

Fuzzy Information System to Classify Hypertension According to Blood Pressure

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Abstract— The paper discusses about the fuzzy information system developed for depicting the hypertension level according to the blood pressure level of the person. Since Fuzzy Logic provides the advantage of human like thinking and we can deduce results when we do not have crisp data set and instead we are using a range of inputs to deduce outputs. The simulation is carried out in MATLAB and the results show that the FIS designed is optimum outputs.

Index Terms—FIS (Fuzzy Information System), Systolic, Diastolic, Hypertension.

I. INTRODUCTION

Fuzzy Logic was introduced by Lotfi A.Zadeh in 1965 as a soft computing tool to deal with uncertain data. It provides the capability of human way of thinking as it makes use of linguistic variables to define the problem on hand. It has been proved a useful method in decision making.

FIS are the rule based systems based on fuzzy logic where the rule base is formed in the form of “if-then” rules and it makes use of connectors “AND” and “OR” to provide necessary rule base. The output produced may be fuzzy or crisp depending on our requirements.

[1]Blood Pressure means the force exerted by the blood by the blood against any unit area of vessel wall. When one says that the pressure in a vessel is 50 mm Hg, one means that the force exerted is sufficient to push a column of mercury against gravity up to a level 50 mm high.

[2]The cardiac cycle consists of a period of relaxation called *diastole*, during which the heart fills with blood; followed by a period of contraction called *systole*.

[3]When a person is said to have hypertension, it is meant that his or her mean artial pressure is greater than the upper range of accepted normal pressure

We have used FIS to provide an easy and time saving solution to decide the level of BP for a person to make it easy for people like us to see an estimate of our BP.

II. FUZZY INFERENCE SYSTEM

A. Blood Pressure Classification

The Blood Pressure (BP) is classified as per the systolic and the diastolic pressure of the person. The table for classification is as shown below.

| Blood Pressure Classification | Systolic, mmHg | Diastolic, mmHg |
|--------------------------------|----------------|-----------------|
| Normal | <120 | And <80 |
| Prehypertension | 120-139 | Or 80-89 |
| Stage 1 Hypertension | 140-159 | Or 90-99 |
| Stage 2 Hypertension | >=160 | Or >=100 |
| Isolated Systolic hypertension | >=140 | And <90 |

[4]Table 1: Blood Pressure Classification

B. Mamdani FIS

The FIS type used is Mamdani where the output is taken in the fuzzy form and hence to take the final output a de-fuzzification method is to be used. We have used the centroid method for defuzzification.

Two input Systolic and Diastolic pressures are taken and the four membership functions are used for each input. The membership functions are the curves which enables the mapping of input over the range of 0 to 1 so as to define the membership value of the parameters in the input. The ranges used by both the inputs for membership functions are shown below.

| Membership Function | Systolic, mmHg | Diastolic, mmHg |
|---------------------|----------------|-----------------|
| 1 | 90-120 | 60-80 |
| 2 | 120-139 | 80-89 |
| 3 | 140-159 | 90-99 |
| 4 | 160-200 | 100-200 |

Table 2: Input Membership Function Ranges

The type of membership function (MF) used in our FIS is triangular. We have used triangular MF because of the ease of defining the ranges and correspondingly the ease of defuzzification as centroid method is used.

The corresponding output is Hypertension and we are agin using the triangular MF because of reasons explained above. This time we have used five MF and the corresponding range is derived from the following formula:

$$\text{MAP (mean artial pressure)} = [(2 * \text{diastolic}) + \text{systolic}] / 3$$

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As for the concerned rule base we have used both “OR” and “AND” connectors and the if-then rules are used. The rule base consists of total 21 rules on the basis of the FS deduce the decision of a person’s hypertension level. For instance, If systolic(S) is 90-120 AND diastolic (D) is 60-80 then blood pressure (BP) is normal.

Similarly all the rules are deduced.

C. Simulation and Testing

For the purpose of simulation and testing MATLAB environment.

The FIS is created by

```
a=newfis('BP_Classification');
```

The input is created by using following commands:

```
a.input(1).name='systolic';
```

```
a.input(1).range=[90 200];
```

```
a.input(1).mf(1).name='sys_normal';
```

```
a.input(1).mf(1).type='trimf';
```

```
a.input(1).mf(1).params=[90 105 120];
```

where 1 is the index for the input and the membership function.

The output is created in the same way by replacing “input” for “output”.

