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An Artificial Neural Network Model for Neonatal Disease Diagnosis

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Abstract

The significance of disease diagnosis by artificial intelligence is not obscure now a day. The increasing demand of Artificial Neural Network application for predicting the disease shows better performance in the field of medical decision making. This paper represents the use of artificial neural networks in predicting neonatal disease diagnosis. The proposed technique involves training a Multi Layer Perceptron with a BP learning algorithm to recognize a pattern for the diagnosing and prediction of neonatal diseases. A comparative study of using different training algorithm of MLP, Quick Propagation, Conjugate Gradient Descent, shows the higher prediction accuracy. The Backpropogation algorithm was used to train the ANN architecture and the same has been tested for the various categories of neonatal disease. About 94 cases of different sign and symptoms parameter have been tested in this model. This study exhibits ANN based prediction of neonatal disease and improves the diagnosis accuracy of 75% with higher stability.

Key words: Artificial Intelligence, Multi Layer Perceptron, Neural Network, Neonate

1. INTRODUCTION

Artificial Intelligence techniques consist of developing a computer based decision support system does somewhat that it were done by a human being. Several Neural Network Models are developed which helps doctors in diagnosing the patients more correctly and accurately. Neural networks provide a very general way of approaching problems. When the output of the network is categorical, it is performing prediction and when the output has discrete values, and then it is doing classification. Neural Network based Decision Support in medicine, particularly for the neonates, has at least the role of enhancing the consistency of care.

Among various phases of child development, Neonatal phase is considered to be one of the vital phases. In India, 30% to 40% babies are Low Birth Weight babies and about 10% to 12% of Indian babies are born less than 37 completed weeks (preterm). Thus, these babies are physically immature and cause the high neonatal mortality [1]. In a study, authors describe about prevalence diseases those are the major causes of deaths in the neonates in Terai region of West Bengal [2]. This mortality problem, especially in rural areas [3], can prevail over through fast

and accurate disease diagnosis and management of the newborn. In our earlier studies of data mining model development, several classification techniques have applied to get the maximum accuracy [4]. However, any ANN based model may be useful for classification of disease and even for taking necessary decision. This paper describes how artificial intelligence, for example artificial neural networks can improve this area of diagnosis.

The proposed model has the potential to cover rare conditions of all the exceptional symptoms of neonatal diseases to diagnose. The increasing range of neonatal patient information makes it feasible to more accurately quantify important experimental indicators, such as the relative likelihood for competing diagnoses or the clinical outcome. It is observed that, in few instances, computer-assisted diagnoses, particularly ANN based model have been claimed to be even more accurate than those decision taken by domain experts [5].

2. RELATED STUDIES OF ARTIFICIAL NEURAL NETWORK

There are several studies which have applied neural networks in the diagnosis of different disease. An artificial neural network trained on admission data can accurately predict the mortality risk for most preterm infants. However, the significant number of prediction failures renders it unsuitable or individual treatment decisions. In a study[6], the artificial neural network performed significantly better than a logistic regression model (area under the receiver operator curve 0.95 *vs* 0.92). Survival was associated with high morbidity if the predicted mortality risk was greater than .50. There were no preterm infants with a predicted mortality risk of greater than 0.80. The mortality risks of two non-survivors with birthweights >2000 g and severe congenital disease had largely been underestimated.

In another study [7], an effective arrhythmia classification algorithm used for the heart rate variability (HRV) signals. The proposed method is based on the Generalized Discriminant Analysis (GDA) feature reduction technique and the Multilayer Perceptron (MLP) neural network classifier. At first, nine linear and nonlinear features are extracted from the HRV signals and then these features are reduced to only three by GDA. Finally, the MLP neural network is used to classify the HRV signals. The proposed arrhythmia classification method is applied to input HRV signals, obtained from the MIT-BIH databases. Here, four types of the most life threatening cardiac arrhythmias including left bundle branch block, fist degree heart block, Supraventricular tachyarrhythmia and ventricular trigeminy can be discriminated by MLP and reduced features with the accuracy of 100%.

The study [8] of a functional model of ANN is proposed to aid existing diagnosis methods. This work investigated the use of Artificial Neural Networks (ANN) in predicting the Thrombo-embolic stroke disease. The Backpropogation algorithm was used to train the ANN architecture and the same has been tested for the various categories of stroke disease. This research work demonstrates that the ANN based prediction of stroke disease improves the diagnosis accuracy with higher consistency. This ANN exhibits good performance in the prediction of stroke disease in general and when the ANN was trained and tested after optimizing the input parameters, the overall predictive accuracy obtained was 89%.

As per the artificial neural networks in medicine world map[9], different universities, research centres, medical diagnostic centres are using ANN for medical diagnosis and management. Some studies are carried out using some combined architecture using ANN and different data mining techniques [10].

3. MLP NEURAL NETWORK MODEL

3.1 Structure of MLP

In medical decision making a variety of neural networks used for decision accuracy. MLPs are the simplest and commonly used neural network architectures programs due to their structural litheness, good representational capabilities and availability, with a large number of

programmable algorithms[11]. MLPs are feed forward neural networks and universal approximators, programmed with the standard back propagation algorithm. They are supervised networks so they require a desired response to be trained. They are able to transform input data into a desired response, so they are widely used for pattern classification. With one or two hidden layers, they can approximate virtually any input-output map. Generally, an MLP consists of three layers: an input layer, an output layer and an intermediate or hidden layer. In this network, every neuron is connected to all neurons of the next layer, in other words, an MLP is a fully connected network[12]. Figure 1 shows the structure of a MLP network.

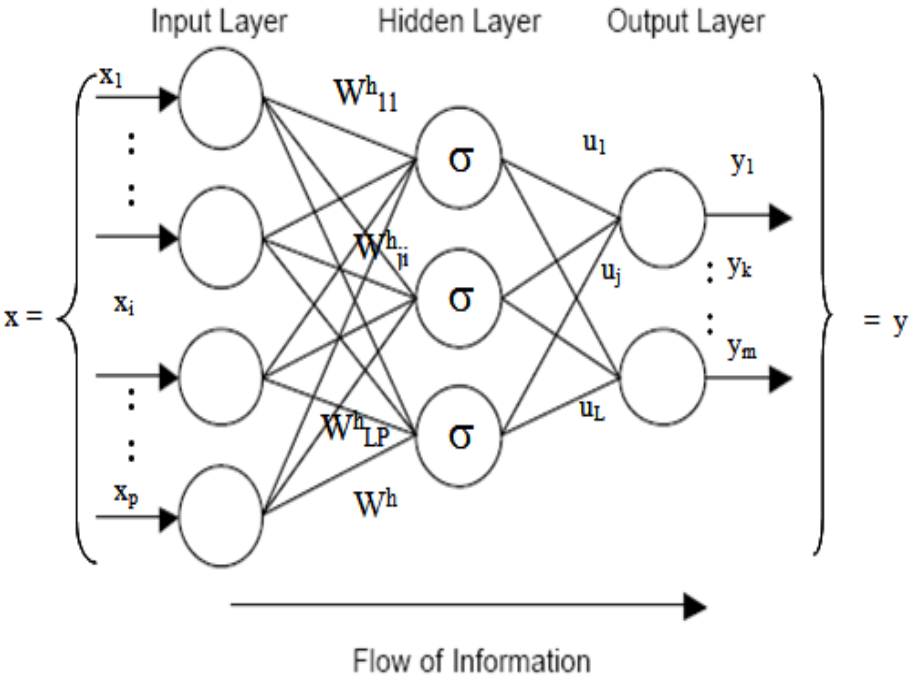

FIGURE 1: A structure of MLP Network

On the left this network has an input layer with three neurons, in the middle, one hidden layer with three neurons and an output layer on the right with two neurons. There is one neuron in the input layer for each predictor variable ($x_1 \ldots x_p$). In the case of categorical variables, *N*-1 neurons are used to represent the *N* categories of the variable.

3.2 MLP Input Layer

A vector of predictor variable values ($x_1 \ldots x_p$) is presented to the input layer. The input layer (or processing before the input layer) standardizes these values so that the range of each variable is -1 to 1. The input layer distributes the values to each of the neurons in the hidden layer. In addition to the predictor variables, there is a constant input of 1.0, called the *bias* that is fed to each of the hidden layers; the bias is multiplied by a weight and added to the sum going into the neuron.

The net calculation of input and output of the j hidden layer neurons are as follows:

$$net^h_j = \sum_{t=1}^{N+1} W_{ji} x_i$$

$$y_j = f\,(net^h_j)$$

3.3 MLP Hidden Layer

Arriving at a neuron in the hidden layer, the value from each input neuron is multiplied by a weight (w_{ji}), and the resulting weighted values are added together producing a combined value u_j. The weighted sum (u_j) is fed into a transfer function σ. The outputs from the hidden layer are distributed to the output layer.

3.4 MLP Output Layer

The value from each hidden layer neuron is multiplied by a weight (w_{kj}), and the resulting weighted values are added together producing a combined value *u, at time of a*rriving at a neuron in the output layer *j*. The weighted sum (u_j) is fed into a transfer function, σ, which outputs a value y_k. The *y* values are the outputs of the network. If a regression analysis is being performed with a continuous target variable, then there is a single neuron in the output layer, and it generates a single *y* value. For classification problems with categorical target variables, there are *N* neurons in the output layer producing *N* values, one for each of the *N* categories of the target variable.
Calculate the net inputs and outputs of the k output layer neurons are :

$$\text{net}^{o}_{k} = \sum_{j=1}^{j+1} V_{kj} y_j$$

$$Z_k = f(\text{net}^{0}_{k})$$

Update the weights in the output layer (for all k, j pairs)

$$v_{kj} \leftarrow v_{kj} + c\lambda\,(d_k - Z_k)\,Z_k\,(1 - Z_k)\,y_j$$

4. PROPOSED MODEL

4.1 Input Data

The data for this study have been collected from 94 patients who have symptoms of neonatal diseases. The data have been standardized so as to be error free in nature. All the cases are analyzed after careful scrutiny with the help of the pediatric expert. Table 1 below shows the various input parameters for the prediction of neonatal disease diagnosis.

Sl.No.	Parameters	Column Type
1	Birth_Term_Status	Categorical
2	Birth_Weight_Status	Categorical
3	Age_in_Hours>72	Categorical
4	Lathergy	Categorical
5	Refusual_to_Suck	Categorical
6	Poor_Cry	Categorical
7	Poor_Weight_gain	Categorical
8	Hypothalmia	Categorical
9	Sclerema	Categorical
10	Excessive_Jaundice	Categorical
11	Bleeding	Categorical
12	GI_Disorder	Categorical
13	Seizure	Categorical
14	Sluggish_Neonatal_Reflex	Categorical

TABLE 1: Input Parameters for Prediction Neonatal Disease

4.2 Feature Selection of Dataset

Data analysis information needed for correct data preprocessing. After data analysis, the values have been identified as missing, wrong type values or outliers and which columns were rejected as unconvertible for use with the neural network [13]. Feature selection methods are used to identify input columns that are not useful and do not contribute significantly to the performance of neural network. In this study, Genetic method is used for input feature selection. Genetic algorithms method [14] starts with a random population of input configurations. Input configuration determines what inputs are ignored during performance test. At each following step uses a process analogous to natural selection to select superior configurations and use them to generate a new population. Each step successively produces better input configuration. At the last step the best configuration is selected. The method is very time-consuming but good for determining mutually-required inputs and detecting interdependencies. This method use generalized regression neural networks (GRNN) or probabilistic neural networks (PNN) because they train quickly and proved to be sensitive to the irrelevant inputs. The removal of irrelevant inputs will improve the generalization performance of a neural network. Table 2 shows the finalized input parameters after applying feature selection method.

Code	Name of the Input Column	Input state	Importance %
C3	Age_in_Hours>72	Two-state	0.551381
C4	Lathergy	Two-state	12.344225
C6	Poor_Cry	Two-state	0.832139
C7	Poor_Weight_gain	Two-state	18.140229
C8	Hypothalmia	Two-state	15.23048
C9	Sclerema	Two-state	0.088902
C10	Excessive_Jaundice	Two-state	14.179179
C11	Bleeding	Two-state	4.159191
C12	GI_Disorder	Two-state	8.745518
C13	Seizure	Two-state	22.076618
C14	Sluggish_Neonatal_Reflex	Two-state	3.652138

TABLE 2: Percentage of Importance of Input Data after feature selection

4.3 Development of Neural Network Architecture

In this study, the multilayered feed-forward network architecture with 11 input nodes after feature selection of the input data, 5 hidden nodes, and 13 output nodes have been used for the neural network architecture. The numbers of input nodes are determined by the finalized data; the numbers of hidden nodes are determined through trial and error; and the numbers of output nodes are represented as a range showing the disease classification. The most widely used neural-network learning method is the Back Propagation algorithm [15]. Learning in a neural network involves modifying the weights and biases of the network in order to minimize a cost function. The cost function always includes an error term; a measure of how close the network's predictions are to the class labels for the examples in the training set. Additionally, it may include a complexity term that reacts a prior distribution over the values that the parameters can take. The activation function considered for each node in the network is the binary sigmoidal function defined (with $\sigma = 1$) as output = $1/(1+e^{-x})$, where x is the sum of the weighted inputs to that particular node. This is a common function used in many Back Propagation Network. This function limits the output of all nodes in the network to be between 0 and 1. Note all neural networks are basically trained until the error for each training iteration stopped decreasing. Figure 2 shows the architecture of the specialized network for the prediction of neonatal disease. The complete sets of final data (11 inputs) are presented to the generic network, in which the final diagnosis corresponds to output units.

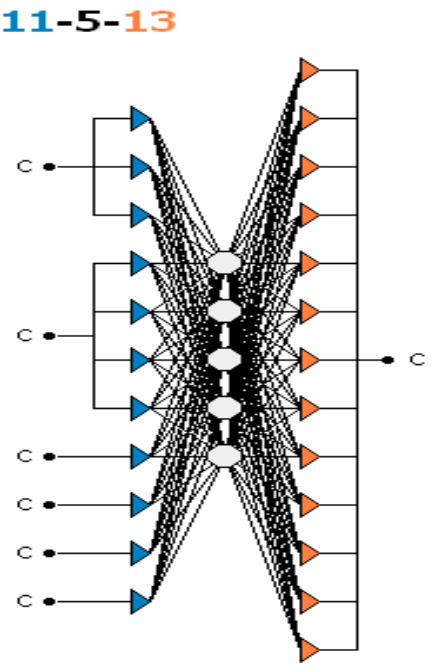

FIGURE 2: ANN Architecture for Neonatal Disease Diagnosis

The following are the results generated from the input given to the neural network after going through the process of careful training, validation and testing using NeuroIntelligence tool[16]. Table 3 shows the various categories of neonatal diseases and their classification and probability statistics.

Category	Probability
HIE_III	0.1702128
Hemorrhage	0.0106383
HIE_II	0.0425532
Hypo_Thalmia	0.0212766
Jaundice	0.0212766
Jaundice_BA	0.0319149
MD_Hypocalcemia	0.0957447
MD_Hypoglycemia	0.0319149
MD_Hypothermia	0.0319149
No_Disease	0.0851064
Others	0.0531915
Septicemia	0.3936170
Sizure_Disorder	0.0106383

TABLE 3: Category weights (prior probabilities)

4.4 Training Process of MLP Networks

In this context, our objectives of the training process was to find the set of weight values which will cause the output from the neural network to match the actual target values as closely as possible. We have faced several issues concerned in designing and training a multilayer perceptron network model. Some of the issues are:

i. To select the number of hidden layers to use in the network.
ii. To decide the number of neurons to be used in each hidden layer.
iii. Converging to an optimal solution in a reasonable period of time.

iv. Finding a globally optimal solution that avoids local minima.
v. Validating the neural network to test for overfitting.

4.5 Hidden Layers Selection

In my study one hidden layer is sufficient for the network. Two hidden layers are required for modeling data with discontinuities such as a saw tooth wave pattern. As we found that using two hidden layers rarely improves the model, and it may introduce a greater risk of converging to a local minima. So, Three layer models with one hidden layer are recommended for our study.

4.6 Deciding How Many Neurons to be Used in the Hidden Layers

The most significant characteristics of a multilayer perceptron network is to decide the number of neurons in the hidden layer. The network may be unable to model complex data, and the resulting fit will be poor, if an inadequate number of neurons are used in the network. Similarly, if too many neurons are used, the training time may become excessively long, and, worse, the network may overfit the data. When overfitting occurs, the network will begin to model random noise in the data. The result is that the model fits the training data extremely well, but it generalizes poorly to new, unseen data. Validation must be used to test for this. In view of the above our model consists of 5 neurons with one hidden layer.

5. RESULTS AND DISCUSSION

During data analysis, the column type is recognized. The last column is considered as the target or output one and other columns will be considered as input columns. The dataset is divided into training, validation and test sets. The Data have been analyzed using Neuro-intelligence tool [16].Table 4 shows the statistics of data partition sets.

Partition set using	Records	Percentage (%)
Total	94	100
Training Set	64	68
Validation Set	15	16
Test Set	15	16
Ignore Set	0	0

TABLE 4: Data Partition Set

To train a neural network is the process of setting the best weights on the inputs of each of the units. It has been proved that Genetic Algorithm and Back-Propagation neural network hybrids in selecting the input features for the neural network reveals the performance of ANN can be improved by selecting good combination of input variables [13]**.** Training set is considered to be the part of the input dataset used for neural network training and network weights adjustment**.** The validation set is parts of the data are used to tune network topology or network parameters other than weights. The validation set is used to choose the best network we have changed the number of units in the hidden layer. The test set is a part of the input data set used to test how well the neural network will perform on new data. The test set is used after the network is trained, to test what errors will occur during future network application.

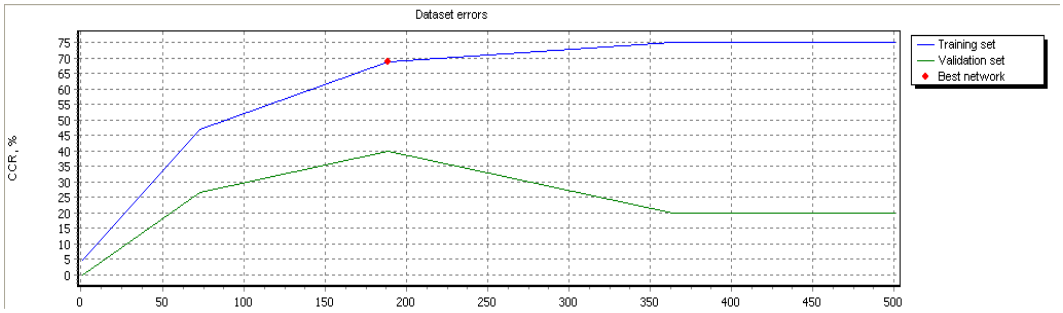

FIGURE 3: Error in Data Set

Figure 3 shows the various data set errors with respect to training set, validation set and the best network. It accomplishes the level of best network after training through repeated iterations. Correct Classification Rate for training and validation has been done to find the best network after a number of iterations. Table 5 shows the number of Iterations and CCR for training and validation as well.

Iteration	CCR (training)	CCR (validation)
73	46.875	26.666666
189	68.75	40
364	75	20

TABLE 5: Best Network on Iterations

The Network errors have been shown graphically in figure 4. We have tested the trained network with a test set, in which the outcomes are known but not provided to the network. We used diagnostic criteria and disease pattern status to train a neural network to classify individuals as diagnosed with disease name by several categories of neonatal disease.

