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DIAGNOSIS WINDOWS PROBLEMS BASED ON HYBRID INTELLIGENCE SYSTEMS

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Abstract

This paper describes the artificial intelligence technologies by integrating Radial Basis Function networks with expert systems to construct a robust hybrid system. The purpose of building the hybrid system is to give recommendations to repair the operating system (Windows) problems and troubleshoot the problems that can be repaired. The neural network has unique characteristics which it can complete the uncompleted data, the expert system can't deal with data that is incomplete, but using the neural network individually has some disadvantages which it can't give explanations and recommendations to the problems. The expert system has the ability to explain and give recommendations by using the rules and the human expert in some conditions. Therefore, we have combined the two technologies. The paper will explain the integration methods between the two technologies and which method is suitable to be used in the proposed hybrid system.

Keywords: Radial basis function, Windows, Neural network, Hybrid system.

1. Introduction

An operating system (Windows) is complicated in principle and there are numbers of elements distributed over the plane, so fault phenomenon differs much and fault reasons are difficult to identify, it is necessary to develop corresponding assistant diagnosis system.

In recent years there has been an explosive growth in the successful use of hybrid intelligent systems in many diverse areas such as robotics, medical diagnosis, fault diagnosis of industrial equipment, monitoring/control of manufacturing processes and financial applications [1].

Using intelligent theories in fault diagnosis are successful day by day, there have been many achievements on intelligent fault diagnosis, typical examples include diagnosis based on Neural Networks (NN), expert system (ES) based on generate rules, diagnosis based on rough set and so on. All these intelligent theories have been successfully applied in diagnosis supply us effective ways to deal with faults [2].

Section 2 is about the related works, in Section 3 Neural Networks characteristics is discussed, Section 4 explains Expert Systems, in Section 5 a proposed Hybrid System is discussed and Section 6 depicts the proposed system.

2. Related Work

During the last years the integration between Expert Systems and Artificial Neural Networks have received considerable amount of attention in the research community. Li Chunming and Hu Dawei in 2007 proposed system dependent on Expert Systems and Neural Networks to diagnosis faults of signal circuits [3], when Lizhi Xiao and Dexiang Sun (2010) proposed a hybrid neural expert system to diagnosis UAV system faults [4] and other researchers as Dhanunjaya Y.A. Reddy and Dilip Kumar Pratihar (2011) combined Neural Networks and Expert Systems to predict temperature distributions in electron beam welding process [5].

In this paper we proposed a Hybrid System depended on Expert Systems and Neural Networks techniques to diagnosis Windows 7 (operating system) troubleshooting.

3. Artificial Neural Network

Research on neural networks dates back to the 1940s; the discipline of neural networks is well developed with wide applications in almost all areas of science and engineering. The powerful penetration of neural networks is due to their strong learning and generalization capability [6].

Artificial neural networks have gained enormous popularity in the last years. They have been applied in a variety of problems including control, monitoring and diagnostics [7].

Artificial Neural Networks (ANNs) are computational modelling tools that have recently emerged and found extensive acceptance in many disciplines for modelling complex real-world problems. Neural network is a network of many simple processors (“units”), each possibly having a small amount of local memory. The units are connected by communication channels (“connections”) which usually carry numeric (as opposed to symbolic) data, encoded by any of various means. The units operate only on their local data and on the inputs they receive via the connections. The restriction to local operations is often relaxed during training [8].

As it can be anticipated, there is not a unique algorithm for the design of neural networks. In general way, they are usually considered of two kinds: supervised learning and unsupervised learning. Depending on which paradigm is used we can classify the network in:

- Artificial neural network with supervised learning.
- Artificial neural network with unsupervised learning.

The fundamental difference between both kinds is the existence of an external agent (supervisor) that controls the learning process in the net [9].

The artificial neural networks have diverse successful applications in computer vision, image/signal processing, speech/character recognition, expert system, medical images analysis, remote sensing, industrial inspection and scientific exploration [9].

