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Design an Intelligent System for Thyroid Diseases Diagnosis

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Abstract: Thyroid Gland is a part of the endocrine system, it produces hormones that regulate key body functions and metabolic processes. Increased or decreased thyroid hormone results indicate that there is an imbalance between the body's requirements and supply. About 306 patient's data for training and 116 for testing are collected from Al-Jamhoree Hospital under the supervision of doctor to diagnosis the thyroid gland patients. Combining the Fuzzy Logic approach with ANN concept this study was conducted. In this paper there are two purpose; first; investigation the applicability and capability of the three proposed algorithms Fuzzy Radial Base Function neural networks: FuzRBF-1,2,3 for detect and diagnosis thyroid disease. The fuzzy logic is used to design fuzzy expert system Fuzzy Thyroid Gland FIS that deals with uncertain risk factors; this is the first step of these algorithms. In the second step , three methods of RBF neural network (RBF-1,2,3) are applied to deal with others factors (sign and symptoms of the thyroid disease) as well as the output of Fuzzy Thyroid Gland FIS after been normalized. Experimental results show that the overall performance of FuzRBF-1 algorithm is better than those of the others which gives DR=100% for training and testing thyroid data set with 0.0468 and 0.0156 second execution time respectively. The second purpose of this study: an intelligent system The Thyroid's Patients Diagnosis System for the automatic diagnosis of the thyroid gland disease has been designed that outperform the traditional systems. The FuzRBF-1 algorithm has been applied in this system as well as thyroid database has been established that include the detailed information about patients and providing the report of each patient which is implemented using GUI in MATLAB 7.10.0 (R2010a) language. The diagnosis performance of The Thyroid's Patients Diagnosis System shows the advantage of this intelligent system: it is rapid, easy to operate, noninvasive and not expensive. It also helps for training beginner's doctors and medical students who work in the tedious and complicated task of diagnosing thyroid diseases.

Keywords: Artificial Intelligence, Radial Basis Function, Fuzzy Logic, Thyroid Gland diseases diagnosis, Detection Rate (DR), GUI in MATLAB.

I. INTRODUCTION

Thyroid Gland is a part of the endocrine system, it produces hormones that regulate key body functions and metabolic processes. Increased or decreased thyroid hormone results indicate that there is an imbalance between the body's requirements and supply. The thyroid disease is common among women[8][18]. Significant life saving can be achieved if an accurate diagnosis decision can be promptly made to patients suffering increase or decrease thyroid hormone, after which an appropriate treatment can immediately follow. Unfortunately, accurate diagnosis of thyroid diseases has never been an easy task. As a matter of fact, many factors can complicate the diagnosis of thyroid gland disease, often causing the delay of a correct diagnosis decision. For instance, the clinic tests, signs and symptoms of thyroid gland disease are associated with many human organs other than the thyroid gland, and very often thyroid diseases may exhibit various syndromes. At the same time, different types of thyroid diseases may have similar symptoms.To reduce the diagnosis time and improve the diagnosis accuracy, it has become more of a demanding issue to develop reliable and powerful intelligent diagnosis system to support the yet and still increasingly complicated diagnosis decision process. The medical diagnosis by nature is a complex and fuzzy cognitive process, hence soft computing methods, such as fuzzy logic and neural networks have shown great potential to be applied in the development of diagnosis of thyroid diseases.

Kurban and Beşdok [9] used several algorithms for training radial basis function (RBF) neural networks. The training performance of the Artificial Bee Colony (ABC) algorithm is better than Genetic algorithm (GA), Kalman filtering (KF) algorithm and gradient descent (GD) algorithm for well known classification problems such as Iris, Glass, and Wine and also for experimental inertial sensor based terrain classification. The test results of this algorithm (ABC) are 96.2%, 96.9%, 92.1%, 79.6% of 8 neurons in the hidden layer for these datasets respectively. Hannan [5] has predicted the heart disease by using a redial basis function neural network. About 300 patients data was collected from the hospital, and then the RBF was applied to heart disease data for prediction of medical prescription of heart diseases. Djam and Kimbi [2] used fuzzy logic approach to design (MEDDIAG) system that can assist medical experts in the tedious and complicated task of diagnosing hypertension. Diagnostic data from 30 patients with confirmed diagnosis of hypertension were evaluated and the computed results were in the range of the predefine limits by the domain experts. Fuzzy diagnosis had 85% exact diagnosis. Faran el al. [3] used fuzzy logic for the medical diagnosis of hemorrhage and brain tumor and develop a control system to enhance the efficiency of diagnosis of disease related to brain. Raich and Kulkarni [13] used multilayer perceptron with back propagation learning algorithm for the medical diagnosis of diseases and a brief description about Nephritis and how its diagnosis could be done. The accuracy is in training data set was found to be 82.051% and in validation data set was found to be 83.33%. Sethukkarasi and Kannan[16] proposed an efficient approach to produce significant rule patterns from the heart disease dataset that is used for the purpose of diagnosis.

Diagnosing the thyroid gland disease based on tests , signs and symptoms is a very challenging task. In domain of thyroid disease risk, there are two types of factors: 1. main (uncertain) risk factors that affect on thyroid gland disease risk. 2. signs and symptoms. Because of these uncertain risk factors in the thyroid gland disease risks, sometimes thyroid gland 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 these factors to diagnose the thyroid gland 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. To handle the vagueness the fuzzy logic is used to design fuzzy expert system Fuzzy Thyroid Gland FIS that deals with uncertain risk factors, this is the first step of the three proposed algorithms Fuzzy Radial Base Function neural networks : FuzRBF-1,2,3. In the second step , three methods of RBF neural network are applied to deal with others factors (sign and symptoms of the thyroid disease) as well as the output of Fuzzy Thyroid Gland FIS after been normalized.

The objective of this study is to investigate the applicability and capability of these three proposed Fuzzy Radial Base Function neural networks: FuzRBF-1,2,3 for diagnosis thyroid disease. Then apply the best one of them in an intelligent system proposed Thyroid Gland Patients Diagnosis System for diagnosis thyroid disease. Using this intelligent system can assist medical experts in the tedious and complicated task of diagnosing thyroid gland diseases and provide a scheme that will assist medical personnel especially in rural areas, where there are shortage of doctors, in the process of offering primary health care to the patients. The paper is organized as following, in Section II , a brief background of neural networks and in section III, problem statement. Section IV, the proposed methodology and preparing data to implement three proposed algorithms Fuzzy Radial Base Function neural networks : FuzRBF-1, FuzRBF-2 and FuzRBF-3. Section V, Experimental Results & Discussion. Finally, Conclusion and Future work in Section VI.