The rules are created as follows:

```
a.rule(1).antecedent=[1 1];
```

```
a.rule(1).consequent=[1];
```

```
a.rule(1).weight=1;
```

```
a.rule(1).connection=2;
```

where antecedent takes values of indexes of MF of input one and two respectively and the consequent is for the output index.

Save the FIS by

```
writefis command using .fis extension
```

```
and read by
```

```
readfis command
```

The FIS is evaluated for the results using

```
output= evalfis (input, a)
```

input: it takes the values of all the inputs in the specified range

a: it is the FIS structure considered for evaluation.

We edit the rule base using

```
ruleedit(a)
```

plotmf: used for viewing the plot of MF

ruleview: used for viewing the rule base

plotfis: used for plotting the FIS

gensurf: used to view the surface structure of FIS

surfview: represents input vs output plot

III. RESULTS AND DISCUSSIONS

The simulation and testing provides us with following

results. First we have shown all the plots generated for the FIS and then we discuss the results drawn by *evalfis* command.

Figure 1 shows the basic FIS structure.

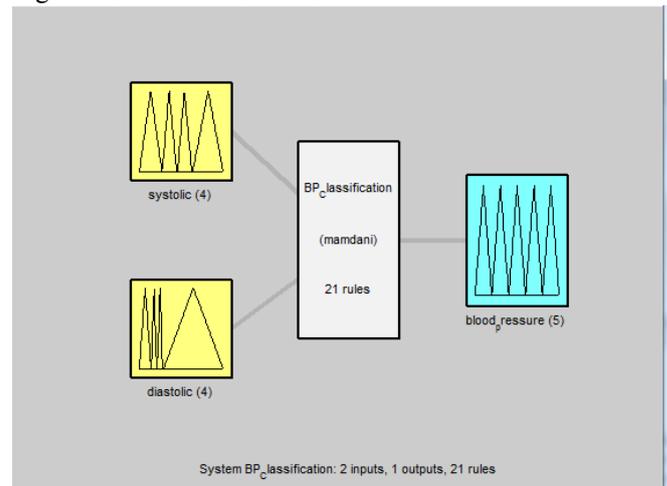


Fig 1: FIS Structure