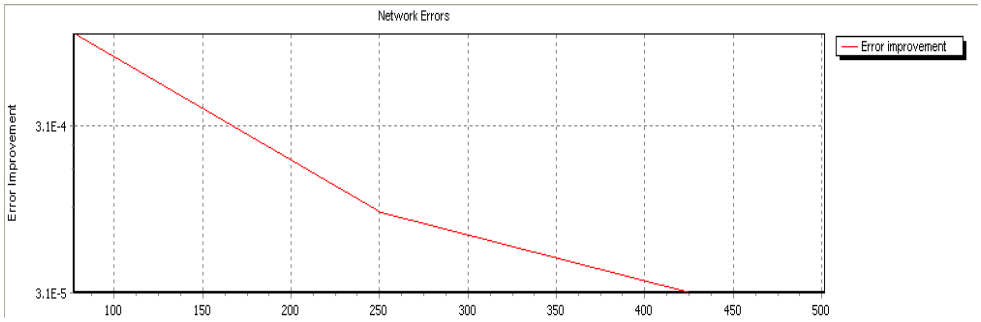

FIGURE 4: Network Error

The study shows that 39.36% of the respondents have the symptoms of Septicemia; 17.02% have the symptoms of HIE III; and 9.57% of the patients have the symptoms of Metabolic Disorder - Hypocalcemia. These are the most prevalent disease in the Terai region of North Bengal [2]. Table 6 shows the disease conformation percentage with category. Disease conformation is also presented in Fig. 5 representing disease vs. number of cases.

No. of cases	Name of Disease Conformation	Percentage (%)
1	Hemorrhage	1.06%
4	HIE_II	4.26%
16	HIE_III	17.02%
2	Hypo_Thalmia	2.13%
2	Jaundice	2.13%
3	Jaundice_BA	3.19%
9	MD_Hypocalcemia	9.57%
3	MD_Hypoglycemia	3.19%
3	MD_Hypothermia	3.19%
8	No_Disease	8.51%
5	Others	5.32%
37	Septicemia	39.36%
1	Sizure_Disorder	1.06%

TABLE 6: Disease Conformation Set

6. CONCLUSION

Neural network has been established of their potentials in many domains related with medical disease diagnosis and other application. Although, Neural networks never replace the human experts instead they can helpful for decision making, classifying, screening and also can be used by domain experts to cross-check their diagnosis. In our earlier studies on rough set based computing model [17] and soft computing model [18], we have established the accuracy of 71% for decision making of prevalence neonatal disease. This ANN MLP model proves the better results and helps the domain experts and even person related with the field to plan for a better diagnose and provide the patient with early diagnosis results as it performs realistically well even without retraining. As clinical decision making requires reasoning under uncertainty, expert systems and fuzzy logic will be suitable techniques for dealing with partial evidence and with uncertainty regarding the effects of proposed interventions. Neural Networks have been proven to produce better results compared to other techniques for the prediction tasks. Our study concludes with higher prediction result and when the Network has trained and tested after optimizing the input parameters, the overall predictive accuracy acquired was 75%.

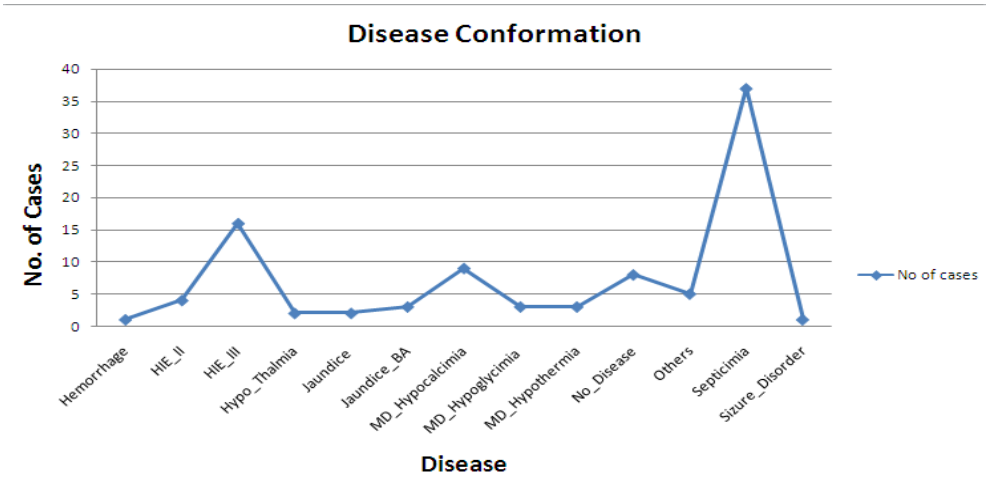

FIGURE 5: Various Neonatal Disease with no. of cases

A comparative study [19] is being presented in table. 7 to establish the relative suitability of ANN technique with other techniques such as RSES [20] and ROSSETTA [21]. The result of the table clearly demonstrates the superiority of ANN technique over other techniques explained earlier.

Tools	Methods/ Algorithms	Prediction Accuracy (%)
RSES[20]	Exhaustive without Reduct	70
	Genetic without Reduct	70
	Exhaustive with Reduct	70
	Genetic with Reduct	70
	Dynamic with Reduct	70
ROSETTA[21]	Genetic without Reduct	71.6
	Johnson(with approx. solutions) with Reduct	70.5
NEURO INTELLIGENCE [16]	ANN with MLP	75

TABLE 7: A Comparative Study of Different Techniques

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Data Mining Visualization to Support Biochemical Markers for Liver Fibrosis in Patients With Chronic Hepatitis C Virus

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Abstract

The reference diagnostic test to detect fibrosis is liver biopsy (LB), a procedure subject to various limitations, including risk of patient injury and sampling error. FibroTest (FT) and ActiTest (AT) are biochemical markers (noninvasive tests) used in determining the level of fibrosis and the degree of necroinflammatory activity in the liver [1]. The objective of this work is to discover the differences in the temporal patterns between noninvasive tests and liver biopsy by visualization tools, which made it easier to understand the relations of the complicated rules. This Study ware focused on the major serum fibrosis markers (FT/AT). The test uses a combination of serum biochemical markers with visualization technique to evaluate whether biochemical markers can be used to estimate the stage of liver fibrosis and necro-inflammatory activity in the liver.

Keywords: Data mining, Visualization, Hepatitis C, Serum Markers, Liver fibrosis.

1. INTRODUCTION

Artificial intelligence (AI) research in medicine is an excellent area that combines sophisticated representational and computing techniques with the insights of expert physicians to produce tools for improving health care. It can be observed that the focus on expert systems (ES) in medicine in early days of AI has been changed to intelligent data analysis (IDA) in medicine, especially data mining techniques [2]. Visual data mining is another area that greatly contributes to medical information systems. Appropriate visualization can support deeper understanding of patterns discovered in data, or to uncover their hidden relations [3].

The Arab Republic of Egypt has the highest prevalence of hepatitis C in the world. The national prevalence rate of hepatitis C virus (HCV) antibody positivity has been estimated to be between 10-13% according to a study published on August 2010 in the National Academy of Sciences. Chronic HCV is the main cause of liver cirrhosis and liver cancer in Egypt and, indeed, one of the top five leading causes of death. Genotype 4 represents over 90% of cases in Egypt.

Liver biopsy is important diagnostic tool in chronic liver diseases (CLD), cirrhosis and hepatocellular carcinoma but had its limitation and risks [4], [5]. Unfortunately, liver biopsy is often painful, requires bed rest for at least six hours, and is associated with a small but definite mortality. Among the complications of percutaneous liver biopsy are pain (10%-30%), bleeding (which may be severe and necessitate blood transfusion or emergency surgery). Accidental needle puncture of the lung, intestines, gallbladder, or kidney. Abdominal infection may accrue with pain. Furthermore, Subjective to many factors difference in the biopsy sampling size may

miss the diseased part of the liver may require repetition of the samples (20%) is due to liver biopsy failure (small length).The risk of death from the biopsy is less than 1 in 1,000.[6] ,[7]

In the recent years, there has been an increasing interest in identifying and describing liver fibrosis through noninvasive surrogate markers measurable in the peripheral blood. Serum markers of liver fibrosis offer an attractive alternative [8]. They are less invasive than biopsy, with no risk of complications which is in the case of liver biopsy. Noninvasive tests are needed to avoid the dangerous side effects that can occur with a liver biopsy and to avoid the discomfort and expense of repeat biopsies [9]. According to BioPredictive [10] FT/AT has higher diagnostic values than several other markers, whether isolated or combined and unlike biopsy, the test can provide a non-invasive assessment of the stage of fibrosis and grade of necro-inflammatory activity by a numerical quantitative estimate of liver fibrosis ranging from 0.00–1.00 [11] (corresponding to stages F0-F4 and grades A0-A3 of the METAVIR scoring system [12], [13]

2. PREVIOUS WORKS

Data mining techniques (such as visualization) often used to create and deploy successful business intelligence solutions. By applying visualizations and data mining techniques, we can fully exploit data to discover previously unknown trends. In the medical industry uses data mining to predict the effectiveness of surgical procedures, medical tests and medications [14].Data visualization played an important role in health care. For instance in cancer microarray studies, (Khan, et al., 2001) summarized their analysis results in a planar visualization that shows a clear separation of diagnostic cases. FibroTest and ActiTest In previous study, Bourliere et al. (2006) assessed the diagnostic accuracy of noninvasive indexes in comparison with liver histology performed in HCV infected patients (n=235) and Forns score were assessed with liver histology performed on the same day. The authors reported that performing all the tests, and liver biopsy, improved the diagnostic accuracy (96%) for liver fibrosis in HCV patients without comorbidities. The authors state that any single test could not be a gold standard. The combination of all tests without liver biopsy allowed 81.3% of the patients to be correctly classified. Liver biopsy was mandatory in 18.7% of the patients.

3. RESEARCH METHODOLOGY

3.1 Data Mining Visualization

In healthcare, data mining is becoming increasingly popular, if not increasingly essential. Several factors have motivated the use of data mining in medical applications. Visual data mining techniques have proven to be of high value in exploratory data analysis. According to Friedman “the main goal of data visualization is to communicate information clearly and effectively through graphical means” [15]. The visualizations of the data allow the user to gain insight into the data and come up with new hypotheses. Visualization technique helps users understand their data. Visualization makes the bridge from text based to graphical presentation. Such things as decision tree, rule, cluster and pattern visualization help users see data relationships rather than read about them.

We used the Weka 3.6 software which is a collection of machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization. We also used the Grapheur software which takes data that is organized by rows and columns, visualizes them in a variety of ways, and helps you to discover patterns and similarities, to find causes and explanations. We also used Microsoft Excel to collect laboratory data but the input data file needs to be organized in the form of ARFF in order to be processed in the Weka environment. The root node is the Biopsy Fibrosis with five branches which present the 5 levels where the different laboratory values and patient characteristic are assigned one level at a time (figures 5, 6 and 7).

3.2 Case Study

3.2.1 Patients

A total number of 158 serum samples were collected from patients with (CHC). Serum samples were obtained and liver needle biopsy was performed on the same day. Levels of fibrosis in FibroTest and levels of activity in ActiTest, both determined via serum biochemical markers, were compared with levels of fibrosis and activity in histopathological examination.

The study group consisted of 158 patients (120 males and 38 females) with no prior antiviral treatment were included; All patients had positive HCV- RNA (genotype 4). The mean age of the patients was 50.4±10.3 years, ranging from 18 to 65 years. Biochemical assays are usually performed with fresh serum. Serum can be decanted and stored at –80°C, although freezing and thawing can only be done once.

Results of liver function tests within 4 weeks before biopsy were used for the analysis. Bilirubin, total protein, albumin, alanine transaminase (ALT), and alkaline phosphatase (ALP) were measured by OLYMPUS AU640 Chemistry Analyzer. Serum levels of (6 components of FibroTest-Acti Test) (Table 1) were measured using OLYMPUS AU640 Chemistry Analyzer and the complete blood count was measured using Hematology Analyzer (ABBOTT CELL-DYN 3700). Serum levels Detection of HCV RNA and HBV DNA was done by semiquantitative polymerase chain reaction.

FibroTest (FT)	ActiTest (AT
Total bilirubin	Total bilirubin
Gamma glutamyl transferase (GGT)	Gamma glutamyl transferase (GGT)
Haptoglobin	Haptoglobin
Alpha 2 macroglobulin (A2M)	Alpha 2 macroglobulin (A2M)
Apolipoprotein A1	Apolipoprotein A1
Age and gender	Age and gender
	Alanine transaminase (ALT)

TABLE 1: Serum Biochemical Markers for Fibrotest and Actitest.

3.2.2 Histologic Staging

Needle liver biopsy specimens were obtained from HCV-infected patients and histology for fibrotic staging (F) and inflammatory process (A) was determined by the department of pathology according to the METAVIR score. Fibrosis was staged on a F0–F4 scale: F0, no fibrosis; F1, portal fibrosis without septa; F2 portal fibrosis with few septa; F3 septal fibrosis without cirrhosis; and F4 cirrhosis. And grade of activity on A0-A3; A0, no activity; A1 mild; A2 moderate; A3 severe activity [16]. Patients with scores of F0 or F1 were considered to have insignificant fibrosis, and those with scores of F2, F3, or F4 were considered to have clinically significant fibrosis that qualified for combination antiviral therapy. Liver biopsies were performed at the time of serum sampling and were reviewed and classified according to the Metavir scoring systems (Table 2). All liver biopsies were formalin fixed and paraffin embedded. The stains used were haematoxylin, eosin and reticulin; the latter for better assessment of fibrosis.

Fibro Test	Metavir fibrosis stage estimate	Acti Test	Metavir Activity grade estimate
0.75-1.00	F4	0.63-1.00	A3
0.73-0.74	F3-F4	0.61-0.62	A2-A3
0.59-0.72	F3	0.53-0.60	A2
0.49-0.58	F2	0.37-0.52	A1-A2
0.32-0.48	F1-F2	0.30-0.36	A1
0.28-0.31	F1	0.18-0.29	A0-A1
0.22-0.27	F0-F1	0.0-0.17	A0
0.00-0.21	F0		

TABLE 2: Metavir Fibrosis Staging and Activity Grading.

4. RESULTS

4.1 FibroTest and Actitest

Tables 3 and 4 summarize the results of the six biochemical parameters in relation to Metavir fibrosis and activity scores, respectively (figure 1).

	Reference range	Metavir fibrosis score 0-1 (62 patients)	Metavir fibrosis score 2-4 (96 patients)
Total bilirubin(µmol/l)	< 17.0	16.6±0.21	19.3±2.2
GGT(U/L)	8.0 – 61.0	31±16	1234±21
Haptoglobin(g/l)	0.3 – 2.0	2.2±0.45	5.71±0.11
Alpha 2 macroglobulin(g/l)	1.32 – 3.0	3.88±1.28	4.02±1.24
Apolipoprotein A1(g/l)	1.04 – 2.02	1.66±1.22	1.86±0.90
ALT(U/L)	10.0 - 50.0	84±33	107±19

TABLE 3: Results of laboratory parameters in relation to Metavir fibrosis score.

	Reference range	Metavir activity score 0 (35 patients)	Metavir activity score 1-3 (123 patients)
Total bilirubin(µmol/l)	< 17.0	13.1±0.21	19.3±2.2
GGT(U/L)	8.0 – 61.0	160±16	1234±17
Haptoglobin(g/l)	0.3 – 2.0	1.99±0.87	5.71±0.11
Alpha 2 macroglobulin(g/l)	1.32 – 3.0	3.54±2.23	4.02±1.24
Apolipoprotein A1(g/l)	1.04 – 2.02	1.86±0.90	1.79±1.04
ALT(U/L)	10.0 - 50.0	44±19	107±33

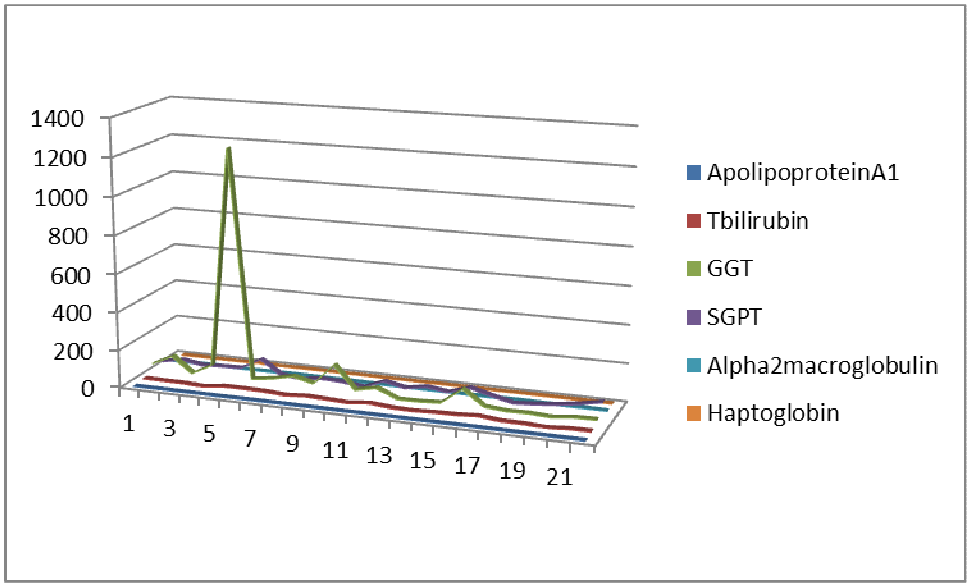


FIGURE 1: Results of the six biochemical parameters.

The reported FT scores indicate that 3% were F0, 65% F1, 18% F2, 2% F3, and 12% F4; The reported AT score indicate that 12% were A0, 38% A1, 25% A2, and 25% A3 (Table 5 and figure 2).

Fibrotest (n=158)		**Actitest (n=158)**	
F0	3%	A0	12%
F1	65%	A1	38%
F2	18%	A2	25%
F3	2%	A3	25%
F4	12%		

TABLE 5: Fibrosis stage (FibroTest Score).

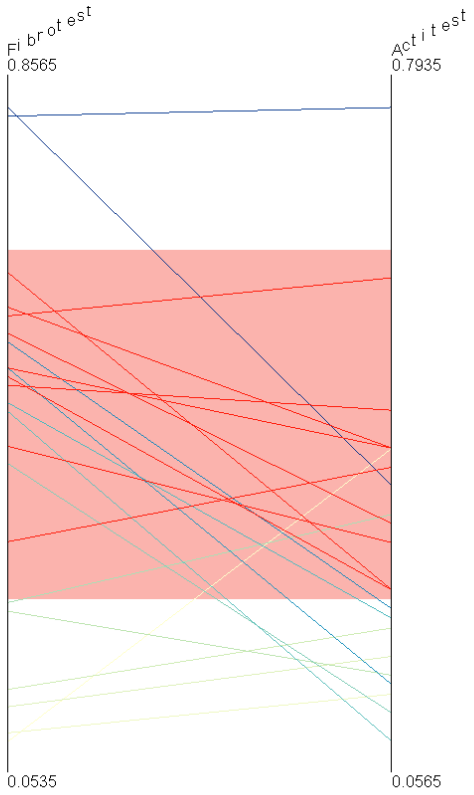


FIGURE 2 FT and AT score.

