

Fuzzy based Congestive Heart Failure Diagnosis and Analysis

Sharat Chandra
CA, SGVU
Jaipur, Rajasthan, India

Ripu Ranjan Sinha
CA, SGVU
Jaipur, Rajasthan, India

ABSTRACT

The main target of this research is to design a Fuzzy Based Expert System for the diagnosis and analysis of congestive heart failure (CHF). The designed system has seven inputs like breathing problem, cough, heart rate, swelling, weight gain, urination, lack energy. The output field provide the stage of CHF in the patient. There are four stages stage1, stage2, stage3 and stage4. It is an integer valued from 0 (means no presence) to 1 (which is distinguish presence). Various membership functions are used for different symptoms. The proposed fuzzy expert system uses Mamdani inference method. The input data is collected from a total of 10 people which consists of male and female with different working background. The results obtained from proposed expert system are compared with data in database and it is observed that results of proposed system are correct in 90% and also the expert system designed in Matlab software. This proposed expert system may be used as an alternative approach for existing methods to distinguish of congestive heart failure (CHF) presence. Heart failure is a common cardiovascular disease with high morbidity and mortality. Thus, an intelligent and accurate diagnostic system is needed in order to threat the CHF patients. The linguistic variables, diagnosis process and their values were modeled based upon expert's knowledge and from existing literature survey. It is expected that the proposed Fuzzy Expert System can provide a cheaper, faster and more approximate result compared with other traditional methods available today. Congestive heart failure (CHF) is almost common clinical disorder that results in pulmonary vascular congestion and reduced cardiac output. Patients with CHF are suffer with pulmonary complications, including obstructive sleep problem, edema (pulmonary), and pleural effusions.

Keywords

Congestive heart failure, CHF, Fuzzy logic, Expert system, membership function .heart, .diagnosis, analysis

1. INTRODUCTION

Now these days the methods and concepts of artificial intelligence and its domain have largely been used in the medical science and its applications whether it is medicine or surgery or disease diagnosis. In these areas, many expert systems were designed and developed to treatment and diagnose the disease. There are various approaches of artificial intelligence such as fuzzy logic, neural network, genetic algorithm, image processing, and pattern recognition etc. Due to many and uncertain factors in congestive heart failure; sometimes CHF diagnosis is difficult for experts. There exists no strict boundary between a Healthy and a diseased person, therefore distinguish is uncertain and vague. There are so many factors that have to analyze to diagnose the CHF (congestive heart failure) of a patient makes the

physician's job difficult. Therefore an experts require an accurate tool or system that considering these factors and show certain and appropriate result in uncertain term. In this research a fuzzy rule-based expert system has developed that simulates an expert-doctors behavior for diagnosis of the Congestive Heart Failure disease.

2. CONGESTIVE HEART FAILURE (CHF)

Our heart has two independent pumping mechanisms, one on the left hand side and second one on the right hand side. The right atrium, or right chamber, of the heart relaxes and expands to fill with blood that comes from the body. The used blood has less amount of oxygen and huge amount of carbon dioxide. Then it enters a second muscular chamber of heart called the right ventricle, and which pumps the entire blood into the lungs where blood releases carbon dioxide and absorb oxygen. Then this oxygen rich blood goes through pulmonary veins to the left atrium in the heart where it is pumped to the whole body by the left ventricle. Congestive heart failure is not a kind of disease but a complex condition when the heart cannot able to pump enough blood, which meet the needs of our body's tissues. To ensure the severity, physicians used a calculation based approach which is known as an ejection fraction, which is the percent of the blood pumped out while each heartbeat. In a general situation an ejection fraction of limit 50% to 75% is normal. In most of cases in heart failure cases the left side of heart fails, causing **systolic dysfunction**, in which fluid return backs and accumulates in the mostly left part of lungs. The ejection fraction in these cases falls below 40%; in more severe failure case it may drop as low as 5%. Right-sided heart failure, which is much less common **diastolic dysfunction**, in this condition fluid entering the heart backs up, causing accumulation the veins in the body and accumulate in tissues surrounding them to swell. As a result of these circumstances, the body's vital organs or organs do not receive enough oxygen and nutrients, and the body's wastes are removed more slowly; eventually vital systems break down.

The current Staging system deals with progression of the underlying disease.

Stage A: Patients is at high risk for developing heart failure are those with:

- Hypertension
- Diabetes mellitus History of cardio toxic drug therapy
- History of alcohol abuse
- Coronary artery disease (including being S/P myocardial infarction)
- History of rheumatic fever

- Family history of cardiomyopathy

Stage B: Patients with known heart disease but who have **never** had significant symptoms of heart failure.

