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Line Trap and Artificial Inteligence based Double Ciruit Tranmission Line Fault Classification

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***Abstract*—The protection of double circuit transmission lines could be a difficult task. This paper presents a protection technique supported the high-frequency transients generated by the fault to hide nearly the entire length of double circuit transmission lines.**
For this purpose, befittingly designed line traps area unit put in at terminals of the protected line, and therefore the Artificial Neural Network with appropriate range of Neurons is employed to classify the faults supported the frequency spectrum of the RMS current and RMS voltage signals. In depth simulation studies indicate that the projected approach is well capable of discriminating differing types of faults and provides a really quick, secure, and reliable protection technique
The simulation model done in MATLAB simulink for system analysis. In this model 300 km, 25 KV, 50Hz transmission line power system model design with three zone bus bar system. One end bus bar data measurement utilized for three phase RMS voltage and current measurement. Also Neural Network training done for designed power system model using MATLAB Simulink.

Keywords—Artificial Intelligence, Double circuit tranmission line, line trap.

I. INTRODUCTION

An overhead conductor is exposed to the surroundings and therefore the chance of experiencing faults on the conductor is usually more than alternative main parts. Once a fault happens on a conductor, it's vital to find it and notice its zone so as to create necessary repairs and to revive power as shortly as doable. Distance relaying has been wide used for the protection of transmission lines. A distance relay must perform the twin task of primary and back-up protection. The first protection ought to be quick and with none intentional time delay. Back-up protection ought to operate if and on condition that corresponding primary relay fails. Distance relays area unit given multiple zones of protection to satisfy the demanding property and sensitivity needs. Zone one provides the quickest protection with no intentional time delay; the in operation time are often of the order of 1 cycle.
It is set to cover major portion of the line length owing to the problem in identifying between faults that square measure near remote bus. Zone two protections are delayed by co-ordination measure. Zone two is ready to shield primary line and additionally provides secondary protection to half portion of the adjacent line with 0.25–0.4 s delay. Setting of zone three is ready to hide complete primary and adjacent line and up to quarter line additionally with further delay. However, numerous conditions like remote in-feed currents, fault-path resistance and shunt capacitance degrades the performance of distance relays [1]. The present differential protection theme has been with success applied to shield the complete line. However, the relay settings square measure tough to come to a decision as a result of line-charging currents and unobvious current variation throughout high resistance faults. Any composite voltage and current measurements were accustomed improve relay sensitivity [2]. For quick fault clearance to enhance system stability, the relaying schemes supported traveling wave square measure planned [3, 4]. However, the techniques square measure tough to discover close-in and zero voltage faults. Numerous quite protection schemes for transmission lines are planned within the past for fault detection and classification (phase selection) and distance location [5–12]. However, these techniques estimate the direction of fault and its zone.

II. PROPOSED APPROACH

A. Block diagram

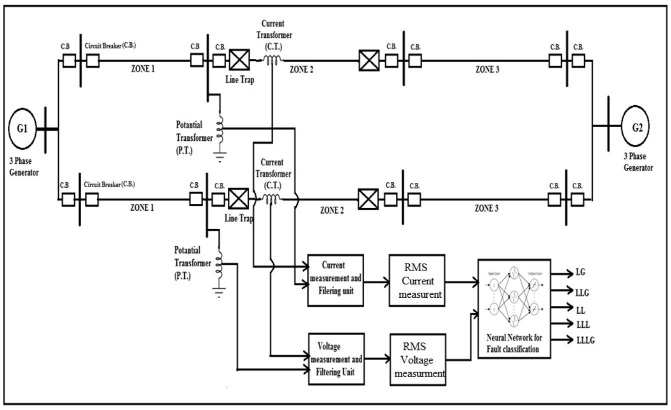


Fig.1. Block diagram of proposed approach

Figure 1 shows the block diagram of proposed approach in which two generators based double circuit transmission line fed a three phase load. Three phase transmission line divided into three zones. The voltage and current of transmission line measured at middle bus bar (B2) which transfers to voltage measurement and current measurement block for filtering the waveform and measurement purposes. Then after RMS value of three phase voltage and current of double circuit transmission line measured which transferred to Artificial Neural Network for fault classification and fault zone identification of faulted line.

