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Transmission Line Fault Detection using BFONN

Ashok kumar[1], Mr. Anil kumar[2]
[1]M.Tech Scholar, DCRUST Murthal, Haryana, India
[2]Asst. Professor DCRUST Murthal, Haryana, India

Abstract: In this paper a new method to classify the types of faults and to determine the exact location of faults in transmission lines from the sender's end has been proposed. This method uses famous optimisation techniques neural network for fault position detection. This neural network is further optimised to minimise the error and for exact fault location with bacterial foraging optimisation (BFO). The three phase voltage and current measured are used to find out the exact position of fault.

I. INTRODUCTION

In recent years, power systems have been very difficult to manage as the load demands increase and environment constraints restrict the transmission network. Three main factors cause voltage instability and collapse. The first factor is dramatically increasing load demands. The second factor is faults in the power system. The last factor is increasing reactive power consumption. Many solutions have been developed to avoid blackouts since the Northeast Blackout of 1965. However, catastrophic blackouts still happen on the transmission line systems in some countries.

In the early 1980s, a new technology, which is called the Synchronized Phasor Measurement Unit, was developed to address many power systems problems around the world. The output of the synchronized phasor measurement unit is very accurate due to the phasor measurement at different locations being exactly synchronized. Using data, comparisons could be made between two quantities to determine the system conditions. The advantages of synchronized phasor technology are increasing power system reliability and providing easier disturbance analysis system protection.

Most power system failures are due to transmission line faults. Therefore, to find the exact location of a fault in order to remove that fault is very important. This can improve efficiency, safety and reliability of the grid. The fault location algorithm is very worthwhile to study. Methods to determine transmission line fault location have been studied for decades .These methods generally can be divided into the single-ended measuring distance method and double-ended measuring distance method. The Single-ended method produces less information with less accuracy, and it is also influenced by the system operating mode and the fault resistance.

The results are not good. The Double-ended measuring distance algorithm takes full advantage of fault information. It can improve accuracy, especially with phasor measurement units-based location algorithm, which is based on transmission line current and voltage relationships. This algorithm does not depend on the fault type, impedance or load effects. Accurate transmission line parameters can build an accurate grid model which can be used in state estimation, fault analysis and relay calculations. In this paper, as the voltages and currents at both ends of the transmission line are available to the phasor measurement units, the transmission line parameters in real time can be calculated.

The paper will focus on the concept of synchrophasors and how they can be used in the applications of voltage instability prediction, determining transmission line parameters, and determining fault location. Mathematic modelling and simulation software tool such MATLAB will be used to solve these problems. Achievement of following points will be discussed in this paper :

- To develop a technique for detecting the occurrence of a fault on a transmission line, which can find the accurate position of fault. Neural network helps in this but at some points premature termination of iterations of neural network is the reason to optimise the weights and biases of network. So bacterial foraging optimisation (BFO) is used to optimise the neural network.

- To determine the distance of a fault on the protected line from the information of difference of post-fault voltages minus pre-fault voltages.

II. PRESENT WORK

In our proposed work fault location is determined by feedforward neural network. But neural network is a local search optimization technique. It sometimes terminates without looking for minimum error position or it can be said that it premature terminates sometime. This fault inception of minimum point leads to false location of error in transmission line. So there is always requirement to look for an option which can avoid premature termination of neural network and remove its limitations. Bacterial foraging optimization comes to be savior in this case. It is a global search optimization technique and works well in case of constraint driven objective function. In our case it is used to train the neural network. The training of neural network denotes the training of weights and biases of network as stated in previous chapter.

Weights are multipliers which are multiplied to input to neural network function and biases are added to them. Change in values of these, changes the output of network. So to achieve minimum error these values are optimized with the help of bacterial foraging optimization. Each bacteria in BFO is assigned position in searching space that position changes in search of nutrition or in other words position of bacteria changes to achieve minimum error. Every time position of bacteria is assigned to weights and biases and new network is analyzed for test data, if error is less than the previous one then values of weights and biases at that instant is taken as new values of neural network otherwise new positions of bacteria is assigned to weights and biases and process repeats till minimum error positions is achieved. A flow chart depicting above process is shown in figure 2.1.

