Journal of Computer and Mathematical Sciences, *Vol.8(5), 218-224 May 2017* *ISSN 0976-5727 (Print)*
(An International Research Journal), *www.compmath-journal.org* *ISSN 2319-8133 (Online)*

Fuzzy Logic Based Thyroid Diagnosis system

Zhang Liuyang, J. Jayashree and J. Vijayashree

School of Computer Science & Engineering,
VIT University, Vellore-632014, INDIA.

(Received on: May 10, Accepted: May 12, 2017)

ABSTRACT

This study aims at designing and implementing thyroid disease diagnosis system. Thyroid is one of the most important glands in our body which maintains metabolism.Nowadays most of the people suffer from thyroid related problems. This study uses T3, T4 and Thyroid Stimulating Harmone as inputs to the fuzzy expert system. Fuzzy expert systems performs better tha the traditional methods of thyroid diagnosis.

Keywords: Thyroid, hyperthyroidism, hypothyroidism, Thyroid Stimulating Harmone.

1. INTRODUCTION

Thyroid is a small butrefly shaped gland found in front of neck wrapped aroung the windpipe. Thyroid gland is one of the most important glands in our baody because it controls our body metabolism. The two harmones produced by thyroid gland are namely Thyroxine (T4) and Triiodothyronine (T3). These two harmones together is known as thyroid harmone. When the level of thyroid harmone is small pituitary gland produces a harmone called Thyroid Stimulating Harmone (TSH) which then stimulates thyroid gland to produce more harmones. When the level of thyroid harmone is high pituitary gland produces less TSH which in turn releases less thyroid harmone. Thyroid gland and pituitary gland work togather to main the metabolism of our body. When the levels of thyroid stimulating harmone is not balanced properly by the thyroid gland, two types of thyroid related disease occur: Hyperthyroidism and hypothyroidism. Hyperthyroidism also known as overactive thyroid occurs when thyroid gland produces excess amout of thyroid harmones and hypothyroidism also known as underactive thyroid occurs when thyroid gland produces a lesser amount of thyroid harmones.

Symptoms of hyperthyroidism vary from hypothyroidism. Symptoms of hypothyroidism are feeling cold when other people do not, Constipation, Muscle weakness, Weight gain, even though you are not eating more food, joint or muscle pain, feeling very tired, pale, dry skin, dry, thinning hair, slow heart rate, less sweating than usual, a puffy face and more than usual menstrual bleeding. Symptoms of hyperthyroidism are weight loss, eating

more than usual, rapid heartbeat, feeling nervous, irritable, hot, muscle weakness, trembling in your hands and fingers, increased sweating, lighter menstrual periods than normal.

Women are more likely to suffer from thyroid related problems than men. The main issues faced by women due to thyroid are menstrual problems, problems to get prgnent and problems during pregnancy. Usually thyroid diseae is diagnosed by performing blood test for TSH, T3, T4, TSH receptor antibody (TSI) and Antithyroid antibody. In this paper T3, T4 and TSH are given as input to the fuzzy expert system for the diagnosis of thyroid disease.

2. RELATED WORK

Rawte, Vipula, and Bidisha Roy (2015) proposed an ontology based expert system for the diagnosis of thyroid disease. This method predicts the presence of thyroid disease in an efficient way. Rana, Manish, and R. R. Sedamkar (2013) designed and implemented medical diagnosis system for diagnosig three diseases namely heart disease, brain tumour and thyroid disease using fuzzy logic. Radwan, Elsayed, and Adel MA Assiri (2013) used rough sets with modified similarity relation for the diagnosis of thyroid. Omiotek, Zbigniew (2015) applied some of the classification methods for the detection of Hashimoto's thyroiditis using ultrasound images. Chen, Hui-Ling, *et al*., (2012) proposed a three stage expert system for the diagnosis of thyroid disease using support vector machine. Khosravi (2015) used an expert system developed using C# for the diagnosis of thyroid cancer.