B. *Double circuit tranmission line*

Low price of construction, less floor house, liableness of power provide, more economic benefits and length of power provide are the explanations behind exploitation double circuit transmission lines on prevailing grid network. Basically, these lines are made to lessen the issues of getting new right-of-way. The circuits of those lines are either of different voltage levels or of same voltage levels. And, in same manner, over two three phase circuits will be used i.e. multi-circuit lines. Because, the two circuits of double circuit lines, are nearer to every different in order that they are reciprocally coupled. The magnetic coupling influences the present flowing in one in all the circuit that any, affects the voltage profile of different circuit. So, it implies that the profile of voltage of a given circuit isn't completely dependent on the present that flows during this circuit [26]. Also, the steady state stability is enhanced by exploitation double circuit lines as compare to single circuit lines.

C. *Distributed parameter line*

Generally, lumped parameters are used for short and medium lines. But to enhance fault location accuracy, mainly in case of long lines, distributed parameters of the line are considered. The transmission line of unit length is considered as an electrical circuit which consists of series resistance R, series inductance L, shunt capacitance C, and leakage conductance G. R, L, C, and G are the parameters which are uniformly distributed along the whole length of the line. So, it is known as distributed parameter line. Each line consists of these four parameters and these parameters are recognized as primary constants of line.

Where,
R = Total series resistance/unit length (Ω/km)
L = Total series inductance/unit length (H/km)
C = Shunt capacitance/unit length (F/km)
G = Shunt conductance/unit length (℧ /km)
Then,
Total series impedance, $Z = R + j\omega L$ ohm/km (3.1)
Total shunt admittance, $Y = G + j\omega C$ mho/km (3.2)

The characteristics impedance (Z0) and propagation constant (γ) parameters are extremely useful parameters used for analyzing transmission line. These parameters are known as secondary constants of the transmission line and these parameters are obtained in the form of primary constants.

D. *Artificial Neural Network*

Roughly speaking, a neural network is a collection of artificial neurons. An artificial neuron is a mathematical model of a biological neuron in its simplest form. From our understanding, biological neurons are viewed as elementary units for information processing in any nervous system. Without claiming its neurobiological validity, the mathematical model of an artificial neuron is based on the following theses:

1. Neurons are the elementary units in a nervous system at which information processing occurs.
2. Incoming information is in the form of signals that are passed between neurons through connection links.
3. Each connection link has a proper weight that multiplies the signal trans- mitted.
4. Each neuron has an internal action, depending on a bias or firing threshold, resulting in an activation function being applied to the weighted sum of the input signals to produce an output signal.

In the first computational model for artificial neurons, proposed by McCulloch and Pitts [43], outputs are binary, and the function f is the step function.

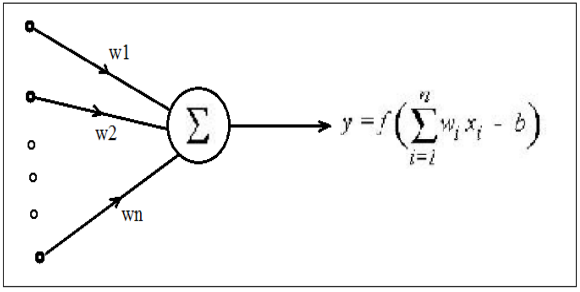


Fig.2. First model for artificial neuron.