III. RESULTS

In this work as discussed above fault location is found out by using neural network and bacterial foraging optimisation is used to train the neural network. This simulation is done by using the simpower and neural network toolbox of MATLAB. SimPower Systems™ provides component libraries and analysis tools for modeling and simulating electrical power systems. The libraries offer models of electrical power components, including three-phase machines, electric drives, and components for applications such as flexible AC transmission systems (FACTS) and renewable energy systems. Harmonic analysis, calculation of total harmonic distortion (THD), load flow, and other key electrical power system analyses are automated.

For fault location detection a simple transmission line model is developed. A generator of 6*350e6 MVA with 13.8e3 V is used for generation of power which is further step down and put on transmission line of total length 350 km. Two PV buses are used at each end of transmission line to measure the voltage and current in three phase. The complete system model is shown in appendix at the end of paper. A three phase fault is introduced in transmission line. The distance of three phase fault is variable and can be changed as per desire. The simulation time of 0.1 is taken and transition time in circuit breakers is also set to 0.1 Initially when no error is introduced in the line then voltage and current for both buses are shown in figure 3.1(a) and 3.1(b). This figure proves that in case of no fault voltage and current at bus B2 are same as at bus B1.

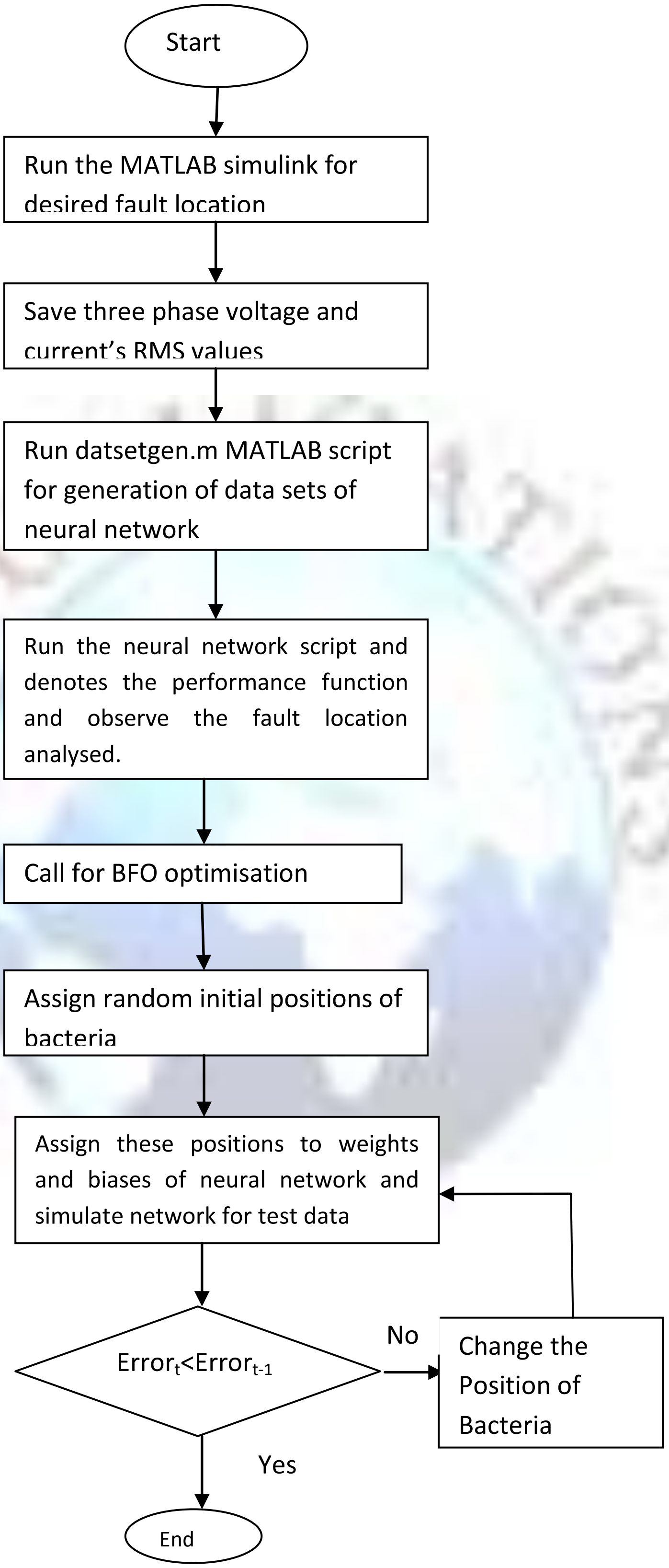

Figure 2.1: Flow chart of proposed work

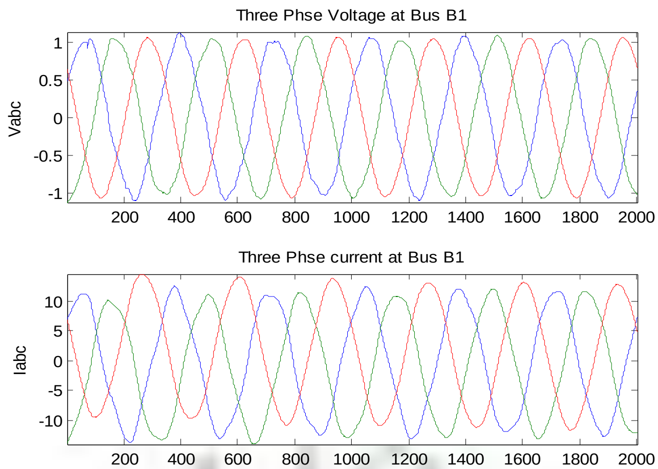

Figure 3.1(a): Three Phase voltage and current at bus B1 in case of no fault

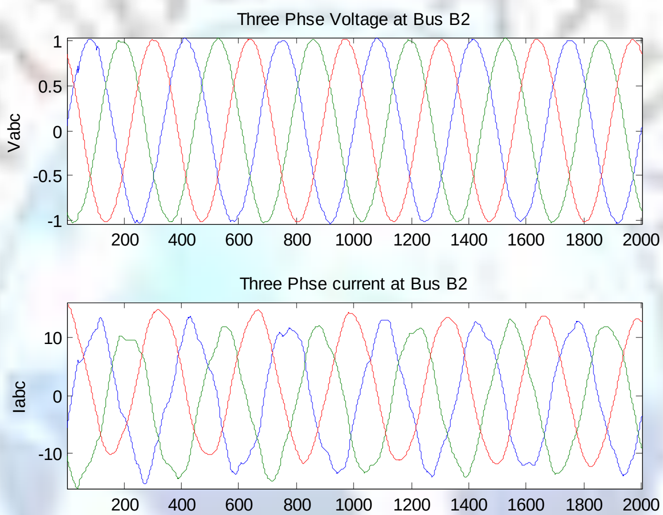

Figure 3.1(b): Three Phase voltage and current at bus B2 in case of no fault

When three phase fault is introduced in transmission line then voltage and current at both buses are shown in figure 3.2(a) and (b).