The advantages of Neural Networks for classification are [10]:

- Neural Networks are more robust because of the weights
- The Neural Networks improves its performance by learning. This may continue even after the training set has been applied.
- The use of Neural Networks can be parallelized as specified above for better performance.
- There is a low error rate and thus a high degree of accuracy once the appropriate training has been performed.
- Neural Networks are more robust in noisy environment.

4. Expert Systems

Expert systems are a branch of Artificial Intelligence that makes extensive use of specialized knowledge to solve problems at the level of a human expert [7].

An expert can solve problems that most people cannot solve or can solve them much more efficiently (but not as cheaply). Thus, an expert system is a computer program that performs a complex decision-making task within a particular narrow problem domain that is normally done by a human expert. The expert system can replace an expert who can be too expensive and sometimes even not available to advise, analyse, consult, diagnose, explain, forecast, justify, monitor, plan, etc. [7].

There are many terms used synonymously for the term Expert Systems such as Knowledge-Based System, Knowledge-Based Expert Systems.

Expert Systems are capable of handling enormously complex tasks and activities as well as an extremely rich Knowledge-Database structure and contents. As such, they are well suited to model human activities and problems.

Expert Systems can reduce production downtime and, as a result, increase output and quality. There are five major components of Expert Systems

i. The ***knowledge base*** contains the domain knowledge useful for problem solving. In a rule-based expert system, the knowledge is represented as a set of rules. Each rule specifies a relation, recommendation, directive, strategy or heuristic and has the IF (condition) THEN (action) structure. When the condition part of a rule is satisfied, the rule is said to fire and the action part is executed [11].

ii. ***Database*** Consists of predicate calculus facts that match against the IF parts of the rules in the knowledge base [12].

iii. The ***inference engine*** carries out the reasoning whereby the expert system reaches a solution. It links the rules given in the knowledge base with the facts provided in the database [11].

iv. ***Explanation subsystem*** analyses the structure of the reasoning performed by the system and explains it to the user, giving the user the possibility to enquire the systems about the way in which a conclusion has been reached or about the facts used [12].

v. The ***user interface*** is the means of communication between a user seeking a solution to the problem and an expert system. The communication should be as meaningful and friendly as possible [11].

These five components are essential for any rule-based expert system. They constitute its core, but there may be a few additional components, such as external interface and developer interface.

5. Hybrid system

Expert systems and neural networks are individually useful in specific domains, but sometimes they are not sufficient on their own to cope with particular problems. Several researchers have attempted to combine the best features of both by integrating expert systems with neural networks [13].

As it was shown in previous sections the advantages and disadvantages of expert systems and artificial neural networks are complementary. Thus, there is a natural tendency to integrate the advantages of both techniques in hybrid system [7]. Hybrid intelligent system is a technique that integrates the advantages of various artificial techniques to construct a more powerful and complex system that gives better performance.

A hybrid system that combines a neural network and a rule-based expert system is called a neural expert system (or a Neuro-Symbolic System). Learning, generalization, robustness and parallel information processing make neural networks a ‘right’ component for building a new breed of expert systems [11].

A neural expert system as shown in Fig. 1 explains the basic structure. Unlike a rule-based expert system, the knowledge base in the neural expert system is represented by a trained neural network [11].

The heart of a neural expert system is the inference engine. This controls the information flow in the system and initiates inference over the neural knowledge base [11].

Integration strategies can be classified into two categories: physical integration and functional integration.

Table 1 shows the integration of expert systems and neural networks and gives the neural expert system capabilities.