II. A BRIEF BACKGROUND OF NEURAL NETWORKS

Artificial neural networks (ANN) have emerged as a result of simulation of biological nervous system, such as the brain, on a computer. On the other hand, biological neural networks are much more complicated than the mathematical models used for ANNs. ANN was founded by McCulloch and co-workers beginning in the early 1940s. They built simple neural networks to model simple logic functions. Since it is customary to drop the ''A'' or the ''artificial'', NN and ANN will be used interchangeably throughout the rest of the paper to refer to an artificial neural network. Nowadays, neural networks can be applied to problems that do not have algorithmic solutions or problems for which algorithmic solutions are too complex to be found. In other words, it is not easy to formulate a mathematical model that does not have a clear relationship between inputs and outputs for some systems. To overcome this problem, ANN uses the samples to obtain the models of such systems. Their ability to learn by example makes neural networks (NN) very flexible and powerful. Therefore, neural networks have been intensively used for solving classification problems in many fields. In short, neural networks are nonlinear processes that perform learning and classification. Recently neural networks have been used in many areas that require computational techniques such as pattern recognition, optical character recognition, outcome prediction and problem classification [4].

III. PROBLEM STATEMENT

A disease is usually characterized by directly observable symptoms that prompt the patient to visit a physician. A series of clinical observations are undertaken to detect the presence of a disease. The signs and symptoms of the disease are usually expressed by the deviation of the observations from their normal state or value. The correct classification of the tests , signs and symptoms will lead to diagnosis of the disease that enables the doctor to plan further treatment. The diagnosis of disease is a vital and intricate job in medicine. Clinical decisions are often based on physician's perception and experience rather than on knowledge and patterns that are hidden among the vast amounts of data in the database. Hence, medical field requires a reliable decision making system that can assist the doctors in making the right diagnosis.

The purpose of this work is to reduce the diagnosis time and improve the diagnosis accuracy by investigating the applicability and capability of the three proposed algorithms: FuzRBF-1,2,3 based combining the Fuzzy Logic approach with ANN concept for diagnosis thyroid disease. The main objective of this work is to design an intelligent system that can diagnosis the thyroid glands' patients with minimum execution time and high performance. This system is designed to assist the health care practitioners to answer queries that relate to thyroid gland disease thereby enabling them to make intelligent clinical decisions. In addition to this, a thyroid gland database has been established providing with a report of patient which is implemented using GUI in MATLAB.

IV. METHODOLOGY

IV.I Proposed methodology to implement three proposed Algorithms Fuzzy Radial Base Function neural Networks: FUZRBF-1, FuzRBF-2 and FuzRBF-3

In this section of paper we present the proposed methodology to implement three proposed algorithms Fuzzy Radial Base Function neural networks: FuzRBF-1, FuzRBF-2 and FuzRBF-3 as shown in Fig. 1. The proposed methodology consists of three major components namely the Fuzzy Thyroid Gland FIS subsystem, train and test three methods of the RBF neural networks (RBF-method1,2,3) subsystems. The following subsections provide the details of every subsystem design process.

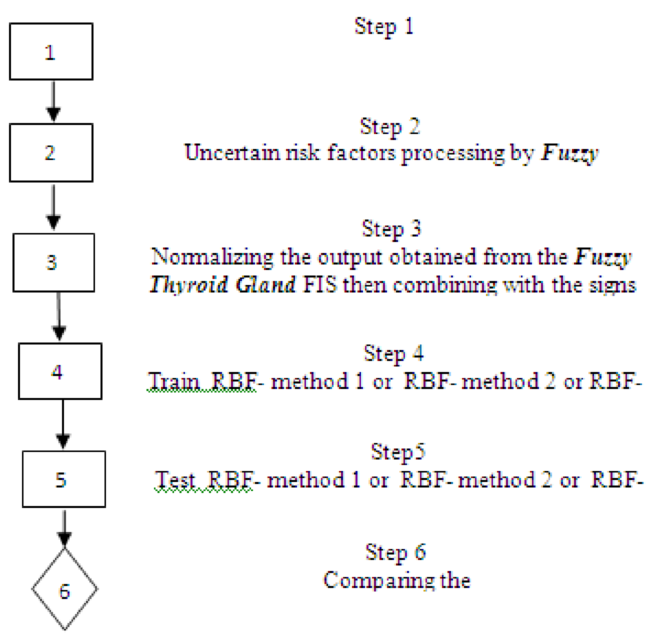


Fig. 1 General flowchart of the proposed methodology.

IV. II DATA SET

The data set is collected from Al-Jamhoree Teaching Hospital under the supervision of doctor. The purpose of this dataset is to diagnose the five states of thyroid gland disease given the results of various clinical tests, signs and symptoms carried out on a patient. These five state are : Normal, Hyperthyroidism , T3-thyotoxicosis, Primary Hypothyroidism and Secondary Hypothyroidism. The thyroid dataset used for this work presented contains 306 patient for training and 116 for testing with 44 attributes.
First three attributes are :
The Thyroid-Stimulating Hormone (TSH) , Triiodothyronine (T3) and Thyroxin (T4) examinations.

The others attributes are signs and symptoms of this disease. At first, you might not notice symptoms of hyperthyroidism or hypothyroidism .They usually begin slowly. But over time, a speeded up metabolism can cause symptoms. These signs and symptoms are shown in Table I.[7][12][18]:

TABLE I: SIGNS AND SYMPTOMS OF THYROID DISEASE.

Signs and Symptoms of Hyperthyroidism	Signs and Symptoms of Hypothyroidism
Weight loss despite increased appetite	Weight gain despite poor appetite
Increased sensitivity to heat	Feeling cold more than others and the inability to withstand cold weather
Pain, fatigue and muscle weakness	Pain, fatigue and muscle weakness
Osteoporosis fractures occur	Feeling depressed
Vomiting and diarrhea	Constipation
Irregular heartbeat and tachycardia	Slowing the heart rate
Shortness of breath	Reduced respiratory rate
Tremors in the hands and fingers	Anemia
High blood pressure	High cholesterol
Menstrual disorder or interruption in women, and may lead to impotence in men	An increase in the menstrual in women
Fine hair	Coarse hair
Bulging eyes and with the advent of visual problems	Hoarseness with difficulty in speech
Nervousness and Anxiety	Difficulty in hearing
Increased sweating	Slow in thinking and frequent forgetfulness
Goitre	Goitre
Thyroid Antibodies	Thyroid Antibodies
Pigment increase in the palm of the hands and feet	Paresthesia
Weakness and difficulty of reproduction	Imbalance
Bouts of panic and headache	Dry or coarse skin
Chest pains	Chest pains
More frequent bowel movements	
Namwalazafar very quickly	
Weak libido	
Trouble sleeping	
Abdominal pain	

TABLE I FONT SIZES FOR PAPERS

IV.III Processing Uncertain Factors Using Fuzzy Logic

The most important application of fuzzy system (fuzzy logic) is in uncertain issues. When a problem has dynamic behaviour , fuzzy logic is a suitable tool that deals with this problem[2][15]. First step of the three proposed algorithms Fuzzy Radial Base neural networks FuzRBF-1,2,3 is processing uncertain risk factors using fuzzy logic. These factors are the examinations and laboratory data where inserted into the designed system (Fuzzy Thyroid Gland FES): TSH , T3 and T4 examinations are used for diagnosis : Normal , Hyperthyroidism (Hyper) , T3-thyotoxicosis , Primary Hypothyroidism (Hypo-prim) and Secondary Hypothyroidism (Hypo-sec). The units of the used factors are: uIU/ml for TSH and nmol/l for T3 and T4.The fuzzy control application structure as shown in Fig. 2 has three crisp input variables , these input parameters represent the patients data. The mamdani model of inference was used. The max-min operators were used for implication throughout for implementing (Fuzzy Thyroid Gland FES). It was necessary to obtain crisp output for the purposes of evaluation of the fuzzy model , center-of- gravity (centroid) defuzzification was used to produce crisp values on an arbitrary scale of the fuzzy output variable (OutFES) .