3. PROPOSED SYSTEM

The proposed system uses mamdani fuzzy inference system for the diagnosis of thyroid disease. The mamdani fuzzy inference system[7] uses input variables and output variables for generating rules. Fuzzification and defuzzification are done to convert the real crisp values into fuzzy values and vice versa. The proposed thyroid diagnosis system takes three inputs namely T3, T4 and Thyroid stimulating harmone (TSH) and one output as in fig1. This output variable variable contains three values not probable, uncertain and probable. Membership functions for the input variables are given in table1.

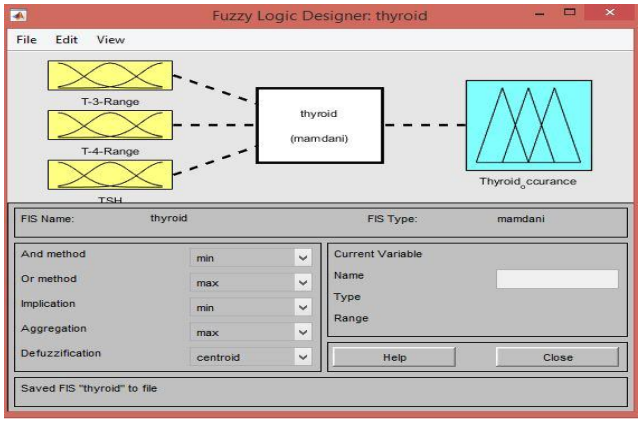

Fig1. Inputs and output of mamdani inference engine

Table 1. Membership Functions of Input variables: T-3,T-4 & TSH.

Membership function	T-3 Range	T-4 Range	TSH
Low	0-1	60-65	0.25-0.9
Medium	1-1.7	63-80	0.8-3
High	1.6-2.5	78-120	2.8-5

3.1 Input Variables

3.1.1 Triiodothyronine (T3)

Triiodothyronine (T3) is a harmone produced by thyroid gland. Increased or decreased level of this harmone causes thyroid disease. T3 input variable has three fuzzy sets namely low, medium and high. Membership function of these fuzzy sets is triangular. Membership functions for the fuzzy sets are given in fig 2 and fuzzification of T3 is done by the below function.

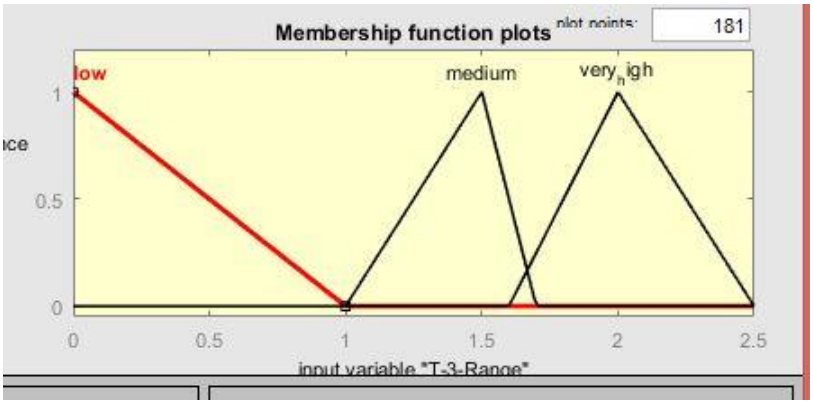

Fig 2. Membership functions of input variable –T-3 range

$$\mu_{low} = \begin{cases} \dfrac{x-0.5}{0.5}, 0 \le x \le 0.5 \\ 1, \quad x = 0.5 \\ \dfrac{1-x}{1-0.5}, 0.5 \le x \le 1 \end{cases} \qquad \mu_{medium} = \begin{cases} \dfrac{x-1}{1.5-1}, 1 \le x \le 1.5 \\ 1, \quad x = 1.5 \\ \dfrac{1.7-x}{1.7-1.5}, 1.5 \le x \le 1.7 \end{cases}$$

$$\mu_{high} = \begin{cases} \dfrac{x-1.6}{2-1.6}, 1.6 < x \le 2 \\ 1, \quad x = 2 \\ \dfrac{2.5-x}{2.5-2}, 2 \le x \le 2.5 \end{cases}$$

3.1.2 Thyroxine (T4)

Thyroxine (T4) is a harmone produced by thyroid gland. Increased or decreased level of this harmone causes thyroid disease. T4 input variable has three fuzzy sets namely low,

medium and high. Membership function of these fuzzy sets is triangular. Membership functions for the fuzzy sets are given in fig 3 and fuzzification of T4 is done by the below function.

