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FAULT MONITORING APPROACH IN TRANSFORMER USING DGA

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Abstract— Dissolved gas analysis (DGA) is most reliable and trustful tool for monitoring the health status of transformer. Using DGA can monitoring the status of concentration level of various combustible gasous in transformer oil. The concentration of combustible gaseous use as determining the status of transformer oil to diagnose the incipient fault or indicator of undesirable event inside the transformer transformer has may be suffer from incipient fault such as partial discharge, electrical arcing, overheating, hot spot. Here neural network is used to diagnose the status of transformer to reduce human error as well as time. Here DGA data is get from various substation and analyse it and reach to conclusion that which type of fault to be occur in transformer and can save the transformer.

Index Terms— Dissolved Gas Analysis, Neural Network, Fuzzy logic

I. I. INTRODUCTION

In power system large power transformer is importantl equipment, transformer health status always impact the safety and stability of the power system. It is important to findout incipient fault of power transformers timely and accurately. Incipient fault can be findout by using electrical or non-electrical tests such as electrical characteristic tests, detection and DGA. Incipient insulation faults of oil-immersed power equipment are sensitise by dissolved gas analysis. There are many diagnostic methods based on DGA, such as like the contents of key gases, roger's ratio method, the IEC triple-ratio method but in practice, diagnosis of fault always affected due to the uncertainty which could not be eliminated, uncertainty present due to the ambiguity of the inference and insufficient standard for judgment. For detection of incipient fault in power transformer dissolved gas analysis (DGA) is one of the most useful technique. This paper is a study of artificial neural networks (ANN) applications for the diagnosis of power transformer incipient fault. The fault diagnosis is depend on dissolved gas-in oil analysis (DGA). Using historical transformer failure data, a multi-layer Perceptron

(MLP) neural network is applied in this work. The proposed network can overcome the drawbacks of conventional methods. The proposed schemes are simulated and tested.

Different Methods of Fault Detection by DGA:

The DGA is important tool for power transformer incipient fault diagnosis. DGA has various approaches under three major categories: 1) Ratio method 2) Key gas method 3) CIGRE's method 4) Duval's Triangle 5) IEC ratio method 6) Expert System

Ratio Definition of Ratio Method

Ratio	CH4/H2	C2H2/C2H4	C2H2/CH4	C2H6/C2H2	C2H4/C2H6
Abbreviation	R1	R2	R3	R4	R5

In 1970 Dornenburg's was able to differentiate between thermal and electrical faults using four ratios and six gases. The six gases are H2, CH4, CO, C2H2, C2H4 and C2H6.

Dornenburg's ratios: Dornenburg's method is based on ratios CH4/H2, C2H2/C2H4, C2H4/C2H2 and H2/CH4. Three types of faults are detectable, In this method 3 types of fault determine thermal fault, partial discharge and other types of discharges (electrical fault). This method should apply with determining if dissolved gases (including CO and CO2) are below the quoted concentration limits; faults are may be determine if one or more gases exceed the limits. Rules were also defined to determine the applicability of these ratios. Implementation of Dornenburg's method may trace result in a significant number of 'no-interpretation' cases arising from incompleteness in the ratio-ranges and non-applicability of the method.

Gas	H_2	CH_4	CO	C_2H_2	C_2H_4	C_2H_6
L1	100	120	350	35	50	65

In IEC's ratios (IEC 60599) the ratio C2H6/CH4 from roger's method was dropped since it only indicated a limited temperature range of decomposition. Four conditions are detectable, i.e. normal ageing, partial discharge of low and high energy density, thermal faults and electrical faults of various degrees of severity. But it is not possible to determine both thermal and electrical faults into more precise subtypes. Simple coding scheme is the base of first edition of IEC's method while the second edition (IEC 60599 -1999) utilizes the revised ratio ranges directly. The assessment is required to determine the normality limits before being interpreted using ratios. Other improvement in the second edition of IEC method is the use of 3D graphical representation for the ratio ranges. Fault which cannot possible to detect that can be plotted onto the graph and its nearest distance to a certain fault region can then be observed.