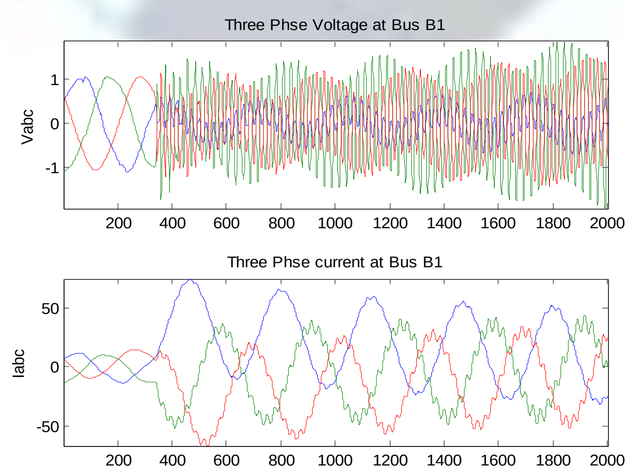

Figure 3.2(a): Three Phase voltage and current at bus B1 in case of three phase fault

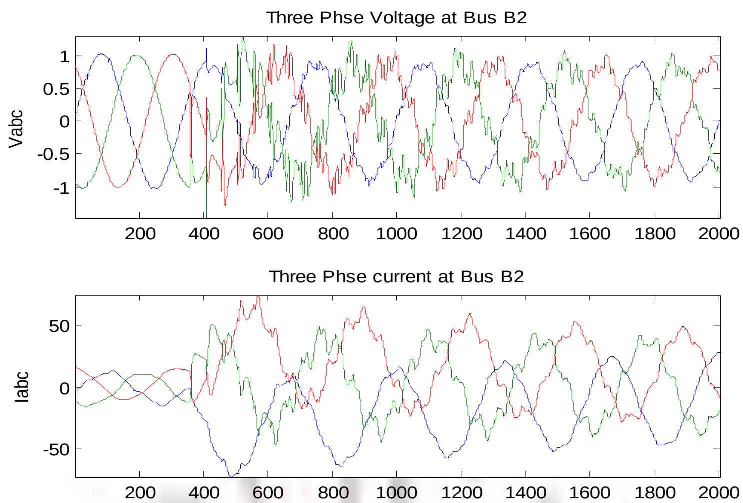

Figure 3.2(b): Three Phase voltage and current at bus B2 in case of three phase fault

Now error is placed at different position of transmission line and neural network is used to find out the location of error. The accuracy of neural network depends upon the data points taken. More will be number of data points more accurate will be the network and position. In our case randomly selected some data points are taken which are given in below table.

Fault position = [94,112,122,133,142,153,162,173,182,193,202,213,222,227,233,242,248,252,262,273,277,283,288,292,297,303,313,312,316,319]

At these positions fault will be introduced and based on these positions training and testing data set will be generated for neural network.

In BFO optimized neural network weights and biases of neural are optimized by bacterial foraging optimization. Because of size of weights and biases, the searching space for bacteria is set to 42 dimensions. The position of bacteria is assigned to weights of neural network and error is checked for new network. If error is less than the previous error value then network for that will be finalized as minimum error network and that will be BFO optimized. In system model double click on 'bfonn' block will optimize the neural network for fault location at that instant.

Initially fault is given at 94kmm from the sending end or at bus B1 side. Then performance curve of neural network optimization in this case is shown in figure 3.3.

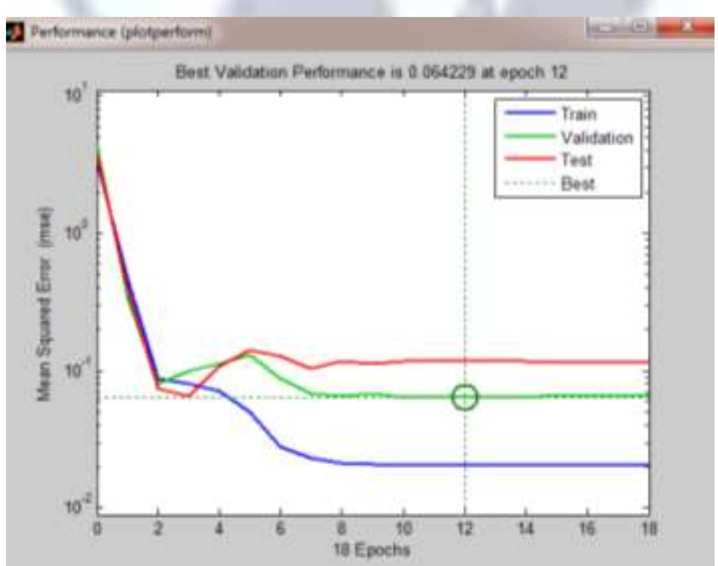

Figure 3.3: Performance curve of BFONN

Error is placed at different locations and BFONN finds the location. A table 1 is constituted which shows the distance measured by BFONN and error with the original position.