Stage C: Patients with known heart disease with **current or prior** symptoms. Symptoms include:

Shortness of breath

Fatigue

Reduced exercise tolerance

Stage D: Presence of advanced symptoms even with optimized medical care

3. FUZZY LOGIC AND FUZZY EXPERT SYSTEM

Fuzzy means vague thing, which cannot determine either yes or no. Actually fuzzy is measurement of vague things like beauty, intelligence. It has linguistic variable, membership function of each fuzzy condition respectively. In this paper it is used seven vague symptoms of congestive heart failure. Each and every symptom has its own membership function. Membership functions shows their degree of belonging. Besides traditional logic or set or crisp logic, element of attribute is either belongs to set or not belongs to set, but in fuzzy theory it is shown by its degree how much inside the set and how much outside the set.

Fuzzy expert system consists of three components

1. Fuzzyfication
2. Inference engine
3. Defuzzyfication

Inference rules are if then rules

In traditional logic crisp value is given to fuzzy expert system fuzzyfier convert crisp value to fuzzy linguistic variable, after that fuzzy inference engine takes fuzzy input apply if then rules and give it to defuzzifier, which give crisp output.

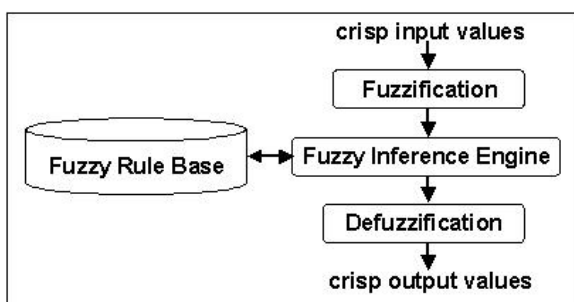


Fig 1.A fuzzy expert system

4. PROPOSED MODEL

In this paper there are seven symptoms are used to identify Congestive Heart Failure. These are the most common symptoms in CHF. Some are vague and some are crisp.

These are as follows with their weight given as contribution of their presence in CHF out of 10 points....

- | | |
|---|---|
| 1. Shorting of breath during daily life | 9 |
| 2. Sudden weight gain | 7 |
| 3. Swelling in anklet and feet | 8 |
| 4. Weakness | 6 |
| 5. Irregular heart beat | 9 |
| 6. Cough | 8 |
| 7. Lack of concentration | 7 |

With the help of these symptoms and fuzzy rules and membership function and graph it more easy and accurate diagnosis of congestive heart failure (CHF).

4.1 Shorting of Breath

In CHF during stage A and B there is no frequent

Breathing problem occurs, but in stage C and D it became more severe. Linguistic variables are

{Not-at-all, some-times, more time, always}

Membership graph as follows:-

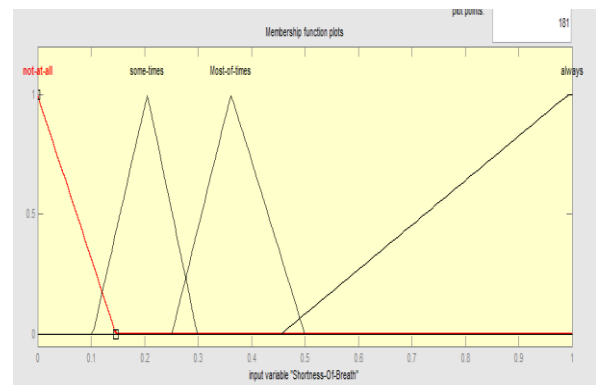


Fig 2. Shortening of breath

4.2 Sudden Weight Gain

In primary stages there is less weight gain problem viewed, but as increase in weight observed then it goes to higher stages of CHF. Linguistic variables as follows

{Not at all, little, significant, large amount}

Membership graph as follows:-

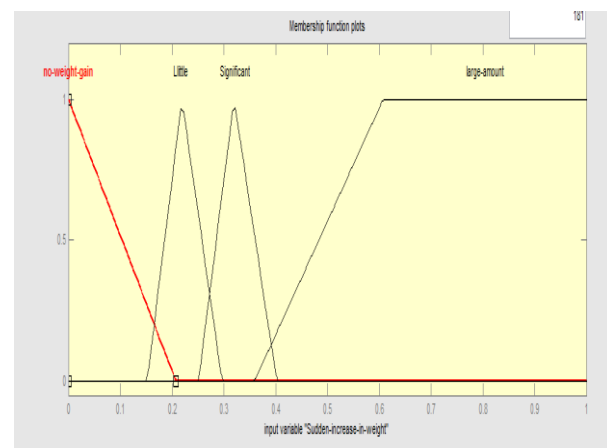


Fig 3. Sudden weight gain

4.3 Swelling in Anklet and Feet

In first two stages stage A and stage B there is no significant symptoms of swelling in anklet and feet, since there is no accumulation of fluid in tissues. But in later stages stage A and stage B swelling in feet and legs are observed. Linguistic variable for swelling are as follows {no swelling, little bit, more, severe}