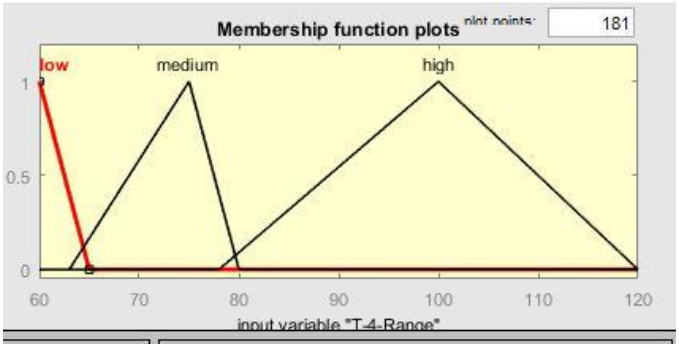

Fig 3. Membership functions of input variable –T-4 range

$$\mu_{low} = \begin{cases} \dfrac{x-60}{63-60}, 60 \le x \le 63 \\ 1, \quad x = 63 \\ \dfrac{65-x}{65-63}, 63 \le x \le 65 \end{cases} \qquad \mu_{medium} = \begin{cases} \dfrac{x-63}{70-63}, 63 \le x \le 70 \\ 1, \quad x = 70 \\ \dfrac{80-x}{80-70}, 70 \le x \le 80 \end{cases}$$

$$\mu_{high} = \begin{cases} \dfrac{x-78}{100-78}, 78 \le x \le 100 \\ 1, \quad x = 100 \\ \dfrac{120-x}{120-100}, 100 \le x \le 120 \end{cases}$$

3.1.3 Thyroid Stimulating Harmone (TSH)

Thyroid Stimulating Harmone (TSH) is a harmone produced by pituitary gland. When the level of thyroid harmone is small pituitary gland produces a harmone called Thyroid Stimulating Harmone (TSH) which then stimulates thyroid gland to produce more harmones. When the level of thyroid harmone is high pituitary gland produces less TSH which in turn releases less thyroid harmone. TSH input variable has three fuzzy sets namely low, medium and high. . Membership function of these fuzzy sets is triangular. Membership functions for the fuzzy sets are given in fig 4.

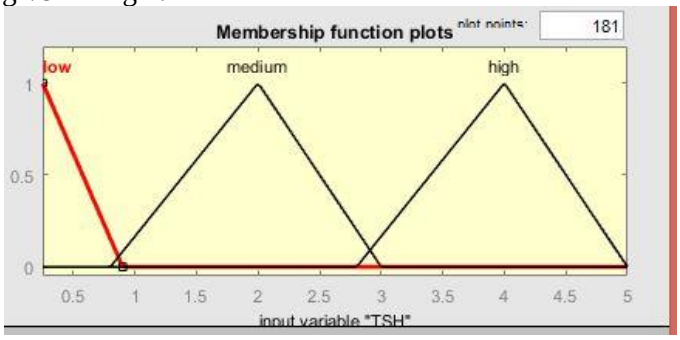

Fig 4. Membership functions of input variable –TSH

3.2 Output Variable

3.2.1 Thyroid Occurrence

The output variable thyroid occurrence has three values namely not probable, uncertain and probable. Membership function of these fuzzy sets is triangular. Membership functions for the fuzzy sets are given in fig 5 and fuzzification of thyroid occurrence is done by the below function.

