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Risk Factor Analysis to Patient Based on Fuzzy Logic Control System

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Abstract— Fuzzy logic has proved in this paper, a medical fuzzy data is introduced in order to help users in providing accurate information when there is inaccuracy. Inaccuracy in data represents imprecise or vague values (like the words use in human conversation) or uncertainty in using the available information required for decision making handle the uncertainty of critical risk for human health. In this paper involved to diagnosis the health risk which is related to Blood Pressure, Pulse rate and Kidney function. The confusing nature of the symptoms makes it difficult for physicians using psychometric assessment tools alone to determine the risk of the disease. This paper describes research results in the development of a fuzzy driven system to determine the risk levels of health for the patients. The system is implemented and simulated using MATLAB fuzzy tool box.

Keywords—Fuzzy logic control system, Risk analysis, Sugeno-type, Fuzzy Inference System, MATLAB Tool, ANFIS, Defuzzification

INTRODUCTION

In the fields of medicine area diagnosis, treatment of illnesses and patient pursuit has highly increased. Despite the fact that these fields, in which the computers are used, have very high complexity and uncertainty and the use of intelligent systems such as fuzzy logic, artificial neural network and genetic algorithm have been developed. In the other word, there exists no strict boundary between what is Healthy and what is diseased, thus distinguish is uncertain and vague [2]. Having so many factors to analyze to diagnose the heart disease of a patient makes the physician's job difficult. So, experts require an accurate tool that considering these risk factors and show certain result in uncertain term. Motivated by the need of such an important tool, in this study, it designed an expert system to diagnose the heart disease. The designed expert system based on Fuzzy Logic. This fuzzy control system that deals with diagnosis has been implemented in MATLAB Tool. In this paper introduced fuzzy control system to design fuzzy rule base to analyse the risk factor of patient health and the rule viewed by surface view.

FUZZY INFERENCE SYSTEM

In this study, it present a Fuzzy control System for the diagnosis risk factor from the collection of Blood pressure value, pulse rate and kidney function are used as a several parameter to determine risk analysis by fuzzy rule respectively. A typical architecture of FLC is shown below, which comprises of four principal comprises such as a fuzzifier, a fuzzy rule base, inference engine, and defuzzifier. In fuzzy inference process, Blood pressure value, pulse rate and kidney function value are the inputs to transmit for making decision on basis of pattern discerned. Also involves all pieces that are described in Membership Functions and If-Then Rules.

METHODOLOGY BACKGROUND

INPUT DATA

Medical diagnosis is a complicated task that requires operating accurately and efficiently. Such complicated databases are supported of uncertain information is called a fuzzy database [7] [8]. Neuro-adaptive learning techniques provide to learn information about a data set for modeling the operation in procedure. Using a given input/output data set, the toolbox function adaptive neuro-fuzzy inference system (ANFIS) constructs a fuzzy inference system (FIS) whose membership function parameters are adjusted using either a back propagation algorithm. The inputs of linguistic variable are put into the measurement for performing to the Sugeno member function method and assigned the rule base refer the Table I, Table II, and Table III using If.. Then rule insert into the tool to analyse the risk factor of patient.

Kidney function was measured by several classified Glomerular Filtration Rate (GFR) such as Normal, problem started GFR, Below GFR, Moderate GFR, Below Moderate GFR, Damage GFR and Kidney failure. Blood pressure (BP) values also classified by different ranges such as Low normal, Low BP, Very Low BP, Extreme Low BP, Danger Low BP, Very Danger Low BP, Danger too Low BP, Normal BP, High Normal BP, Border line BP, High BP, Very High BP, Extreme very High BP, Very danger High BP. Pulse values are derived from systolic and diastolic Blood pressure value. Such Blood pressure values to be analyzing to the kidney function for determine the risk factor.