4.2 Liver Biopsy

The following distribution of METAVIR fibrosis stages was observed on liver biopsy: no fibrosis in 8 of 158 patients (F0 _ 5%); portal fibrosis in 101 of 158 (F1 _ 64%); few septa in 30 of 158 (F2 _ 19%); numerous septa in 3 of 158 (F3 _ 2%); and cirrhosis in 16 of 158 (F4 _ 10%) (Figure 3)

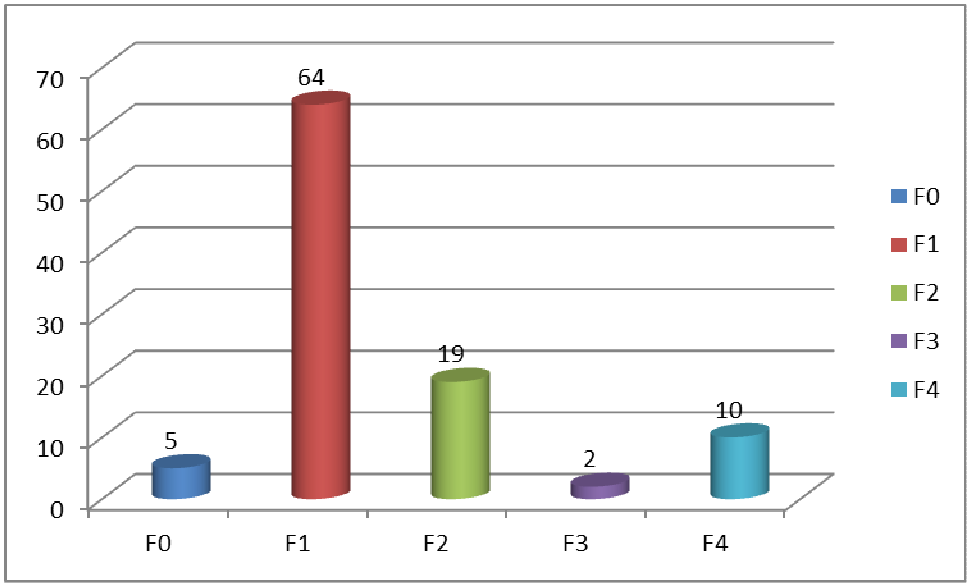
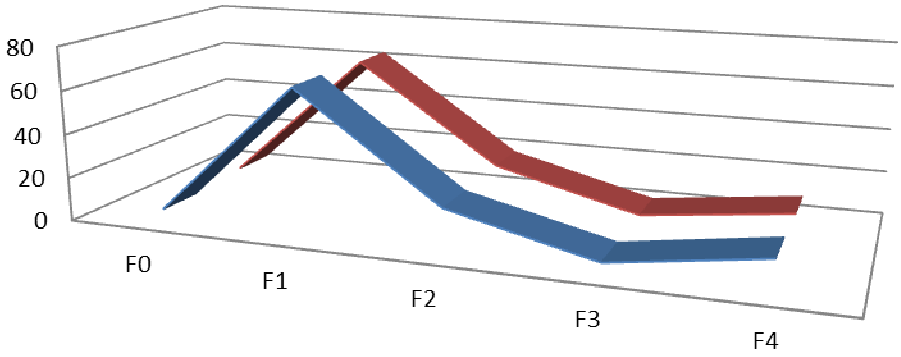


FIGURE 3 Severity of fibrosis in the studied group (%).



	F0	F1	F2	F3	F4
FibroTest	3	65	18	2	12
liver biopsy	5	64	19	2	10

FIGURE 4 Comparisons between FT and LB (%).

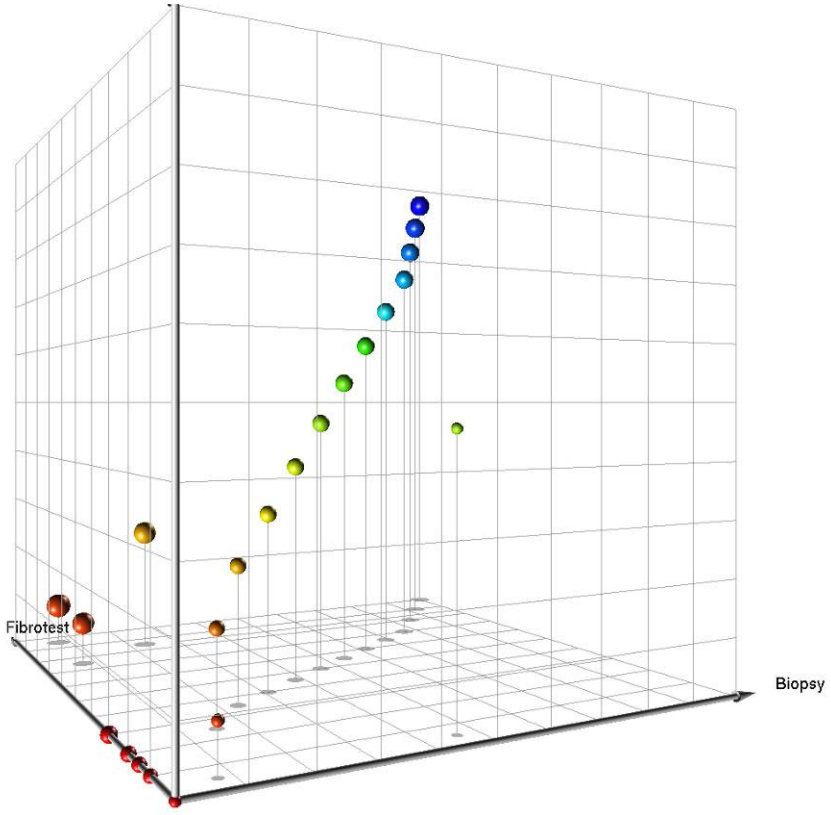


FIGURE 5 Comparisons between FT and LB.

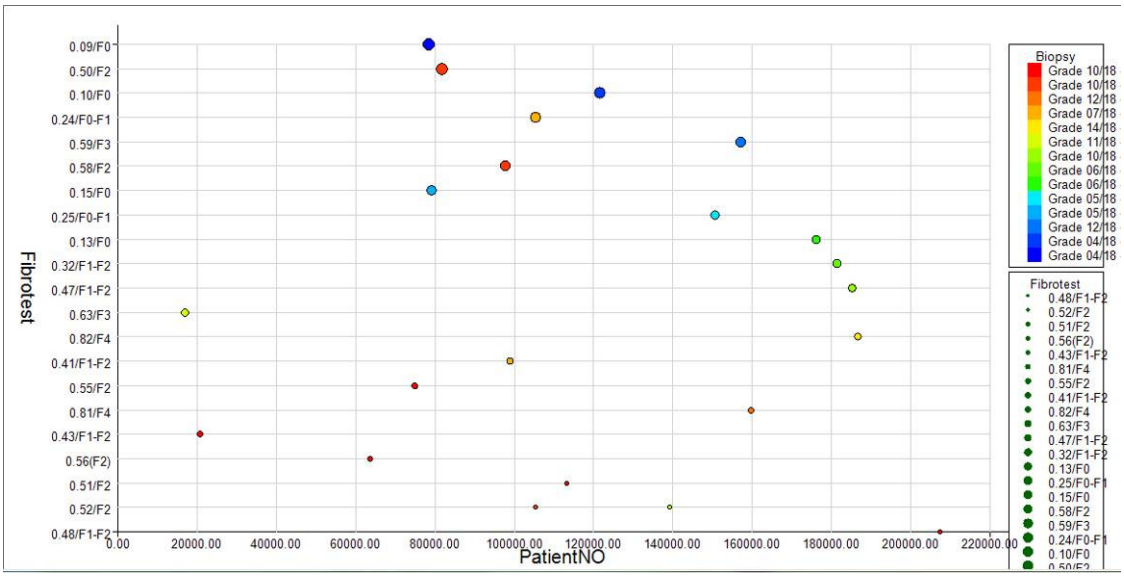


FIGURE 6 Comparisons between FT and LB.

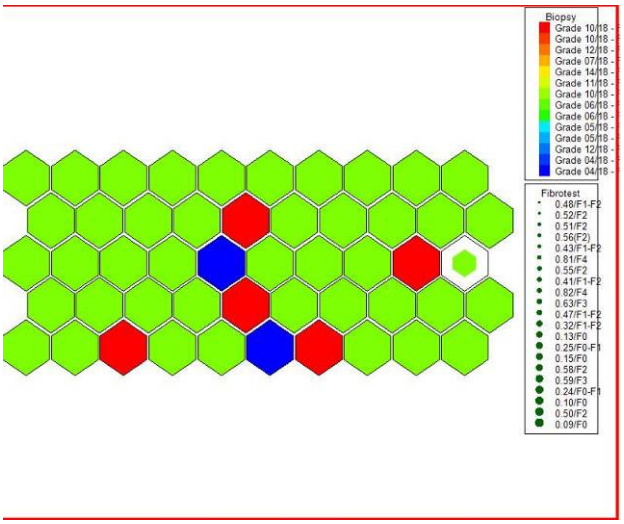


FIGURE 7: Comparisons between FT and LB.

5. EVALUATION AND DISCUSSION

Fibrotest-Actitest (FT/AT) – *BioPredictive* are a composite algorithm-based score computed from age, sex, and serum α2 macroglobulin, haptoglobin, apolipoprotein A1, total bilirubin, gamma glutamyltranspeptidase (GGT) and alanine aminotransferase (ALT). FibroTest (FT) measures the degree of fibrosis (scarring) and combines α2-macroglobulin, haptoglobin, apolipoprotein A1, total bilirubin and gamma glutamyltranspeptidase (GGT). ActiTest (AT) measures the degree of activity (necrosis and inflammation) by combining the above measures with alanine aminotransferase (ALT). Biochemical markers for liver fibrosis (FibroTest) and necroinflammatory features (ActiTest) are an alternative to liver biopsy in patients with chronic hepatitis C. Since September 2002, Fibrotest-Actitest has been used in several countries as an alternative to liver biopsy in order to estimate liver fibrosis and necroinflammatory activity in chronic viral hepatitis C. The main advantages of noninvasive fibrosis tests are the absence of risks and the potential to reflect the status of the entire liver.

There have been many studies made by researchers from all over the world in finding the best possible way to assessment the degree of hepatic fibrosis in patients with chronic HCV infection and compare them to liver biopsy and have suggested the use of FibroTest as a noninvasive alternative to liver biopsy for assessing fibrosis in patients with HCV and ActiTest for assessing necroinflammatory activity [17], [18], [19], [20]. In the present study FT-AT was found to have a greater diagnostic performance than LB which was in accordance with other researches.

Our results indicate that visualization techniques is useful and effective to show the prognostic value of FT was at least similar to biopsy and provide a qualitative and quantitative overview for doctors to find the relations between FT and LB. This value comes in the form of the stimulation received from the graphic which helps to give the viewer an understanding of the visual that would have been difficult to convey otherwise. Visualization has now come to mean the graphical representation of data or the transformation of information into images to support decision making. Value is the visual variable of color. This is a very powerful variable and can take on as many variations as the eye can distinguish. Visualization made it easier to visualize this information in the form of a graphic [21]. In conclusion, we have shown that the Fibrotest-Actitest is an easy test to perform and enables an accurate evaluation of the amount of fibrosis and inflammation in HCV patients in 92% of cases.

6. CONSLUSION

Data mining visualization can provide an excellent approach to knowledge discovery and provide a clear visual differentiation between biochemical markers and liver biopsy. Based on these results, the use of the biochemical markers of liver fibrosis (FibroTest) and necrosis (ActiTest) can be recommended as an alternative to liver biopsy for the assessment of liver injury in patients with chronic hepatitis C. The main advantages of noninvasive fibrosis tests are the absence of risks and the potential to reflect the status of the entire liver. Fibrotest is a simple and effective method to assess liver fibrosis, inflammation, and has the same diagnostic value as a biopsy, while being noninvasive and easily repeatable.

7. ACKNOWLEDGEMENT

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A Novel Hybrid Voter Using Genetic Algorithm and Performance History

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Abstract

Triple Modular Redundancy (TMR) is generally used to increase the reliability of real time systems where three similar modules are used in parallel and the final output is arrived at using voting methods. Numerous majority voting techniques have been proposed in literature however their performances are compromised for some typical set of module output value. Here we propose a new voting scheme for analog systems retaining the advantages of previous reported schemes and reduce the disadvantages associated with them. The scheme utilizes a genetic algorithm and previous performances history of the modules to calculate the final output. The scheme has been simulated using MATLAB and the performance of the voter has been compared with that of fuzzy voter proposed by Shabgahi et al [4]. The performance of the voter proposed here is better than the existing voters.

Keywords : TMR, Soft Threshold, Genetic Algorithm, Weighted Average Voting

1. INTRODUCTION

The fault tolerant techniques are adopted to increase reliability of critical systems like aerospace, telecommunication, healthcare etc. Triple Modular Redundancy (TMR) is the most commonly adopted scheme due to its ease of implementation and considerable increase in the reliability. Here three modules work in parallel and there outputs are evaluated by a voter which gives an output based on the voting scheme implemented in the voter. In digital voting scheme, the determination of exact majority vote is straight forward; however, while in case of analog systems, finding the majority consensus amongst the outputs of redundant modules of a TMR requires determination of majority considering two closest matching analog outputs of the redundant modules. For example, it is very difficult to obtain an exact match between the outputs of replicated analog sensors of a fault tolerant data acquisition system or if the output is generated by diversely implemented software using floating point arithmetic. Therefore the design and performance of analog fault tolerant systems has been greatly focusing on development of improved voter design which can use '*hard threshold*' or '*soft threshold*' based voter implementation [9,4] The hard threshold based voter implementations determine the majority consensus among the outputs of redundant analog modules using mid-value, fixed threshold [5,6]. The mid-value selector voting algorithm [5] generates voted output by considering the mid values of the outputs of redundant modules, fixed threshold voting [6] scheme generates majority output if the absolute difference between the outputs of different pairs of redundant modules are less than a prefixed value. In fixed threshold voting, the output from different modules are in agreement if the absolute difference between them is less than a fixed value otherwise they will be in disagreement. But the use of inexact voter with a fixed threshold value encounters many problems as (i) the value of threshold is application specific so selection of the threshold is critical. (ii) Different operational modes in applications require may require different value of

threshold (iii) some acceptable results may get ignored by using fixed threshold. Alternatively, soft threshold based fuzzy voters [4] has been reported to tackle the voter's accuracy problem. These voters convert the mod value of relative differences into fuzzy membership and apply fuzzy rules to generate consensus output from the voter. The fuzzy voters perform better than hard threshold voting schemes having fixed threshold but it proves ineffective beyond moderate differences between outputs of redundant modules. Therefore a need is felt to evolve a new voting logic adopting best of all method depending on the input.

In this paper a new hybrid method of voting using genetic algorithm and history based record is proposed which overcomes the disadvantages of previous voting methods. The availability and safety performance of the proposed genetic voter has been evaluated through MATLAB simulation studies and it is shown that our proposed design gives higher number of correct results without compromising with safety even in presence of larger mod differences. Section II describes the basic concepts of genetic algorithm followed by the proposed genetic and history based voter in section III. Section IV presents the MATLAB simulation of the proposed voter along with the variation in outputs of redundant modules. The simulation results indicating the error minimization in the voted output in terms of availability and safety as compared to the fuzzy voter have been discussed in section V. Section VI contains the conclusion indicating its benefit in design of fault tolerant systems.

2. GENETIC ALGORITHM

Genetic algorithm introduced by John Holland works on principle of natural evolution [11]. Further the efficiency of Genetic algorithm has been mathematically established [2].

Solution to problems using genetic approach involves encoding and evaluation. The parameters of interest are converted into codes and combined together to form a chromosome. Further the solution is evaluated for a fitness function in an iterative manner. Figure 2.1 shows the basic flow chart of the genetic algorithm where an initial population of solutions of a given problem is generated and the value of fitness function (which has to be minimized/maximized) for each solution is calculated, the solution with better fitness function has a higher probability of survival. A simple genetic algorithm that yields good results is composed of three operations:

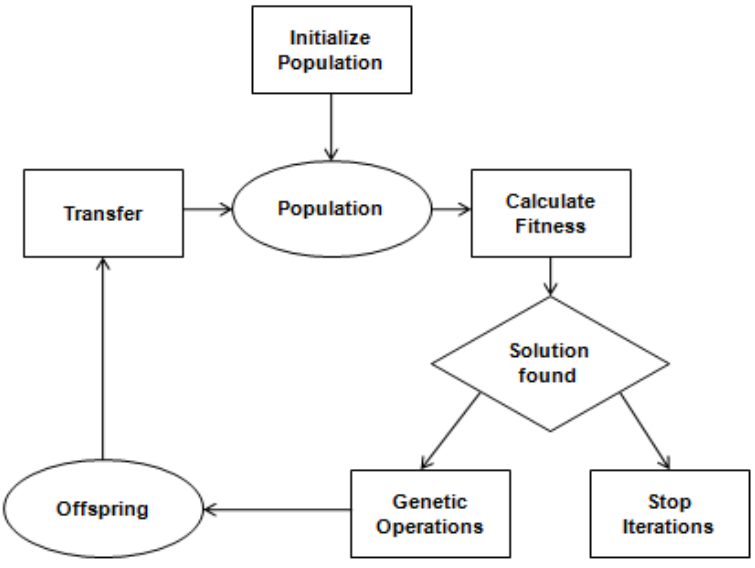

FIGURE 2.1: Flow Chart of Genetic Algorithm Process

1. Reproduction
2. Crossover

3. Mutation

Reproduction is a process in which individual solutions are selected according to their objective function values, F (fitness function). Selecting solutions according to their fitness values ensures that they have a higher probability of contributing one or more offspring in the next generation.
After reproduction, simple **crossover** may proceed in two steps. First, members of the newly reproduced solutions are selected randomly. Second, each pair of solutions undergoes swapping of information at certain position/s.

Mutation is a genetic operator that alters one or more gene value in a chromosome (solution) from its initial state. This can result in an entirely new chromosome added in next generation. With these new gene values, the genetic algorithm would be able to arrive at better solution compared to the previous cycle.

3. THE PROPOSED VOTING METHOD

The proposed voter has been implemented as a Triple Modular Redundancy (TMR); however it can be extended to N-Modular Redundancy. It has been observed during our study of different majority voting schemes reported in the literature that a common voting strategy is generally considered for all categories of module outputs across the board. It is felt that if the voter can be made intelligent to adopt voting logic depending on the modules' agreeability with each other, it can give better results. Therefore here we propose a hybrid voting scheme which adapt itself depending on the agreeability between different modules. The agreeability between two modules is defined in terms of their mod differences with each other. If the mod difference is less than a predefined threshold value (∈); the two modules are said to be in agreement. Let d_{ij} represents the mod difference between outputs of modules *i* and *j* i.e. $d_{ij} = |X_i - X_j|$

In all for a TMR, three cases can occur namely:

Case-1 is the case where all the modules are in agreement with each other i.e. the max difference d_{ij} is within threshold limit.

Cae-2 is the case where all three modules are not in agreement with each other but atleast one module-output pair is in agreement with each other so that it follows TMR principle. So in this case min difference d_{ij} should be less than threshold value.

Case-3 is the case where no module output-pair is in agreement with each other, so here principle of TMR violates.

The output **y** will be calculated using weighted average method in all three cases but the strategy to calculate weight of each module will be different for the three cases.
The procedure to calculate voter output y for (all these three cases) is shown in figure (3.1). The max value of difference d_{ij} less than the threshold value (∈) indicates that all module outputs are in agreement with each other**.** Therefore the output y is taken as mean of all three inputs.

i.e**.** $W_1 = W_2 = W_3 = 1$ and

$$y = \frac{(X_1+X_2+X_3)}{3} \quad (1)$$

If the max value of difference d_{ij} is not less than threshold value but min value of difference d_{ij} is less than threshold (**ε**)**.** It implies that atleast one pair is in agreement with each other, the weights are calculated using the fitness function defined in eq. (2) which should be minimized to get the weights for modules:

$$F = \sum_{i=1}^{3} \frac{\epsilon}{\min(d_{ij}, d_{ik})} * (y - X_i)^{\frac{(d_{ij}+d_{ik}+d_{jk})}{(d_{ij}+d_{ik})}} \; ; i \neq j \neq k \quad (2)$$

The value of output y corresponding to minimum fitness value is considered as the voter output.
The value of weight W_i in genetic algorithm is represented in binary number b and the real value of this weight is calculated by eq. (3)

$$W_i = W_{min_i} + \frac{b}{2^L - 1}(W_{max_i} - W_{min_i}) \quad (3)$$

As the values of weights are in [0-1] range so W_{min}= 0 and W_{max}= 1, where b is the binary value of weight W_i and L is no. of bits representing W_i.