III. MATLAB SIMULATION MODEL

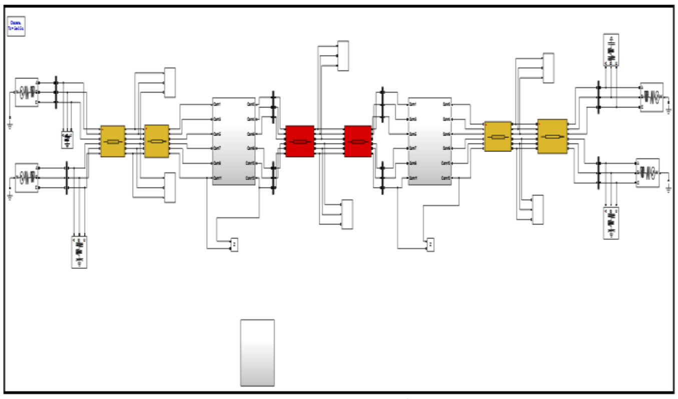


Fig.3. MATLAB simulation model of proposed approach.

Figure 3 shows the complete MATLAB simulation model of 25 KV, 60 Hz transmission line having three zone separated by bus bar. First zone and third zone of power system have simple protection and having length of 120 km and 60 Km respectively. Zone second of line is main protection zone of line at which line trap installed at each end of second zone of line for high transient based protection. Line trap provide high impedance during high transient frequency while negligible impedance during normal supply frequency.

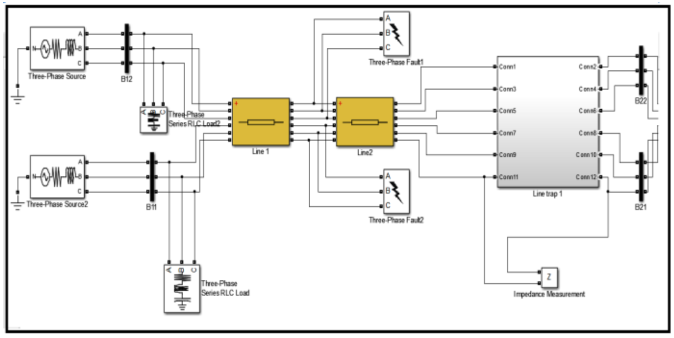


Fig.4. MATLAB simulation model for zone 1 of line.

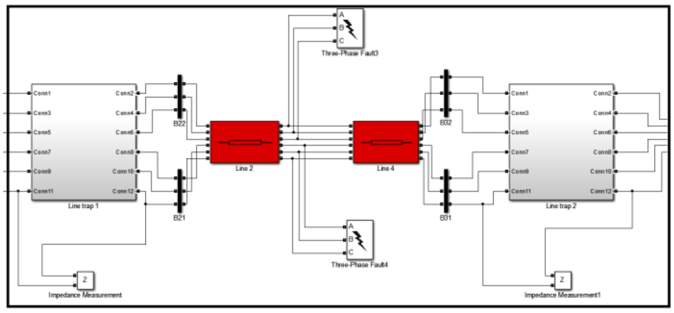


Fig.5. MATLAB simulation model for zone 2 of line

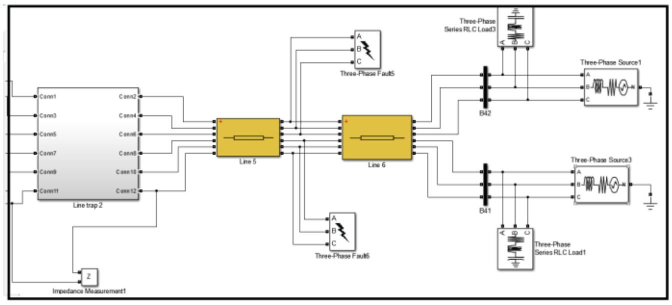


Fig.6. MATLAB simulation model for zone 3 of line

At bus bar B21 and B22 voltage and current of each phase of double circuit transmission line was analyzed and measured which transferred to measurement subsystem. In measurement subsystem block voltage and current measured a bus bar B21 and B22 was converted into RMS value. This RMS measured data of each phase i.e. six phase voltages and six phase current RMS value send to two separate Neural network in which one neural network classify the type of fault occurs and second neural network identify the fault zone at which fault occurs in line.