TABLE I. Analysis the variable in Rule Base

Cases	**Comment**	**Blood Pressure**				
		60-40 Very Danger Low BP	**50-30 Danger Too Low BP**	**120-80 Normal BP**	**130-85 High Normal BP**	**140-90 Border Line BP**
Kidney Function [Glomerular Filtration Rate]	Normal (> 90)	Very Danger Low BP ++	Low BP ++	Normal BP	High Normal BP	Border Line BP
	Below GFR (80-89)					
	Moderate GFR (45-59)	Very Danger Low Bp +	Low BP +		High Normal BP +	
	Below Moderate GFR (30-44)					
	Damage GFR (15-29)	Very Danger Low BP	Low BP		High Normal BP ++	
	Kidney Failure GFR<15					

TABLE II. Analysis the variable in Rule Base (Contd)

Cases	**Comment**	**Blood Pressure**				
		115-75 Low Normal	**100-65 Low BP**	**90-60 Very Low BP**	**80-55 Extreme Low BP**	**70-45 Danger Low BP**
Kidney Function [Glomerular Filtration Rate]	Normal (> 90)	Low Normal + +	Low BP ++	Very Low BP	Extreme Low BP ++	Danger Low BP
	Below GFR (80-89)					
	Moderate GFR (45-59)	Low Normal +	Low BP +		Extreme Low BP +	
	Below Moderate GFR(30-44)					
	Damage GFR(15-29)	Low Normal	Low BP		Extreme Low BP	
	Kidney Failure GFR<15					

TABLE III. Analysis the variable in Rule Base (Contd)

Cases	**Comment**	**Blood Pressure**			
		160-100 High BP	**180-110 Very High BP**	**210-125 Extreme Very High BP**	**240-140 Very danger Low BP**
Kidney Function [Glomerular Filtration Rate]	Normal (> 90)	High BP ++	Very High BP ++	Extreme Very High BP	Very danger Low BP
	Below GFR (80-89)			Extreme Very High BP+	Very danger Low BP+
	Moderate GFR (45-59)	High Bp +	Very High BP +	Extreme Very High BP++	Very danger Low BP++
	Below Moderate GFR (30-44)			Extreme Very High BP+++	Very danger Low BP+++
	Damage GFR (15-29)	High BP	Very High BP	Extreme Very High BP++++	Very danger Low BP++++
	Kidney Failure GFR<15			Extreme Very High BP+++++	Very danger Low BP+++++

SUGENO FIS METHOD

Adaptive neuro fuzzy inference system (ANFIS) represent Sugeno e Tsukamoto fuzzy models. A typical rule in a Sugeno fuzzy model has the form an example, If Input 1 = x and Input 2 = y, then Output is z = ax + by + c

For a zero-order Sugeno model, the output level z is a constant $(a=b=0)$.The output level z_i of each rule is weighted by the firing strength w_i of the rule.
Typical membership function is followed by the formula,

$$\mu_A(x)=\frac{1}{1+\left|\frac{x-c_i}{a_i}\right|^{2b_i}} \qquad (1)$$

Where parameters are referred as premise parameters. Every node in this layer is a fixed node labeled; an output of factor will produce by all incoming signals of given parameter. An i^{th} node calculates the ratio of the i^{th} rules by firing strength to the sum of all rule's firing strengths. The outputs are called normalized firing strength. An overall output computes by the summation of all incoming signals such as

$$\sum_i \overline{w_i} f_i = \frac{\sum_i w_i f_i}{\sum_i w_i} \qquad (2)$$

Through this Sugeno method gives a crisp output f(u) generated from the fuzzy input. Under the process Fuzzification was handle for first step a proper choice of process state variables and control variables is essential to characterization of the operation of a fuzzy logic control system. In decision making logic, If...Then rule base follow for measuring the membership values obtained. Finally the defuzzification is processed for combining the fuzzy outputs of all the rules to give one crisp value [2].

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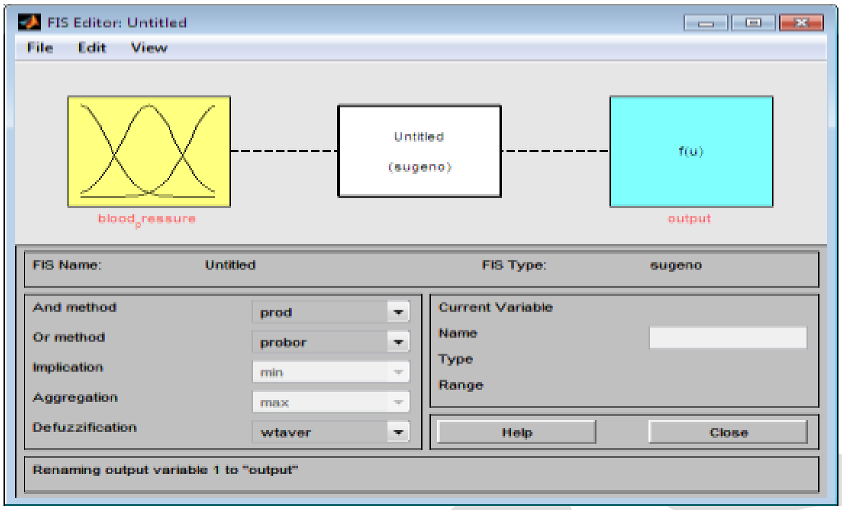