Figure 2 shows the rule base of FIS

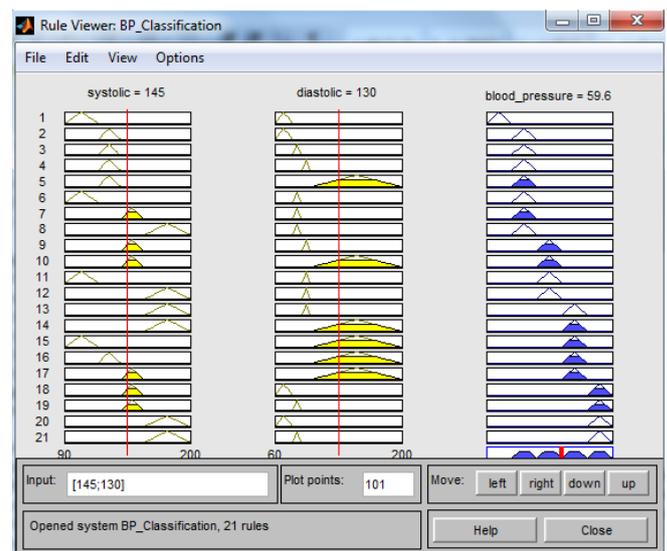


Fig 2: FIS Structure

Figure 3 and 4 shows the FIS surface view

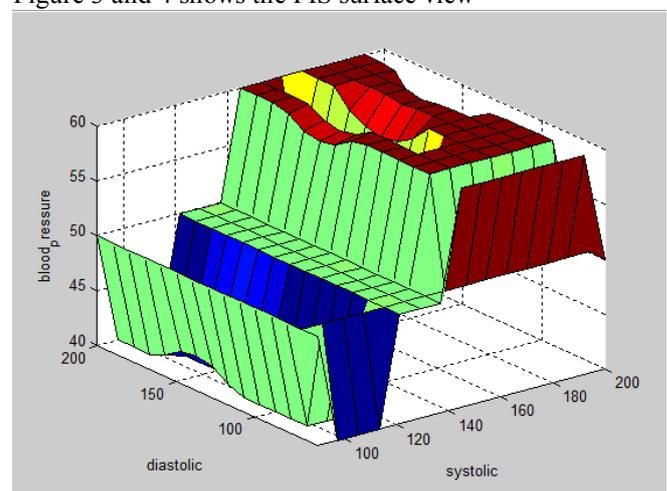


Fig 3: FIS Surface View

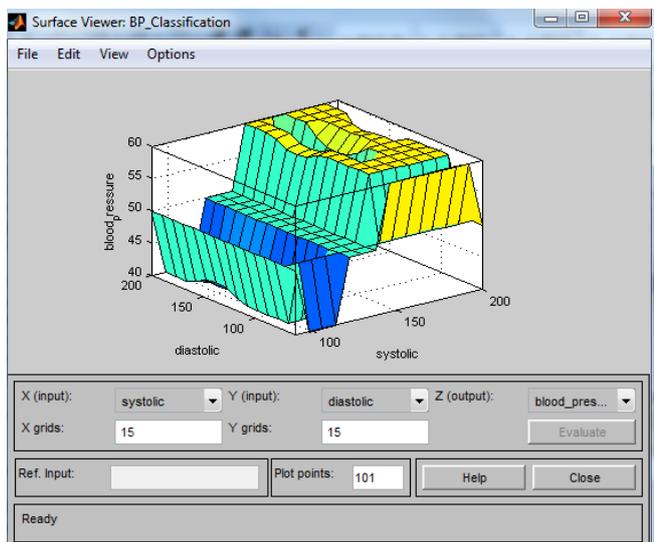


Fig 4: FIS SurfaceView

Figure 5 shows the input one MF plot

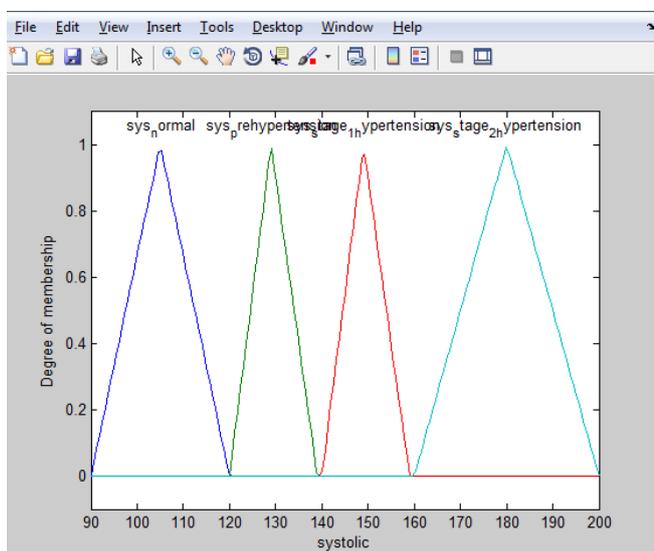


Fig 5: Systolic MF plot

Figure 6 shows the output MF plot.

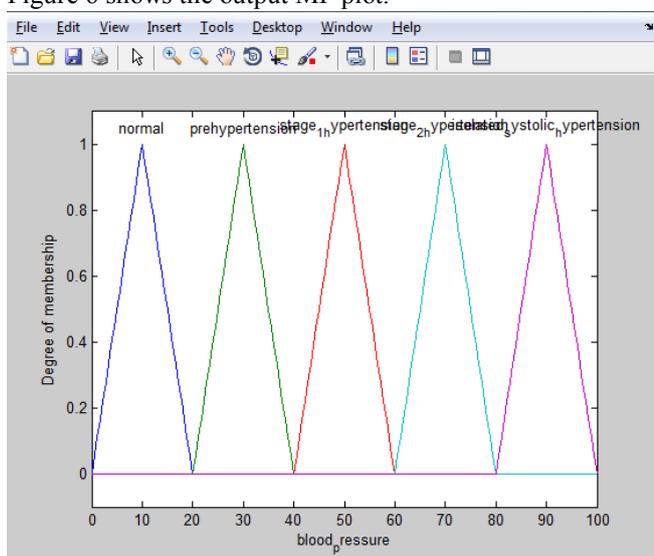


Fig 6: BP MF plot

The *evalfis* used for evaluation shows that the FIS developed gives promising results. We evaluated the FIS for 35 different combination of inputs from which we got correct result from 32 evaluations which gives the efficiency percentage of 91.4. Hence the FIS developed is giving satisfactory results

IV. CONCLUSION

In the paper we have tried to develop a Fuzzy Inference System for the evaluation of Hypertension level according to the systolic and diastolic BP levels. After carrying out the testing we have found that the developed system is giving output with 91.4 percent accuracy. Hence the results validate the developed FIS system for the diagnosis of Hypertension level .

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