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Artificial Intelligence based Power Fault Detection and Power Restoration

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***ABSTRACT*- The main objective of this research is to detect the fault in the power system and rectify it before it affects the entire system. Artificial Intelligence circumstancing Artificial Neural Network (ANN) methods and its topologies are used to detect the fault. In this method, the system specifically analyses the data obtained from the transmission and consumer ends of the power system. The intelligence -based detection is undertaken by the power system which has a capacity of rapid fault detection, and this prediction can be obtained in ANN algorithm. ANN is the core part of this research which stimulates the detection of fault before it's occurrence. A simulated medium length transmission line has been tested by the detector and the results demonstrate the capability of the detector which is visualized in the MATLAB.**

Keyword: Artificial Neural Network, Artificial Intelligence, Simulation, Fault Restoration

I. INTRODUCTION

As a result of increase in population, the product in various commodities increases and with respect to that the production also increases which leads to the large setup of the industries, and this also leads to the large consumption of power. The power constrained to customers and consumers should not be as such and hence this work intends to get the detection before the occurrence of fault. This type of system undertakes the "WHAT IF" criteria to estimate the fault with various methods involved in the power fault detection which can estimate the type of fault occurred, and the location of fault, either from the transfer end or from the receiver end and the nature of the fault. These criteria of fault detection are obtained to rectify the fault, however this system intends to analyze the fault before its occurrence with the previous data.

The Artificial Neural Network (ANN) is a neural system, which acts as the neural system for Artificial Intelligence (AI), as how the human intelligence analyze the past data with present and if any abnormality occurs within the neural system, it tries to communicate with the human brain and stops it before execution. The same process is undertaken to sustain these methodologies for detection of fault from the previously updated data which consist of several stored data of different topologies towards which the system and the device are connected mutually to detect the fault.

The previous data, that is the uploaded data is merely obtained by the input output topologies used in the system as several sensors and meter range ratings which coincides with current and voltage values of input and output. Both these combinations are placed in both ends from receiver and sender, that is in transmission lines and consumer lines.

The system accompanied in both areas tries to communicate continuously with the main system which holds the system previously obtained, and the neurons of neural network try to communicate by

giving the present data. The consideration of present data with previous data keeps on regulating the comparison between them. If both results are equally equipped with considerable variations, the system gets to work without interruptions that is if the value of the fault is merely 3-5%, the AI system can accept it, and if it goes beyond the accepted tolerance, the system communicates and it interrupts with the fault occurrences to the subsystem.

II. EXISTING SYSTEM

The fault in power is an accidental issue that frequently happens in the distribution system due to many uncontrollable factors like animals and weather-related factors. The fault occurrence caused during the rainy season may cause accidents when people don't know about its condition and they accidently touch the electric pole [1][2]. Due to earth line fault occurring in the pole, electricity can easily flow via rainy season since water is a good conductor of electricity. When the insulation surrounding old wires begin to degrade, the wires become degraded and exposed to the soil [3]. Stray electrical currents can travel through the soil and metal objects on the surface, including steel utility poles, streetlights, fire hydrants and manhole covers [4][5]. Simply touching these surfaces, especially with bare feet or during a rainstorm, can cause an electric shock to rattle the body. People and pets have been hurt or killed by such stray voltage [7][8]. The identification and rectification of fault can be estimated only after the fault occurrence. The system can show the exact location of fault with some geographical topologies. And lastly the technicians come to perform the fault rectification [3]-[6].

Disadvantages:

1. The technician gets information only after the occurrence of fault.
2. The type of faults cannot be identified without checking the faulted area and examining them.
3. This traditional method of fault detection takes time.
4. Overcoming the blackout-condition is not easier during the rainy season.

III. PROPOSED SYSTEM

In this proposed system AI (Artificial Intelligence) with ANN (Artificial Neural Network) is implemented as a new methodology. This neural network acts as a nervous system in the main system. The entire system circumstanced with the neural connections within them are accompanied with the certain data which is attained by the sensors used in certain places like receiver and transfer ends. Certain topologies like fault occurrence voltage and drop-up current, i.e., the criteria used in fault situations are usually analyzed and stored as previous data. Whenever the system acts similar to it, as per the data, the minute variation in the line can accurately be certified as the fault occurrence. The ANN based algorithm is implemented in the proposed system such that the feedback loop in between the input and output values hides the value between the layer which also stores the feedback values to the main system.