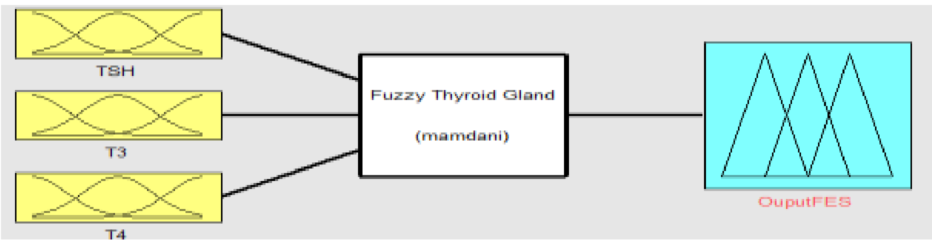


FIG. 2 : THE STRUCTURE OF THE FUZZY EXPERT SYSTEM (FUZZY THYROID GLAND FIS).

Each of the three input parameters was assigned a linguistic variable and examination of the data and rules showed that each could naturally be divided into two or three fuzzy terms corresponding to meanings of Low (L), Normal (N), and High (H) for the types laboratory examinations. One output fuzzy variable was used , from the rules it was determined that the output fuzzy variable (OutFES) has five linguistic terms: (Normal , Hyper , T3-thyotoxicosis , Hypo-prim and Hyper-sec), these terms represent the general thyroid gland diseases. Fuzzy membership functions for the medical factors for the mentioned laboratory parameters are calculated by the following functions as shown in Fig. (3) and (4) .

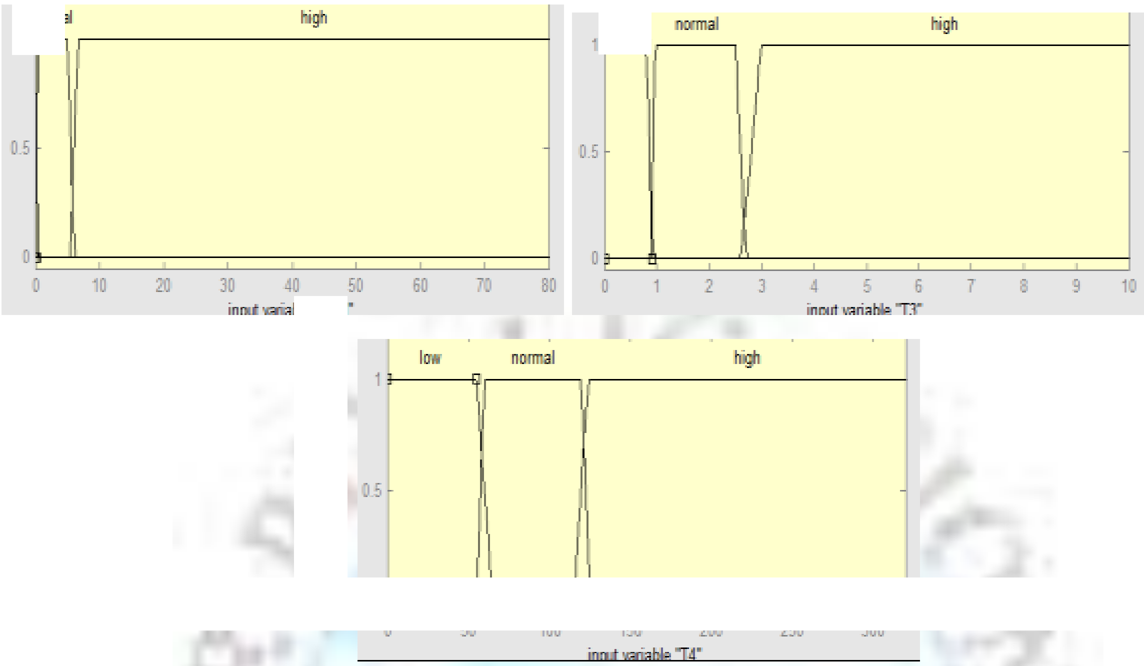
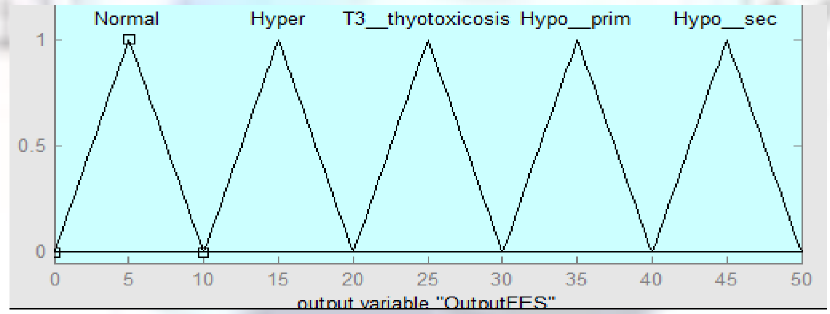


Fig. 3: The membership functions of input terms for Fuzzy Thyroid Gland FIS



Normal (0,10) ; Hyper (10,20) ; T3_thyotoxicosis (20,30) ; Hypo_prim (30,40) ; Hypo_sec (40,50)

Fig. 4: The membership functions of output term (OutputFES) for Fuzzy Thyroid Gland FIS

The Rule base is the main part in fuzzy inference system and quality of results in a fuzzy system depends on the fuzzy rules [14]. The Fuzzy Thyroid Gland FIS includes 7 rules that can deal with fuzzy tags, fuzzy sets and relations and must provide an appropriate output which corresponds to a particular input. These rules were obtained by means of knowledge expert-doctor and had been carefully refined to form a complete and consistent set of classifiers. The following Table II shows fuzzy knowledge base rules.

Table II : Fuzzy Thyroid Gland FIS rules.

