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Implementation of Fuzzy Controller for Diagonse of Patient Heart Disease

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***Abstract*— Intelligent biomedical diagnosis system based has been one of the most active research areas nowadays. Use of artificial intelligence or computer technology in diagnosis and treatment of illnesses has highly increased. Heart disease diagnosis is a challenging task which can offer automated prediction about the heart disease of patient so that further treatment can be made easy. In this paper we implemented and tested fuzzy logic based heart disease diagnosis system. We use main risk factors like cholesterol, blood pressure, diabetes, sex and age that affect on heart disease risk.**

Keywords—Fuzzyc, FIS, Heart dignosis, Fuzzy set.

1. INTRODUCTION

In several areas of biomedical domain, including prediction of the effectiveness of surgical procedures, medical tests, medication, and the discovery of relationships among clinical and diagnosis data, data mining techniques have been applied [1]. Modern-day medical diagnosis is a very composite process, entailing precise patient data, a philosophical understanding of the medical literature and many years of clinical experience. The health care data which, unfortunately, are not ‘‘mined’’ to discover hidden information for effective decision-making are collected in a huge amount by the health care industry [2]. Use of artificial intelligence or computer technology in the fields of medicine area diagnosis and treatment of illnesses has highly increased. The biomedical field has a challenging field because of very high complexity and uncertainty. Therefore the use of intelligent systems such as fuzzy logic, artificial neural network and genetic algorithm has been developed. Because of the many and uncertain risk factors in the heart disease risks, sometimes heart disease diagnosis is hard for experts. In the other word, there exists no strict boundary between what is Healthy and what is diseased, thus distinguish is uncertain and vague.

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, we designed a fuzzy based expert system to diagnose the heart disease. This fuzzy expert system that deals with diagnosis has been implemented and experimental results showed that this system did quite better results. The designed system aims to achieve the following:

- Detection of heart diseases and risks using fuzzy logic.
- The system also defines the precautions according to the risk of the patient.

2. FUZZY BASED ALGORITHMS

There are huge data management tools available within health care systems, but analysis tools are not sufficient to discover hidden relationships amongst the data. Most of the medical information is vague, imprecise and uncertain. Medical diagnosis is a complicated task that requires operating accurately and efficiently. According to the World Health Organization, 12 million deaths occur each year due to heart diseases. When the studies in the literature related with this classification application are examined, it can be seen that a great variety of methods were used which reached high classification accuracies using the dataset taken from UCI machine learning repository. There are many papers published related to the diagnosis of heart diseases.

Adeli et al. [3] proposed a Fuzzy expert system for the Heart Disease Diagnosis. The developed system uses fuzzy logic. In their system the crisp value is fuzzified to get fuzzy values. The expert system uses those fuzzy values and the output is also fuzzy. The fuzzy output is defuzzified to get a crisp output. Sony et al. [4] designed an Intelligent and Effective Heart Disease Prediction System using weighted associative classifiers. They used Java as front end and Ms Access as backend tool. They only consider two cases for prediction (Heart disease and No Heart Disease). Novruz Allahverdi & Serhat Torun & Ismail Saritas [5] proposed a fuzzy expert system to determination of coronary heart disease risk (CHD) of patient for the next ten-years, in 2007.

Kemal Polata, & Salih Güne [6] develop a system of Diagnosis of heart disease using artificial immune recognition system and fuzzy weighted pre-processing.

P.K. Anooj [7] developed Clinical Decision Support System for heart disease using weighted Fuzzy Rules. E.P. Ephzibah et al [8] framed Fuzzy Rules for Heart Disease diagnosis using 6 attributes. Sulabha S. Apte et al [9] compared various data classification techniques by using 15

attributes for heart disease diagnosis. M. Anbarasi et al [10] developed an Enhanced Prediction System for heart disease with feature subset selection using Genetic Algorithm.

3. Dataset for Design of Fuzzy System

Dataset for the designed system is collected from various Hospital of Amritsar and by consulting the expert in the field of heart disease. The purpose of this dataset is to diagnose the presence or absence of heart disease given the results of various medical tests carried out on a patient. This system uses 6 attributes for input and 2 attribute for output.

The Input attributes are chest pain type, blood pressure, cholesterol, blood sugar, maximum heart rate and old peak (ST depression induced by exercise relative to rest), . The output field refers to the presence of heart disease in the patient and the Precautions according to the risk. It is integer value from 0 (no presence) to 1; increasing value shows increasing heart disease risk.

Fuzzy logic is a form of multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate rather than precise. In contrast with binary sets having binary logic, also known as crisp logic, the fuzzy logic variables may have a membership value of only 0 or 1. We are using fuzzy expert system for the detection of heart diseases. Firstly we have to make a dataset to decide the range of parameters on which the heart diseases are depending.

The result shows that the patient have the heart risk or not. This system also gives the precautions accordingly. The following steps are involved in the system and the flow diagram of the fuzzy system is shown in figure 1.

- Select the parameters on which heart disease depends.
- Then select the range of different parameters from the data base.
- Make the membership four .membership function can be variable for different parameters. There are different membership functions for input and output variables.
- Make the rules in fuzzy tool box.
- The result ranges from 0-1 where 0 corresponds to no disease or no risk n 1 depicts that patient have high heart disease risk.

4. Fuzzy Expert System Designing

The most important application of fuzzy system (fuzzy logic) is in uncertain issues. When a problem has dynamic behavior, fuzzy logic is a suitable tool that deals with this problem. First step of fuzzy expert system designing is determination of input and output variables. The system consists of 6 input fields and two output field. Input fields are chest pain type, cholesterol, maximum heart rate, blood pressure, blood sugar, old peak. The output field detects the presence of heart disease in the patient and precautions accordingly. These membership functions determine the membership of objects to fuzzy sets.

a. Chestpain

In input attribute Chest pain, we choose five different membership functions which are very low, low, moderate, high and very high. The range of this attribute is given in table 1.