Advantages:

1. The technicians or engineers get the entire information about the immediate fault occurrence, so that they can act accordingly.
2. Time for identification of fault occurred area is reduced.
3. This method is useful for both overhead and underground transmission lines.
4. The sustainment of power outage time for a long time will be reduced.
5. Implementation of different techniques can give the segregated output to the system.
6. This system can be used in Hospitals, especially during emergency conditions.

IV. BLOCK DIAGRAM

In this proposed model, the several layers of inputs are analyzed and used as the accumulators for output. Here, several data are experimented for further classification and the entire function is uni-connected with the main system as neurons are connected with the brain system. By this algorithm, the fault occurring data are sampled and initiated in the input layer. Several parameters like x_i, y_i, and z_i, grasp the data from the different sensors and get calculated automatically.

The ANN used in the system compensates the attained values with all the obtaining value and

gives the output to various levels, which again takes the initiative condition and proceeds with several calculations and specifies the probability of fault occurrence in the output. The *x, y,* and *z* in the hidden layer automatically excide the output and provide the feedback to the main system about its initial function with the parametric analysis. The block diagram of the proposed system is shown in fig.1.

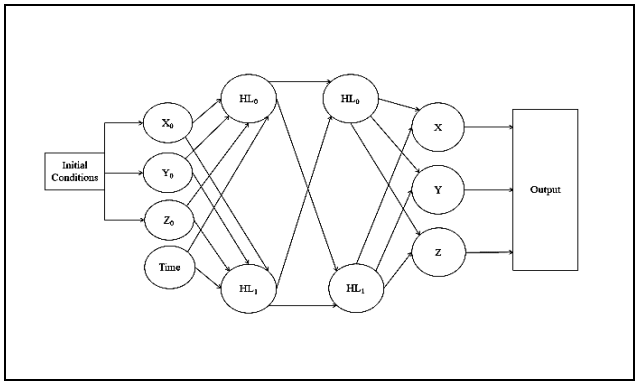

Fig.1: Block diagram of the proposed method

In the figure, HL1-2 are the Hidden Layers, X0 Y0 and Z0 are the input or initial conditions and X Y and Z are the outputs. Here *x, y, z* of input and output parameters are used to access the loads of inputs from two different ends. The hidden layers of HL_1 in the input side gathers the data of the previous function and the hidden layers of HL_2 in the output side accepts the new incoming data, and simultaneously they analyze the data obtained from the HL_1 with HL_2 by the ANN Algorithm which predicts the occurrence of fault.