Rule No.	TSH	T3	T4	OutputFES
1	N	N	N	Normal
2	L	H	H	Hyper
3	L	H	N	T3_thyotoxicosis
4	H	L	L	Hypo_prim
5	H	N	L	Hypo_prim
6	L	N	L	Hypo_sec
7	N	N	L	Hypo_sec

IV.IV DATASET Training Using Radial Basis Function Neural Network

The most common classifier technique is ANN, the reason for being common is that it uses learning from examples and exhibits some generalized capability beyond the training dataset [8]. The dataset training is performed by the Radial Basis Function Neural Network (RBFNN) which is a popular type of network that is very useful for pattern classification. Generally, a RBFNN is a three layer feed forward network that consists of: one input layer, one RBF layer (hidden layer) and one output layer as shown in Fig.5 [1][11][13]. Each input data X with N dimensions $X=[x_{1,} x_{2, \dots,} x_N]$ are located in the input layer, which broadcast to hidden layer. The hidden layer has K neurons and one bias neuron. Each node in the hidden layer uses the radial basis function denoted with φ(.) , as its non-linear activation function. A radial basis function is a multidimensional function that describes the distance between a given input vector and a pre-defined center vector. There are different types of radial basis function; a normalized Gaussian function usually used. That is, the radial basis function $\varphi_i(X)$ of the i^{th} hidden node for an input vector X is given by [6][[9][16]:

$$\varphi_i(X) = \exp\left(-\frac{\|X-\mu_i\|^2}{2\sigma_i^2}\right) \quad \text{for } i = 1,2,\dots,K \quad \dots(1)$$

Where μ_i and σ_i denote the center and spread width of the i^{th} hidden node respectively. The biases of the output layer neurons can be modeled by an additional neuron in the hidden layer, which has a constant activation function ($\varphi_0(x)=1$). The output layer yields a vector $y = [y_{1,}\ y_{2, \dots,}\ y_m]$ for m outputs by linear combination of the outputs of the hidden nodes to produce the final output. Thus, for an input pattern X, the output $y_j(X)$ of the j^{th} node of the output layer can define as; [6][9][16]:

$$y_j(X) = f_j(X) = \sum_{i=1}^{K} w_{ij}\, \varphi_i(X) \quad \text{for } j = 1,2,\dots,M \quad \dots(2)$$

Where w_{ij} is the connection weight from the i^{th} hidden unit to the j^{th} output unit.

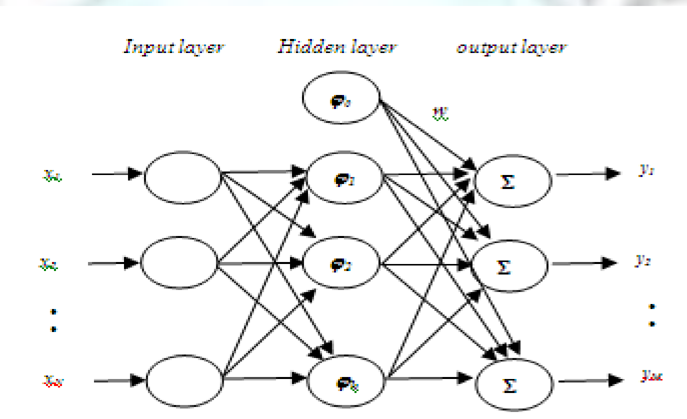


Fig. 5: The structure of a RBFNN

The network is trained by learning the output with that of the desired output. By normalizing the values of the input parameters the errors are reduced. In this work gives brief descriptions of three training techniques of RBF networks namely RBF method1, 2, 3.

A. RBF method 1

In [19] Haykin states that the reduction of the complexity of the network is necessary to overcome the computational difficulties, which demands an approximation to the regularized solution. Assume the element of the matrix G is the outputs of the hidden units corresponding the whole input patterns. These elements are calculated by equation (1). The problem represented here is over determined in the sense that there are more data points than free parameters. That is why the G matrix is not square. Therefore, matrix G does not have a unique inverse. The pseudoinverse (minimum-norm) solution to the over determined least-square data fitting problem can be employed to defeat this difficulty for obtaining the finally weights matrices w in the following form:

$$w = G^{+}d \quad \dots(3)$$

Where d is the desired output and G^+ is the pseudoinverse of the matrix G; that is:

$$G^{+} = (G^{T}G)^{-1}G^{T} \quad \dots(4)$$

Where (G^TG) is a square matrix with a unique inverse of its own.

An algorithm for the RBF method 1

Step 1: Read the data file to get the feature vectors and their target vector, set the centres of RBF's as the exemplar vectors.

Step 2. Find average distance between the feature vectors and centres , and then set the final centres.

Step 3. Compute φ_i and w , and then compute y_j by equations (1,3,2) respectively.

B. RBF method 2

The network is trained by learning the actual output with that of the desired output. In practice, the training RBFN is to find the adequate parameters weight and σ such that the error metrics such as the mean square error (MSE) is minimum. The MSE can defined as follows [9]:

$$\mathrm{MSE} = \frac{1}{M}\sum_{j=1}^{M}\left(d_j - y_j\right)^2 \quad \ldots (5)$$

Where M is the number of the training samples, d_j and y_j denoted to the desired output vector and actual output vector for training sample. Then update the weights between the hidden layer and the output layer as follows:

$$\mathrm{new\_w} = \mathrm{old\_w} + \left(\left(d_j - y_j\right)^2 * \eta * \varphi\right) \ldots (6)$$

Where η is the coefficient of learning rate.

An algorithm for the RBF method 2:

Step 1: Read the data file to get the feature vectors and their target vector, input η, tolerance and the number of iterations I, set i = 0, set the centres of RBF's as the exemplar vectors.

Step 2. Find average distance between the feature vectors and centres, and then set the final centres. Set the initial weights randomly between [-0.5,0.5].

Step 3. Compute φ_i and y_j, and then compute MSE by equations (1,2,5) respectively.

Step 4. Update the weights by equations (6).

Step 5. Compute φ_i and y_j, and then compute the new value for MSE by equations (1,2,5) respectively.

Step 6. If new MSE is less than old MSE then increase η else decrease it.

Step 7. If new MSE ≤ tolerance or i=I then stop else Increment iteration i then go to Step 4.

C. RBF method 3

This method similar to method 2 except with generated initial centers randomly between [-0.5, 0.5] instead of using the exemplar vectors. All these methods are employing the sigmoid function for generating the output signal from the processing elements of all the hidden layers and output layer after the Gaussian form of radial basis function is used for the hidden layer elements.

V. Experimental Results & Discussions

As we have mentioned that the problem domain has been divided in two phases. In the first phase introduces a comparison of the three proposed algorithms Fuzzy Radial Base Function neural networks : FuzRBF-1, FuzRBF-2 and FuzRBF-3 for the thyroid disease detection and diagnosis. In the second phase an intelligent system has been designed (The Thyroid's Patients Diagnosis System) for diagnosis the thyroid disease. The parameters used in both the problem domains are described in Table III.