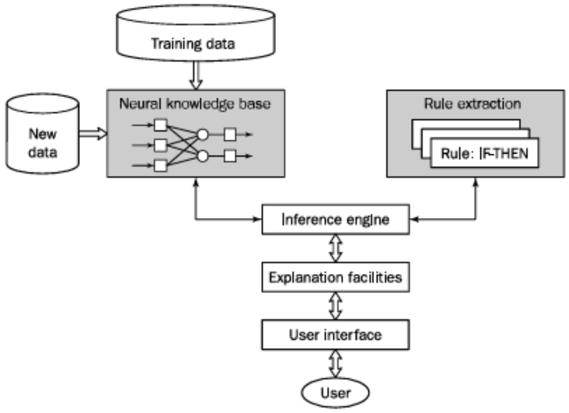


Fig. 1. Basic Structure of a Neural Expert System [11].

Table 1. Neural Expert Systems References.

	Expert system	Neural network	Neural expert system
Knowledge representation	★	●	★
Uncertainty tolerance	●	★	★
Imprecision tolerance	●	★	★
Adaptability	●	★	★
Learning ability	●	★	★
Explanation ability	★	●	★
Maintainability	●	★	★

The terms used for grading are: ★ Good , ● Bad

In general, five models for physical integration can be defined: loose coupling, tight coupling, full integration, localist implementations of rule-based reasoning and distributed implementations of rule-based reasoning [13, 14].

i. Loosely coupled systems; an expert system and a neural network communicate indirectly by access to a database. A model for capturing human skill learning consists of two levels: A symbolic rule level and a connectionist network level. The two levels work rather independently, but their outcomes are combined in decision-making [13, 14].

ii. Tightly coupled systems; the database is not only accessed, but also shared directly by both expert system and neural network. It consists of a concept level and a microfeature level (i.e., where represented knowledge is diffused). The representation is localist at the concept level, with one node for each concept, and distributed at the microfeature level, with a set of nodes representing each concept. Rules are implemented, at the concept level, using links between nodes representing conditions and nodes representing conclusions, and weighted sums are used for evaluating evidence [13, 14].

iii. Fully integrated systems; expert system may select the appropriate neural network to deal with the input data, or vice versa, where a neural network allocates the right rules for the expert system. Consists of a number of symbolic components, including declarative memory (a set of structured chunks), procedural memory (a set of production rules), and goal stack [13, 14].

iv. Localist implementations of rule-based reasoning; the simplest way of mapping the structure of a rule set into that of a connectionist network is by associating each concept in the rule set with an individual node in the network, and implementing a rule by connecting each node representing a concept in the condition of the rule to each node representing a concept in the conclusion of the rule [14].

v. Distributed implementations of rule-based reasoning; a stronger notion of integration emphasizes developing symbolic processing capabilities in truly connectionist models, rather than juxtaposing symbolic codes with localist implementation (i.e., where each condition and conclusion of a rule is represented by a node in the concept level). This approach is more parsimonious explanatorily and thus potentially a more interesting form of cognitive modelling if it can be properly developed [14].

Functional integration is a combination of expert systems and neural networks based on the functions that each technology is best at [13].

6. Proposed Hybrid System

In this paper a proposed system that combines two artificial intelligence components is designed, an artificial neural network and the expert system. The neural network is the first component used in the system as shown in Fig. 2.

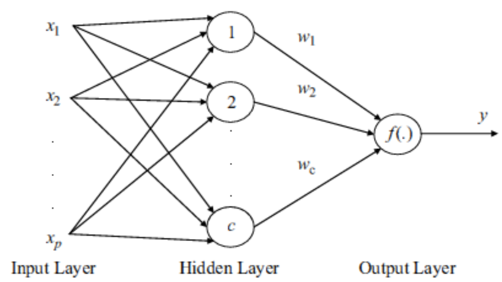


Fig. 2. Basic Structure of RBF Network References.

The neural network is proposed as database for the neural expert system and it is used to diagnose the operating system errors, the Radial Basis Function neural network (RBF) is the topology that we suggested for the proposed system because the network construction and training process is done in one stage, and it has the ability of classification and giving the results in a short time. The RBF network consists of three layers the input layer which has nodes; the data will enter the network via the nodes, with a one hidden layer and the output layer that gives the actual output, unlike the backpropagation (BP) network that consists of one or more of hidden layers. The network combines the two types of neural network learning algorithm "A Hybrid of unsupervised and supervised learning", the first stage from input layer to hidden layer is unsupervised and the second stage is supervised.