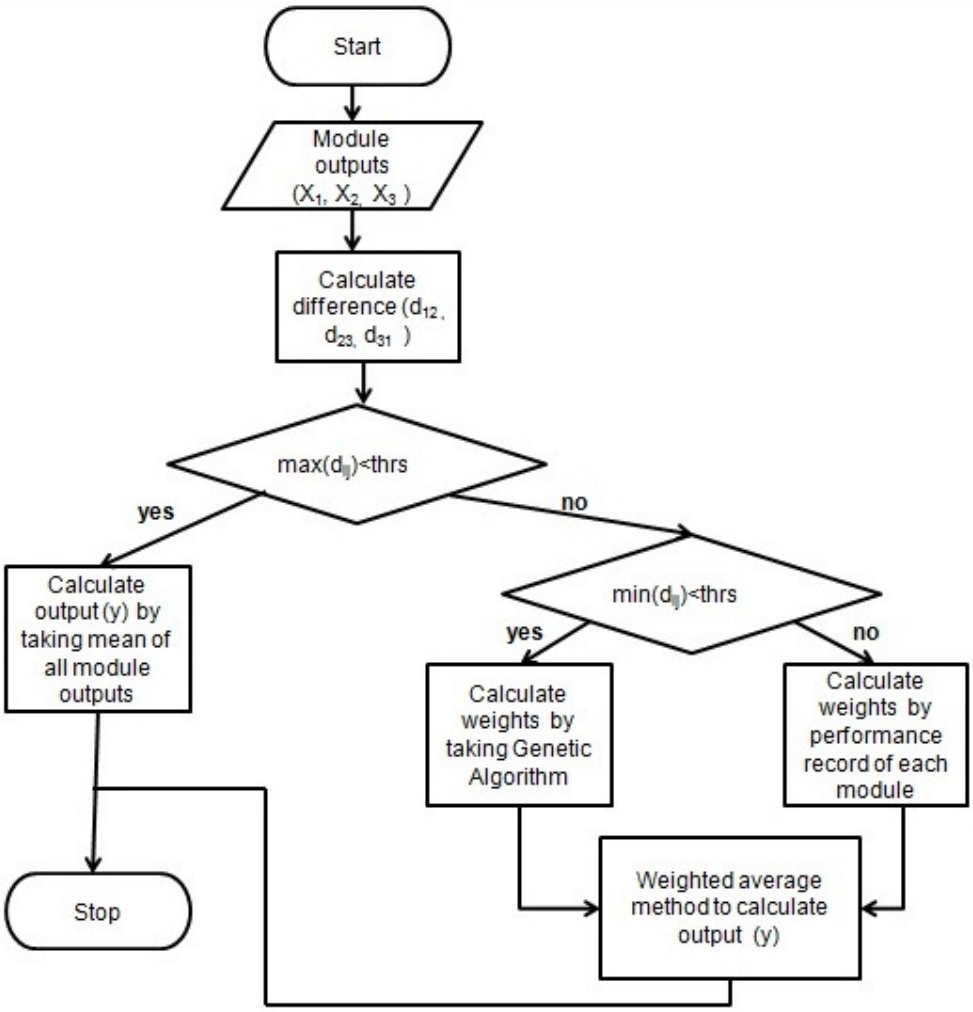

FIGURE 3.1: Flow chart of proposed voter

When there is no agreeability even between a single module pair (case 3) i.e. min (d_{ij}) > ε, the output y is calculated with the help of previous performance history of each module. A performance parameter P_i for each module is defined and its value depends upon the participation history record of each module. The algorithm below describes how the performance of each module is saved when at least one module pair is in agreement, and when there is no agreeability even between a single module pair, the performance parameter P_i is used as weight for each module.

Initialize all P_i's to 0 and j=0
For each cycle
{
If min (d_{ij}) < threshold
Calculate weights W_i's with the help of genetic algorithm;
Increment P_i by 1 corresponding to the module with max weight;
j = j+1;
When min (d_{ij}) > threshold

For each module, weight $W_i = {}^{P_i}/_{j}$ ***;***

}

The performance parameter corresponding to the module whose weight is highest will get incremented by 1 and in each cycle this procedure will be repeated so in totally disagreement condition these P_i's will be used as weights for the modules. j represents total number of cycles.

IV. MATLAB Simulation:

The proposed genetic voter has been designed in MATLAB R2009a which uses genetic toolbox. The schematic depicting the experiment conducted using the proposed genetic voter based TMR system is shown in figure (4.1) below.

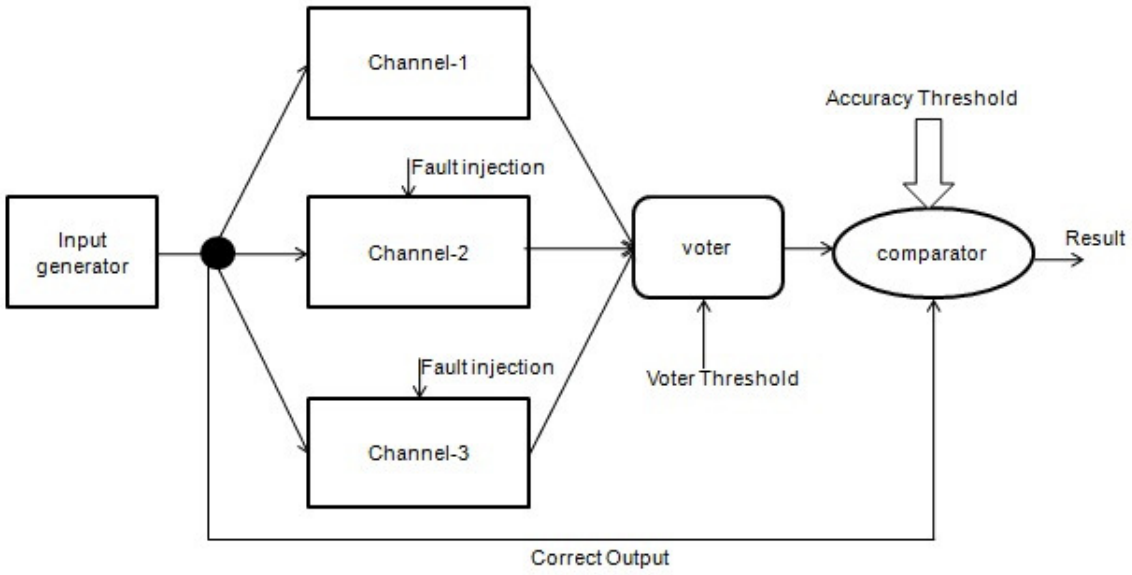

FIGURE 4.1: Simulation Model

An input data generator is used to generate data and error in two channels is injected. The input data generator produces correct output in each cycle and uniformly distributed random errors are injected in this notional correct output. Now these faulty outputs are supplied to the genetic voter and voter result is compared with the notional correct output. If the voter output is within an accuracy threshold value from the notional correct output, the voter output is considered to be correct while if the difference is larger than threshold value, output is considered to be incorrect. The method adopted is same as used by shabgahi et al.[4] where a fuzzy based voter has been proposed.

The following parameters are used to do experiment on proposed voter:

- Input data: u (t) = 100+100*sin (t) sampled at 0.1 sec.
- Accuracy Threshold value=0.5
- One module is fault free, while the error in other two has been injected randomly by uniform distribution in interval [$-e_{max}+e_{max}$].
- The simulation experiment is performed for 10^4 cycles and no. of correct results n_c, no. of incorrect results n_{ic}, and no. of benign results n_d are calculated. Benign output means that voter is not able to produce any output.
- The availability A of the system is defined as: $A - \frac{n_c}{n}$
- The safety S of the system is defined as: $S = (1 - \frac{n_{ic}}{n})$

  Where n is total no. of outputs i.e. $n = n_c + n_{ic} + n_d$

5. SIMULATION EXPERIMENTS

Experiments compare the performance of proposed genetic voter with the fuzzy voter [4] in terms of safety and availability parameter defined above. Figure 5.1(a) and 5.1(b) shows the availability and safety performance respectively of two voters when one module is fault free and the fault in other two modules has been injected randomly with uniform distribution in range [$-e_{max}$ $+e_{max}$]. The x-axis in graph shows the value of maximum amplitude e_{max}. It is observed that our proposed voter gives [0-32]% better availability and [0-5]% better safety results as compared to fuzzy voter proposed in [4]. For example when the fault injected in two modules are of magnitude [-5 +5], the following table shows the results for both the voters:

Voter	No. of correct outputs (n_c)	No. of incorrect outputs (n_{ic})	No. of benign outputs (n_d)
Genetic Voter	5515	2390	2095
Fuzzy Voter	2503	2391	5106

TABLE 1: comparison of results for max error amplitude of 5

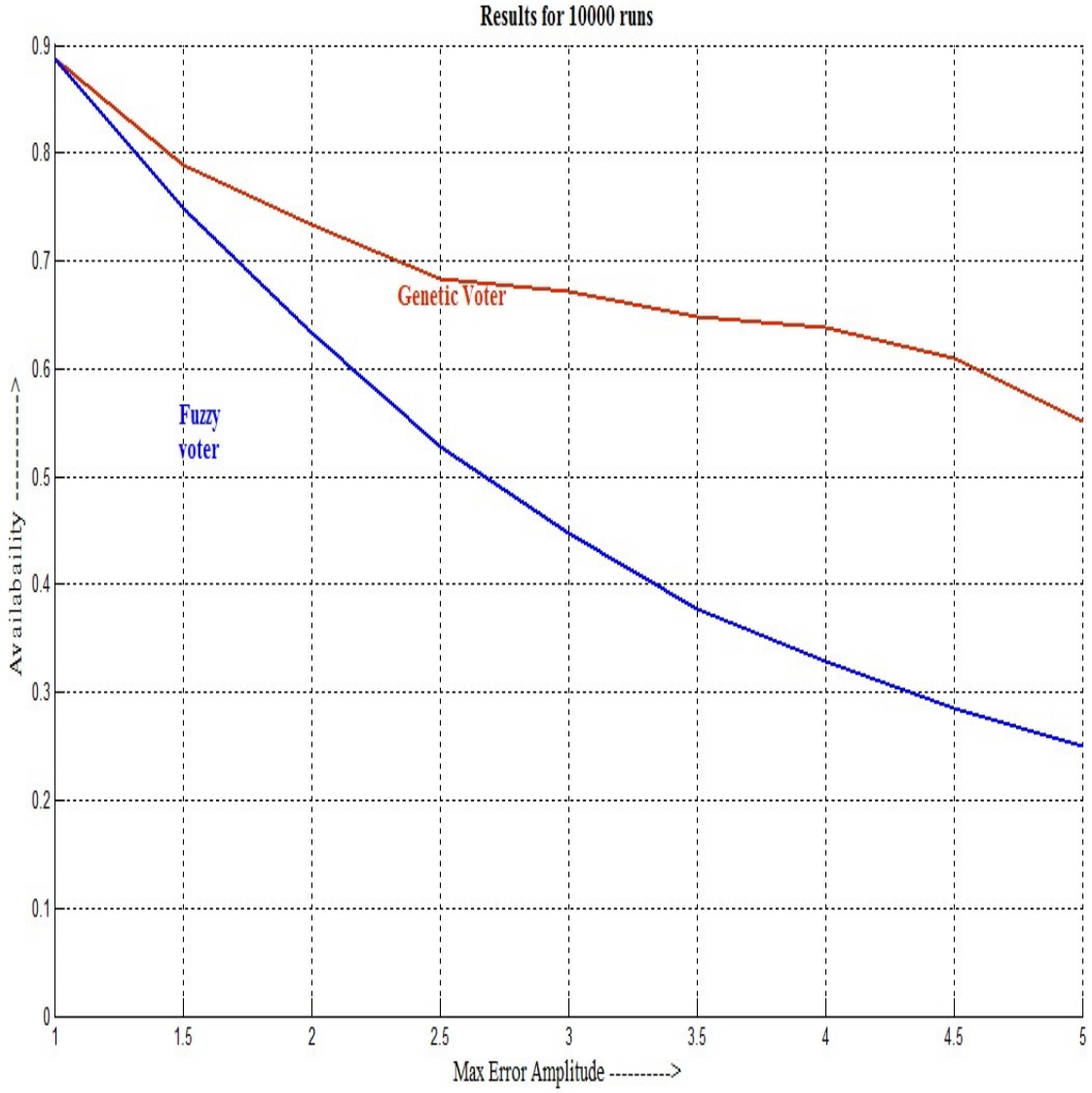

FIGURE 5.1(a): Performance comparison of voters in terms of availability when fault injection in two modules is within the same range

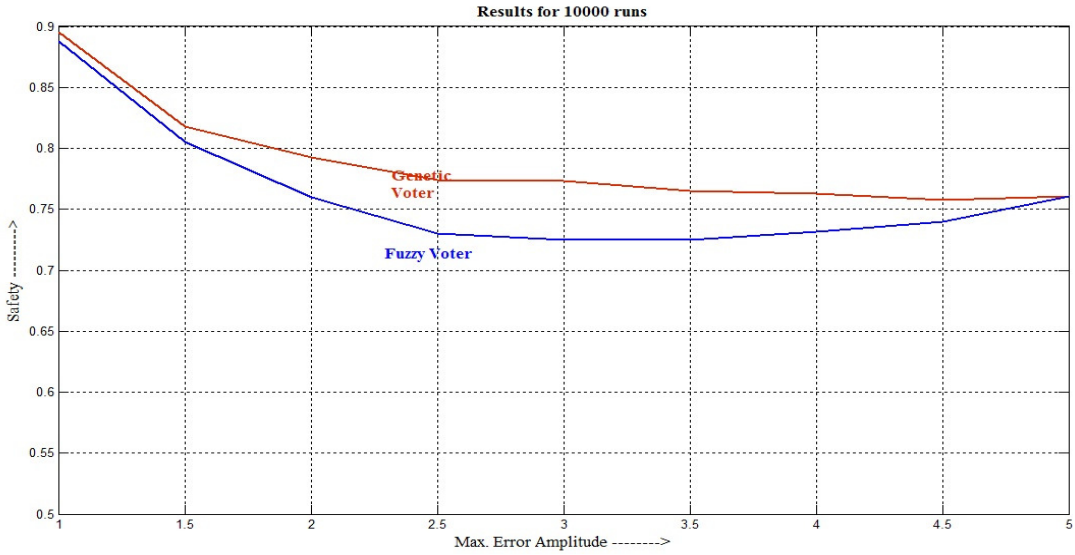

FIGURE 5.1(b): Performance comparison of voters in terms of safety when fault injection in two modules is within the same range

Figure 5.2(a) and 5.2(b) shows the availability and safety performance respectively of two voters when one module is fault free, second module is more faulty where the fault has been injected randomly with uniform distribution in range [-5 +5], and fault in third module is varied from [$-e_{max}$ $+e_{max}$]. The x-axis in graph shows the value of maximum amplitude e_{max}. It is observed that without compromising with safety our proposed voter gives [1-35] % better availability in this case as compared to fuzzy voter.

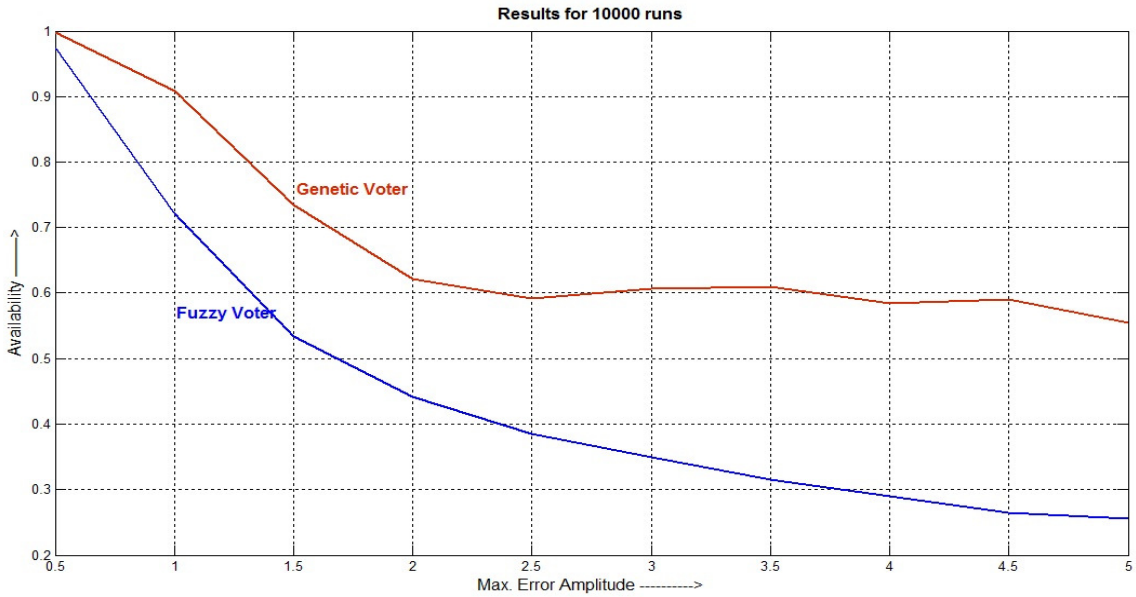

FIGURE 5.2 (a): Performance comparison of voters in terms of availability when fault injection in two modules is in the different ranges.

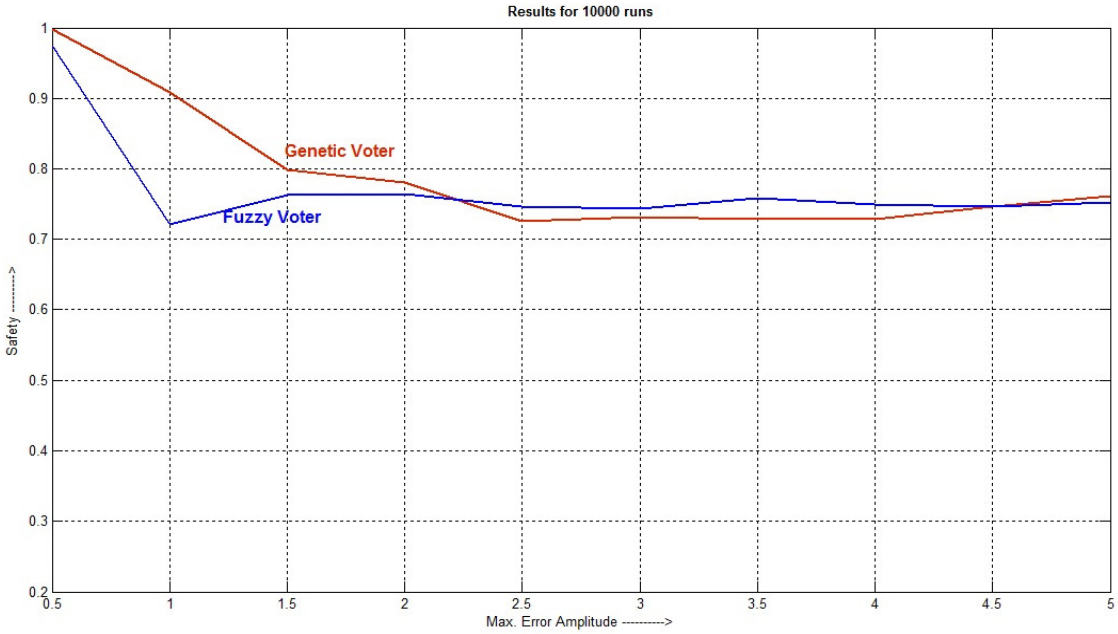

FIGURE 5.2 (b): Performance comparison of voters in terms of safety when fault injection in two modules is in the different ranges.