V. ALGORITHM

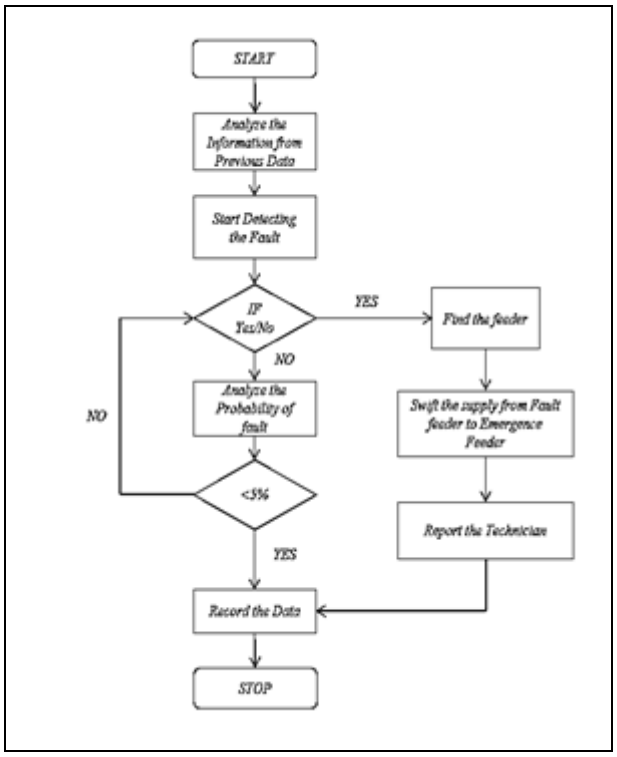

Fig.2: ANN Algorithm

Steps involved in ANN Algorithm

Step 1: Start the program.
Step 2: Analyze the previously stored information with the present upcoming data.
Step 3: The present data are analyzed and formulated by the ANN algorithm.
Step 4: The feedback loop is created in such a way to compare the obtaining results.
Step 5: Compare those results to check if there is any variation.
Step 6: If the program prints 'Yes', proceed to the further process like Shifting of Feeder.
Step 7: Else go to the calculation of probability of occurrence.
Step 8: If percentage of fault occurrence is more than 5%,
Step 9: Repeat step no.2 and proceed the same until it gets rectified.
Step 10: Then store the result and send to the main station, and the technician can rectify it.
Step 11: Else print the result.

Step 12: Stop the Process.

VI. METHODOLOGY

The biological neural network has been modeled in the form of Artificial Neural Networks with artificial neurons simulating the resemble function of a biological neuron. The proposed system undergoes these topologies for acquiring data. X_i=Inputs Y_i=Outputs W_i=Mass
Whereas,

$$p(H_1) = \frac{1}{(1+e^{-f})}$$

S_q-Length of the fault feeder

The fault takes place 'y' away from the Bus Bar Z_{sc} of '*x*' away from the Bus Bar, before fault point

$$I_{kx} = \frac{j\omega(S_k - x)C_o^k}{S_k} \times \left(U_{AC}^* + U_{BC}^*\right)$$

$$I_{kx} = \frac{j3\omega(S_k - x)C_o^k}{S_k} U_C^*$$

$$0 \le x \le S_x$$

If Z_{sc} of *x* away from the Bus Bar, after the fault point

$$I_{gx}^* = -\left(U_{AC}^* + U_{BC}^*\right)\left(j\omega\frac{C_o^g}{S_g} + j\omega(C_o^k - C_o^g)\right)$$

$$I_{gx} = -j3\omega\left(C_o - \frac{S_q - x}{S_q}C_o^g\right)U_C^*$$

$$0 \le x \le y$$

Where Z_{sc} of *x* away from the Bus Bar, after the fault point

$$I_{gx}^* = \frac{j\omega(S_q - x)C_o^g}{S_q} \times \left(U_{AC}^* + U_{BC}^*\right)$$

$$I_{kx} = j3\omega\frac{(S_q - x)}{(S_q)}C_o^g U_C^*$$

$$y \le x \le S_q$$

The output can be estimated with these topologies.

$$Output = \sum_{i=1}^{n} I_{ki} - I_{gi} + b$$

Hence, the data are stored and used for comparison for ANN Algorithm.

VII. EQUIVALENT CIRCUIT

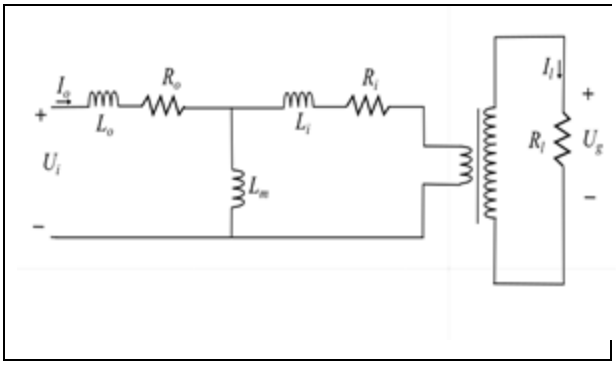

Fig.3: Equivalent Circuit

U_i is the initial voltage that is the input for transmission line for consumer

U_g is the final voltage that is the input for consumer or receiver end.

L_o, L_i, L_m are used to store the charge for impedance calculation.

R_o, R_i, R_l are the loads that are eventually connected. These act as grid connection with different loads.

$$V = IR - Ohm'sLaw$$

$$I = L\frac{di}{dt}\hat{i}$$

$$R = \rho\frac{l}{A}$$

$$V = L\frac{di}{dt} \times \rho\frac{l}{A}$$

$$\int_0^\infty V dt = \rho\frac{l}{A}\int_0^\infty L di$$

$$R_e = \frac{R(\omega l)^2}{\left(R^2 + (\omega l)^2\right)}(\Omega / km)$$

$$l_e = \frac{Rl^2}{\left(R^2 + (\omega l)^2\right)}(H / km)$$

The transfer of voltage will eventually get stored in the Neural Network as the existing data. If the value of these Resistor and Inductor exceed the mean value, then the system indicates the probability of fault occurrence.