There are two types of activation functions used in the neural network, in the first stage the function is Gaussian and in the second stage the function is sign, the weights are initiated randomly.

Steps of how RBF works are shown below:

Step 1: Input the data through the Graphical User Interface (GUI), the data is in a text formation.

Step 2: Convert the data from text to binary, so the network can deal with them. Encode the target data to binary (Fig. 3).

	A	B	C	D	E	F	G	H	I	J	K
1	D3d9.dll Error Messages	0		0	0	0	0	0	0	0	1
2	D3d9.dll Error Messages	0		0	0	0	0	0	0	0	1
3	D3d9.dll Error Messages	0		0	0	0	0	0	0	0	1
4	D3d9.dll Error Messages	0		0	0	0	0	0	0	0	1
5	404 Not Found error messages	0		0	0	0	0	0	0	1	0
6	404 Not Found error messages	0		0	0	0	0	0	0	1	0
7	404 Not Found error messages	0		0	0	0	0	0	0	1	0
8	404 Not Found error messages	0		0	0	0	0	0	0	1	0
9	404 Not Found error messages	0		0	0	0	0	0	0	1	0
10	404 Not Found error messages	0		0	0	0	0	0	0	1	0
11	404 Not Found error messages	0		0	0	0	0	0	0	1	0
12	404 Not Found error messages	0		0	0	0	0	0	0	1	0
13	Code 37 Error Message	0		0	0	0	0	0	0	1	1
14	Zlib.dll Error Messages	0		0	0	0	0	0	1	0	0
15	Zlib.dll Error Messages	0		0	0	0	0	0	1	0	0
16	Zlib.dll Error Messages	0		0	0	0	0	0	1	0	0
17	Zlib.dll Error Messages	0		0	0	0	0	0	1	0	0

(a)

	A	B	C	D	E	F	G	H	I	J	K
1	The file d3d9.dll is missing	0	0	0	0	0	0	0	0	0	1
2	D3d9.DLL Not Found	0	0	0	0	0	0	0	0	1	0
3	File d3d9.dll not found	0	0	0	0	0	0	0	0	1	1
4	D3d9.dll not found	0	0	0	0	0	0	0	1	0	0
5	404 Error	0	0	0	0	0	0	0	1	0	1
6	404 Not Found	0	0	0	0	0	0	0	1	1	0
7	Error 404	0	0	0	0	0	0	0	1	1	1
8	HTTP 404	0	0	0	0	0	0	1	0	0	0
9	Error 404 Not Found	0	0	0	0	0	0	1	0	0	1
10	404 File or Directory Not Found	0	0	0	0	0	0	1	0	1	0
11	HTTP 404 File Not Found	0	0	0	0	0	0	1	0	1	1
12	404 Page Not Found	0	0	0	0	0	0	1	1	0	0
13	Windows cannot initialize the device driver for this hardware	0	0	0	0	0	0	1	1	0	1
14	Zlib.dll Not Found	0	0	0	0	0	0	1	1	1	0
15	This application failed to start because zlib.dll was not found.	0	0	0	0	0	0	1	1	1	1
16	Cannot find [PATH]\zlib.dll	0	0	0	0	0	1	0	0	0	0
17	The file zlib.dll is missing	0	0	0	0	0	1	0	0	0	1
18	Cannot start [APPLICATION]. A required component is missing: zlib	0	0	0	0	0	1	0	0	1	0

(b)

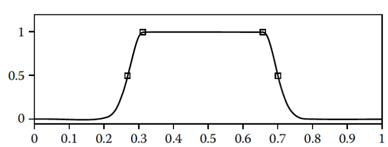
Fig. 3. (a) Sample of the Target Data (Error Messages) after it is Converted, (b) Sample of the Input Data (Symptoms) after it is Converted.

