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Mitigation Techniques on the Nigerian 132KV Transmission Network.

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ABSTRACT: Its goal is to use a single technique to solve the problem of detecting, classifying, locating the exact fault distance, and mitigating faults on Nigeria's transmission network while lowering costs. This work aims to look into the various problems with Nigeria's 132kv system, as well as evaluate and compare the various fault detection systems available to Nigerian engineers. The main goal of this work is to monitor Nigeria's 132kv transmission network and provide accurate, reliable fault detection, classification, location, and mitigation tools.

I. INTRODUCTION :

Today, fault locators based on microprocessor-protected relays, digital fault recorders (DFRs), and stand-alone fault locators are widely used. A fault locator is a piece of auxiliary protection equipment that uses a fault location algorithm to calculate the distance to the defect/fault. Based on the type of signals used by the fault locator, fault location methods can be further classified into different categories. There are two types of impedance-based fault location algorithms: one-terminal methods and two-terminal methods (synchronized or unsynchronized data from both terminals). This research will focus on fault location, and the two methods (single end method and double end method) will be tested and compared in terms of error minimization. As the world's power transmission and distribution systems grow, so does the risk of faults; as a result, accurate fault location techniques in the transmission grid are becoming more important".

"The lengths of transmission lines range from short to long, single circuit transmission lines to "double-circuit transmission lines," and so on. There are several methods for simulating the network quickly and accurately under various power system conditions. After each disruption, the electrical power system's conditions change. However, in order to develop a fault mitigation strategy for efficient power distribution to end users, fault assessment is required to determine the nature and frequency of defects. When improving system resilience for fault mitigation in the electricity system, environmentally induced fault circumstances such as wind, rain, or car accidents must be taken into account. These variables have the potential to cause short circuits or three-phase failures in transmission networks. End users continue to demand improved system reliability and performance, so the "impact of wind on transmission lines" has been investigated, as well as the resulting modeling error".

II. PROBLEM STATEMENT

Maintaining a reliable power system operation necessitates the ability to quickly detect, isolate, locate, and repair various faults. The classification of various fault types, on the other hand, is critical in digital transmission line distance protection. Fault classification that is accurate and timely can help to prevent further damage to the power system. The accuracy of the power system's fault detection technique becomes critical given the size and dimensions of Nigeria's 132 kV transmission line (Afam to Port Harcourt main).

III. REVIEW RELATED WORKS

To detect and diagnose faults in a single-phase transformer, Bernierri et al. (2016) used neural networks. To begin, the residual is computed by comparing the neural network output to the process output. Based on the residual, the second neural network detects the defect.

"A two-stage neural network was proposed by Yunosuke et al (1997). The first stage of a continuous stirred tank reactor detects and diagnoses the problem, while the second stage identifies the dynamic trend of each measurement. Each primary network corresponds to a measured

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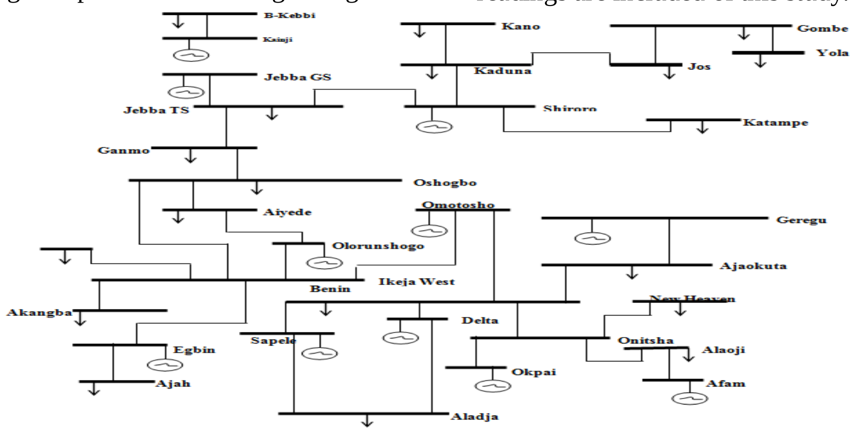
data channel and is used to detect changes such as increasing, decreasing, and steady-state behavior, with the number indicating the magnitude of the changes. A feed forward network is used to classify faults in the second layer".