The majority voting techniques for analog inputs work towards an approximation for approval of agreeability between the modules. It becomes a challenging task to evolve a method for the approximation which is a compromise between safety and availability of the system output. The aim is to suggest a scheme to maximise both these parameters so that these schemes can be used as a generic algorithm for critical fault tolerant systems. Among the existing algorithms reviewed in the literature it has been seen that the fuzzy voter proposed by Shabgahi provides a better fault tolerant solution both in terms of the safety and availability parameters. However the voter falls short of expectations for larger errors. The new hybrid scheme based on genetic algorithm and performance history has been validated through simulation and found to be better in terms of availability [0-32]% for all the cases with higher magnitude and the safety parameter has been ensured to be better to some extent [0-8]%.

6. CONCLUSION

In this paper we propose a novel hybrid voter using genetic method and performance history of the modules. The algorithm has been simulated using MATLAB and its performance with respect to safety and availability has been found to be better than the existing voting techniques. This voter can be implemented for systems requiring high availability without compromising with the safety; however for time critical applications better genetic search techniques would be required to ensure time bound response of the system.

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The Identification Level of Security, Usability and Transparency Effects on Trust in B2C Commercial Websites Using Adaptive Neuro Fuzzy Inference System (ANFIS)

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Abstract

With the rapid development of Internet, the number of online customers is growing fast. This growth is supported by spreading of Internet usage around the globe. However, the question of security and trust within e-commerce has always been in doubt. This study generates general knowledge about e-commerce. This study specifically gives an overview to understand different factors about security and trust between companies and their consumers. In order to Three e-stores and their websites were examined based on the model proposed .This study also mentions that security and trust work parallel and close to each other. If a consumer feels that an online deal is secured and they can trust the seller, it leads to a confident e-commerce's trade. The main focus of this study is to find out a suitable way to resolve security and trust issues that make e-commerce an uncertain market place for all parties. The findings of this study indicate that, character of security is regarded as the most important to building trust of B2C websites. The proposed model applies Adaptive Neuro-Fuzzy model to get the desired results. Two questionnaires were used in this study. The first questionnaire was developed for e-commerce experts, and the second one was designed for the customers of commercial websites. Also, Expert Choice is used to determine the priority of factors in the first questionnaire, and MATLAB and Excel are used for developing the Fuzzy rules. Finally, the Fuzzy logical kit was used to analyze the generated factors in the model.

Keywords: ANFIS, E-commerce, Trust, Security.

1. INTRODUCTION

These years many researchers have put eyes on this new academic area of online environment because of the rapidly popularity of Internet. Some researchers examined impact of online shopping environments on consumer choices and factors which influence shopping online, some researchers have discussed the role of Internet shopping as a channel of distribution, and some researchers pointed out impact of online shopping on price sensitivity. There are also other researchers; they are interested in the people who are not willing to shopping online. According to the findings of Sandra, Forsythe and Shi (2003), Internet users are classified into Internet shoppers (those who have made purchases on the Internet) and Internet browsers (those who have browsed online for product/service but not made purchases on the Internet) [1, 12].

The Previous findings in e-commerce trust area has showed that trust is an interpersonal determinant of behavior that deals with beliefs about the integrity, benevolence, ability and predictability of other people [11].

The detailed information on trust and the security system that is implemented by companies for secure transactions are important attributes in B2C e-commerce. According to Lightner the rewards of B2C e-commerce are realized partially through well-designed websites, since they act as the primary contact with customers. There are some factors for consumers trust in online buying when they plan to buy, and also there are more factors and matter of interactions when they are on the buying process in online and after one[13].So website designers must consider factors, in a website allowing the emergence of confidence between an online seller and a customer. A significant survey, which took place in United States between educators and practitioner, was about the security issues in e-commerce. The survey's result showed that most of educators and practitioners were worried about their online payment and personal information, because the lack of trust regarding the security issues within the e-commerce. They were even unhappy to get unpleasant long mailing list from different places, which could cause variants of virus attack, spreading of their personal information and their credit card number. (Carr et al., 2010) Security and trust issues could be found both within companies that engaged with small businesses and companies doing broader businesses. Jonathan (2003) means that the criminals often try to crop the information of the online consumers by establishing so called "spoof sites", which are fake Web sites. He means that such Web sites are being created by using the HTML code of the Web sites that are legitimate. By doing this the criminals manage to create a site that exactly looks like the legitimate businesses' site[2,14].

Further the author means that the criminals could misuse the consumers of that Web site by different ways, like sending them e-mails with false information in order to gain consumers' personal information. He means that the whole process could end up with criminals tricking the consumers and get access to their financial accounts and so on.

Technical competence is a key factor when it comes to gaining the customers trust. It is imperative that the e-commerce website is completely functional. Make sure all words are spelled correctly, there are no broken links or dead images, search engines yield proper results, etc. If the website does not function properly, it gives an unprofessional impression. Customers will rather put their trust in a website that seems qualified [3,10].There are many factors that are important within e-commerce, which should be improved. But

considering our limited resource we have chosen to focus on security within e-commerce. The study is limited to only e-commerce companies, i.e. security issue and solutions for it would be studied from business to consumers' (B2C) perspective. This study will be about finding ways to create trust for consumers while doing businesses within e-commerce. So a key element in e-commerce is trust. Without trust it would be impossible to do business at all. It is not easy for customers to know if an e-commerce site is trustworthy or not. Therefore, it is essential to have a well structured site where the customer can find the information needed. Security is also an important issue when developing an e-commerce site. The customers should always know that the information they provide will not be sold or misused in any other way. This is essential since the customers might provide sensitive information such as their credit card number [4, 5, 6, and 8].Importance of trust makes it a critical success factor for most suppliers/retailers to focus on it more, comparing other issues necessary for their business. As the Internet develops and grows, its success will largely depend on gaining and maintaining the trust of visitors. Such trust will be paramount to sites that depend on consumer commerce. The concept of trust is crucial because it affects a number of factors essential to online transactions, including security and privacy. Trust is also one of the most important factors associated with branding. Without trust, development of e-commerce can not reach its potential. In a joint research project conducted by Cheskin and Studio Archetype/Sapient, released in January 1999, the factors that produce a sense of trustworthiness on a website were identified [33].

In a follow-up study begun early in 2000, Cheskin probed the dimensions of online trust across the Americas by linking the learning in both studies, understanding of the nature and dynamics of website trust can be dramatically enhanced [33].

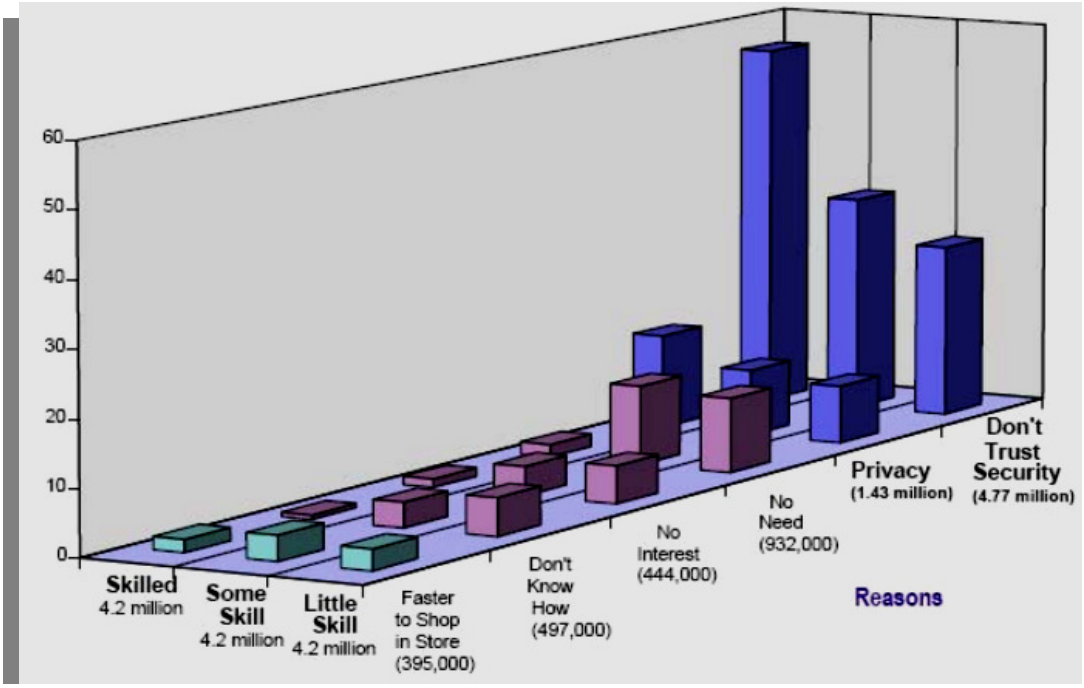

FIGURE 1: Attitudes impact customer internet to buy on the web.

In Figure 1, they have examined the relationship between online experience, closely correlated with and reported here as skill and also the reasons for not shopping online [33].

They have examined only that combination of web users who have never shopped online and never plan to. Overall, the most important reasons that non-buyers are uninterested in online shopping and it's not important for them not to shop online are not functional, but those are related to issues of controlling their personal information.

It is apparent that negative perceptions regarding security and privacy increase with increasing levels of online proficiency. The reverse is true for the functional reasons; web users do not shop online, including no perceived need, no interest, no knowledge of how to shop online and the belief that it is faster to shop in physical stores. In essence, the more experience one acquires online, the less important are the functional barriers to online shopping and the more important are concerns of control over personal information. Trust is an essential component of all successful buyer-seller relationships; the emergence of online business has brought about new challenges for building trust. On Business to customer relations, trust is very hard to achieve because comparing to Business to Business relations, it is for a short time and it is more transaction focused.

By developing the technology world, due to high investments, lack of a sudden shift for a better transaction and safer one, always is noticed and considered.

2. BASIC CONCEPTS

2.1. BACKGROUND OF ANFIS

Fuzzy logic was introduced by Zadeh in 1965 to represent and manipulate data and information in which there are various forms of uncertainty. Fuzzy rule-based systems use linguistic variables to reason using a series of logical rules that contain IF-THEN rules which connect antecedent(s) and consequent(s), respectively. An antecedent is a fuzzy clause with certain degree of membership. Fuzzy rules can have multiple antecedents connected with AND or OR operators, where all parts are calculated simultaneously and resolved into a single number.

Consequents can also be comprised of multiple parts, which are then aggregated into a single output of a fuzzy set [18].Fuzzy inference is a process of mapping from a given input to an output using the fuzzy set methods.

ANFIS is the implementation of fuzzy inference system (FIS) to adaptive networks for developing fuzzy rules with suitable membership functions to have required inputs and outputs. FIS is a popular and cardinal computing tool to which fuzzy if-then rules and fuzzy reasoning compose

bases that performs mapping from a given input know-ledge to desired output using fuzzy theory. This popular fuzzy set theory based tool have been successfully applied to many military and civilian areas of including decision analysis, forecasting, pattern recognition, system control, inventory management, logistic systems, operations management and so on. FIS basically consist of five subcomponents (Topçu and Saridemir, 2008), a rule base (covers fuzzy rules), a database (portrays the membership functions of the selected fuzzy rules in the rule base), a decision making unit (performs inference on selected fuzzy rules), fuzzification inference and defuzzification inference. The first two subcomponents generally referred knowledge base and the last three are referred to as reasoning mechanism (which derives the output or conclusion) [34].

An adaptive network is a feed-forward multi-layer Artificial Neural Network (ANN) with; partially or completely, adaptive nodes in which the outputs are predicated on the parameters of the adaptive nodes and the adjustment of parameters due to error term is specified by the learning rules. Generally learning type in adaptive ANFIS is hybrid learning (Jang, 1993). General structure of the ANFIS is illustrated in Figure 2 [35].

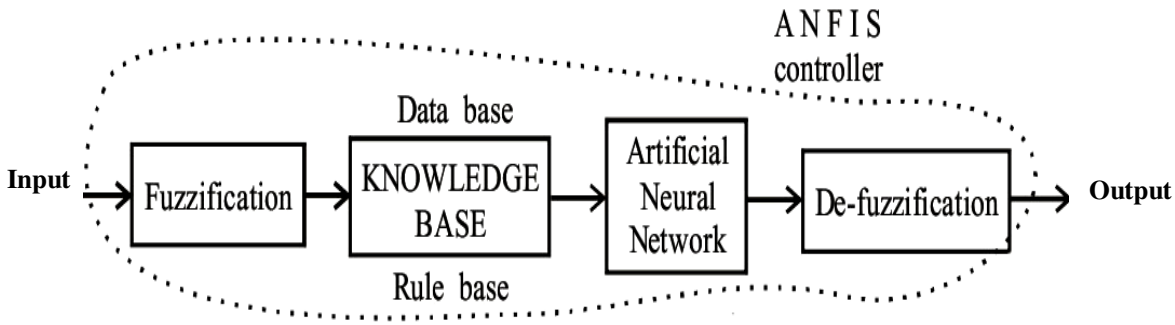

FIGURE 2: Schematic diagram of Fuzzy building blocks

The ANFIS is a multilayer feed-forward network which uses neural network learning algorithms and fuzzy reasoning to map inputs into an output. Indeed, it is a fuzzy inference system (FIS) implemented in the framework of adaptive neural networks. For simplicity, a typical ANFIS architecture with only two inputs leading to four rules and one output for the first order Sugeno fuzzy model is expressed [15, 16, 17, 18, 22, 23, and 24].
The ANFIS architecture is shown in figure3.

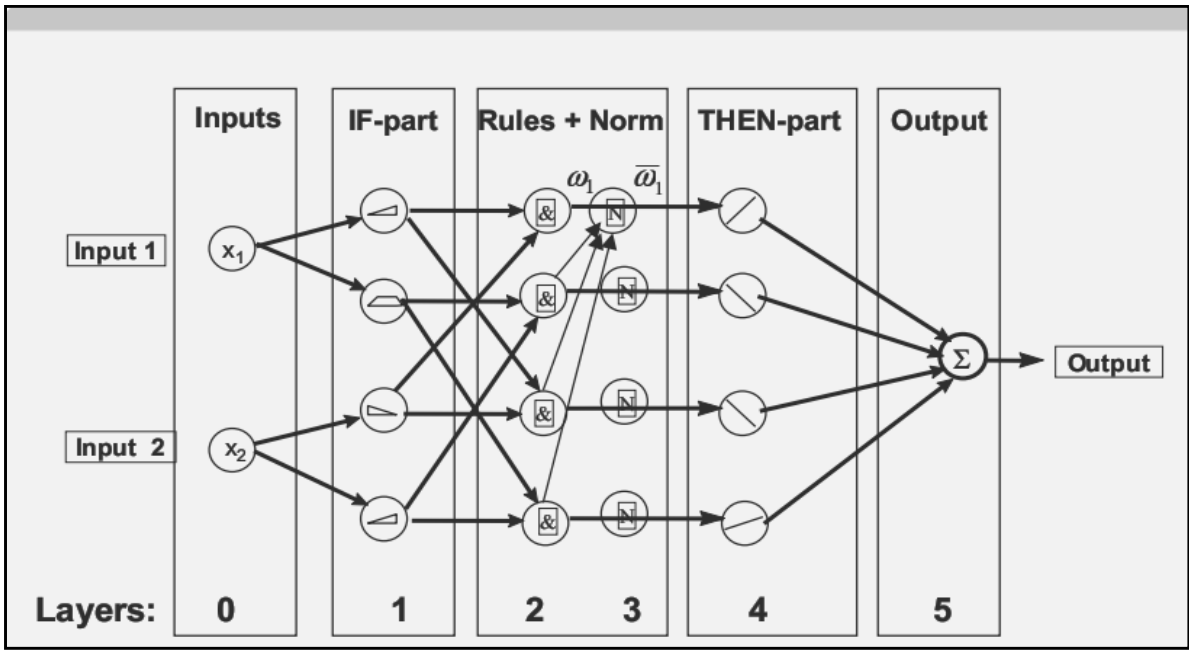

FIGURE 3: A typical ANFIS architecture for a two-input Sugeno model with four rules

Using a given input/output data set, the ANFIS method constructs a fuzzy inference system (FIS) whose membership function parameters are tuned (adjusted) using either a

backpropagation algorithm alone, or in combination with a least squares type of method. This allows fuzzy systems to learn from the data they are modeling. FIS Structure is a network-type structure similar to that of a neural network, which maps inputs through input membership functions and associated parameters, and then through output membership functions and associated parameters to outputs.

In our case ANFIS is a four-layer neural network that simulates the working principle of a fuzzy inference system. The linguistic nodes in layers one and four represent the input and output linguistic Variables, respectively. Nodes in layers two are term nodes acting as membership functions for input variables. Each neuron in the third layer represents one fuzzy rule, with input connections representing preconditions of the rule and the output connection representing consequences of the rules. Initially, all these layers are fully connected, representing all possible rules.

The suggested ANFIS has several properties:

- The output is zero ^{the} order Sugeno-type system.
- It has a single output, obtained using weighted average defuzzification. All output membership functions are constant.
- It has no rule sharing. Different rules do not share. The same output membership function, namely the number of output membership functions must be equal to the number of rules.
- It has unity weight for each rule.

Three feature variables are selected as inputs of the ANFIS. Three membership functions (Mfs) are assigned to each linguistic variable. The suggested ANFIS model is shown in Fig. 4. It shows the fuzzy rule architecture of ANFIS consists of 27 fuzzy rules. In this study for space trust problem, the cross sectional areas of the structures are selected as ANFIS inputs and nodal displacements, element stresses and ultimate load factor can be separately considered as ANFIS output. For each input two Gaussian membership functions are adopted and the maximum number of epochs in training mode is set to 250. Figure 5 shows the flow chart for trust model via ANFIS.