Table 1: Positions calculated by BFONN

Theoretical Fault Position	Calculated Position by BFONN	Error
94	93.1512	0.8488
112	111.4908	0.5092
122	121.4127	0.5873
133	132.924	0.076
142	141.3684	0.6316
153	152.7157	0.2843
162	161.7285	0.2815
222	221.3903	0.6097
227	226.7619	0.2381
248	247.3896	0.6104

A graph representing the error for each fault location is shown in figure 3.5. maximum error comes out to be at 94 km and minimum error is at 133 km fault.

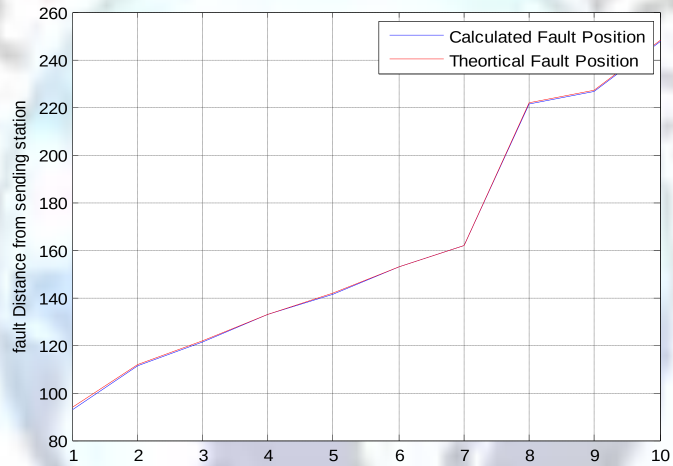

Figure 3.4: graph showing comparison between calculated fault location and theortical location

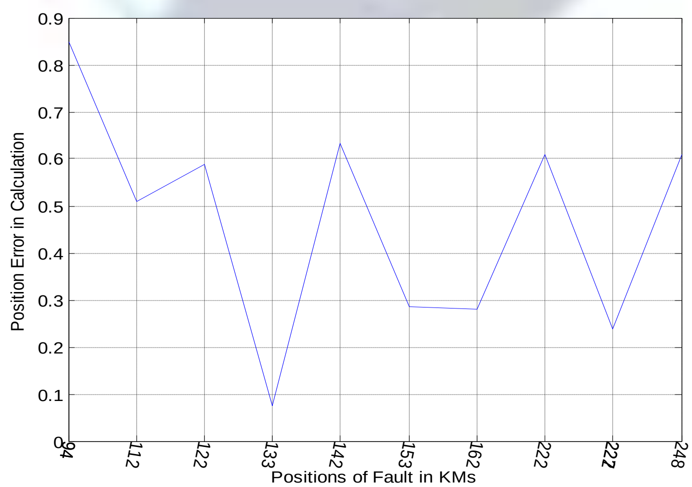

Figure 3.5: Error in faulty location by BFONN

IV. CONCLUSION

In my work a transmission line system has been designed in MATLAB simulink using simpower tool. All types of faults are applied on transmission line at various distances from sending end. I proposed work a 6*350 MVA power system is used for transmission line and neural network is used to find out the location of faults. In order to avoid neural network drawbacks, bacterial foraging algorithm is used as training algorithm. Training patterns are generated by MATLAB power system toolbox and trained by using a bacterial foraging optimisation. The proposed method is tested under different fault conditions such as different fault locations. Based on the obtained results, it can be concluded that the purposed method is very effective and gives a good estimation of fault location.