Table III: Parameters used for RBFNN

Parameter	Value
Learning Rate (η)	2.5
Spread parameter (σ)	0.2427
Maximum iteration (Epoch)	50 for detection 1000 for diagnosis
Tolerance	0.0000001

a). Results for First phase of problem domain

This section presents the performance of three proposed algorithms: FuzRBF-1,2,3 to detect existing thyroid disease or not as well as classifying them. These algorithms have been evaluated by calculating the Detection Rate (DR) as follows[10]:

$$\mathrm{DR} = (\text{number of corrected classified samples} * 100)/\text{total number of samples} \ldots (7)$$

We have demonstrated that a large clinical dataset can be successfully employed to assist the medical practitioners in diagnosis of the thyroid disease. The dataset used for this work presented contains 306 patient for training and 116 for testing. The use of Fuzzy Logic in the first stage in these algorithms adds on to increase efficiency of the final diagnosis. By normalizing the output obtained from the Fuzzy Thyroid Gland FIS then combining with the signs and symptoms of this disease the errors are reduced of these algorithms. Also this expert system indirectly reduces the count of uncertain risk tests that a patient should undergo for the diagnosis purposes. Thus, in the second stage of these algorithms, 42 input units for the three methods RBF-1,2,3 have been used (instead of 44) with one hidden layers of five numbers of neurons and two numbers of neurons in output layer in the case of thyroid disease detection while five neurons in output layer in the case of diagnosis of this disease. The comparative results are presented in Table IV and V for training and testing these three algorithms (FuzRBF-1,2,3) to detect and diagnosis thyroid disease respectively.

Table IV DR of FuzRBF-1,2,3 algorithms to detect thyroid disease .

DR	FuzRBF-1		FuzRBF-2		FuzRBF-3	
	Train	Test	Train	Test	Train	Test
normal	100%	100%	100%	100%	85%	83.3333%
abnormal	100%	100%	100%	100%	99.3007%	98.8701%
DR_all	100%	100%	100%	100%	98.3660%	97.4359%
Execution time	0.0468	0.0312	0.9984	0.0468	1.0764	0.0156

Table V DR of FuzRBF-1,2,3 algorithms to diagnosis thyroid disease.

classes	FuzRBF-1		FuzRBF-2		FuzRBF-3	
	Train	Test	Train	Test	Train	Test
normal	100%	100%	100%	100%	95%	0%
Hyper	100%	100%	100%	100%	98.9583%	73.5294%
T3-thyotoxicosis	100%	100%	100%	100%	97.6190%	23.0769%
Hypo_prim	100%	100%	100%	100%	99.0099%	64%
Hypo_sec	100%	100%	100%	100%	97.8723%	90.9091%
DR_all	100%	100%	100%	100%	98.3660 %	60.5128%
Execution time	0.0468	0.0156	12.0745	0.0312	14.2429	0.0624

b). System Implementation Phase

In the second phase an intelligent system has been designed (The Thyroid's Patients Diagnosis System) for diagnosis the thyroid disease as well as thyroid gland database has been established that include the detailed information about patients and providing the report about the patient which is implemented using GUI in MATLAB. Fig. 6 shows the flowchart of the proposed system.

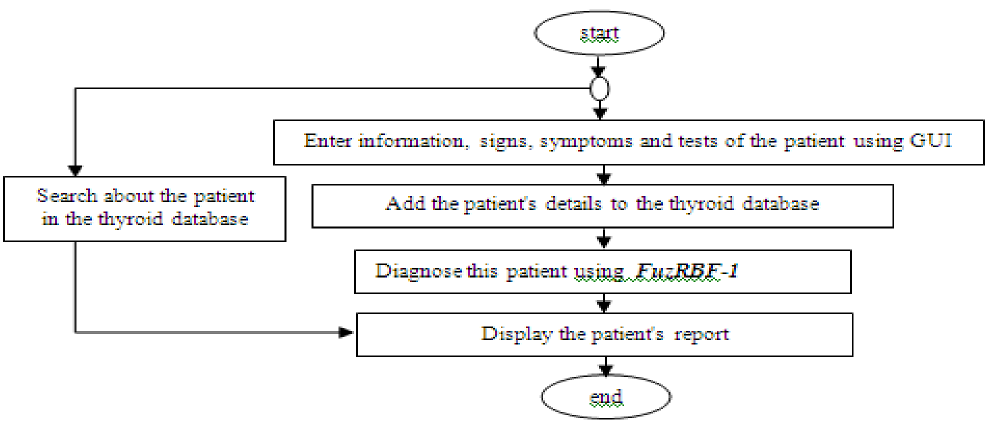


Fig. 6 Flowchart of the proposed an intelligent system

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While implementing in GUI first we create a Main GUI (gui_patient_thyroid) as shown in Fig. 7 , which consists of three push buttons : Add New Patient, Search about the Patient and Exit. When we click on the first two buttons then corresponding GUI will be called from (gui_patient_thyroid) but Exit push button will be directly exit from this GUI.

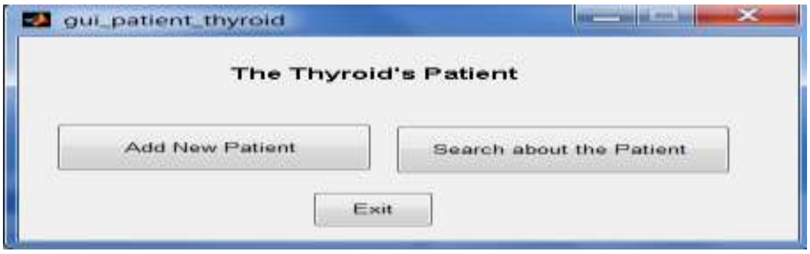

Fig. 7: GUI for Main Page (gui_patient_thyroid) to add new patient and search about the patient.

When we click on the Add New Patient push button in the main page GUI then immediately (gui_patient_inf) will be called as shown in Fig. 8. In this (gui_patient_inf) GUI we have three main push buttons one for Add The Patient's Information to store the information about the patient that we entered like Patient's name, Gender , Age , Married , Children number, Weight , Profession , Residetional Address and Revision date in the patient_information table in thyroid_database using Microsoft Access 2007 as shown in the Fig. 9. The second push button is Delete The Patient's Information to delete the text fields. Clicking on the Tests ,signs and Symptoms push button then corresponding (gui_patient_sign) will be called from this (gui_patient_inf) as shown in the Fig. 10. Along with the above said push buttons we have two additional buttons Back to return to the previous GUI (gui_patient_thyroid) and Exit buttons.

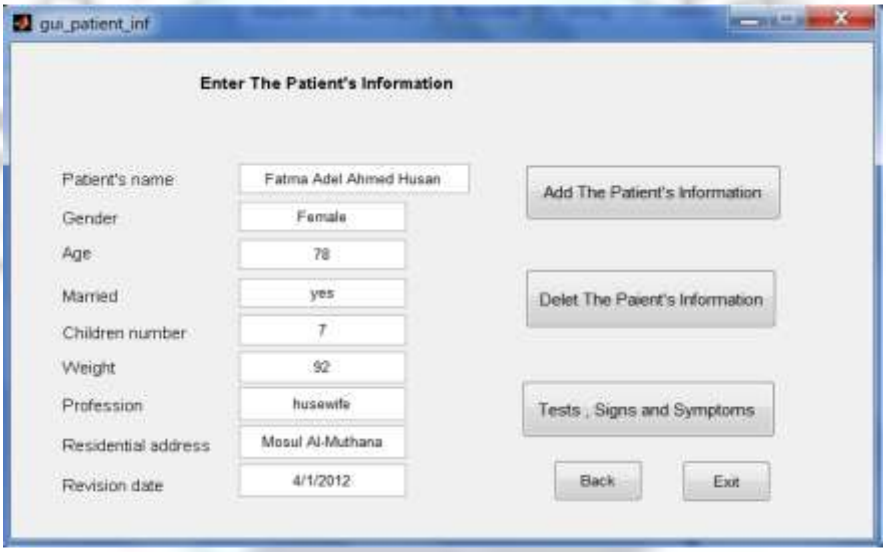

Fig. 8: GUI for gui_patient_inf to add and delete the patient's information and calling gui_patient_sign GUI by clicking on tests, signs and symptoms push button