Step 3: Broadcast the data to the network through the nodes in the input layer.

Step 4: By using Gaussian function in the first stage, the data is moved to the hidden layer.

$$g(x) = e^{-||x-w||/2*\sigma^2} \quad (1)$$

where x is the input data, w is the weight of the first stage, σ is the parameter that controls the data spread around the curve that gives the correct results.



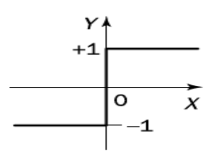
Step 5: The data is moved from hidden layer to the output layer, using Eq. (2) to calculate the net value.

$$Net = \sum x_i w_i \quad (2)$$

where x is the output data from stage one and w is the weight of the second stage.

Step 6: Calculate the actual output by using the sign function.

$$Y = sign\,[\sum_{i=1}^{n} x_i w_i - \theta] \quad (3)$$



$$Y^{sign} = \begin{cases} +1, & \text{if } X \geq 0 \\ -1, & \text{if } X < 0 \end{cases}$$

Step 7: Compare the actual output with the target, if they are equal no change to the weight will happen and consider them as optimal weights; if they were different the weights will change by using Eqs. (4) and (5).

$$e(p) = Y_d(p) - Y(p) \quad \text{where } p = 1, 2, 3, \ldots. \tag{4}$$

$$w_i(p+1) = w_i(p) + \alpha\, x_i(p)\, e(p) \tag{5}$$

Step 8: Take the outputs as text and binary and save them in a database, so the data is preprocessed to enter the expert system.

Figure 4 shows a flowchart of how the Radial Basis Function (RBF) network works.