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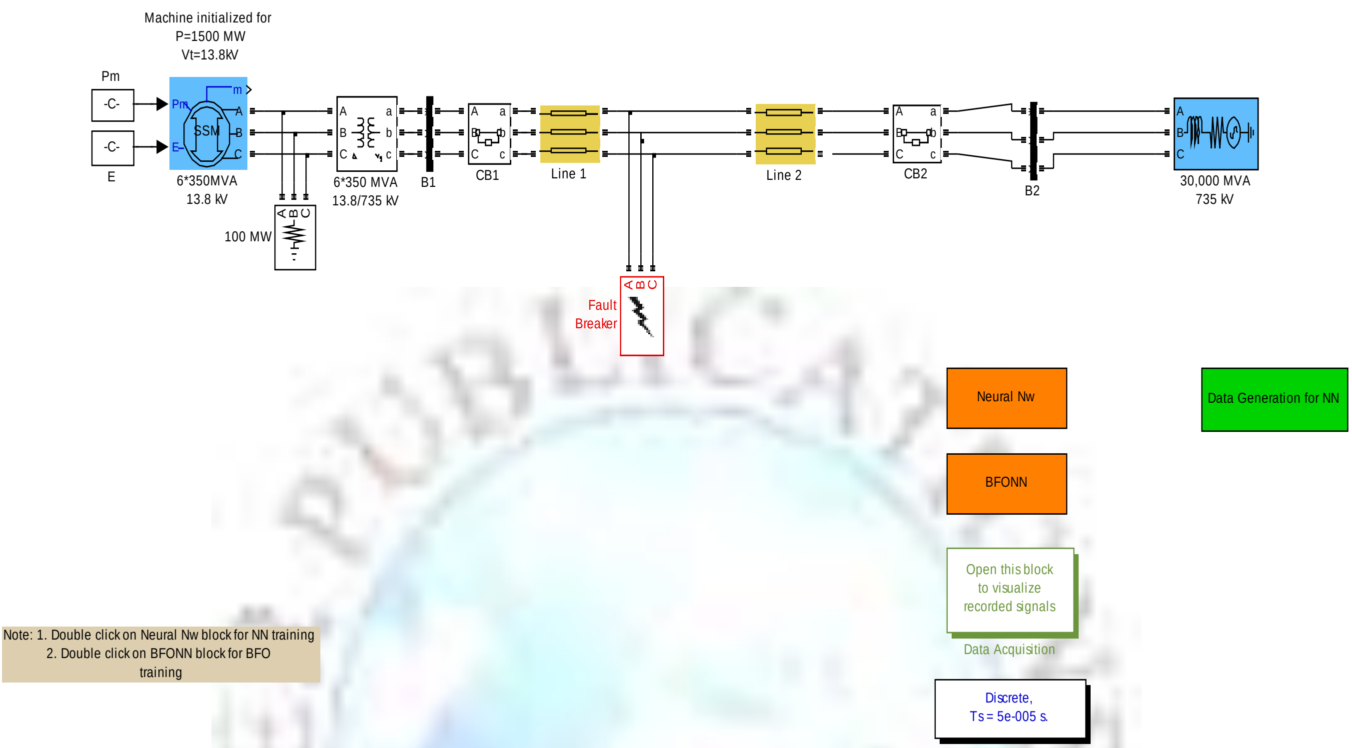
Appendix


Machine initialized for
P=1500 MW
Vt=13.8kV
Pm
-C-
-C-
E
SSM
6*350MVA
13.8 kV
100 MW
6*350 MVA
13.8/735 kV
B1
CB1
Line 1
Line 2
CB2
B2
30,000 MVA
735 kV
Fault
Breaker
Neural Nw
BFONN
Data Generation for NN
Open this block
to visualize
recorded signals
Data Acquisition
Discrete,
Ts = 5e-005 s.
Note: 1. Double click on Neural Nw block for NN training
2. Double click on BFONN block for BFO
training