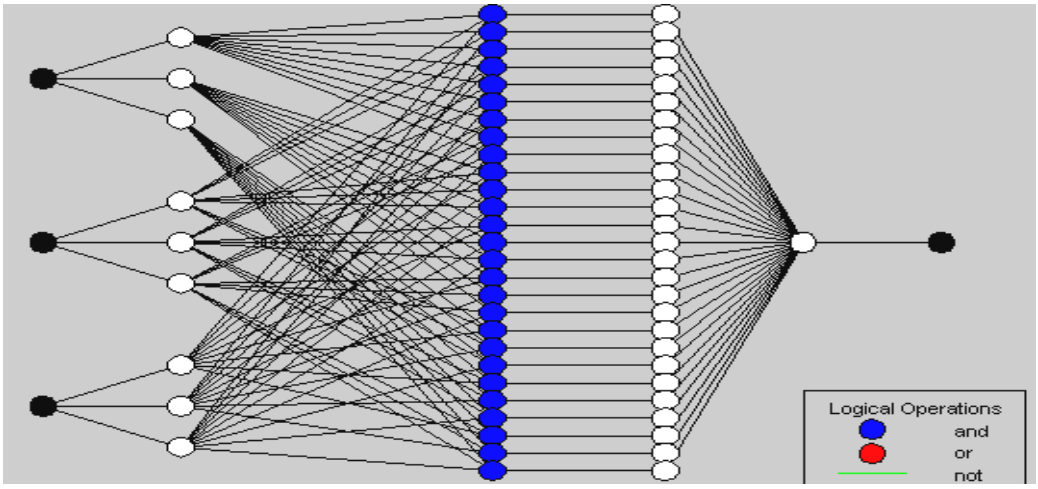

FIGURE 4: The ANFIS structure for research model

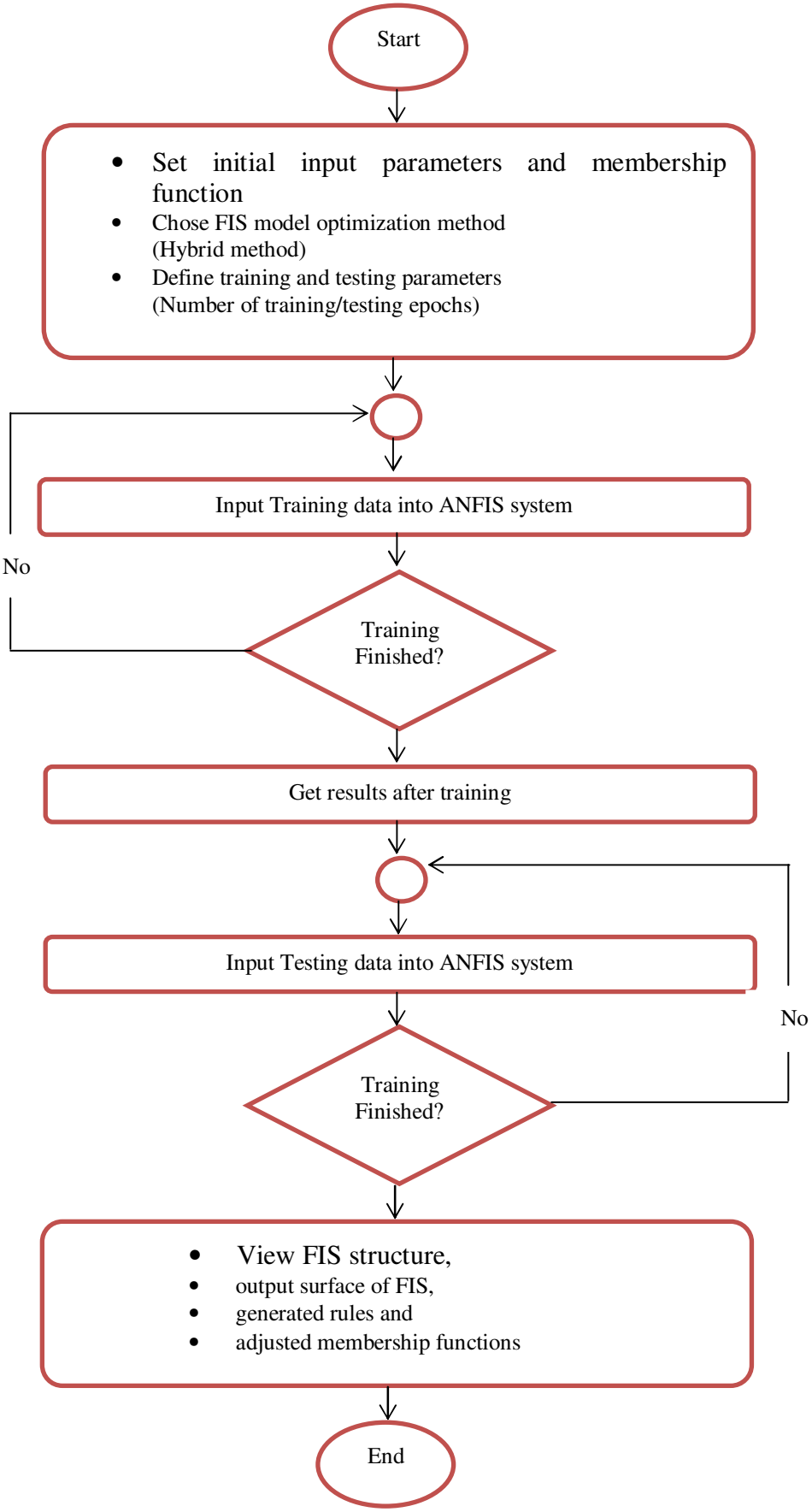

FIGURE 5: Flowchart of force prediction of ANFIS system

2.2 ANALYTIC HIERARCHY PROCESS (AHP)

Fundamentally, AHP provides a "ratio scale" of relative magnitudes expressed in dominance objects to represent judgments in the form of paired comparisons. An overall ratio scale is then synthesized to obtain a ranking of the objects, and thus ratio transitivity is also implied in the process of deriving the relative weight for objects.

Saaty developed the following steps for applying the AHP:

1. Define the problem and determine its goal.

2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which sub-sequent levels depend) to the lowest level which usually contains the list of alternatives.

3. Construct a set of pair-wise comparison matrices (size n □ n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.

4. There are n(n-1)/judgments required to develop the set of matrices in step 3. Reciprocals are auto- magically assigned in each pair-wise comparison.

5. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

6. Having made all the pair-wise comparisons, the consistency is determined by using the igenvalue, λmax, to calculate the consistency index, CI as follows: $CI = (\lambda_{\max} - n)/(n-1)$, here n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 1. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

7. Steps 3-6 are performed for all levels in the hierarchy [25, 26, 27, and 28].

Numerical rating Verbal judgments of preferences	Numerical rating Verbal judgments of preferences
Extremely preferred	1
Very strongly preferred	2
Strongly preferred	3
Moderately preferred	4
Equally preferred	5
Very strongly to extremely	6
Strongly to very strongly	7
Moderately to strongly	8
Equally to moderately	9

TABLE 1. Pair-wise comparison scale for AHP preferences

Fortunately, there is no need to implement the steps manually. Professional commercial software, Expert Choice, developed by Expert Choice, Inc., is available on the market which simplifies the implementation of the AHP's steps and automates many of its computations.

3. THE METHODOLOGY OF RESEARCH

Figure 6 shows the research methodology of ANFIS trust model.

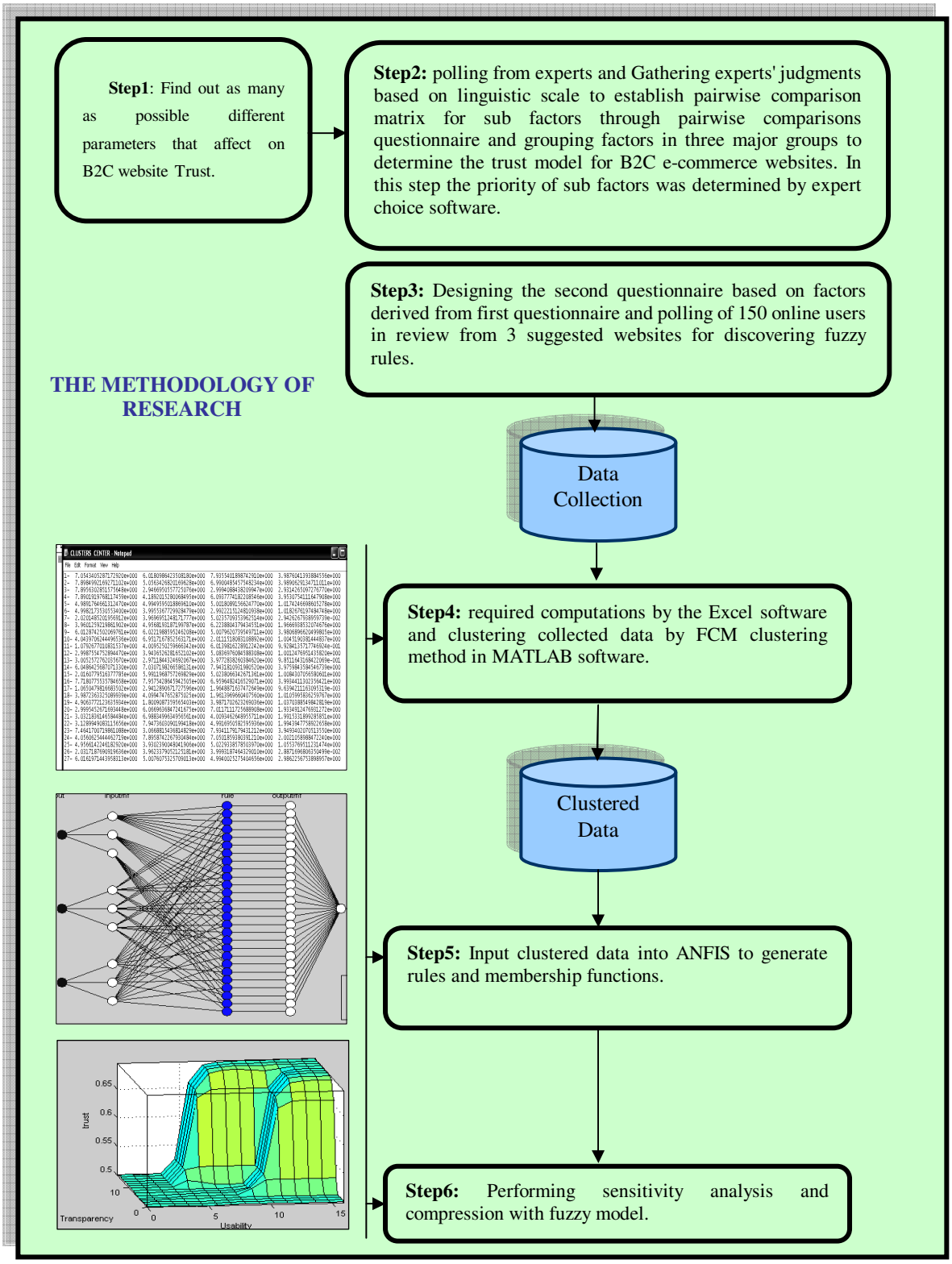

FIGURE 6. The schematic form of research methodology of this research

4. CONCEPTUAL FRAMEWORK

The proposed model has been established based on this principle that trust in B2C websites includes three factors as follows:

- Transparency: what we say is what we do". To all participants it must be clear, understandable, and logical and, if possible, verifiable with whom they are dealing and about what, subject to what conditions, and what information is relevant or being used for that purpose. Transparency forms the basis of trust.
- Usability:" Usability is defined as a set of attributes that bear on the effort needed for the use and on the individual assessment of such use by a stated or implied set of users. According to ISO 9126, usability's sub-characteristics are understandability, learn ability and operability. Based on the definition, it is obvious that the quality factor of us-ability is related to characteristics of e-commerce systems, such as provision of accurate informative texts about products and services offered, as well as provision of thumbnails, photographs and videos presenting the services and products available [31].
- Security: Different threats in e-commerce, like data transaction attacks and misuse of financial and personal information, generate security threats. Thus, security is protection against such threats [32].

The level of trust obtains of these three parameters performance. Figure 7 Presents a model based on our which illustrates the relationships between the different concepts.

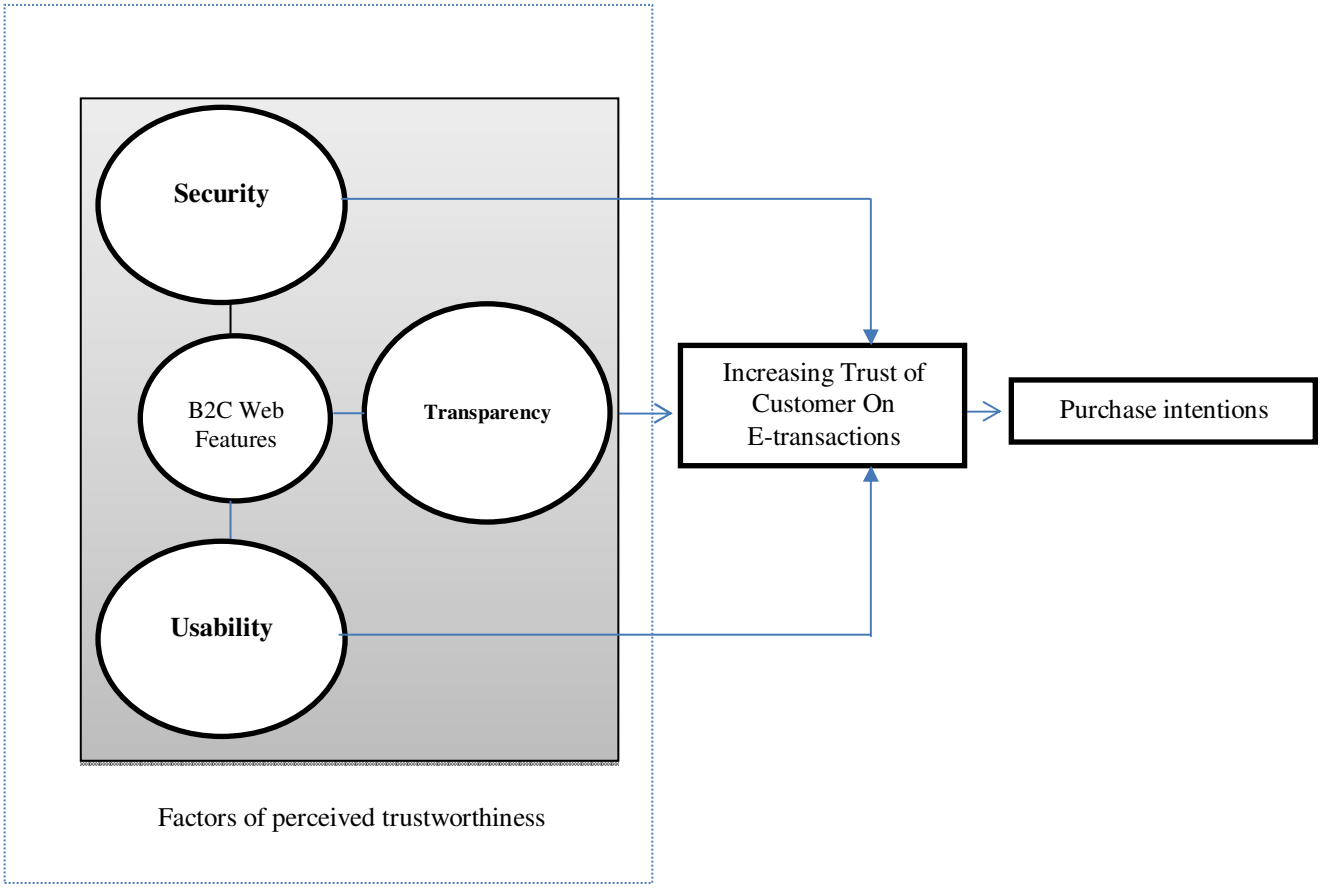

FIGURE 7. Relationships between Trust, Security, Transparency and Usability

4.1. DATA COLLECTION AND ANALYSIS

This study used a web-based survey because of its advantages such as convenience; viable, effective way to access difficult-to-reach respondents [7].

Questionnaire method was used for collecting data: the questionnaire was prepared by using 51 parameters that was shown in the table 3. All the affected parameters on website quality were mentioned in previous findings.

It had also five options (index) ranked by 0-4 for the raised questions could be found as follows:

very low (1) low (2) moderate (3) high (4) very high

The selected population in this study was included in two groups. The first group was included ten experts in the field of e-commerce and the Second group was included 150 numbers of E-Commerce and IT students.

The first group completed the first questionnaire and after obtaining results from the first questionnaire and the second group completed the second.

After collecting data of first questionnaire and finding factors with higher priority, the second questionnaire was designed .it involves 3 major groups. The method of scoring was chosen based on the likert scale of 5 degrees and 13 given questions in questionnaire were scored like 5 selections.

In this questionnaire 12 questions are relative to 3 major groups, and 1 question has been observed relative to the trust level of website.

Cronbach's Alpha method is applied to calculate the reliability of measurement tool e.g. questionnaire or tests which measure different characteristics. According to Jamal & Naser (2002:154) [29] a tool with Cronbach's Alpha greater than the minimum quantity level 0.7 suggested by Nunnally [30] (1987) is considered reasonable from reliability aspect.

To assess the reliability of the questionnaires in this research, Cronbach's Alpha was used. The results of reliability test by using SPSS have been presented in table 2:

Table 2. The counted credit coefficient of second questionnaire

kronbach's alpha coefficient for each website		
Irshop.ir	Tobuy.ir	Parsim.com
0.85	0.83	0.83

The inserted credit trust in table 1 shows the acceptance of second questionnaire credit.

After that customers referred to special website for experimental buying, it was asked the respondents to analyze three websites as parsim.com, Tobuy.ir, irshop.ir

During this process, they should answer some questions in security groups, usability groups, transparency groups, and trust level.

The order of answering the questions is that first of all the respondents should analyze the website and answer the questions in security groups, usability, transparency and then they

were asked to count the trust level and after that the it was weighted respondents were asked to evaluate the selective website for b2c dealings based on their expectation level of trust.

4.2. COUNTING THE LEVEL OF SECURITY

To count the level of security sheet1 was created in EXCEL (security sheet) and linguistic values questionnaire were changed to numerical values. Actually it was related numerical value to each linguistic value (0, 1, 2, 3 and 4) in order to count the level of security the counted level of security is made by adding these values for each factor whose maximum for four factors is number 16.Also, its percent for level of security was counted that has been in table 2, and in general second equation has been used for level of security .Table 3 shows the linguistic scales to evaluate security level.

$$AccumulatedSecurityLevel = \sum_{i=1}^{4} x_i$$
$$PercentageOfMaximum = (AccumulatedSecurityLevel) \Big/ 16) * 100 \quad (9)$$

Table 3. Linguistic and numeric values for security level

domain of values percent	Linguistic value
0-33	low
34-66	moderate
66-100	high

Some Pseudo code for counting the level of factors was written with VBA programming in excel software. The sample Pseudo code for counting the level of security is shown in following:

```
Sub Security_Ind_Prot_Auth ()
Dim i as Integer
Dim col As Integer
Dim x as String
Worksheets ("security").Activate
   For col = 2 To 6 Step 2
      For i = 4 To 153 Step 1
      Cells (i, col).Select
         ActiveCell.Value = Trim ((ActiveCell.Value))
       If StrComp (ActiveCell.Value, "very low", vbTextCompare) = 0 Then
            ActiveCell.Offset (0, 1).Value = 0
         End If
         If StrComp (ActiveCell.Value, "low", vbTextCompare) = 0 Then
            ActiveCell.Offset (0, 1).Value = 1
         End If
         If StrComp (ActiveCell.Value, "moderate", vbTextCompare) = 0 Then
            ActiveCell.Offset (0, 1).Value = 2
         End If
          If StrComp (ActiveCell.Value, "high", vbTextCompare) = 0 Then
            ActiveCell.Offset (0, 1).Value = 3
         End If
          If StrComp (ActiveCell.Value, "very high", vbTextCompare) = 0 Then
            ActiveCell.Offset (0, 1).Value = 4
         End If
      Next i
   Next col
End Sub
```

4.3 THE PRIORITIZED FACTOR RESULTED THROUGH AHP METHOD

In this study the priority of Sub-Criteria in security, Usability and Transparency groups was counted by expert choice software that uses ahp method. Thus Rank and Weight of Criteria, Sub-Criteria Counted by Expert Choice has been noted in Table 4.