Membership graph as follows:-

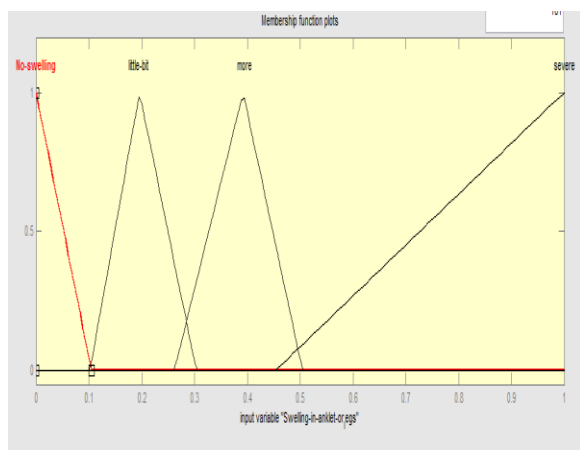


Fig 4. Swelling in anklet and feet

4.4 Weakness

Due to not supply of enough amount of oxygen and nutrients patient feels weak and tired. Linguistic variable for weakness are as follows {no weakness, sometimes, most of time, always}

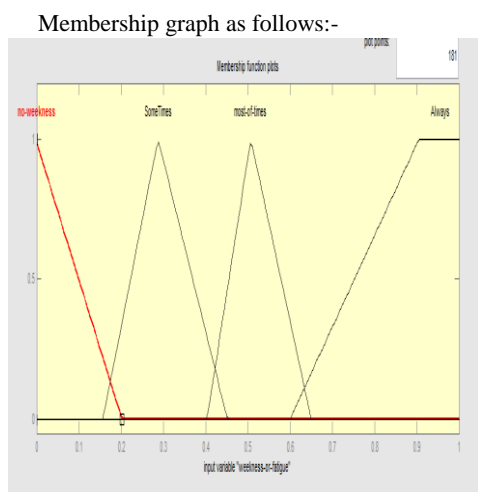


Fig. 5. Weakness

4.5 Irregular Heart Beat

One of the most common and significant symptoms is irregular heart beating, because heart has to pump extra blood in our body.

Linguistic variables for irregular heart beat are {no, sometimes, most of time, always} And membership graph as follows

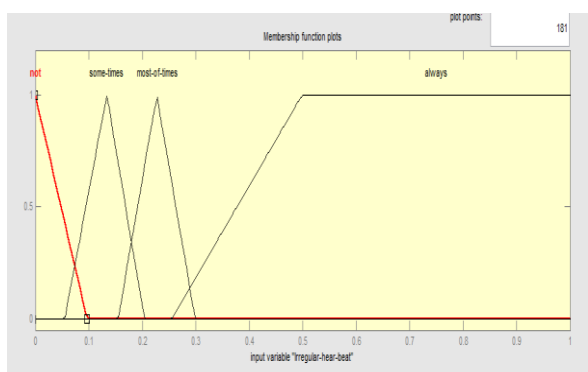


Fig 6. Irregular heart rate

4.6 Cough

In first beginning of two stages stage A and stage B there is no significant symptoms of cough observed, but in later stages it is prominent. Cough happen due to accumulation of blood plasma fluid. This fluid cause for cough, but is only symptoms not any kind of infection. Linguistic variables for cough as follows {no, sometimes, most of time, always} and membership function graph as follows:-

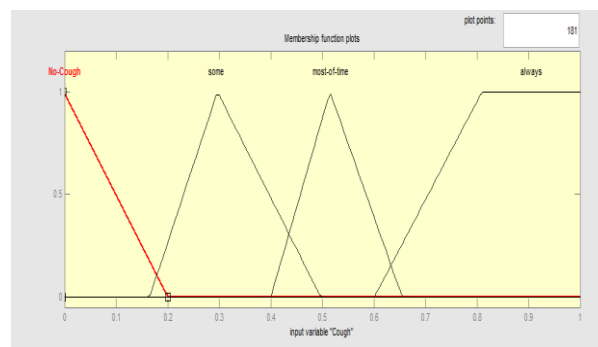


Fig. 7. Cough

4.7 Lack of Concentration

Due to lack of oxygen and nutrients in brain there may happen confusion and also produce lack of concentration. Linguistic variable of lack of concentration is as follows :-{ no, sometime, most of time, always} and membership graph as follows:-

