SIMULATION OF TRANSFORMER FOR FAULT DISCRIMINATION USING WAVELET TRANSFORM & NEURAL NETWORK

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ABSTRACT: Power transformer is the important device of the power system. The protection of power transformer is very necessary for reliable of power system. In this paper it describes the discrimination between magnetising inrush current and fault current of transformer using neural network, for simulation MATLAB/SIMULINK is used. For detection of fault wavelet transform toolbox is used. The wavelet transform has the ability to extract information from transient signal in both time & frequency domain. For discrimination of inrush current & fault current the artificial neural network is used, which is the power fool tool for artificial intelligence. The artificial neural network has the ability to detect & automate the knowledge, has been proposed for discrimination.

Keywords: fault, MATLAB, wavelet transform, artificial intelligence, neural network.

1. INTRODUCTION

Transformer is expensive & most important equipment in power system. So protection of power transformer is most important task, which needs to be isolated quickly & reliably whenever fault is happened. The continuous monitoring of power transformer can provide a protection of fault & prevent the transformer. It minimise the damage & maintain the continuity of power supply [1]. Protective relays are used for protection in power system. The relays have the ability to isolate the faulty part from the healthy part. The differential relays are need for the power transformer in power transformer in power system. The value of differential current greater than the no load current indicates the fault in power transformer [2].

During the energization of power transformer, the magnetizing inrush current has introduced, which has the 10 times greater from full load current, this current is transient in nature, but this current may cause the relay to operate.

To avoid mal operation of relays for protection of power transformer, it is necessary to discriminate the magnetizing inrush current and fault current in power transformer [3]. For simulation of power transformer current the wavelet transform is used. The wavelet transform is used for detect the magnetizing inrush current and fault current, both are the non stationary signals.

The wavelet transform has the signal processing tool. Artificial neural network are used for power transformer protection because it has the ability of highly non linear mapping features [4]. For discrimination of inrush current & fault current in power transformer both wavelet transform & neural network techniques is used. Firstly wavelet transform technique is applied for decomposed the different phase current into the detailed coefficient & secondly this detailed coefficient is the input for the neural network for training the data to discriminate the both inrush current and fault current.

2. WAVELET TRANSFORM

In wavelet transform is similar to the Fourier transform in that it is a decomposition of signal in terms of basis of set of function. In wavelet transform the expansion has two parameters and wavelet are generated from a single mother wavelet using dilation & offset corresponding to the two parameters.

$f(t) = \sum\sum C_{ab}\, \psi_{ab}(t)$……(2.1)

the equation 2.1 have the two parameters, expansion are given by

$C_{ab} = \int f(t)\, \psi_{ab}(t)\, dt$ ……(2.2)

$\Psi_{ab} = 2^{a/2}\, \psi(2^{a}t - b)$……. (2.3)

Here ψ is the mother wavelet, a is the dilation parameter & b is the offset parameter [3]. The wavelet transform has divided into two part discrete wavelet transform and continuous wavelet transform.

The DWT is considerably easier to the CWT. The discrete wavelet transform provides sufficient

ISSN: 2278 – 7798

information both for analysis and synthesis of the original signal, with a significant reduction in the computation time [4].

3. NEURAL NETWORK

Artificial neural network has the interconnection of artificial neurons that tends to simulate the nervous system of a human brain. The neural network has basically defined as the knowledge required by the network from its environment through a learning process & the synaptic weight are used to store acquired knowledge [5].

3.1 Selection of neural network input:

For discrimination it is not practical possible to import the input data direct to artificial neural network because the size of wavelet that is too large to import directly to artificial neural network, it cause the difficulty for convergence of artificial neural network. For reducing the size of input data, spectral energy of wavelet signal is calculated with time length Δt. The data window of wavelet is divided into three block, because the simulation scope output are in three phase [5]. Fig 1 shows the neural network architecture [6].

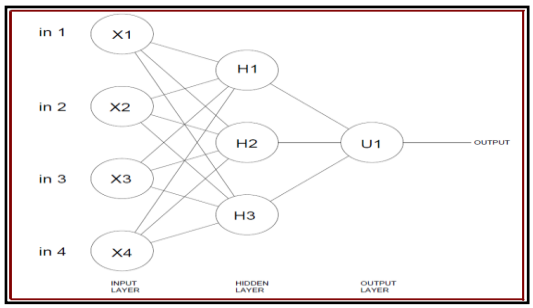

Fig.1 Neural network architecture

3.2 Training of neural network:

For training purpose, in neural network the feed forward neural network is used. This type of network can be used for complex matching pattern problem. Multi layer feed forward network contains there layer first is one input, second is many hidden layer & third is one output layer.