Training of Neural network done for 12 inputs i.e. six phase voltage and six phase current of each phase of double circuit transmission line. That data set generated for different types of fault and at different fault location of transmission line.

Table.1.Simulation model parameter specification

Sr No	Simulation Block	Parameter
1	Three phase source 1,2,3,4	Phase to phase RMS voltage = 25 KV; Frequency = 50 Hz; 3 Phase short circuit level at base voltage = 100 MVA; X/R/ ratio = 2.
2	Double circuit line model (Line 1,2, 3, 4, 5, 6)	Number of phases = 6; Frequency for RLC specification = 50 Hz; Resistance per unit length = 0.068 Ohm/Km; Inductance per unit length = 1.31Mh/km; Capacitance per unit length = 8.85 nF/Km; Line length = vary for different zone and fault location.
3	Three phase series RLC Load1, 2, 3 & 4	Nominal phase to phase voltage = 11KV; Frequency = 50 Hz; Active power = 10 KW; Inductive reactive power = 10 KVar; Capacitive reactive power = 100 Var.
4	Line trap 1 & 2	R1 = 50 Ohm; C1 = 50nF; R2 = 0.5 Ohm; L1 = 2mH; C2 = 50pF
5	Three phase fault	All types of fault simulated. Ground resistance = 0.001 Ohm; Fault resistance = 0.001 Ohm; Fault transition time = 0.5 second start time and 3 second end time

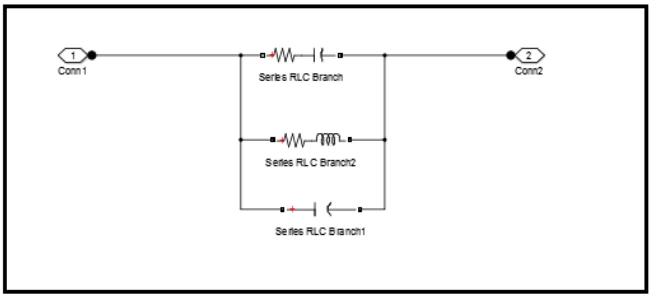


Fig.7. MATLAB simulation model for line trap subsystem.

The main function of the line trap is to present high impedance at the carrier frequency band while presenting negligible impedance at the power system frequency. The high impedance is required to reduce the carrier signal attenuation due to the division among the several transmission lines terminated at the same bus

IV. MATLAB SIMULATION RESULTS

In that section MATLAB simulation model result for different fault condition and different fault location simulated and analyzed.

In MATLAB simulation model of line there are 22 fault cases like AG, BG, CG, ABG, BCG, ACG, AB, BC, AC, ABCG, ABC, A’G, B’G, C’G, A’B’G, B’C’G, A’C’G, A’B’, B’C’, A’C’, A’B’C’G, A’B’C’ simulated at different fault location of six phase transmission line.

A. Voltage and current waveform at B21 and B22 bus bar

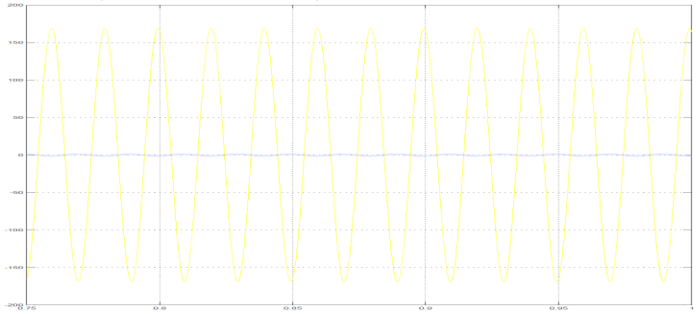
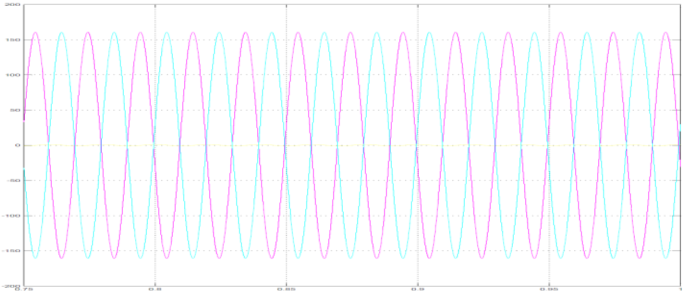


Fig.8. current waveform measured at bus B21 during LG (AG) fault on A to ground at zone 1 of line from bus B21



.Fig.9. current waveform measured at bus B21 during LLG (B’C’G) fault on A’B’to ground at zone 3 of on 125km line from bus B21.