patient_information

Patient_ID	Patient_name	Age	Gender	Married	Children_no	Weight	Profession	Residential_address	Revision_date
1	Ahmed Ali Husan Jasm	60	male	yes	5	80	worker	Mosul Al-Zhoor	05/09/2011
2	Fatma Salem Ali Amar	45	female	yes	4	76	techer	Mosul Al-Baladyat	11/07/2011
3	Salema Hamad Amar Ali	56	female	yes	5	69	engineer	Mosul Al-Baladyat	02/08/2011
4	Muna Amar Salh Waleed	60	female	no	0	65	techer	Mosul Al-Arabe	14/08/2011
5	Majeda Maher salem Saeed	51	female	yes	3	77	techer	Mosul Al-Njar	10/01/2011
6	Manar Maher Ahmad Kamel	57	female	yes	6	81	housewife	Mosul Al-Arabe	15/09/2011
7	Sara Reyad Jamal Muhsn	49	female	yes	3	91	housewife	Mosul Sumer	08/07/2010
8	Samera Zayd Mahmood Ibrahem	76	female	no	0	69	teacher	Mosul Al-Darkzlya	05/01/2010
9	Karema Belal Hmza Ali	75	female	yes	7	98	worker	Talaefar	20/02/2010
10	Maha Maher Ahmad Kamel	61	female	yes	4	82	housewife	Mosul Al-Yarmok	30/09/2011
11	Adel Jasm Mahmmod Husan	78	male	no	0	86	Doctor	Mosul Al-Muthana	13/03/2012
12	Fatma Adel Ahmed Husan	78	female	yes	7	92	housewife	Mosul Al-Muthana	01/04/2012

Fig. 9: Store the patient's information in the patient information table.

In Fig.(10) we have two main push buttons one for Add Tests,signs and symptoms to store such as TSH,T3,T4,Test date and the others signs and symptoms that we entered in the patient_signs_symptoms table as shown in the Fig. 11.The second push button is Diagnosis when we click on it then corresponding (gui_patient_diagnosis) will be called from this (gui_patient_sign) as shown in the Fig. 12. Also in this GUI we have three additional push buttons to delete these fields , to return to the previous GUI (gui_patient_inf), and to exit from this GUI directly.

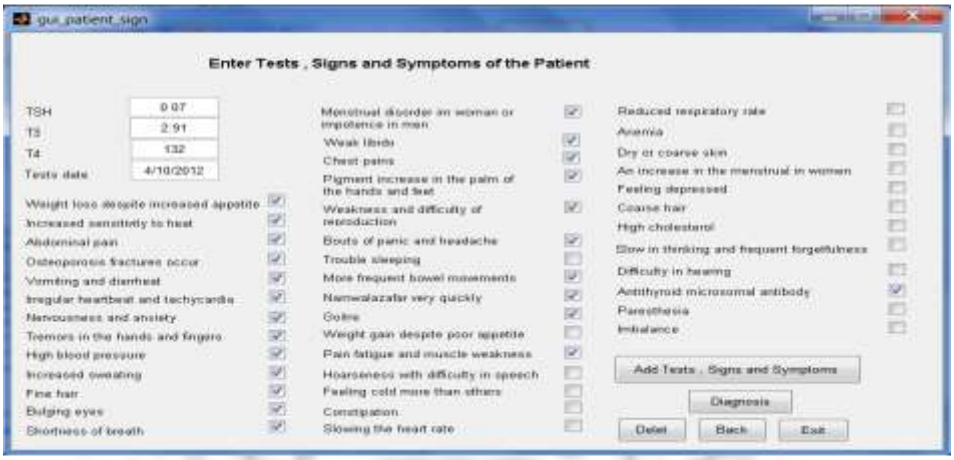

Fig.10: GUI for gui_patient_sign to add tests, signs and symptoms and calling gui_patient_diagnosis GUI by clicking on diagnosis push button.

Patient_ID	TSH	T3	T4	Weight_loss_despite_increased_appetite	Increased_sensitivity_to_heat	Abdominal_pain
1	1.7	1.18	94	0	0	0
2	0.05	2.95	128.96	1	1	1
3	0.07	3.8	103	1	1	1
4	0.07	4.28	147	1	1	1
5	0.35	2.01	99	0	0	0
6	60	1.74	27	0	0	0
7	0.14	2.97	77	1	1	1
8	3.04	1.75	23	0	0	0
9	0.18	2.79	178	1	1	1
10	39.31	0.78	23	0	0	0
11	1.2	2.19	96	0	0	0
12	0.07	2.91	132	1	1	1

Fig. 11: Store the test , signs and symptoms in patient_signs_symptoms table.

In the Fig. 12 ; after entering the diagnosis date and clicking on Patient's diagnosis push button , the diagnosis of this patient appears in the text field (here Hyperthyroidism appears). Then another push button Add Diagnosis to store these fields in the patient_diagnosis table as shown in the Fig. 13. Click on Display Report push button to display the report of this patient as shown in the Fig. 14.

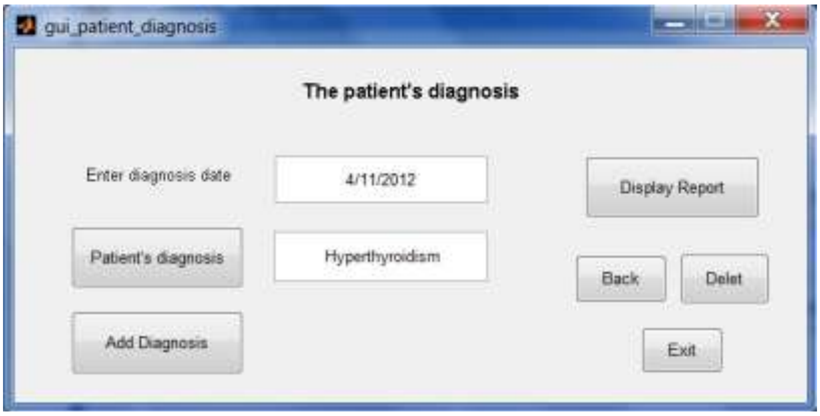

Fig. 12: GUI for gui _ patient_ diagnosis to show the diagnosis of the patient and display the report when clicking on the push button of it.

patient_information | patient_signs_and_symptoms | patient_diagnosis

Patient_ID	Diagnosis	Diagnosis_date
1	normal	16/09/2011
2	Hyperthyroidism	22/07/2011
3	Total Triiodothyronine (T3)	11/08/2011
4	Hyperthyroidism	21/08/2011
5	normal	20/01/2011
6	Hypothyroidism(primary)	23/09/2011
7	Total Triiodothyronine (T3)	16/08/2010
8	Hypothyroidism(secondary)	11/01/2010
9	Hyperthyroidism	26/02/2010
10	Hypothyroidism(primary)	11/10/2011
11	normal	25/03/2012
12	Hyperthyroidism	11/04/2012

Fig.13: Store the patient's diagnosis and the date of it in the patient_diagnosis table.