VIII. SIMULATION RESULT

The following simulations are designed using the MATLAB Simulink which consists of a three-phase line with line voltage 11kv and it is inhibited by the three-phase voltage source which replaces the substation. The current measurement loads the initial voltage before the fault occurrence in the line and later at the end of the receiver end. The current measurement is used to record the output voltage.

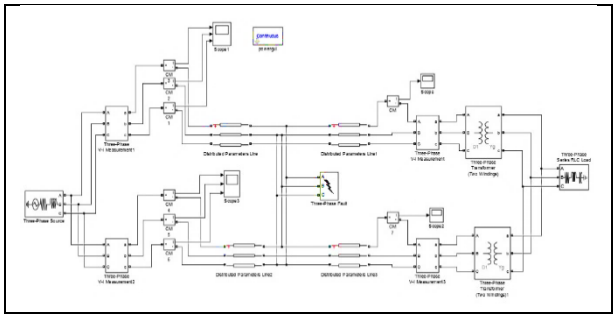

Fig.4: Simulation Circuit

The simulation circuit is shown in fig.4. Fig.5 shows the actual performance, that is the system without fault. Here in this simulation, the fault is given manually by adding the three-phase electric fault in between the substation to the distributed line and distributed line to the transformer. The initial voltage V_i =11kv, 50Hz.

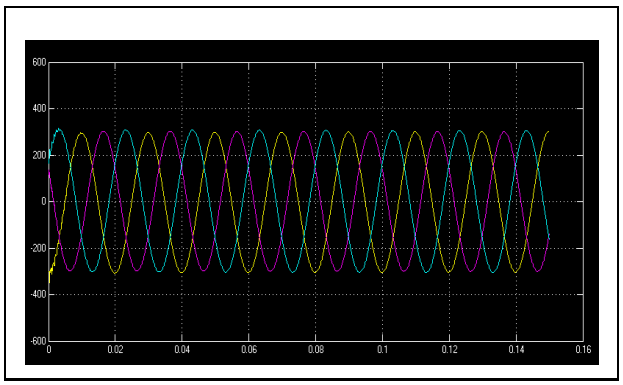

Fig.5: Simulation Result with no Fault

The receiver side gets the voltage of 11kv. After the initiation of fault with phase electric fault, the voltages changes and gives the following simulation result. Although the voltage and its current vary, the Electro Magnetic Relay rectify the fault and show the usual reading of output as in fig.8.

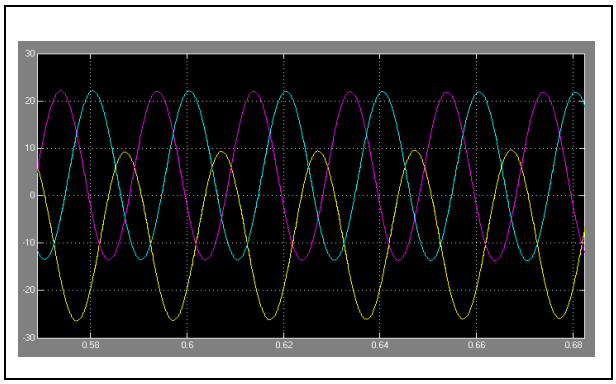

Fig.6: Simulation Result with fault in Y line and Ground

The electric fault is given manually to analyze the fault in the wave form representation, as here the fault is given in the y phase of the RYB line, which is initially deducted in the transfer side and automatically rectified with the Electro Magnetic Relay in receiver side, as shown in figures 6 and 7.