B. Result from Line Trap

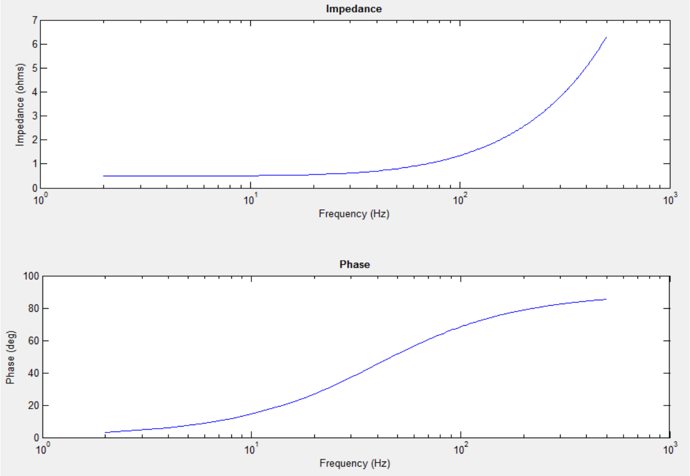


Fig.10. line trap impedance verses frequency characteristics.

Figure 10 shows that line trap is present high impedance at the carrier frequency of 100 kHz while presenting negligible impedance at the power supply frequency 50 Hz.

C. Voltage and current measurment at bus B21 and B22

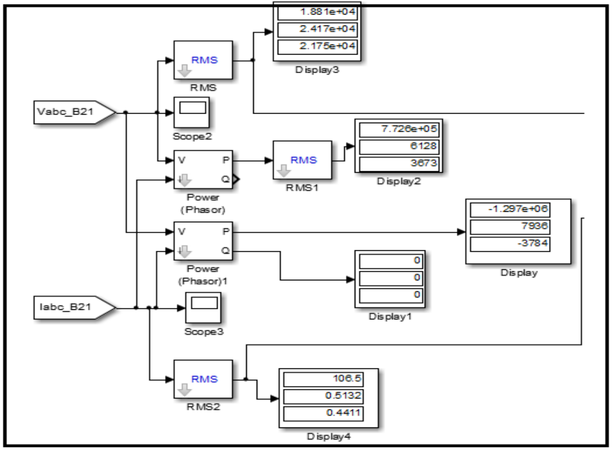


Fig.11. Three phase RMS voltage and current measurement at bus B21during AG fault at zone 1 on 20 km from bus B21.

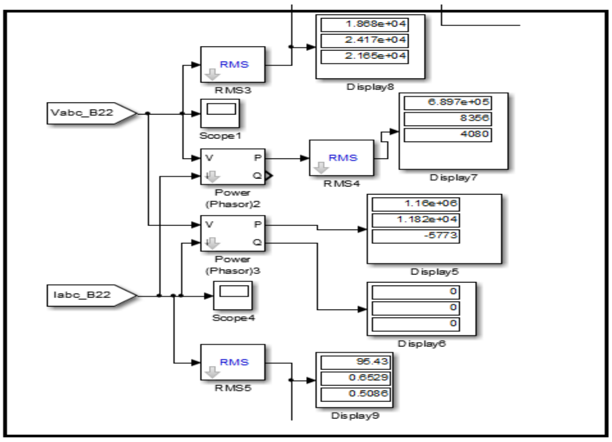


Fig.12. Three phase RMS voltage and current measurement at bus B22 during AG fault at zone 1 on 20 km from bus B22.