Fig.1. Member function of Blood Pressure

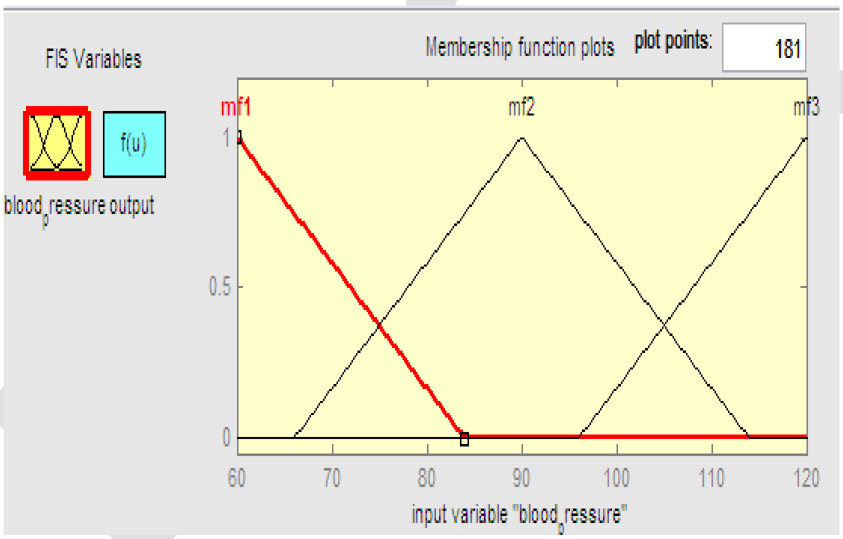

Fig.2. Final plot of Member function - Blood Pressure

From fig.1 and fig.2 represents the member function of blood pressure are constructed for finding the risk factor based on the rule base inputs[4] [5].

INFERENCE ENGINE

The domain knowledge is represented by a set of facts about the current state of a patient. The inference engine compares each rule stored in the knowledge base with facts contained in the database. When the IF (condition) part of the rule matches a fact, the rule is fired and its THEN (action) part is executed. The condition is check blood pressure is mf1, pulse value represents mf2, and kidney function is representing as mf3. The inference engine uses a system of rules to make decisions through the fuzzy logical operator and generates a single truth value that determines the outcome of the rules. This way, they emulate human cognitive process and decision making ability and finally they represent knowledge in a structured homogenous and modular way.