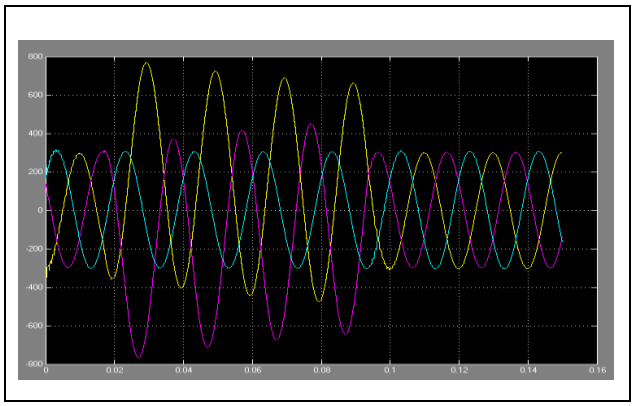

Fig.7: Simulation Result with fault in Y, B Line with ground

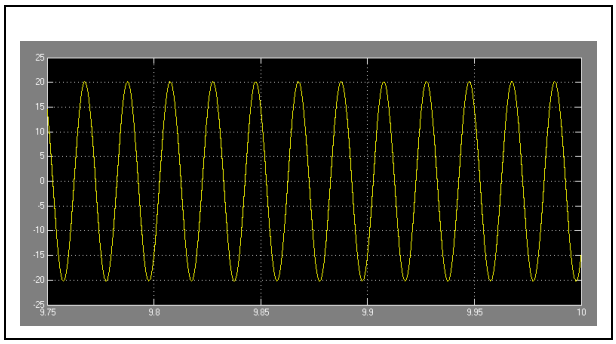

Fig.8: Simulation Result after the Rectification of fault using Relay

Fig.9: Login page for accessing the condition of the feeders to check either fault or normal

IX. WORKING OF THE PROPOSED MODEL

The proposed model is designed in such a way that it detects whenever power fault occurs in the transmission line that is either overhead or underground. The impedance loss of the line occurs often for various natural calamities that is during tough weathering conditions. Due to this, if fault occurs, the identification of it is quite hard and the rectification of fault creates a major problem.

In this system, ANN is a neural network used for the calculation and analyzation of the new data in the system. The sensors in the system sequentially give the voltage rating and its variation to the layers of the ANN. The layers in the proposed system use the specific sequential function that is it initially stores the data, and compares the previous data with new upcoming data. If the upcoming data is tolerated to be more than the accepted tolerance, the system is said to be fault one. The functional calculation and fault determination is inhibited automatically to the specific server as shown in fig.10, which is been indicated in the servers of the substation. The analyzed data are automatically updated in the server and the fault condition also gets updated.

With the help of basic electronic topologies such as resistivity, inductivity, and capability of the line, it may undertake certain calculation for the system with respect to ANN algorithm to get rid off the fault condition. As per intelligence, the system of fault identification, minute variation in the data can even get identified with ANN algorithm. The accepted tolerance is only about 5%, and exceeding can cause the system to be out with limited voltage of the specification and leads to the cause of fault. It specifies fault and rectification as per the data. If it is a major fault, then the system automatically shifts itself towards the nearby feeder for escaping from the power outage condition until the system's fault gets rectified.

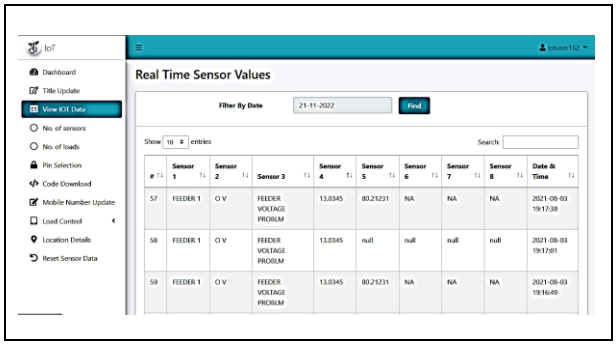

Fig.10: Page displaying the details of the fault, date, time, and place of occurrence.

The total analyzed data is updated in this server as in Fig.10. which eventually keeps updating and analyzing the new upcoming data and ANN

checks with the new data and provides the feedback to the system for future analyzation.

X. CONCLUSION

The power outage conditions occuring due to the entire feeder fault can be overcome by this system. Based on the nature of the loads connected to the feeder, the feeder that attained power outage condition can be provided by a source of the other feeders. The implemented AI based ANN is neural network of which its algorithm is designed in such a way to deduct the fault and reduce it before its occurrence. The neural system of AI undergoes comparison of the data from past and present. The variation of data from the present and stored data is synchronized with simple variation that leads to the development of ANN algorithm, and this algorithm analyse the inputs and feeds the information to the sub-system which causes the supply to stop. The future scope of the system is to shift the supply between the feeders.

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