"For detecting novel events in a vehicle, Dalmi et al. (2018) compared the use of BPN, RFBN, Kohonen, and counter propagation neural networks. To diagnose defects in actuators and sensors, they used RBFN and counter propagation networks. Addison investigated the utility of feature extraction for problem diagnostics in a gas turbine using seven different types of neural network topologies (2009). The performance of various networks is evaluated during training and testing by feeding various features (from turbine sensors) into the networks. The most striking result of these tests is that combining neural networks and linear regression produces similar results. DePold and Gass (1999) described how neural networks were used to diagnose performance changes in gas turbines by detecting and classifying trend changes (1999)".

IV. MATERIALS AND METHOD

1 Data Collection

The data was gathered from the 132KV Afam – Port Harcourt main, Z2 transmission network. The Afam 1 and 2 are two (60MW) generators with transformer ratings of 162MVA, 132KV/132KV/33KV and 150MVA, 132KV/132KV/33KV, respectively, with a transmission line length of 30.8KM from Afam to Oginigbaa, Port Harcourt main, Nigeria. Phasor voltages and currents from both ends of the 132KV transmission system were recorded when faults occurred.These data were used to generate a MATLAB simulation, from which more phasor voltages and currents for the various fault types and fault distances were obtained. For this study, a total of 914,746 simulation readings were used. These readings are included of this study.



One-line Diagram of Nigeria 330KV Transmission Network as at 1999

Table 1.1"Type of Fault and Occurrence"

Fault category	Design	Occurrence (%)	Simplicity
Line ground	L-G	75-85%	Very low
Line-line	L-L	8-15%	Low
Double line ground	L-L-G	5-10%	Moderate
Three phase	3Ψ	2-5%	Very high

(Arghandehet al., 2016).

Table 1.2: "The Transmission Line Parameters"

Parameter	Value
Steady state frequency	50hz
Generator voltage (AC RMS.L-L)	14.0kV
Transmission line voltage(AC RMS,L-L)	132kV
Desired active power flow,p	100MW
Desired reactive power flow,Q	30.8MVAr
Generator phase angle d1	-1.8 degrees
Generator phase angle d2	2.0 degrees

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a) As in a small transmission line model, ignoring shunt admittance in the network.
b) The circuit impedance and admittance were grouped together and concentrated at a single point, as in the medium line model. As shown in the diagram below, we should consider the circuit impedance and admittance to be dispersed over the entire circuit length for all practical purposes.
As a result, as we'll see in this section, the circuit parameter calculations will be slightly more rigorous. For precise modelling and identification of circuit parameters, consider the circuit of the long transmission line shown in the diagram below.

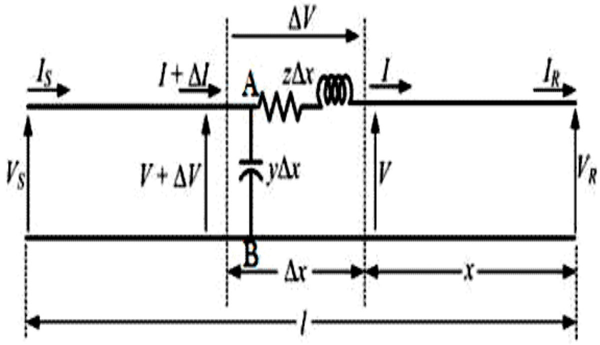

Figure 3.5: "Long Transmission Line"