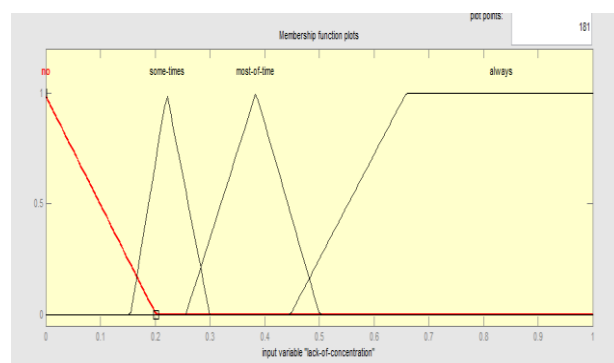


Fig. 8. Lack of concentration

4.8 Output Graph

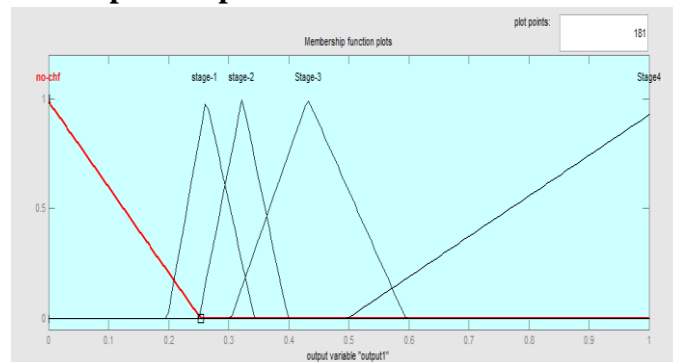


Fig 9. Output graph

Output graph consists of five linguistic variables: - Stage A, stage B, stage C, stage D and no CHF found.

4.9 Surface Curve

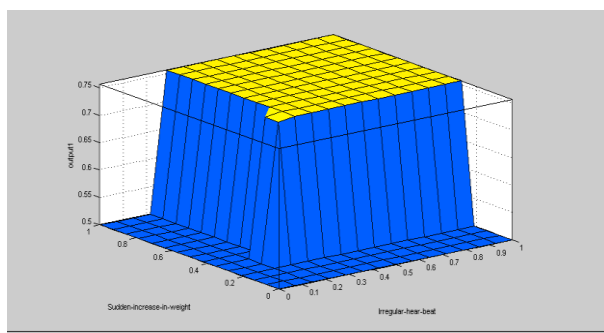


Fig. 10 Surface curve

5. FUTURE SCOPE

In this research paper there are only seven of prominent symptoms are taken, it can be increased for more and more precise result. ECG, Echocardiography report chest x-ray report and other pathological report may be added in future for advance cases. Membership graph and rules may be revised and may be increases.

6. CONCLUSION

This research is for congestive heart failure patients there are only seven symptoms are taken from the user and give it to the fuzzy system and it will show the membership function of output graph. This fuzzy system almost give 90% of accurate result. This research not only for general patients but also for doctor to take accurate diagnosis and analysis of CHF.

7. REFERENCES

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Table1. Patient observation table (Bokaro Steel City, B.G.H, Bokaro General Hospital)

Name	Age	Sex	Shorting of breath	Sudden weight gain	Swelling in anklet	Weak ness	Irregular heart beat	cough	Lack of concentration	Stage calculated	Real stage
Vijay banki	49	M	.2	0	0	.2	0	.2	.1	Stage 1	No chf
Malti verma	38	F	.1	0	.1	.1	0	.1	.1	No chf	No chf
Vipul tripathi	50	M	.5	.1	.2	.2	0	.2	.2	Stage 2	Stage2
Shantanu kakar	45	M	.2	.4	.1	.3	.1	.2	.2	Stage 3	Stage
Shankar lal	55	M	.3	.2	.1	.6	.3	.5	.5	Stage 4	Stage 3
Ram gopal verma	52	M	.1	.0	0	0	0	.1	.1	No chf	No chf
Vikram singh	42	M	.2	0	0	0	0	.3	.1	Stage 1	Stage 1
Radha rani singh	56	F	.4	.1	.3	.4	.2	.6	.4	Stage 4	Stage 4
Payal rani Sinha	50	F	.2	.0	.0	.0	.0	.0	.2	No chf	No chf