II. ANN

The human brain many desirable characteristic these include: 1. Massive parallelism. Distributed representation and computation. 2. Learning ability 3. Generalization ability 4. Adaptively 5. Inherent contextual information processing 6. Fault tolerance, and 7. Low energy consumption It is hope that devices based on biological neural networks will posses some of these desirable characteristics. Modern digital computers perform human brain desirable characteristics in the domain of numeric computation and related symbol manipulation. Complex perceptual problems can be solve by human's effortlessly at such a remarkable difference in their performance? The biological neural system architecture is completely different from the Von Neumann architecture. This different affects the type of function each

computational model can best perform. Biological neural networks inspired artificial Neural network in parallel computing systems. These system consist of an extremely large number of simple processors with many inter-connections. ANN models to use some principles believed to be used in the human brain. Either humans or other computer techniques can use neural networks, with their Due to remarkable ability of neural network computer technique can use to derive meaning from complicated or imprecise data, to extract patterns and trends that are too complex to be noticed. A trained neural network work as an expert in the category of information it has been given to analyze. This expert can then be used to provide prediction of given new situations of interest and answer what if question.

1. Adaptive learning: An ability to learn how to do tasks base on the data given for training or initial experience.

2. Self-organization: An ANN can create its own organization or representation of the information. It receives using learning times.

3. Real Time Operation: ANN computations may be carried out in parallel, using special hardware devises designed and manufactured to take advantage of this capability.

4. Fault tolerance via redundant information coding: Partial destruction of a network leads to a corresponding degradation of performance.

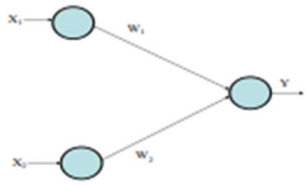
However, some network capabilities may be retained even after major network damage due to this feature..

III. LAYERS OF ANN

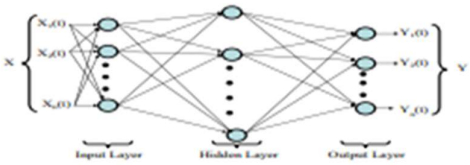
The neural net can generally be a

- Single layer
- Multilayer net

simple artificial neural net having is shown in fig.