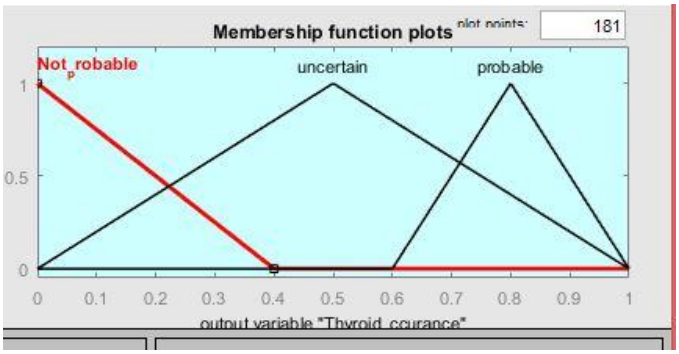

Fig 5. Membership functions of output variable –Thyroid occurrence

$$\mu_{low} = \begin{cases} \dfrac{x-0}{0.2-0}, 0 \le x \le 0.2 \\ 1, \quad x = 0.2 \\ \dfrac{0.4-x}{0.4-0.2}, 0.2 \le x 0.4 \end{cases}$$

$$\mu_{medium} = \begin{cases} \dfrac{x-0.1}{0.5-0.1}, 0.1 \le x \le 0.5 \\ 1, \quad x = 0.5 \\ \dfrac{0.7-x}{0.7-0.5}, 0.5 \le x \le 0.7 \end{cases}$$

$$\mu_{high} = \begin{cases} \dfrac{x-0.6}{0.8-0.6}, 0.6 \le x \le 0.8 \\ 1, \quad x = 0.8 \\ \dfrac{1-x}{1-0.8}, 0.8 \le x \le 1 \end{cases}$$

4. RESULTS AND DISCUSSION

Rules are generated based in the three input variables T3, T4 and TSH and one output variable as

1. If (T-3-Range is low) and (T-4-Range is low) and (TSH is low) then (Thyroid_occurance is Not_probable)
2. If (T-3-Range is low) and (T-4-Range is low) and (TSH is medium) then (Thyroid_occurance is uncertain)

3. If (T-3-Range is low) and (T-4-Range is medium) and (TSH is medium) then (Thyroid_occurance is uncertain)
4. If (T-3-Range is medium) and (T-4-Range is low) and (TSH is low) then (Thyroid_occurance is Not_probable)
5. If (T-3-Range is medium) and (T-4-Range is medium) and (TSH is medium) then (Thyroid_occurance is uncertain)

The rules are generated using rule editor as in fig 6 and fig 7 shows the rule viewer and surface viewer in fig 8. And operator is used here for generating rules.