Each network layer contains processing units called neurons. Signals are received at the input layer, pass through hidden layer then reach to output layer. Neural network work on learning algorithm, in this supervised learning is used. In this algorithm, a pre defined set of input data is used. The first input layer propagates until output is achieved. The output is compared with desired output; if they are not same then the error signal is computed for each output. This process is repeated layer by layer until and unless the output is achieved. The learning process primarily involves determination of connection weights & pattern of connection.

The weight update can be done in each layer. In this layer, it is called the epoch mode. The weights are update in a two way: when to stop updating and when to stop training. The training can be stop in two ways: one is using maximum epoch and second is using the cost function. In neural network the cost function is MSE (mean square error). It defines as in equation (3.1) [5]

$$E = \frac{1}{N}\sum_{n=1}^{N}(d_k(n) - y_k(n))^2 \quad \ldots\ldots\ldots\ldots (3.1)$$

N is the number of pattern in data set, $d_k(n)$ and $y_k(n)$ are the desired output and the output at layer k for n^{th} training pattern respectively. When there is more than one output, the function becomes

$$E = \frac{1}{N}\sum_{n=1}^{N}(\mathbf{d_k}(n) - \mathbf{y_k}(n))^T(\mathbf{d_k}(n) - \mathbf{y_k}(n)) \quad \ldots\ldots\ldots (3.2)$$

Where $\mathbf{d_k}$ and $\mathbf{y_k}$ are column vectors of desired output and output respectively. The training adjusts the weights by minimising E over all the training set. The training stops when a specified value of cost function is reached.

4. FLOW CHART

The first step of the methodology is to design & modelling a power system in MATLAB by using Simulink library. At the receiving end of the system the current signal obtained, this signal is import for the wavelet transform by using wavelet toolbox in MATLAB. In wavelet decomposition of signal we get the detailed coefficient of signal as well as approximate coefficients of signals. This signals are used for classify the fault current i.e. current having the internal fault current or inrush current with help of neural network toolbox.

In figure 2 shows the flow chart for the discrimination of transformer fault which is inrush current and transformer fault.

ISSN: 2278 – 7798

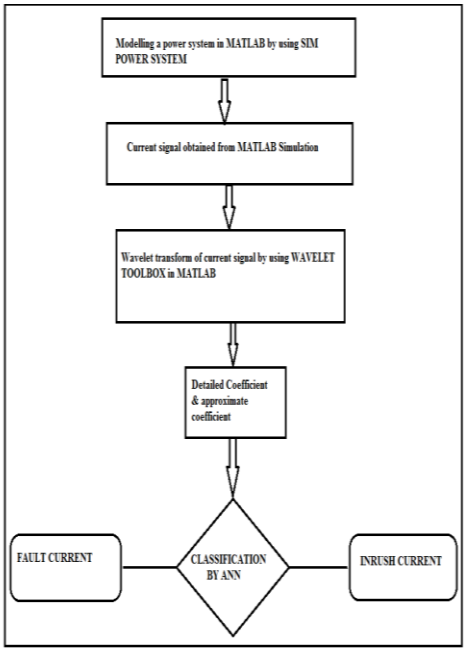

Fig. 2 Flow chart of the proposed algorithm

5. SIMULATION STUDY

In my previous paper [9] I have already explain about the inrush phenomenon in transformer. In this I explain about when external fault occur in transformer, what will be changes are happened. Using MATLAB/ SIMULINK designed the simulation diagram for the transformer fault [8]. A 250 KVA, 50 HZ three phase two winding transformer (Y_g-delta) is connected to 25 KV three phase source. In fig. 4 simulation diagram for the transformer fault is shown.

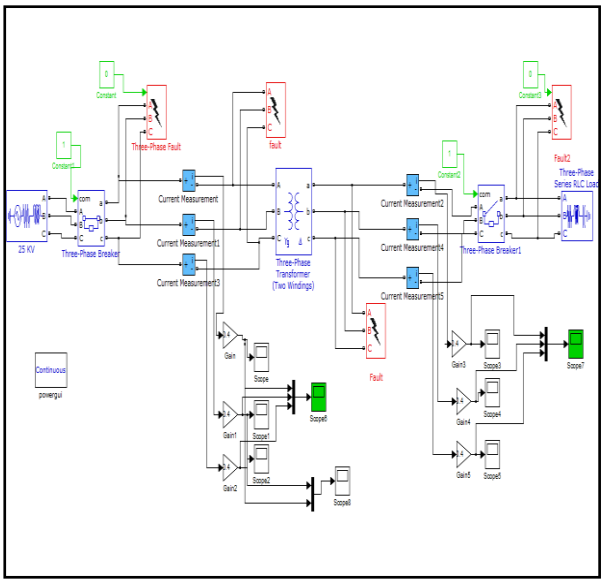

Fig 4 Simulation diagram for transformer fault

When a single line to ground fault occur in transformer, the value of normal current is change to the fault current. The three phase fault block is used for showing the fault in simulation. The scope output of fault current and inrush current in transformer are shown in fig.5 and fig. 6 respectively.