TABLE 4: Sixteen of most important parameters that affect on website trust ranked by their weight via Expert Choice

Objective : **Assessment and prioritizing affective criteria of Security, Usability and Transparency**													
Sub-Criteria Ranking And Their Weighs Counted By Experts.										Priorities of Criteria	CR.	Criteria	
10	9	8	7	6	5	4	3	2	1				
0.24	0.216	0.292	0.224	0.238	0.184	0.257	0.24	0.206	0.23	0.224	0.03	**Secure Payment Systems**	**Security**
0.179	0.226	0.17	0.206	0.227	0.166	0.163	0.229	0.243	0.172	0.204		**privacy**	
0.177	0.189	0.226	0.166	0.145	0.166	0.198	0.201	0.164	0.184	0.189		**Policies to ensure**	
0.121	0.109	0.088	0.106	0.121	0.142	0.136	0.109	0.133	0.146	0.118		**Security protocols**	
0.263	0.272	0.224	0.2	0.304	0.251	0.229	0.241	0.266	0.249	0.266	0.03	**Direct delivery of the products**	**Usability**
0.212	0.215	0.213	0.241	0.184	0.297	0.3	0.19	0.152	0.23	0.187		**Notification by E-mail**	
0.148	0.155	0.191	0.261	0.132	0.149	0.12	0.136	0.179	0.254	0.207		**Possibility to returning the product**	
0.17	0.142	0.166	0.119	0.169	0.114	0.126	0.15	0.164	0.103	0.129		**Thanking message after each purchase**	
0.197	0.22	0.175	0.189	0.136	0.288	0.286	0.191	0.274	0.285	0.25	0.04	**description of the product**	**Transparency**
0.237	0.211	0.207	0.224	0.19	0.201	0.233	0.16	0.232	0.161	0.198		**Information concerning our company**	
0.131	0.16	0.252	0.168	0.212	0.141	0.139	0.203	0.141	0.145	0.14		**sales conditions**	
0.145	0.128	0.138	0.15	0.206	0.113	0.127	0.156	0.12	0.137	0.155		**the way in which the Customer can record transaction data**	

4.4. DEVELOPING EXPERT SYSTEM

4.4.1. FCM CLUSTEING AND FUZZY RULES FOR INDICATING TRUST LEVEL

The most important step of structure identification is the rule generation. Clustering of the input-output data is an intuitive approach to rule generation. The idea of clustering is to produce a concise representation of a system's behavior by dividing the output data into a certain number of fuzzy partitions. The fuzzy C-Means (FCM) clustering algorithm (Bezdek 1981, Bezdek et al. 1987) has been widely studied and applied in many applications.

The number of rules is an important parameter of the FIS. Clearly, the appropriate number of rules depends on the complexity of the system. According to Sugeno and Yasukawa (1993), the number of fuzzy rules corresponds to the order of a conventional model where an optimal model minimizes both the order and the output error. A statistical analysis for evaluating the optimal order of a model is discussed by Akaike (1974). A large number of rules, similar to a high order of a model, will bias the model towards specific data that can be imprecise or even erroneous. On the other hand, less number of rules will likely increase the output error, which is essentially equivalent to disregarding the effect of some of the data points containing valuable information.

Thus, the optimal number of rules n can be obtained from a tradeoff between the numbers of rules and the output error.

The number of rules will be automatically determined through clustering the input and output spaces. Each cluster center is used as the basis of a rule that describes the system behavior.

For refining and finding the rules of fuzzy model, it has been the clustering technique, and the kind of clustering has been chosen the fuzzy C-means (FCM) clustering in MATLAB software.

Equation 1 is as a major function in clustering k-means.

$$J_m(U,V)=\sum_{j=1}^{n}\sum_{i=1}^{c}u_{ij}^{m}\left\|X_j-V_i\right\|^2,\quad 1\le m<\infty \tag{1}$$

Where m is any real number greater than 1, uij is the degree of membership of Xj in the cluster i, Xj is the jth of d-dimensional measured data, Vi is the d-dimension center of the cluster, and ||*|| is any norm expressed the similarity between any measured data and the center.

Fuzzy partition is carried out through an iterative optimization of Equation 8 with the update of membership uij and the cluster centers VI by Equation 2 and 3:

$$u_{ij}=\frac{1}{\sum_{k=1}^{c}\left(\frac{d_{ij}}{d_{ik}}\right)^{\frac{2}{m-1}}} \tag{2}$$

$$V_i=\frac{\sum_{j=1}^{n}u_{ij}^{m}X_j}{\sum_{j=1}^{n}u_{ij}^{m}} \tag{3}$$

The criteria in this iteration will stop when $\max_{ij}\left[\left|u_{ij}-\bar{u}_{ij}\right|\right]<\varepsilon$, where ε is a termination criterion between 0 and 1 [21].

All clustering activities were done in MATLAB software. For example 27 centers of clusters for counting the level of trust is shown in figure 8.after obtain the centers of clusters and save into DAT files, the centers of cluster were loaded into ANFIS. In fact this data is used as training data in ANFIS model.

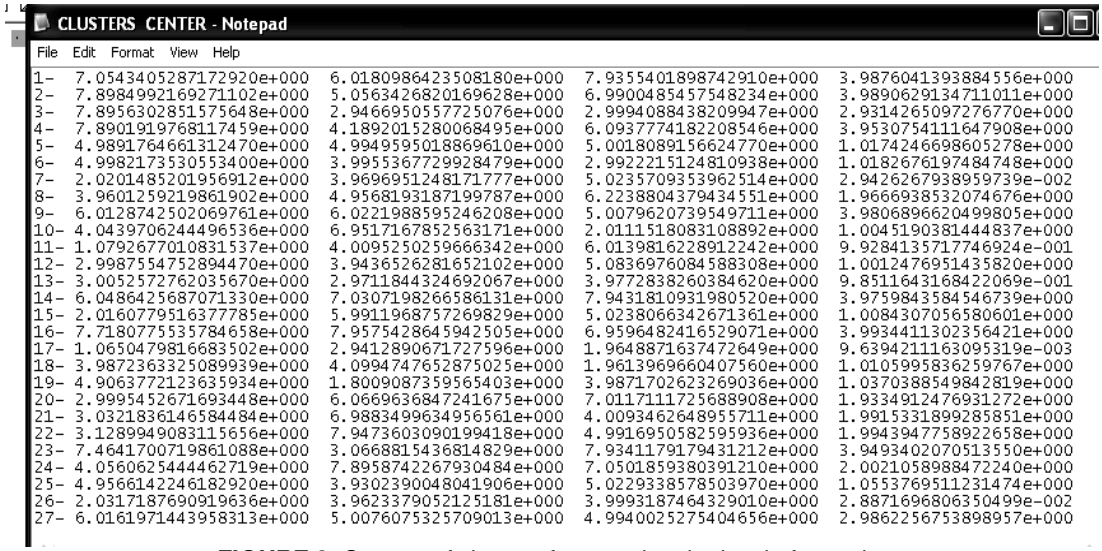

FIGURE 8. Centers of clusters for counting the level of security

After clustering, ANFIS was proposed in an effort to formalize a systematic approach to generating fuzzy rules from an input-output data set.
In ANFIS model 27 rules for trust level is used. The rules describing the trust level are based on the degree of security, usability, and transparency that these degrees have been formulated like linguistic variable .similarly, the degree for trust level has been graded from very low to very high in 5 distinctive fuzzy,collections .these rules have been reached from the users ' answers after ordering ,analyzing ,and clustering. Figure 9 shows some of the rules from ANFIS after raining data.

One of the collection rules of confidence level can be like following:

If (security = high and usability = low and transparency = moderate) then (trust =moderate).

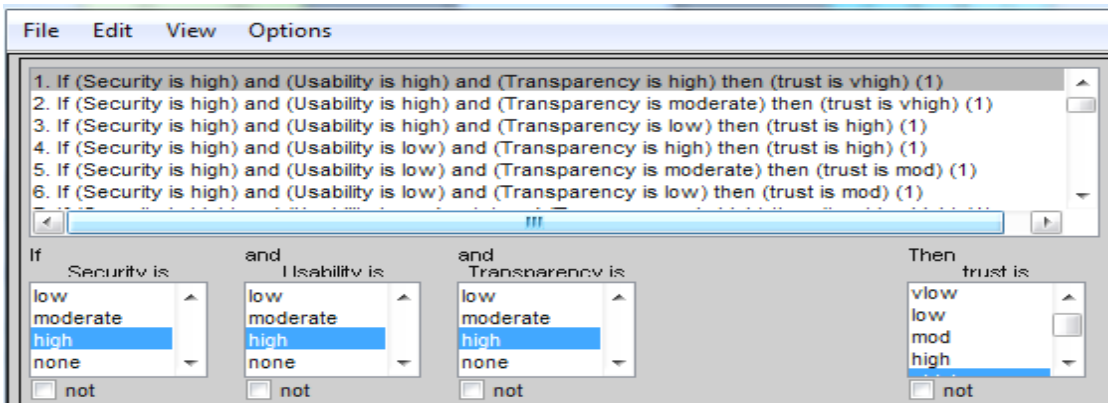

FIGURE 9. Shows the GUI for the rule editor

4.4.2. EXPERT ANFIS SYSTEM

The ANFIS system based on Expert knowledge contains 27 rules, 3 inputs and one single output for trust level. The structure of expert ANFIS is shown in figure 10.
The fuzzy logic toolbox using the MATLAB software is employed to create the ANFIS model.
In fuzzy logic tool box, relevant FIS for trust model is created. In this model type of FIS is selected Sugeno type.

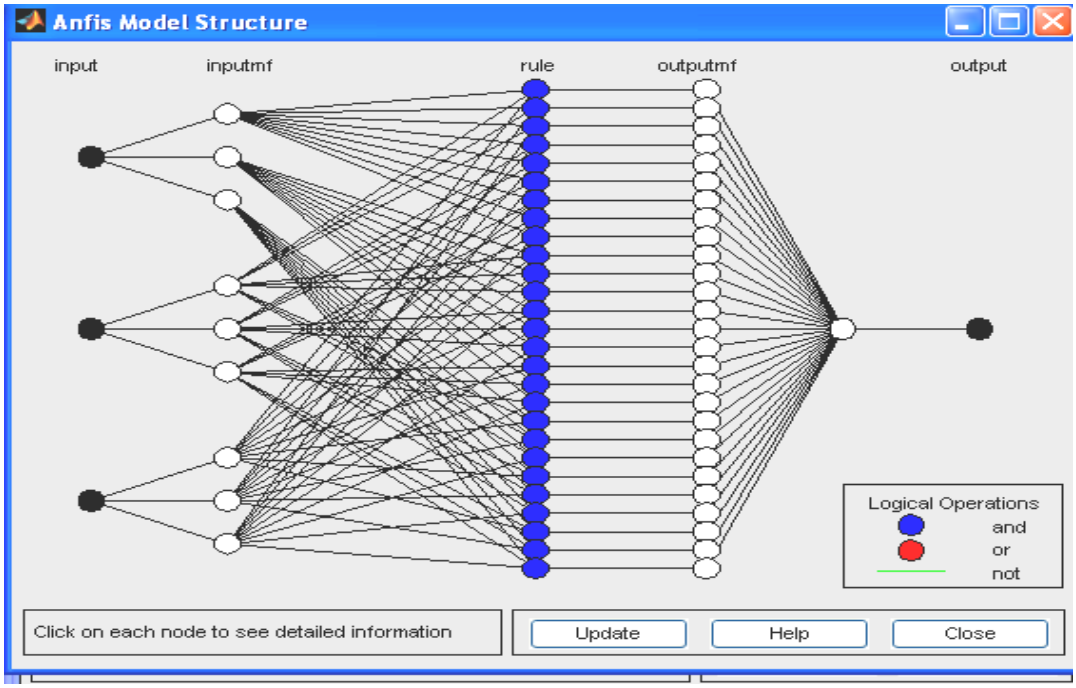

FIGURE 10. ANFIS trust structure

4.4.3. MEMBERSHIP FUNCTION FOR EXPERT ANFIS

Gaussmf are used to build the expert ANFIS model. The shape of membership functions after training the AFNIS for 100 epochs is shown figure 11.

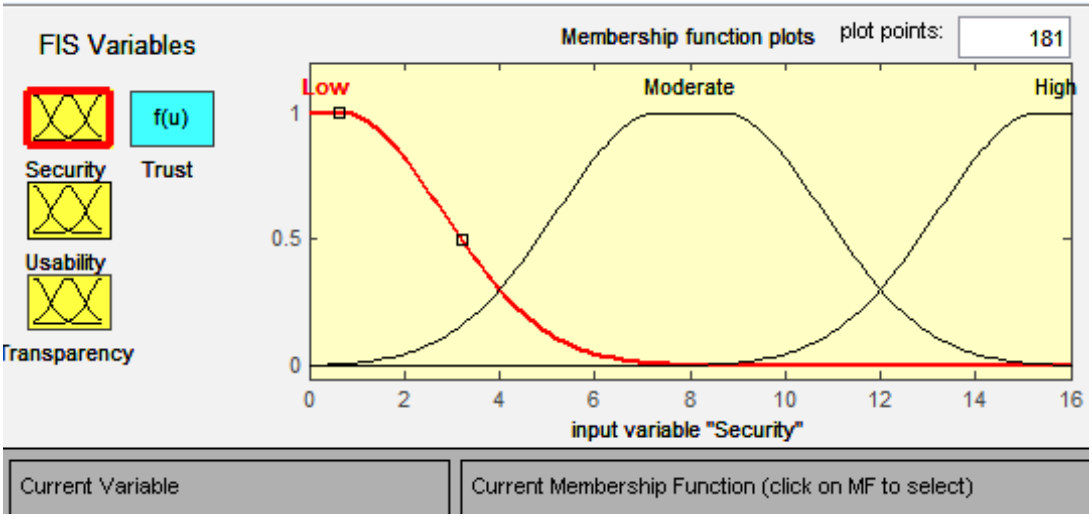

FIGURE 11. Membership function editor

4.4.4. TRAINING DATA FOR TRUST LEVEL

The entire data set of trust level is 27 samples. They are referred to as training data, testing data and checking data. Upon training, the ANFIS shows the training error which reflects the how good the mapping function is. To validate the model, we further apply the testing data to see how the ANFIS behaves for known data. ANFIS maps the function onto the testing data as per the training.

Having created the data set the next step is to train the network. This means we create a new FIS to fit the data into membership functions. Using the grid partitioning method, the ANFIS automatically selects the membership function and also generates the new FIS.
Figure 12 shows training and testing data in ANFIS network that is loaded.

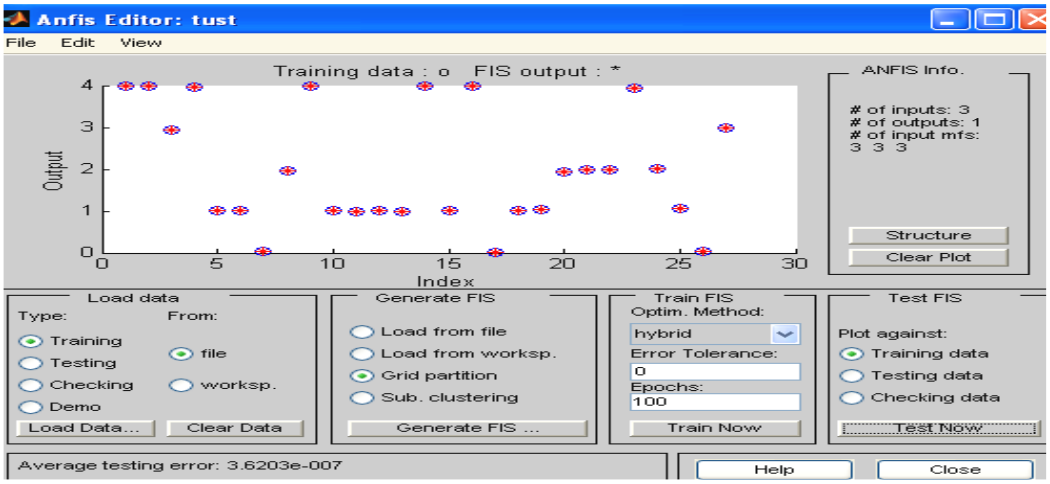

FIGURE 12. ANFIS editor: Training the rules

In figure 13, the course of error during the training of adaptive network is shown.

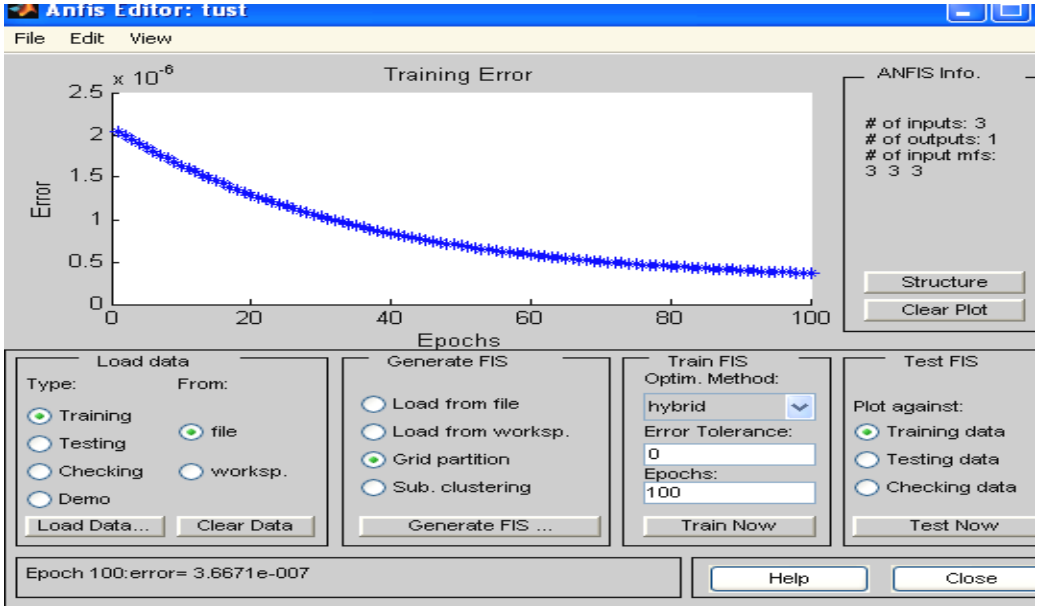

Figure 13. Course of error during the training of adaptive network

At the end of 100 training epochs, the network error (mean square error) convergence course of each ANFIS was derived. From the curve, the final convergence value is 3.6671e–007.
The rule viewer for the 3 inputs and 1 output can be observed pictorially in the Figure 14.