TABLE I. Classification of Chest pain

Input Field	Range	Fuzzy Set
Chest Pain	0-0.22 0-0.5 0.25-0.74 0.5-1 >1	Very low Low Moderate High Very high

b. Blood Pressure

We choose five different membership functions for input attribute Blood Pressure and are named as very low, low, medium, high and very high. This can also be shown in table II.

TABLE II. Classification of Blood Pressure

Input Field	Range	Fuzzy Set
Blood Pressure	<90 0-130 95-165 130-200 >170	Very low Low Medium High Very high

c. Cholesterol

Cholesterol has salient affect on the result and can change it easily. We choose five different membership functions for input attribute cholesterol. The range and membership function of this attribute is shown in table III.

TABLE III. Classification of Cholesterol

Input Field	Range	Fuzzy Set

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Cholesterol	<160 0-250 175-325 250-400 >375	Very low Low Medium High Very high

d. Blood Sugar

Blood sugar field is one of the most important factor in the diagnose of heart disease. The input attribute Blood Sugar, five different membership functions are used which is given as very low, low, medium, high and very high . The range and the membership function of this attribute is given in table IV.

TABLE IV. CLASSIFICATION OF BLOOD SUGAR

Input Field	Range	Fuzzy Set
Blood Sugar	<90 50-150 100-200 150-250 >205	Very low Low Medium High Very high

e. Heart Rate

Heart Rate has five different membership functions i.e. very low, low, medium, high and very high. The range and membership function of this attribute is given in table V.

TABLE V. CLASSIFICATION OF HEART RATE

Input Field	Range	Fuzzy Set
Heart Rate	<88 70-110 90-130 110-150 >132	Very low low Medium High Very high

f. Old Peak

This input attribute means ST depression induced by exercise relative to rest. Old peak field has 5 fuzzy sets (Very Low, Low, Medium, Terrible and risk). These fuzzy sets have been shown in table V with their ranges.

TABLE VI. CLASSIFICATION OF OLD PEAK

Input Field	Range	Fuzzy Set
Old peak	<0.2 0-0.5 0.25-0.75 0.5-1 >0.7	Very low low Medium Terrible Risk

5. OUTPUT ATTRIBUTES

The system recognizes the presence or absence of heart disease and also gives the precaution necessary to avoid the disease.

The "goal" field refers to the presence of heart disease in the patient. It is integer value from 0 (no presence) to 1. By increasing of this value, heart disease risk increases in patient. In this system, we have considered a different output variable, which divides to 5 fuzzy sets Healthy, Low Risk, Moderate Risk, Risk, and High Risk. Figure 8 shows these fuzzy sets with their ranges.

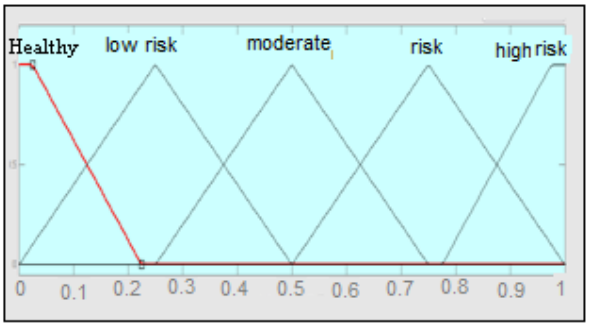

Fig. 1. Membership Function of Reult

6. DEFUZZIFICATION

Membership functions are used to retranslate the fuzzy output into a crisp value called defuzzification. The fuzzy inference evaluates the control rules stored in the fuzzy rule base. First a typical value is computed for each term in the linguistic variable and finally a best compromise is determined by balancing out the results using different methods like center of sum, center of area, center of area, mean of maximum etc. But for this application we use centroid method to process defuzzification of the output variable extension time. This method is mostly used because of better performance in terms of continuity, computer complexity and counting. The surface view of blood sugar and chest pain attributes is shown in figure 2.

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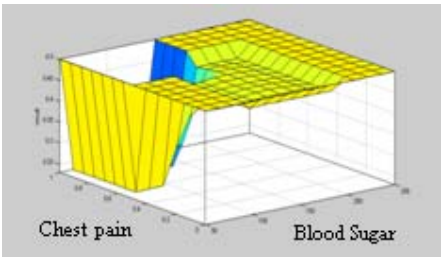

Fig. 2. Surface Viewer of Chest Pain and Blood Sugar

7. System Testing

We have tested the designed fuzzy system to diagnose the heart disease with the real patient's data collected from various hospitals and consult expert doctors in the field. We categorize the patients having high risk, moderate risks, low risks and healthy person. The data so collected is given to the system and validate the result. The output of one of such patient having no risk is given in table VII and corresponding rule viewer is shown in figure 10.

TABLE VII. Testing Result

C.P	Cholesterol	Heart rate	B.P	B. Sugar	Old Peak	Result
0	100	70	60	50	0	0.07
0.5	150	90	90	90	0.5	0.59
0	160	100	100	80	0.2	0.65

Fig. 3. Result of fuzzy system

We have tested the designed system with data of 100 patients of various risk factors. The accuracy of the developed system is found out to b 92%.

8. Conclusion

Fuzzy Expert System for Heart Disease Diagnosis designed with follow membership functions, input variables, output variables and rule base. Designed system has been tested with expert-doctor. Designing of this system with fuzzy base in comparison with classic designed improves results. This system simulates the manner of expert-doctor. This system is designed in way that patient can use it himself. Experimental results showed that this system did quite better than non-expert urologist and about 92 % as a well as the expert did.

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