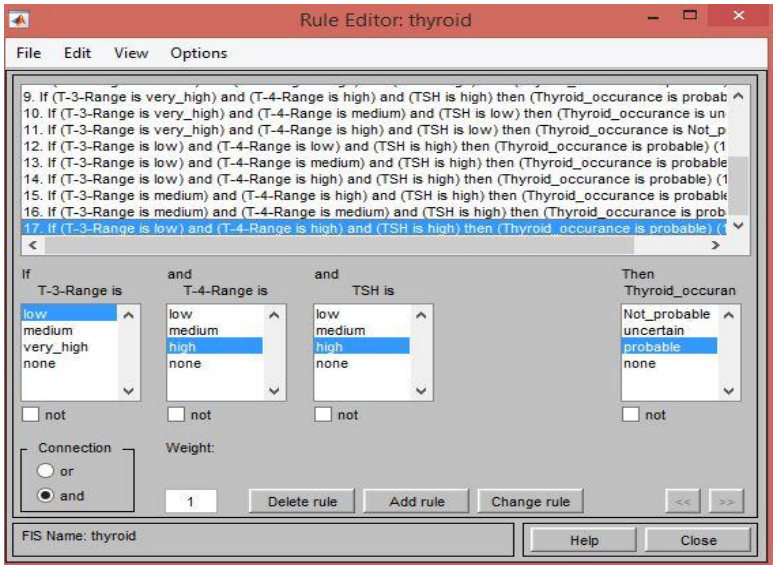

Fig 6. Rule editor

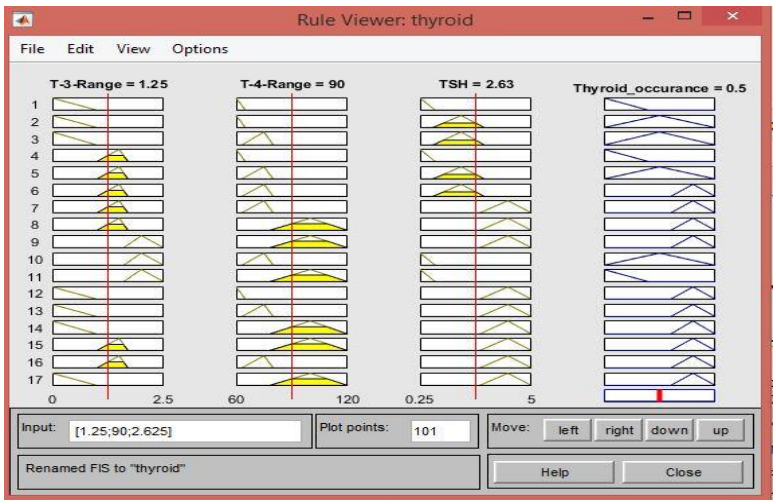

Fig 7. Rule viewer

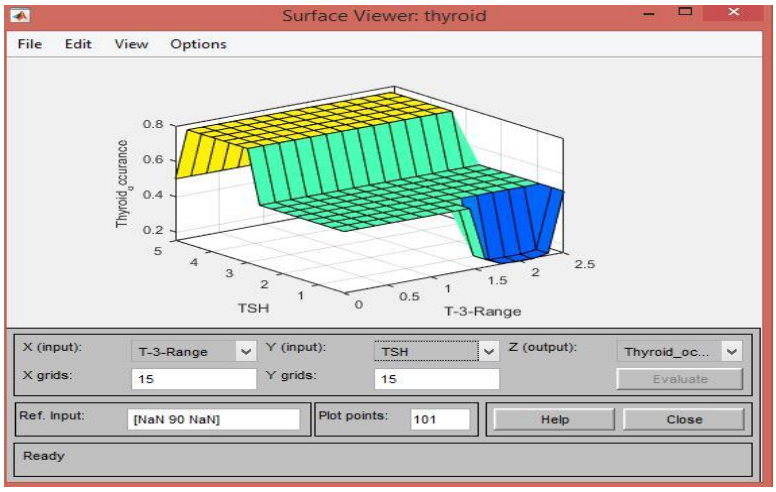

Fig 8. Surface viewer

5. CONCLUSION

Thyroid diagnosis system designed and implemented using fuzzy logic performs in an efficient manner for the diagnosis of disease given T3, T4 and TSH as inputs.

REFERENCES

1. Rawte, Vipula, and Bidisha Roy. "Thyroid Disease Diagnosis using Ontology based Expert System." *International Journal of Engineering Research and Technology*. Vol. 4. No. 06, June-2015. IJERT, (2015).
2. Rana, Manish, and R. R. Sedamkar. "Design of Expert System for Medical Diagnosis Using Fuzzy Logic." *International Journal of Scientific & Engineering Research* 4.6, 2914-2921 (2013).
3. Radwan, Elsayed, and Adel MA Assiri. "Thyroid diagnosis based technique on rough sets with modified similarity relation." *Thyroid* 4.10 (2013).
4. Omiotek, Zbigniew, Andrzej Burda, and Waldemar Wójcik. "Application of selected classification methods for detection of Hashimoto's thyroiditis on the basis of ultrasound images." *Computational Intelligence, Medicine and Biology*. Springer International Publishing, 23-37 (2015).
5. Chen, Hui-Ling, *et al*., "A three-stage expert system based on support vector machines for thyroid disease diagnosis." *Journal of medical systems* 36.3, 1953-1963 (2012).
6. Khosravi, Mehdi, Mohammad Yazdanshenas, and Mohammad Hossein Nemati. "Design of an expert system for diagnosis of thyroid cancer." *Cumhuriyet Science Journal* 36.3, 1420-1424 (2015).
7. Zadeh L.A., "Fuzzy Sets and System", *In Fox J Editor, System Theory, Brooklyn, NY, Polytechnic Press*, 29-39 (1965).