In the (patient_report) GUI as shown in the Fig. 14 we have one important push button Display Report of the Patient when clicking on it then immediately display the Patient's name , Age ,Weight , Gender , Revision date , TSH ,T3 ,T4 ,Tests dates ,Patient diagnosis and Diagnosis date. Also we can print this report from file menu and the doctor can write the medicine , notes , his name and signature in the specific fields. Then we can close this GUI directly by clicking on close from the file menu.

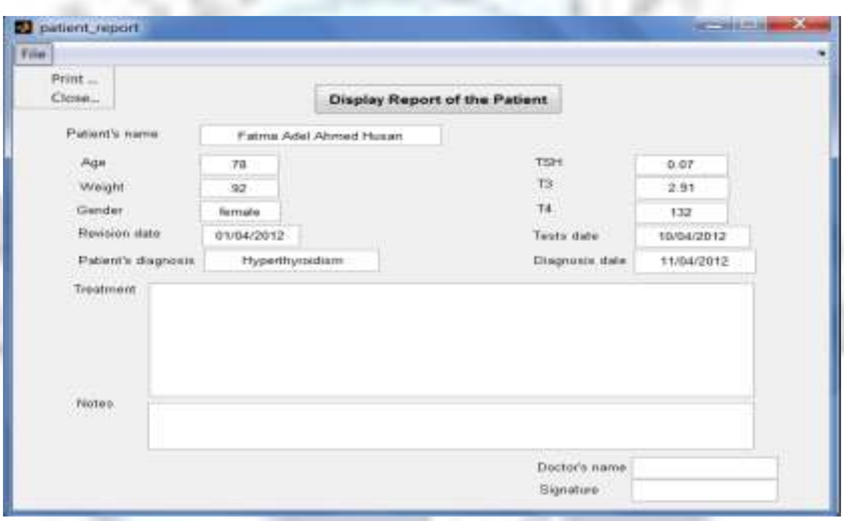

Fig. 14: GUI for gui_report to display the report of the patient when clicking on the push button of it.

But if you want to click on the Search About The Patient push button (in Main GUI (gui_patient_thyroid) as shown in Fig. 7) the (gui_patient_query) dialog box appears as shown in Fig. 15.

Fig. 15: GUI for gui_patient_query to search about the patient by Patient_ID or Name.

When click on the Search about The Patient_ID push button a dialogue box will be open as shown in Fig. 16 and we enter the Patient_ID in the appropriate field. Then, after we click on the Report of the patient push button we get the important details about this patient.

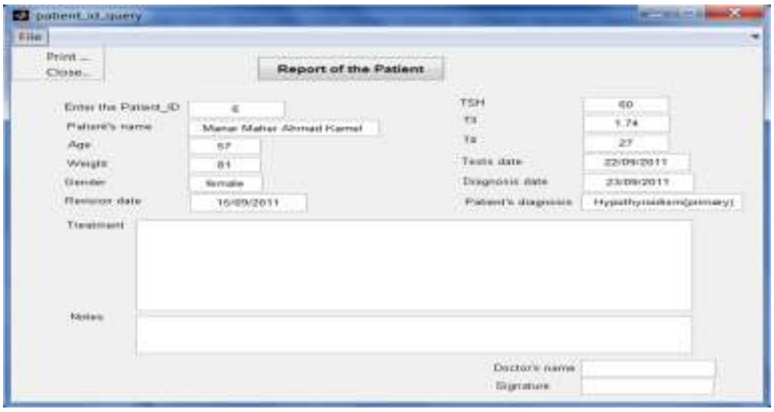

Fig.16: GUI for patient_id_query to display the report of the patient when clicking on the push button of it.

But when click on Search About The Patient's Name push button a dialogue box will be open as shown in Fig. 17 and we enter the patient's name then we click on the Report of the patient push button. After that we get the important details about this patient.

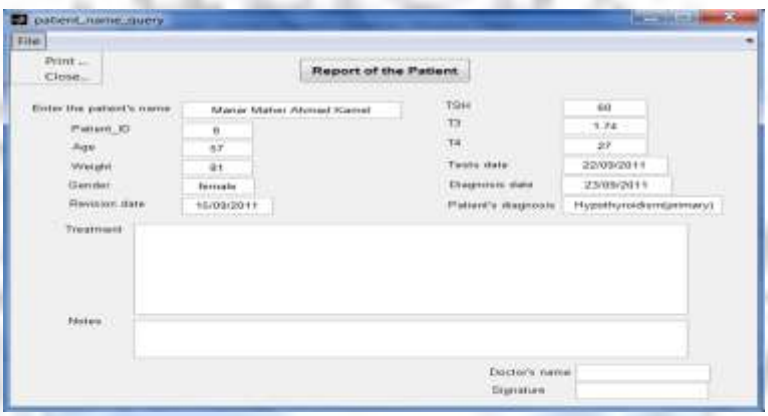

Fig. 17: GUI for patient_name_query to display the report of the patient when clicking on the push button of it.

VI. Conclusion and Future work

Neural networks based on fuzzy logic are one of the recent areas of research. Fuzzy logic are used to determine laboratory data, while neural networks have the strongly fault tolerance. In this study there are two purpose ; first is to investigate the applicability and capability of the three proposed algorithms Fuzzy Radial Base Function neural networks: FuzRBF-1,FuzRBF-2 and FuzRBF-3 for detect and diagnosis thyroid disease. These proposed algorithms combine fuzzy logic approach with the ANN concept. In this paper; around 306 patient's information for training and 116 for testing are collected from Al Jmhoree Hospital under the supervision of doctor. Using Fuzzy logic approach to design an expert system Fuzzy Thyroid Gland FIS as a first step in the FuzRBF-1,2,3 algorithms which provides a simple way to arrive at a definite conclusion from vague, ambiguous, uncertain and imprecise data (as found in medical data). Then the output are normalized and combined with signs and symptoms of the patient and then trained and tested using RBF-method1,2,3 as the second step in these algorithms. If the more data set is used for the training the NN model gives more robust results.

Here the FuzRBF-1 algorithm allows for fast solving of large least square systems and it provides minimum-norm vectors of synaptic weights, which contribute to the regularization of the input-output mapping. This means the basis functions cannot be modified after they have been included in the network, while, in fact, it is frequently desirable to rescale RBFs, for example, as the size of the network increases. Thus, it is clear that the computation time of this algorithm is substantially shorter. Also the initial centers chosen in the hidden nodes carefully by using the exemplar vectors. This is satisfactory when the exemplar feature vectors are scattered well over the feature space, which means they must be numerous and cover all possible classes.

