EHV TRANSMISSION LINE FAULT CLASSIFICATION

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Abstract- This paper presents a novel DWT-ANN approach for EHV transmission line fault classification. In the present situation customer required reliable and quality power so accurately fault classification on a transmission line is extremely important. A real network of 765kv transmission line between unnao and anpara is simulated in PSCAD/EMTDC software. Different faults are created on EHV transmission line like LL, LLL, LLG and LG are used for the fault classification by DWT-ANN approach.

Keywords- Discrete wavelet transform, Modal signal, Artificial Neural Network.

I. INTRODUCTION

The important issue of power system engineering is protected against the fault, because most of cases faults are occurring on the transmission line. So discrete wavelet transforms Are applying for decomposition of fault transient, because its ability to extract the fault information from transient signal. ANN is the best approach have been quite successful in determining the correct fault type, the main disadvantages of Artificial Neural Network are that it requires a considerable amount of training effort for good performance.

II. LITERATURE SURVEY

In the real 765kv EHV transmission line is considered between unnao and anpara has been simulated in EMTP and analysis is done under steady state and transient conditions by determining the power transfer capability of the line with the help series and shunt compensation. Later switching over voltage studies are carried out.

The performance of the line is checked by satisfactory equipment loadings during all the conditions for normal and contingency operation. In fault detection is carried out by using wavelet and classification is done with the help of ANN by using oscillographic data. The network is simulated in EMTP software on the basis of different condition like different fault location, inception angle and fault resistance. LG fault and other power quality issues are discussed in this paper.

In the real power system has been simulated in PSCAD/EMTDC with lines modeled using frequency dependant phase model. DWT of voltage modal signal is used to extract distinguishing features from the voltage waveform of these events. This method differentiates transients arising out of isolated capacitor switching, back-to-back capacitor switching, load switching, line to ground fault, double line ground fault, line to line fault, triple line fault, line energization and line de-energization.

In the main purpose of this method has differentiated the fault zone and indicate exact fault type using one end data only so that only faulted line will be removed. In this paper discrete wavelet transform is used to capture two bands of frequencies from the transient current modal signal using dbl as a mother wavelet. Fault simulations are performed Using MATLAB/Simulink and then the results interface to MATLAB where the algorithm is implemented.

In various types of faults have been simulated at different locations along the transmission line and an attempt have been made to correctly identify and locate the fault. The simulation of real network is done with the help of EMTP for the programming MATLAB are used. Properly configured neural network (NN) can be utilized for classification of the faults based on the DWT signal. Distribution of frequency components and their values as obtained with the help of FFT.

III. POWER SYSTEM SIMULATED NETWORK

Fig-1 shows the 765kv single circuit transmission line between unnao and anpara is simulated in PSCAD and the transmission line is extended upto 430km. The sources are represented by equivalent potential source to ensure proper fault classification. Below tables show system configuration. Tables-1 shows the MVA rating of the sources, table-2 shows the number of bus voltages, table-3 shows transformer ratings and table-4 shows quad bersimis conductor specification.
**SOURCES**

<table>
<thead>
<tr>
<th>Sno</th>
<th>MVA rating</th>
<th>Voltage rating</th>
<th>Power factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2500 MVA</td>
<td>15kv</td>
<td>0.85</td>
</tr>
<tr>
<td>2</td>
<td>2500 MVA</td>
<td>15kv</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**Buses voltages**

<table>
<thead>
<tr>
<th>Bus1</th>
<th>Bus1</th>
<th>Bus1</th>
<th>Bus1</th>
<th>Bus1</th>
<th>Bus1</th>
<th>Bus1</th>
</tr>
</thead>
<tbody>
<tr>
<td>15kv</td>
<td>15kv</td>
<td>400kv</td>
<td>765kv</td>
<td>765kv</td>
<td>400kv</td>
<td>220kv</td>
</tr>
</tbody>
</table>

**Transformer voltage rating**

<table>
<thead>
<tr>
<th>Transformer</th>
<th>MVA rating</th>
<th>Voltage rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>2500 MVA</td>
<td>15kv/400kv</td>
</tr>
<tr>
<td>T2</td>
<td>2500 MVA</td>
<td>15kv/400kv</td>
</tr>
<tr>
<td>T3</td>
<td>5000 MVA</td>
<td>400kv/765kv</td>
</tr>
<tr>
<td>T4</td>
<td>5000 MVA</td>
<td>400kv/765kv</td>
</tr>
<tr>
<td>T5</td>
<td>1200 MVA</td>
<td>400kv/220kv</td>
</tr>
</tbody>
</table>

**Quad Bersimis conductor specifications**

<table>
<thead>
<tr>
<th>DC Resistance (ohms/KM)</th>
<th>Diameter (mm)</th>
<th>Radius (mm)</th>
<th>Area (mm²)</th>
<th>Loading ability of the line (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04742</td>
<td>35.05</td>
<td>0.017352</td>
<td>725</td>
<td>1200</td>
</tr>
</tbody>
</table>

**Table 1**

**Table 2**

**Table 3**

**Table 4**

### IV. PROPOSED METHODOLOGY

In this proposed method, the faults are created on 765kv transmission line designed in PSCAD. Faults reading is taken in the interval of 50km like 50km, 100km, 150km, 200km and 215km on the transmission line from the source side at various inception angles 0°, 45° and 90° degrees. Simulation of the system under study is done in PSCAD/EMTDC software. Capturing of voltage and current signals and preparation of the data sheet from simulation software with 10 KHz sampling frequency, then normalize the voltage and current signals and construct a modal signal for reducing a memory space and fast operation. Importing of the datasheet to MATLAB programming for DWT analysis. Decomposition of captured signal by using db4 wavelet up to 7th level, then calculated energy from the detailed coefficient for 7th levels and Preparation of the data sheet of d6 energy level and importing it to ANN for fault classification.