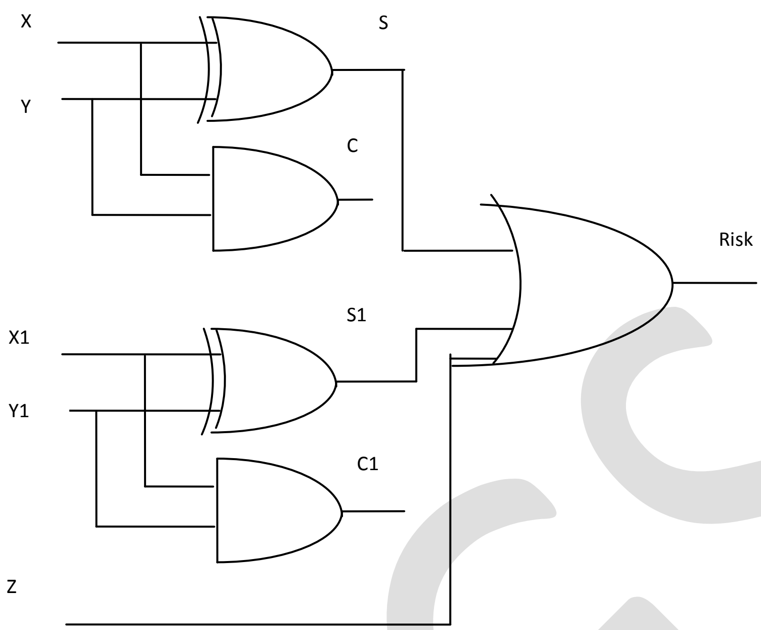

Fig.3. Logic gate for finding the risk rate

From the figure 3 describe, X and Y are pressure value which represent as S, pulse values are derived from given pressure value which represent S1, c and C1 represent as a carry's out which is used to XOR calculation data wants to carry's the value for getting the result and z are Kidney function value which represent X2.The pulse rate was analysed by given Systolic and Diastolic values. Finally risk factor was analysed by Blood Pressure, Pulse rate and GFR rate of kidney functions.

DEFUZZIFICATION

Defuzzification is the process of converting the final output of a fuzzy system to a crisp value. For decision making purposes, the output fuzzy sets must be defuzzifier to crisp value in the real life domain. Finally the process of defuzzification converts the conclusion of the mechanism into the actual inputs for the process. The health risk are determines the level of severity of depression risk given the input variables. The fuzzy system provides an objective process for obtaining the depression risk level. After determining the fuzzy membership functions, for the purpose of the study a standard rule base is developed to generate rules for the inference engine. A total of 250 rules were generated representing three fuzzy linguistically designed inputs. The simulation of the fuzzy system was carried out with MATLAB tool. The severity level is obtained as output response for the input values (blood pressure= 120/80, pulse value =40, kidney function = below moderate). New input values generate new depression risk output responses. Also the inputs can be set explicitly using the edit field and this will again produce a corresponding output that is consistent with the fuzzy rule base. Finally the health risk was observed by the relationship between those attributes in the determination of risk levels as shown in fig. 4.

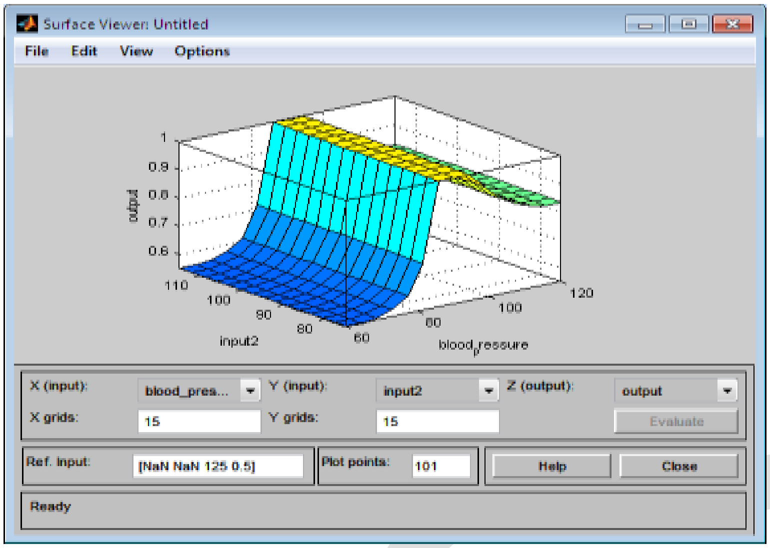

Fig.4 Plot of Surface view of health risk

Fuzzy system is used to obtain the severity level which is the only output variable of the system. The risk determines the level of severity of risk given the inputs.

RESULT AND DISCUSSION

The patient health risk was found from the given input of linguistic variable of Blood pressure, Pulse rate and kidney functions. Using Sugeno FIS method to construct the membership function for assigned the linguistic variable for fuzzification process. Using If ... Then rule and inference strategies are chosen for processing the rule base to determine the risk factor among the blood pressure, kidney function and pulse rate by logical decision making analysis. Through the defuzzification, fuzzy system provides an objective process of risk factor, also to view the surface view of the risk determination using simulation.

CONCLUSION

It can be concluded in this paper, the fuzzy system accurately predicts depression risk severity levels based on expert knowledge embedded as fuzzy rules and supplied patients stage retrieve by given parameters. The use of this approach is contributed to medical decision-making and the development of computer-assisted diagnosis in medical domain and identifies the major risk of the patient in earlier.

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