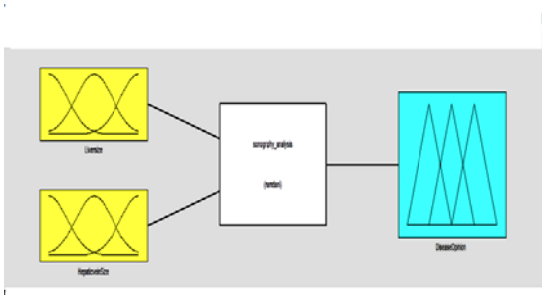

Fig. 4: Sonography_Analysis Inference System

Fig. 5 represents the membership variables for the output disease opinion.

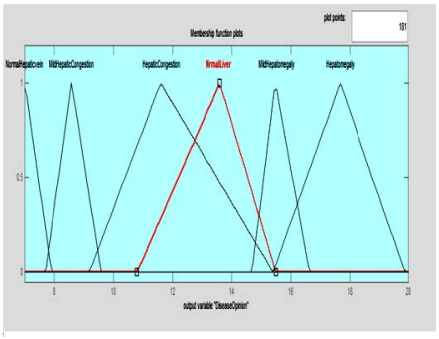

Fig. 5: Output membership variables

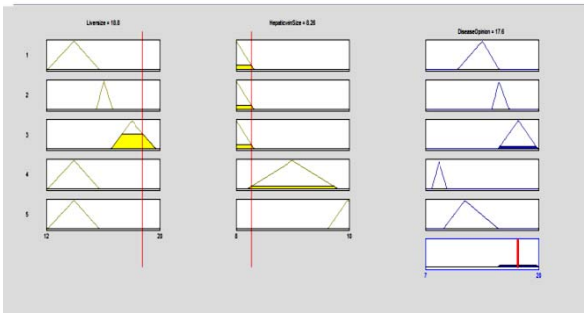

Fig. 6: Rules for Diseases opinion hepatomegaly

Fig. 6. Represents the rule viewer for disease opinion hepatomegaly which is a liver disorder when liver found large in size. Fig. 7 represents the surface view of the system.

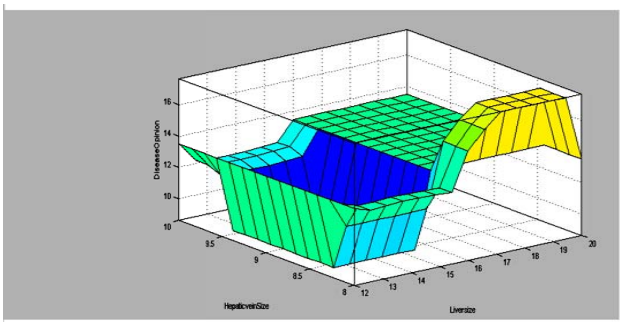

Fig. 7: Surface view

6. CONCLUSION

In the process of analyzing sonographic images, the number of parameters and the number of membership functions for the input and output are known. The output is displayed in the form of disease opinion regarding liver disease with itself from the system which is principally recommended by the Radiologists or field experts in handwritten form. In this way the medical specifications of different body organs can be find by sonography technique and on the basis of displayed parameters, the efficient results may be laid down by fuzzy logic system for simplicity and better improvement in the field of medical diagnosis.

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