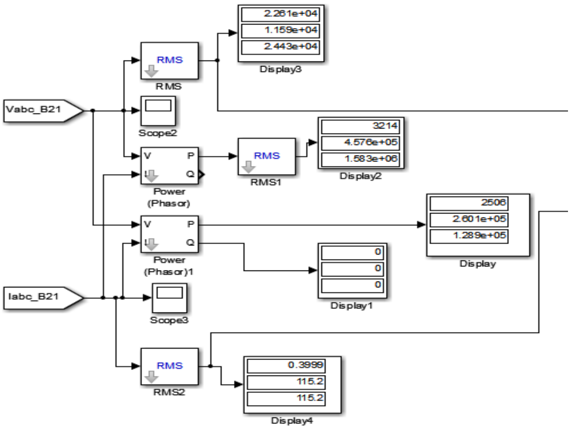


Fig.13. Three phase RMS voltage and current measurement at bus B21 during A'B'G fault at zone 3 on 125km from bus B21.

D. Result from Neural network for fault classification

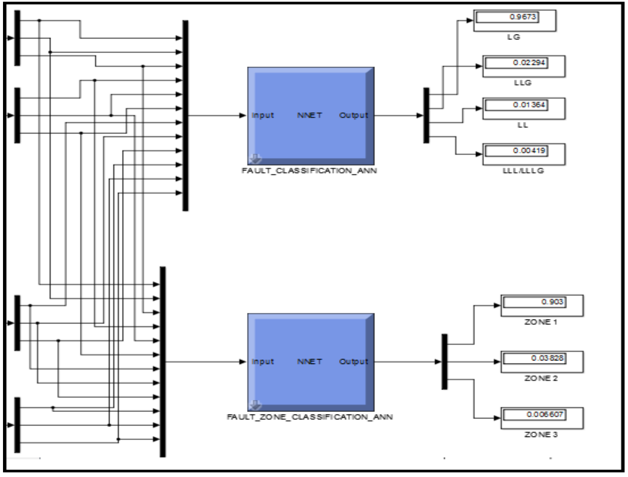


Fig.14. ANN result for fault type classification and fault zone identification during LG (AG) fault in zone 1 from 20km from reference bus B21 & B22.

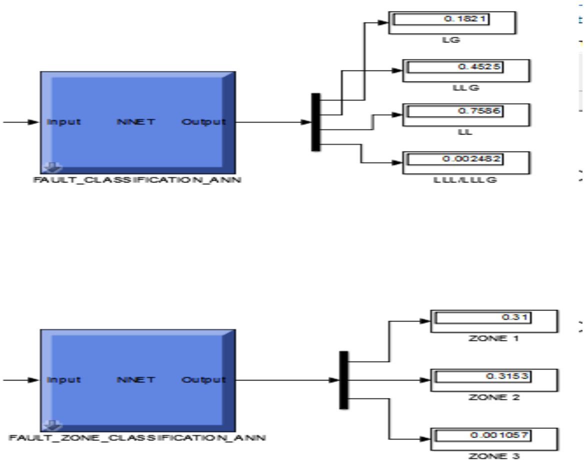


Fig.15. ANN result for fault type classification and fault zone identification during LG (AG) fault in zone 3 from 125km from reference bus B21 & B22.

Figure 14 & 15 shows the ANN result for fault classification in which LG fault shows the reading nearer to 1 that is 0.904 and neural network for fault zone identification shows the value nearer to 1 that is 0.9673 at zone 1.

V. CONCLUSION

The performed simulation studies show that the ANN classifier provides the most accurate result for discrimination between different faults type and faults zone identification using three phase RMS voltage and current measurement of each phase of double circuit transmission line. The ANN classifier is able to reliably identify the internal faults up to 96% of the TL length. Also line trap based high transient based protection provide better transmission line protection and also helpful for distinguish the external and internal fault of transmission line. Line trap provide high transient based protection by opposing high transient frequency surge.

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