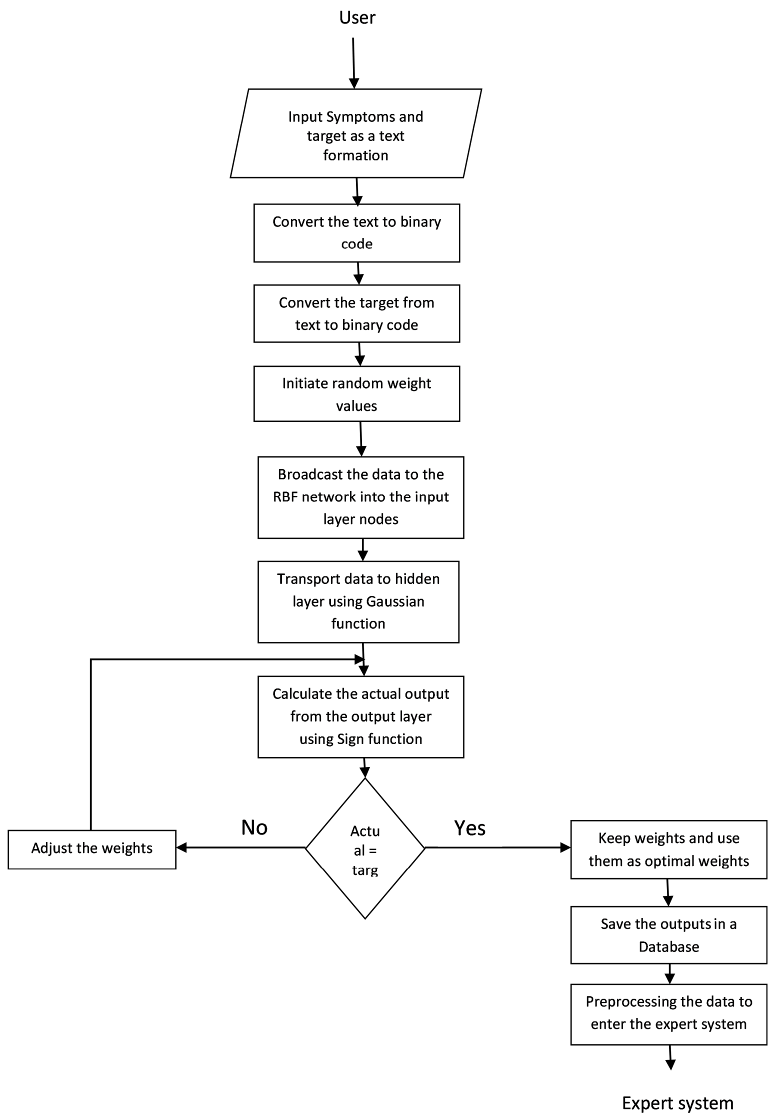


Fig. 4. Flowchart of the RBF Neural Network for the Proposed System.

The expert system is the second component used in the hybrid system, as we mentioned in previous sections that the heart of the hybrid system is the inference engine, using an old expert system in the proposed hybrid system will not succeed, in the old expert systems the inference engine uses the blind search methods to find a rule for a specific error message, these methods have some disadvantages such as the complexity of the system will be very high and it will take a long time to find the rule for a specific error message, these disadvantages will impact the system efficiency. Therefore we used a new method for searching instead of the blind search methods. The new method uses the database systems in the inference engine to find the rules, database systems uses the indexes for finding a rule therefore it is used to reduce the complexity of the system, reduce the time spent and increase the system speed.

The application used to construct the databases of the system is Microsoft office/Excel.

The requirements that we need before the expert system starts its process is to initiate two databases: the first one contains the recommendations and the troubleshooting steps for all the error messages, the second one contains a collection of numbers which each number refers to a field in the first database.

Steps of how the expert system works:

Step 1: The result of the RBF neural network is entered to the expert system.

Step 2: Rule extraction process starts for the entire data that has been entered to the expert system, save the rules in a database. The condition of the rule is the error message and the conclusion is a number which refers to a field in the second database. As shown: ***if*** D3d9.dll Error Messages ***then*** 3.

The inference engine starts working; when the rule is executed the (ID) number is taken from the conclusion part of the rule which refers to an (ID) in the second database, as shown in Fig. 5.

Step 4: After the recommendations for troubleshooting a problem are gained they are moved to the explanation component.

Step 5: Show the recommendations to the user via GUI, so the user can fix his problem.

Figure 6 shows a flowchart of how the expert system works.

The integration model that is used in the system is the tightly coupled integration model, because both components can access and share with the databases. The purpose of integrating the components is because that RBFN has a high ability to deal with incomplete data with a leak of Explanation unlike the Expert System (ES) that has a high ability of Explanation and a leak of dealing with incomplete data (see table. 1). Now the hybrid system is constructed, the user can input the error message and receive the results of how to troubleshoot it. Figure 7 shows the flowchart that will be shown below depicts how the hybrid system works.

7. Conclusions

The proposed system combines the Neural Network techniques and expert system, this work produce hybrid intelligence techniques. The proposed system is more efficient when compare with Artificial Intelligent approaches, because the work mix the two techniques through building a new method for inference engine which reduces the complexity and time.

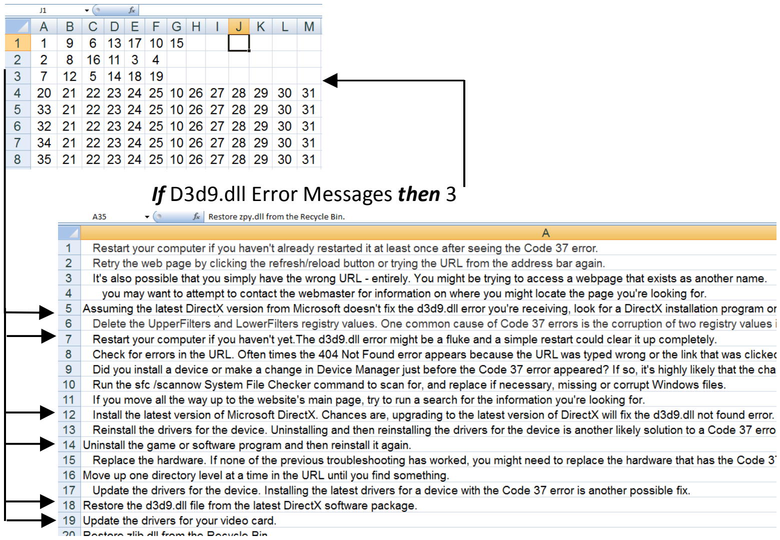


Fig. 5. The Proposed Inference Engine Architecture.