In FuzRBF-2 training algorithm involves selecting the optimal values of the parameters such as weights between the hidden layer and the output layer, spread parameters of the hidden layer base function, centre vectors of the hidden layer and bias parameters of the neurons of the output layer. Also ,the initial centres chosen in the hidden nodes

carefully by using the exemplar vectors. But the initial centers in FuzRBF-3 algorithm generated randomly between [-0.5,0.5] without using the exemplar vectors. Thus FuzRBF-2 algorithm can achieve a global optimal solution to the adjustable weights in the minimum MSE range by using the linear optimization method. It converges in a few iterations so it reduces the computational complexity. Therefore, FuzRBF-2 algorithm is preferable over FuzRBF-3 algorithm. That means the FuzRBF-3 algorithm has disadvantage of a slow convergence rate and less performance comparing with others results show that the performance of the FuzRBF-1 algorithm is better than those of the others. It gives DR=100% for training and testing thyroid data set with 0.0468 and 0.0156 second execution time respectively. Therefore; FuzRBF-1 algorithm is more robust and requires less control parameters and less execution times than other training algorithms. Another characteristic of the FuzRBF-1 algorithm is that it is particularly fast, which is critical whenever there are time constraints, as in on-line learning, or whenever the computation must be updated many times, as in incremental learning procedures.
The second purpose ; an intelligent system The Thyroid's Patients Diagnosis System for the automatic diagnosis of the thyroid gland disease has been designed that outperform the traditional systems. The FuzRBF-1 algorithm has been applied in this system as well as thyroid gland database has been established that include the detailed information about patients and providing the report of each patient which is implemented using GUI in MATLAB 7.10.0(R2010a) language and Microsoft Access 2007. The diagnosis performance of The Thyroid's Patients Diagnosis System shows the advantage of this intelligent system: it is rapid, easy to operate, noninvasive and not expensive. It also helps for training beginner's doctors and medical students who work in the tedious and complicated task of diagnosing thyroid diseases.

In future, developing our system with prescribing the medicine to improve the ability of the physicians.

REFERENCES

[1]. Barnaghi P.M., Sahzabi V.A. and Bakar A.A. "A Comparative Study for Various Methods of Classification", International Conference on Information and Computer Networks (ICICN), IPCSIT Vol. 27, IACSIT Press, Singapore, pp.62-66 , 2012.
[2]. Djam X.Y., Kimbi Y. H. , "A Medical Diagnostic Support System For The Management of Hypertension (MEDDIAG)", Journal of Medical and Applied Biosciences , Vol. 3, pp.41-55, 2011.
[3]. Faran B., Khan M. S., Noor Y., Imran M., "Design Model of Fuzzy Logic Medical Diagnosis Control System", International Journal on Computer Science and Engineering (IJCSE), Vol. 3, No. 5, ISSN : 0975-3397 May 2011,.
[4]. Hannan S. A., Manza R. R. and Ramteke R. J., "Generalized Regression Neural Network and Radial Basis Function for Heart Disease Diagnosis", International Journal of Computer Applications (0975 – 8887),Vol.7, No.13, pp.7-13,October 2010.
[5]. Hannan,.A. Mane,A.V. Manza, Ramteke, " Prediction of heart disease medical prescription using radial basis function" , Computational Intelligence and Computing Research (ICCIC), IEEE,2010.
[6]. Horng M.H., Lee Y.X., Lee M.C. and Liou R.J.",Firefly Meta-Heuristic Algorithm for Training the Radial Basis Function Network for Data Classification and Disease Diagnosis", Theory and New Applications of Swarm Intelligence , Dr. Rafael Parpinelli (Ed.), ISBN: 978-953-51-0364-6, InTech, pp.115-132 , 2012.
[7]. Jayakumar RV., "Clinical Approach to Thyroid Disease"© Supplement to Japi. Vol. 59, pp.11-13 , January 2011.
[8]. Kumar,S.," Diagnosis of heart disease using Advanced Fuzzy resolution Mechanism",International Journal of Science and Applied Information Technology (IJSAIT), Vol.2 , No.2, pp. 22-30, 2013.
[9]. Kurban T. and Beşdok E. , "A Comparison of RBF Neural Network Training Algorithms for Inertial Sensor Based Terrain Classification", Sensors ISSN 1424-8220, 9, pp.6312-6329, 12 August 2009.
[10]. Naoum R.S., Abid N.A. and Al-Sultani Z.N.,"An Enhanced Resilient Backpropagation Artificial Neural Network for Intrusion Detection System", IJCSNS International Journal of Computer Science and Network Security, Vol.12 No.3,pp.11-16,2012.
[11]. Padmavathi J. "A Comparative study on Breast Cancer Prediction Using RBF and MLP", International Journal of Scientific & Engineering Research, Vol. 2, Issue 1, ISSN 2229-5518, January 2011.
[12]. Pinto A. and Glick M., "Management of patients with thyroid disease", D E N T I S T R Y & M E D I C I N E, JADA, Vol. 133, pp. 849-858 , July 2002.
[13]. Raich D. and, Kulkarni P.S., "Application of Intelligent Computing Techniques for the Interpretation and Analysis of Biological and Medical Data for Various Disease diagnosis: Review", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) , Vol.2 , No.4 , Issue-6 , December 2012.
[14]. Rout,S., "Fuzzy Petri Net Application: Heart Disease Diagnosis", International Conference on Computing and Control Engineering (ICCCE 2012), ISBN 978-1-4675-2248-9 © 2012 Published by Coimbatore Institute of Information Technology12 & 13 , April 2012.
[15]. Saleh A.A.E., Barakat S. E. and Awad A. A. E. "A Fuzzy Decision Support System for Management of Breast Cancer", International Journal of Advanced Computer Science and Applications(IJACSA),Vol. 2, No.3, March 2011.
[16]. Sethukkarasi R. and Kannan A., "An Intelligent System for Mining Temporal Rules in Clinical Databases using Fuzzy Neural Networks", European Journal of Scientific Research , ISSN 1450-216X Vol.70 , No.3, pp. 386-395, 2012.
[17]. Sharma N. K., Pande S.R. and Singh M.P., "Performance Evaluation Analysis of MLP & DG-RBF Feed Forward Neural Networks for Pattern Classification of Handwritten English Curve Scripts", International Journal of Computer Science and Information Technologies(IJCSIT), Vol. 2 (2) , pp.932-945 , 2011.
[18]. Tremont G.,Stern R.A.,Westervelt H.J.,Bishop C.L. and Davis,J.D., "Neurobehavioral Functioning in Thyroid Disorders",Medicine and Health / Rbode Island.Vol. 86, No.10, pp.318-321 , 2003.
[19]. Yee p.v. and Haykin S., "Regularized Radial Basis Function Networks: Theory and Applications", New York: John Wiley, 2001.