### V. EXTRACTION OF TRANSIENT ENERGY AND DISCRETE WAVELET TRANSFORM

Discrete wavelet transforms are used to analyze the signal in the time-frequency domain with different frequency ranges, by means of dilating and translating of a single function named mother wavelet. When the fault occurs on transmission line it carries high and low frequency component which carry important fault information. Wavelets can be very effectively used in analyzing transient phenomenon of the fault signals. Multi-resolution analysis is one of the tools of discrete wavelet transform, which decomposes the original Signal to low frequency signals called approximations and high frequency signals called details. The signal of the desired component can be extracted via Repetitious decomposition. Number of decomposition steps should be decided by comparing the scale of sampling Frequency with that of the frequency component of the desired signal. Fig-2 shows the multi resolution steps of the signal.

**VI. FAULT ANALYSIS**

The three phase voltages and three phase current signals for different fault conditions for different faults are taken into account. In this paper for the fault classification different conditions are used between that below Fig 3 to 6 shows only zero degree, inception angle and distance is 215km from source also Figure 7 to 15 shows wavelet decomposition level of current and voltage model signal of LL, LLL, LLG and LG faults. By analyzing the fault waveform it’s clearly understood that if a fault occurred near to source it is very dangerous to the power system. In the decomposition diagram level 6th show the discrimination of different fault on EHV transmission line.
Fig-4 Zero degree instant and Distance are 215km LLL Fault.

Fig-5 Zero degree instant and Distance are 215km LLG fault.

Fig-6 Zero degree instant and Distance are 215km LG fault.

Fig-7 Wavelet Decomposition level of current modal signal For LL Fault.

Fig-8 Wavelet Decomposition level voltage modal signal for LL Fault.

Fig-9 Wavelet Decomposition level of current modal signal For L.LL Fault.

Fig-10 Wavelet Decomposition level of voltage modal Signal for L.LL Fault.

Fig-11 Wavelet Decomposition level of current model Signal for LLG Fault.

Fig-12 Wavelet Decomposition level of the voltage modal signal for LLG Fault.

Fig-13 Wavelet Decomposition level of current model Signal for LG Fault.

Fig-14 Wavelet Decomposition level of voltage modal Signal for LG Fault.
VII. FEATURE SELECTION

Modal voltage signal: \( E_s = E_{41} + E_{42} + E_{43} \) \( E_r = E_{51} + E_{52} + E_{53} \) Where \( E_s \) and \( E_r \) voltage modal signal. \( E_{41}, E_{42} \) and \( E_{43} \) are three phase sending end Voltage signal. \( E_{51}, E_{52} \) and \( E_{53} \) are three phase receiving end Voltage signal [3].

Modal current signal: \( I = I_{a1} + I_{a2} + I_{a3} \) Where \( I \) - current modal signal. \( I_{a1}, I_{a2} \) and \( I_{a3} \) are three phase current.

The number of signals to be handled is reduced from nine to three, hence memory space is saved and computational time is reduced. The preserved transients in modal signal can be extracted using wavelet transform, which provides time-frequency resolutions.

VIII. ARTIFICIAL NEURAL NETWORK

A popular model for ANN is Principal component analysis networks (PCAs) combine unsupervised and supervised learning in the same topology. Principal component analysis is an unsupervised linear procedure that finds a set of interrelated features, principal components, from the input. An MLP is supervised to perform the nonlinear classification from these components. Below table-5 shows the date are given to train the ANN and find out the classification between faults.

IX. RESULTS AND DISCUSSION

After the, the artificial neural network based fault classifier is extensively tested using independent data set consisting of fault scenarios not used previously for training the network. Fault type, fault location and inception angles are changed for the validation and data test set to investigate the effects of these factors on performance of the proposed method. The result of classification for a given system are as shown in table-6. To inquire into the accuracy of the proposed method in these cases, 100% accurate results are found for LLL, LL, LLG, LG type of faults. Hence principal component analysis, modal based fault classifier classifies the types of faults with an accuracy of 100% in a very fast and effective manner.

CONCLUSION

The Base value of the voltage in the system is 765kv and Fault classification is done by using db4 mother wavelet. Decomposition of modal voltage and current signals level 6th differentiate clearly the types of fault by observing the decomposition waveform diagram. The time required for classification of the faults after constructing modal signal is less so number of inputs is reduced and it required less memory space because they user of modal signal complexity for taking a decision for ANN is reduced. In this paper developed an accurate technique of classification of faults on the EHV transmission line is done. The proposed strategy is applicable for any configuration of the system as it is verified for different faiths, locations and different angles of inception. The results obtained with the use of DWT-ANN based algorithm are promising and suggest that this approach could lead to useful application in an actual power system.

REFERENCES

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