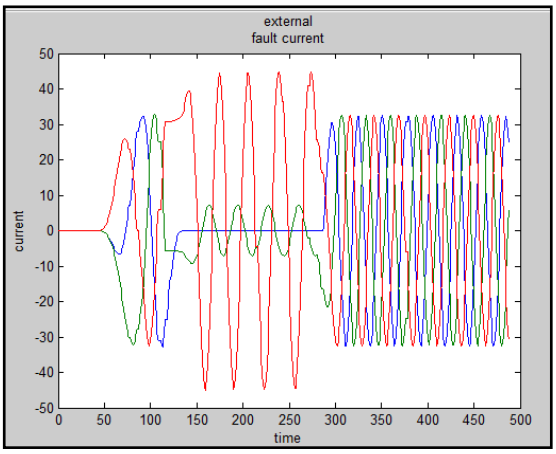

Fig. 5 Waveform for fault current in transformer

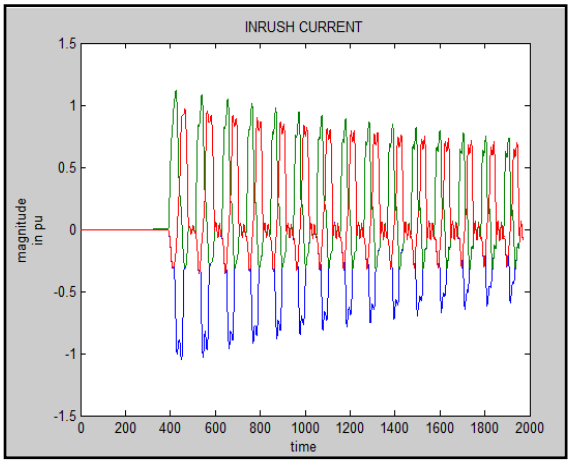

Fig. 6 Waveform for inrush current in transformer

6. RESULT & DISCUSSION

Maximum no. of raw data would create complex and create inaccurate neural network architecture. Featured data was extracted from wavelet analysis and this signal is fed into the neural network. Because this featured data is meaningful & carries more reliable and accurate information. With this data, the no. of neuron in the middle layer will be reduced and simple neural network architecture is needed.

ISSN: 2278 – 7798

In MATLAB we perform the all the analysis of wavelet & neural network [8]. The methodology has already explained in fig.2. There are 274 samples are used for discrimination purpose, comparing the output of the inrush current & internal fault current of transformer. In neural network input , output & hidden layer will use for the discrimination purpose.

7. CONCLUSION

In table I shows the result of the paper, discrete wavelet analysis is to be an efficient feature extract signal & this signal is fed to the neural network to generate featured data & give better discrimination for the inrush current and internal fault current of the transformer. Neural network based classifier has been used for discrimination of fault in transformer. Different input & output data give the accurate result for discrimination.

TABLE I

Time frequency analysis	Discrete Wavelet Transform	Inrush current	
		Internal fault current	
	Artificial neural network	Inrush Current	0
		Internal fault current	1

REFERENCES

[1] H.S.Singh, M.S.Sachdev,T.S.Sidhu "Design implementation and testing of an artificial neural network based fault direction discrimination for protecting transmission line" IEEE transaction on power delivery, Vol.10, no.2 1995, pp 697-706.

[2] Shantanu Kumar, Victor Sreeram " Elimination of DC component & identification of inrush current using harmonic analysis for power transformer protection" IEEE 2013.

[3] S.A.Saleh, M.A.Rehaman "Modeling & protection of three phase transformer using wavelet packet transform" IEEE transaction on power delivery, Vol.20, no.2 2005, pp 1273-1282.

[4] P.Palmer Buckele " A methodology for experimentally verifying simulation model for distribution transformer internal fault" M.S. thesis Texas, A&M University, May 1999.

[5] S.N.Sivanandam, S.Sumathi, S.N.Deepa, " Introduction of neural network using MATLAB 6.0, TMH publication.

[6] Hesham B. Elrefaie, Ashraf I.Megahed " Modeling transformer internal fault using MATLAB, IEEE MELCON, May, 2002, EGYPT.

[7] H.Wang , K.L.Butler " Modeling transformer with internal incipient fault " IEEE transaction on power delivery, Vol.17, pp 500-509, 2002.

[8] MATLAB user guide, version 9, the Math Work inc.2002.

ISSN: 2278 – 7798