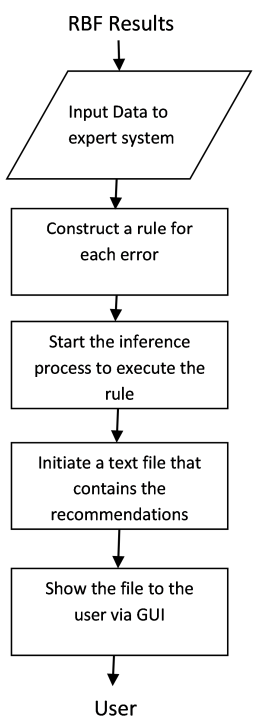


Fig. 6. The Proposed Expert System Flowchart.

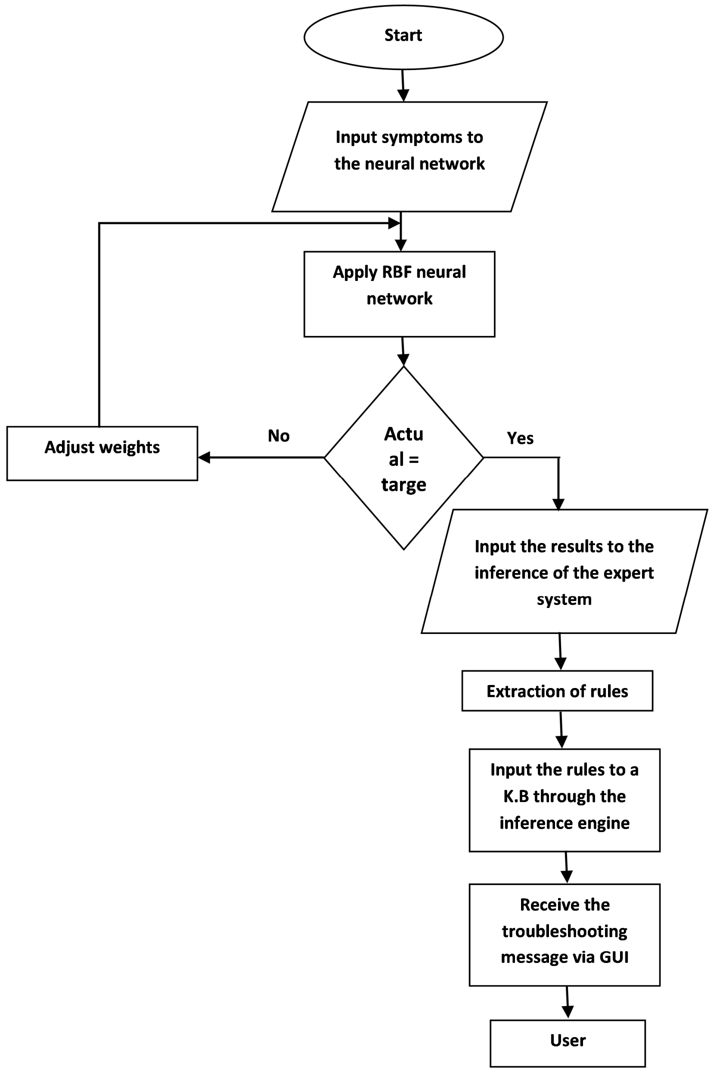


Fig. 7. The Hybrid System Flowchart.

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