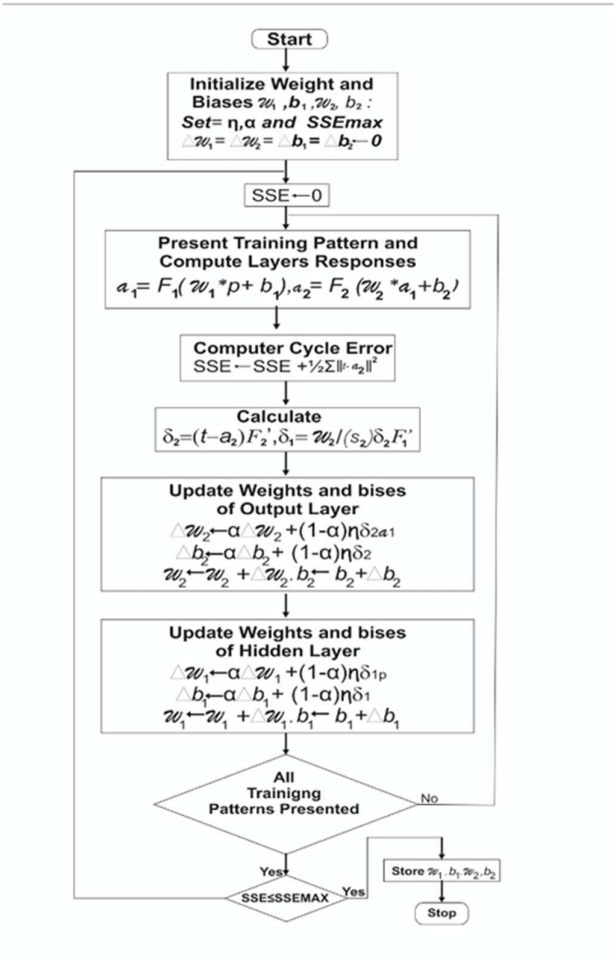


Simplified diagram representation in below figure is a multilayer neural nework, Input layer's units are connected to a layer of hidden units, hidden units layer connected to output units layer. The input layer neuron represent raw information. That information fed into the hidden layers units. The activity of neurons in the hidden layer is determined by the activities of the input neurons and the connecting weights between the input and hidden units. So output of the output layer units is depends on the task to be performed by neurons in the hidden layer and the connecting weights between the hidden and the output layers. This simple neural structure is interesting because neurons in the hidden layers are free to construct their own representation of the input. Due to MNN the computational power of single layer neural network unless there is nonlinear activation function between layers. Neural network has many capacities to perform as like nonlinear functional approximation learning, generalization, etc are in fact performed due to the nonlinear activation function of each neuron.



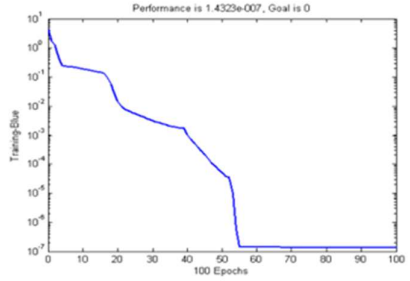
Due to small learning rate for stable learning back-propagation network is very slow. A method for improving the training time of back-propagation algorithm based on exponential smoothing described by sejnowski and rosenberg. The method involves adding a term to the weight adjustment that is proportional to the amount of previous weight change. $\Delta \omega(i+1)=(1-\alpha)\ \eta\ \delta p+ \alpha\Delta\ \omega(i)$ (10) where α is the smoothing coefficient in the range of 0.0 to 1.0. α is the learning rate constant. By using Adaptive learning rate training time decreased, which attempts to keep the learning step size as large as possible while keeping learning process stable. In the current study, the ANN is trained using the Adaptive back-propagation learning algorithm which consists of repeatedly passing the training sets through the neural network until its weights and biases minimize the output error the entire set of inputs. The learning rate (α) is always updated during training process. First, the initial network output and error are calculated. At each epoch, new weights and biases are calculated using the current learning rate. New output and error are then calculated. If the new exceeds the old error by more than a predetermined ratio (1.05), the new weights, biases, output and error are discarded. In addition, the α is decreases, otherwise the new weights are kept. If the error is less than the old error, the α is increased (by multiplying it by 1.05). The complete training procedure is explained in flowchart as shown below. This paragraph describes the design implementation of the ANN based fault detection in Power Transformer. For designing Neural network as a fault detector, following steps were taken in order to carry out the work.

i) Collection of data to form the training data set.
ii) Creation of Network architecture.
iii) Training the Network.
iv) Simulation of the Network response to new inputs for the purpose of generalization

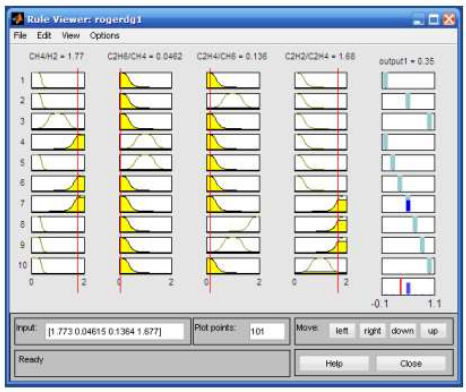


IV. RESULTS

Back propagation algorithm implemented for training of the network using MATLAB. The result of training is displayed in figure followed. After training considering various architectures, mean percentage error has been calculated.



Training of the Patterns



V. CONCLUSION

In this approach to fault detection of power transformer by DGA using Neural Network advancement selection of training cases and the structure of network are proposed here.

• The performance of the neural network affected by the selection of cases used to calculate the weights that used for evaluation of training network

• This logically follows from the fact that the model is based on a self learning concept.

• This project has tried for neural network using Backpropagated feed-forward networks

• The major benefit in ANN-based fault diagnosis is that it can learn directly from the training samples, and update its knowledge whenever necessary. The highly nonlinear mapping capability of the neurons provides a comparable and often superior performance over fuzzy system solutions. ANN computational complication are not high in diagnosis process.

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