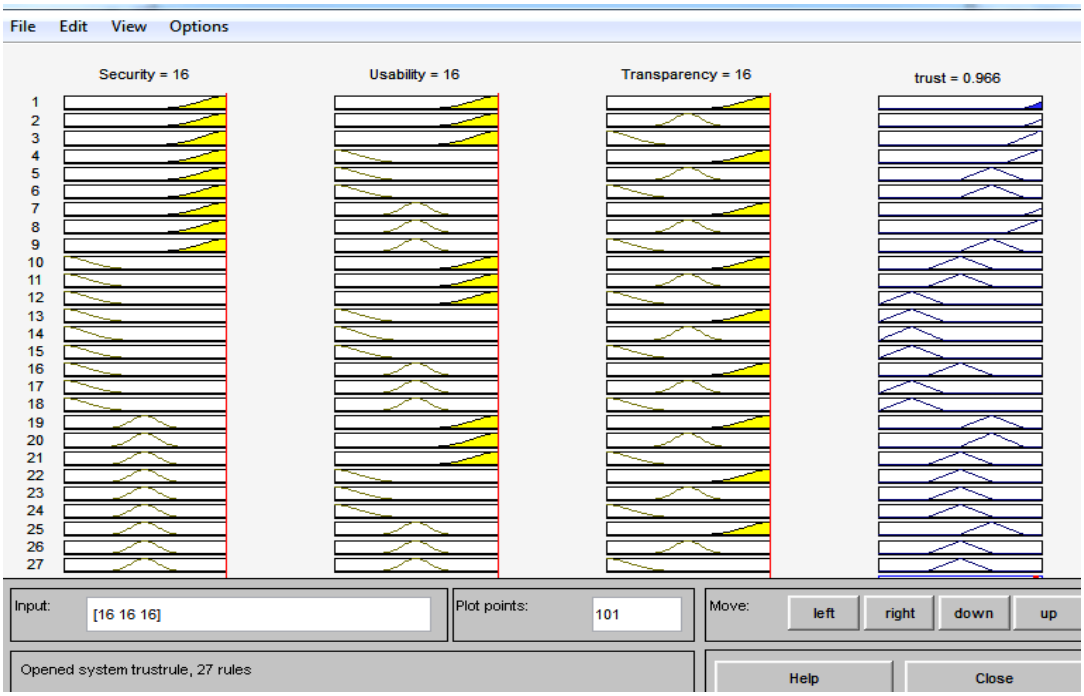

FIGURE 14. Rule viewer window

5. DEVELOPMENT AND ANALYZING FUZZY SYSTEM

After discovering the rules related to trust level, relevant inputs and outputs for earning trust level in fuzzy tool box to be organized and were created relevant membership for input and output figure 15 shows the fuzzy system that can be used to derive the trust level.

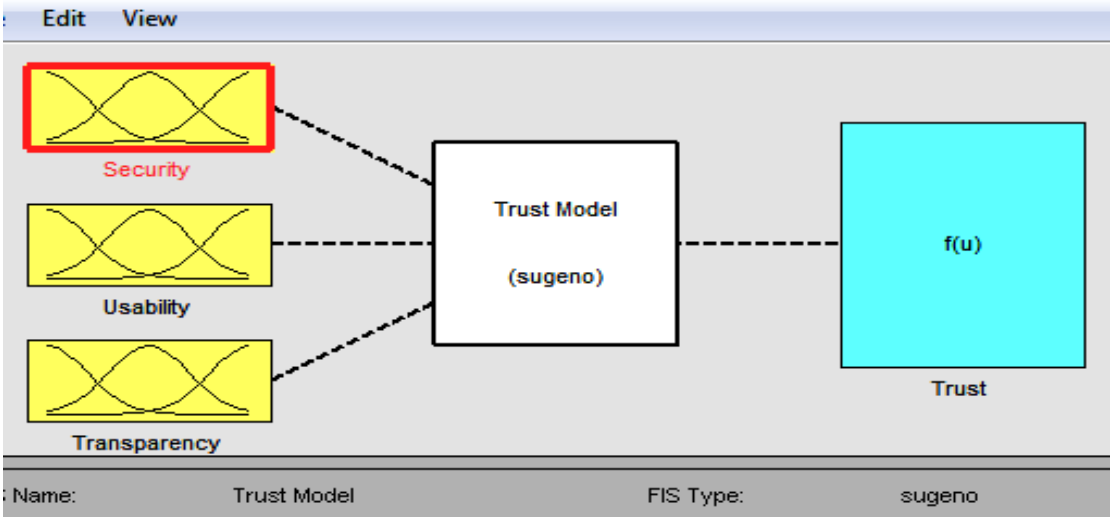

FIGURE 15. The ecommerce ANFIS trust model

5.1. ANALYSIS OF TRUST VERSUS SECURITY FACTOR

For complete understanding of participation needed in trust level, it is necessary to separately test the participation of each factor.

The Figure 16 shows contribution to Trust of a given Website originating from the Security. Therefore, the contribution from Usability and Transparency has been kept constant at high

level corresponding to numeric value for Usability and Transparency of (15). When T&U is high, then Trust remains high and is rather constant (at a value of about 0.9) with increasing security .Figure 12 shows that Trust level is monotonically increasing for increasing perceived security of a website for any given level of Usability and Transparency (However when both U and T is 'High' (numeric value of 15) the Trust level is at its maximum for maximum Security.

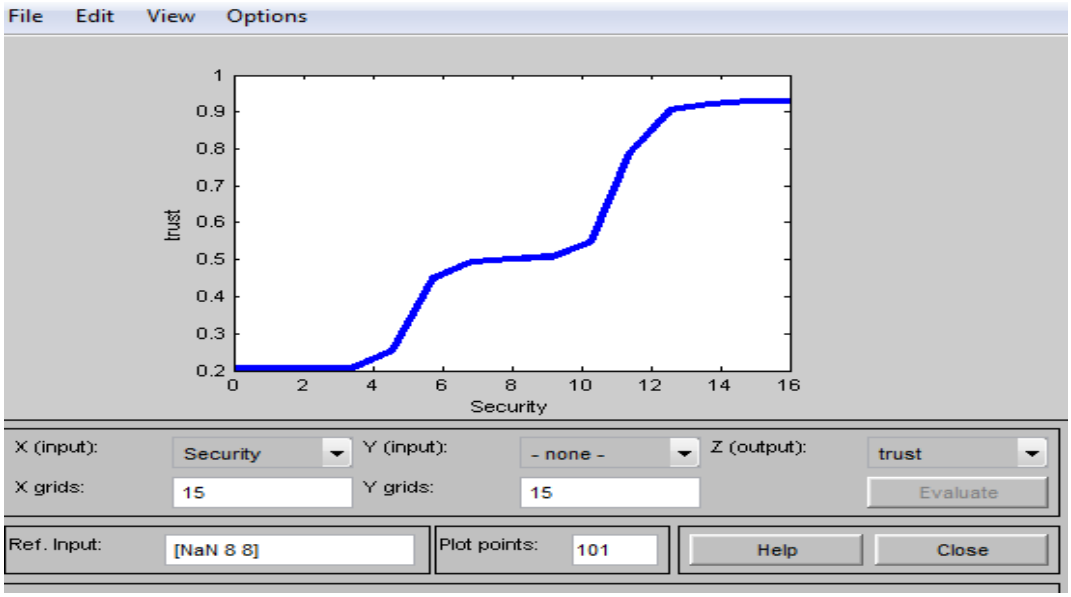

Figure 16. Trust versus security factor

5.2. ANALYSIS OF TRUST VERSUS TRANSPARENCY FACTOR

Figure 17 shows how Trust is contributed from transparency for constant values of Security and usability. The values for high has the same interpretations as explained in the previous section. This figure is considerably different from the previous one. One stunning point to note is that trust levels remain low for any value of transparency when S&U is low. When S&U is high, then Trust remains high and is rather constant (at a value of about 0.7) with increasing transparency. This tends to suggest that Trust is positively related to transparency for high S&U. Also, Trust is high for S&U levels being high with increasing transparency. This means that, although increasing transparency has a positive affect on Trust, the relative increase is more visible for moderate values of S&U.

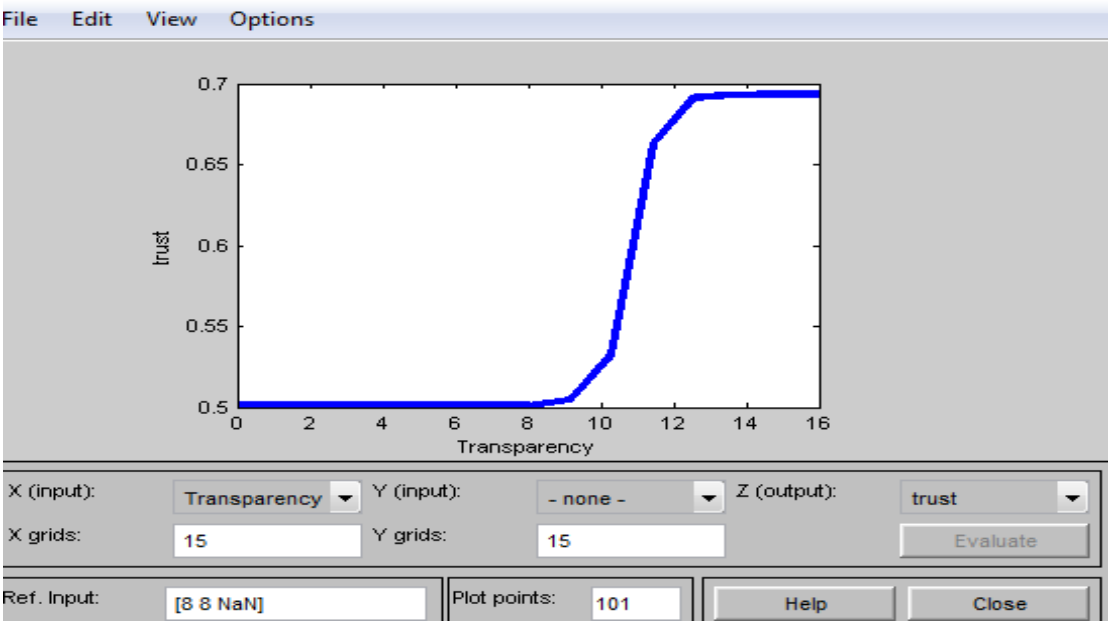

FIGURE 17. Trust versus Transparency factor

5.3. ANALYSIS OF TRUST VERSUS USABILITY FACTOR

Figure 18 is noticeably identical to the figure in the previous section on Trust as a function of transparency. This means that for all intentions and purposes, we can substitute transparency with usability.

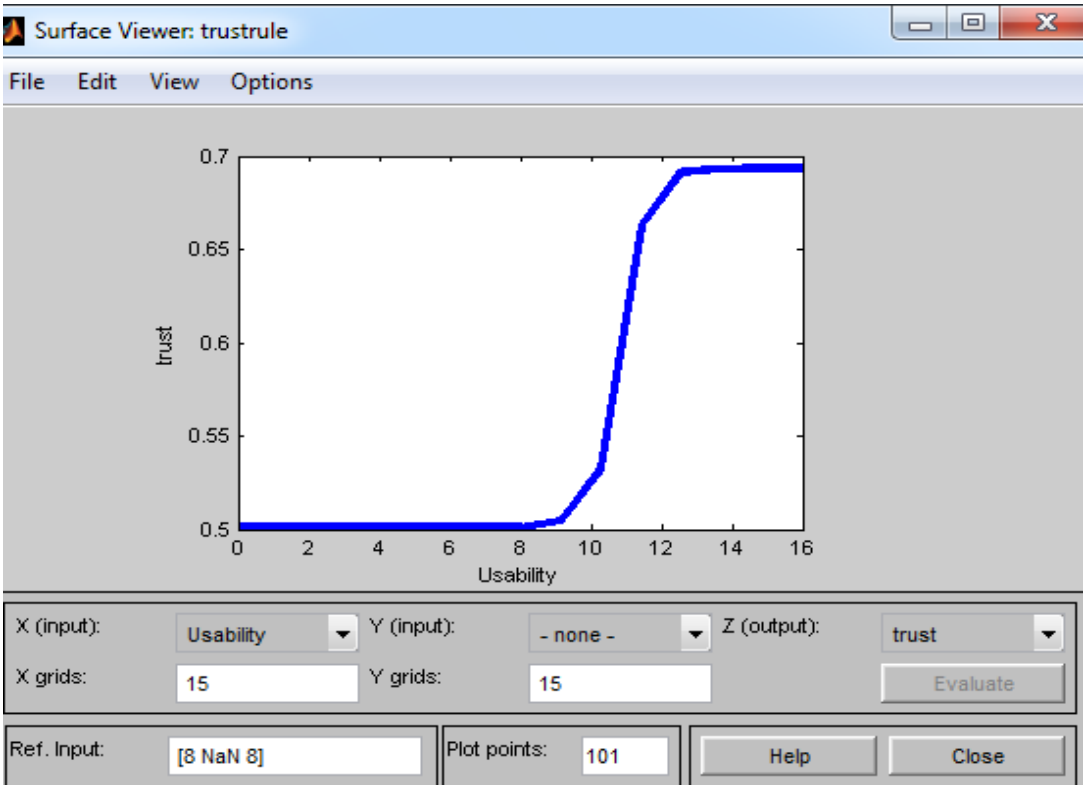

FIGURE 18. Plot of trust vs. usability

5.4. ANALYSIS OF TRUST VERSUS SECURITY AND USABILITY FACTOR

In this section Trust level is depicted as a continuous function of its input parameters as security and usability. Figure 18 intends to depicture variation of Trust as encapsulated in the rules for Trust. The highest gradient for Trust is when Usability is 'moderate' and Security is 'moderate' to 'high'. This suggest that when people are somewhat familiar with a website then a small increase in security levels from between moderate to high security will boost their trust in a significant way. Looking at Figure 18 diagonally from (low, low) to (high, high) levels of Security and Usability one observes three plateaus where the last one is around 0.966, and remains at that level even when the input factors are increased further.

One interesting point to note, however, is that for maximum usability and transparency, the Trust level is never higher than 0.695. This plateau also is reached fairly rapidly with high gradients from both sides of the input variables .figure 20 shows Trust level as a function of usability and transparency.

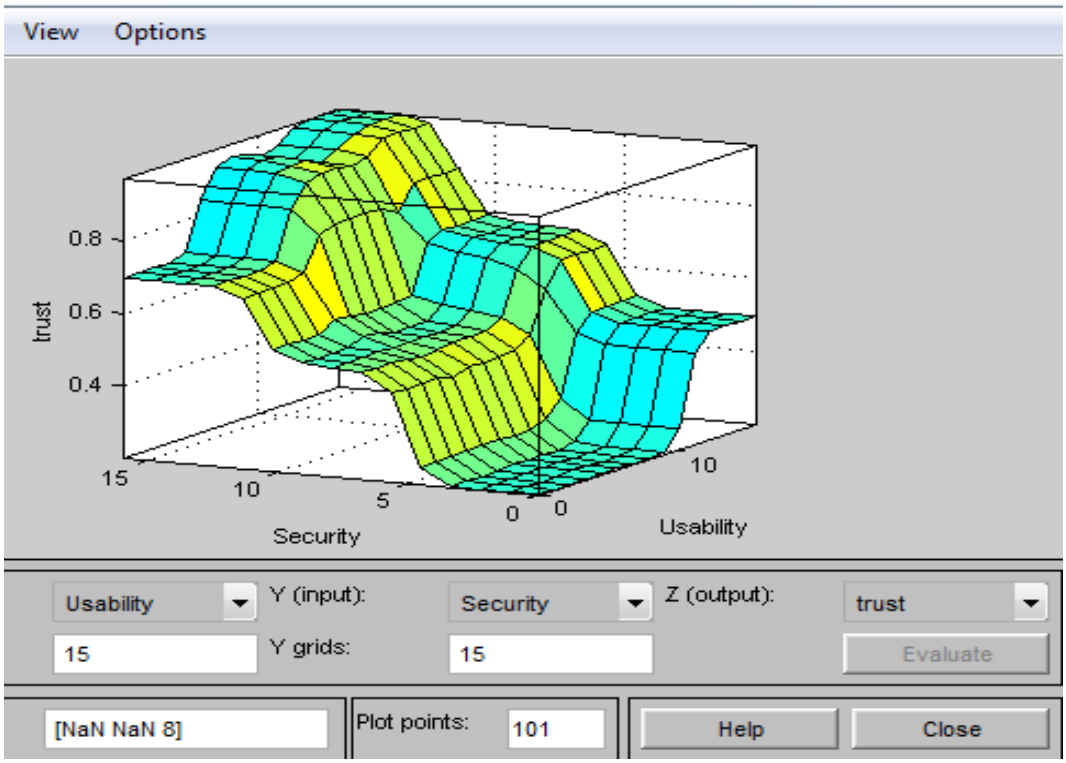

FIGURE 19. Trust level is positively related to levels of security and usability

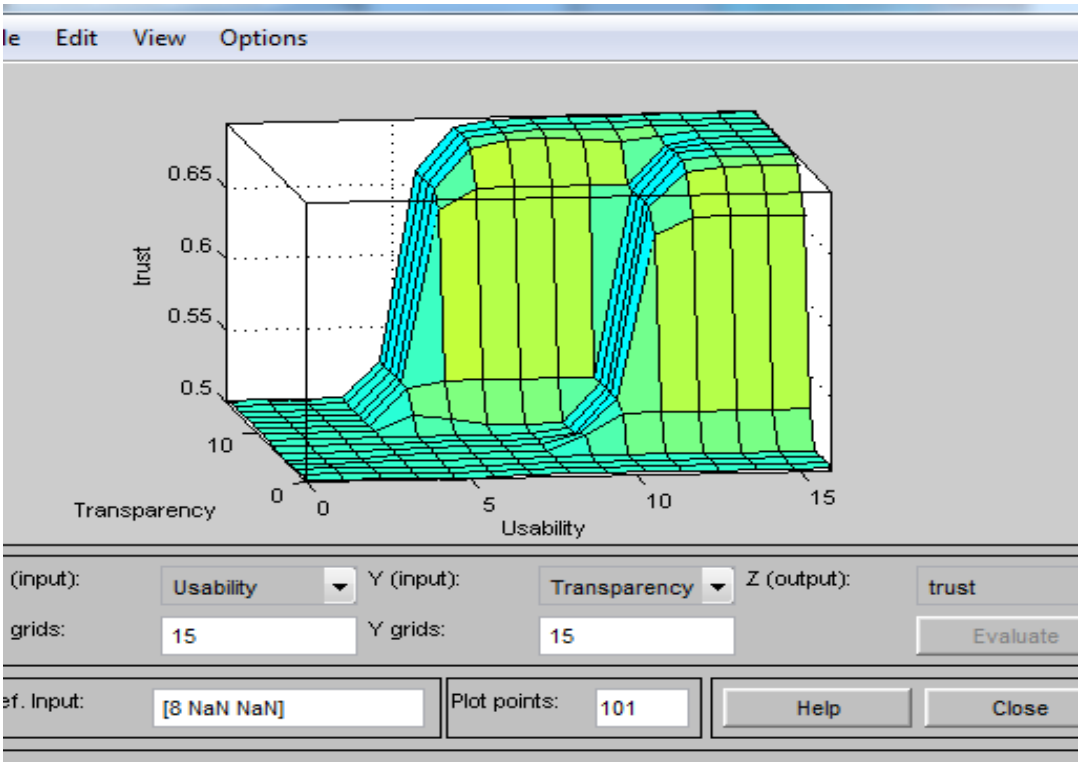

FIGURE 20. Trust level as a function of usability and transparency

6. CONCLUSION

This paper present a new conceptual model for online trust, which three important factors that affect on quality and trust B2C website were clarified completely. The proposed Model depends on fuzzy rules generated by ANFIS method in an e-Commerce support.

The case study was three B2C website in Iran. By using AHP method and completing questionnaire through face to face meeting we finally were able to provide ranking of all factors and sub-factors. This ranking shows the relative importance of success factors with comparison to each other. For the future growth of B2C electronic commerce, barriers such as security concerns must be torn down. There are many methods that can be employed to help engender this trust among online consumers. Security provided by vendor is just one such method.

The main purpose of this research is to tell the readers specially the managers of the B2C websites to understand how these B2C website to build trust, how the consumers' attitude to the issue of information security and how they influent the web trust during shopping. In this study, the connection of trustworthiness and security is disclosed.

This survey can be used to follow step by step the instructions and, based on actual level of a feature, decide its contribution in a category and consequently derive a total value of a factor, say Security. In addition, the vendor can use the survey data to ascertain the Trust level of the site as per the user's perception and rectify, if needed, if this is not obvious or if it is having a negative impact on the Trust level.

Finally in This study respondents mentioned that trust and security both have a high important relationship between them in strengthen the customer purchases with E-story so that he or she can use the buying online services.

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INSTRUCTIONS TO CONTRIBUTORS

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