On a line with a length of l > 250km, the sending end voltage and current are VS and IS, respectively, while the receiving end voltage and current are VR and IR. As shown in the diagram, consider an element of indefinitely short length x at a distance x from the receiving end.
"V is the voltage value right before it enters the element Δx.
I = the current value just before the element Δx is entered.
The voltage leaving the element Δx is V+ΔV.
I+ΔI Equals current when the element Δx is removed.
ΔV represents the voltage drop across element Δx.
zΔx = element Δx's series impedance
yΔx = element Δx's shunt admittance
The values of total impedance and admittance of the long transmission line are Z = z l and Y = y l, respectively". As a result, the voltage drop across the infinitely small element Δx can be calculated as follows:

$$\Delta V = I \approx \Delta x$$

We now apply KCL on node A to determine the current ΔI.
ΔI = (V+ΔV)yΔx = V yΔx + ΔV yΔx
We can ignore the term ΔV yΔx because it is the product of two infinitely small values for the sake of simplicity.

$$\frac{dI}{dx} = Iz \qquad (1.1)$$

As a result, we can write $dI/dx = Vy$. (1.2)

Now, deriving both sides of eq (1) in terms of x,

$$d^2V/dx^2 = z\,dI/dx$$

Now substituting $dI/dx = V\,y$ from equation (2)

$$d^2V/dx^2 = zyV$$

$$\text{or } d^2V/dx^2 - zyV = 0 \qquad (1.3)$$

The above second order differential equation's solution is provided by.

$$V = A_1 e^{x\sqrt{yz}} + A_2 e^{-x\sqrt{yz}} \qquad (1.4)$$

With respect to x, derivation of equation (3.32) yields

$$dV/dx = \sqrt{(yz)}\,A_1 e^{x\sqrt{yz}} - \sqrt{(yz)}A_2$$

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$e^{-x\sqrt{yz}}$

(1.5)

Now comparing equation (3.32) with equation (3.33)

$$Vs = \left(\frac{Y}{2}Z + 1\right)V_R + Z\left(\frac{Y}{4}Z + 1\right)I_R$$

(1.6)

$$I = \frac{dV}{dx} = \frac{zA_1 e^{x}\sqrt{(yz)}}{\sqrt{(z/y)}} - \frac{zA_1 e^{-x}(yz)}{\sqrt{(z/y)}}$$

(1.7)

Let us now define the characteristic impedance Zc and propagation constant, δ, of a long transmission line as follows:

$Z_c = \sqrt{(z/y)}\ \Omega$

$\delta = \sqrt{(yz)}$

The voltage and current equation can then be written using characteristic impedance and propagation constant as follows:

$V = A_1 e^{\delta x} + A_2 e^{-\delta x}$

(1.8)

$I = A_1/ Z_c e^{\delta x} + A_2 / Z_c e^{-\delta x}$

(1.9)

Now at x=0, V= V_R and I= I_r. Substituting these conditions to equation (1.8) and (1.9) respectively.

$V_R = A_1 + A_2$

(1.10)

$I_R = A_1/ Z_c + A_2 / Z_c$

(1.11)

Solving equation (3.39) and (3.40),

we get values of A_1 and A_2 as,

$A_1 = (V_R + Z_C I_R)/2$

(1.12)

And $A_1 = (V_R - Z_C I_R)/2$

(1.13)

We now get V = VS and I = IS when we apply another extreme condition at x=l. To find VS and IS, replace x with l and insert the values of A1 and A2 into equations (1.10) and (3.440).

$V_S = (V_R + Z_C I_R)e^{\delta l}/2 + (V_R - Z_C I_R)e^{-\delta l}/2$

(1.14)

$I_S = ({}^{V}{}_{R}/_{ZC} + I_R)e^{\delta l}/2 - ({}^{V}{}_{R}/_{ZC} - I_R)e^{-\delta l}/2$

(1.15)

By trigonometric and exponential operators we know

$\sinh\delta l = (e^{\delta l} - e^{-\delta l})/2$

and $\cosh\delta l = (e^{\delta l} + e^{-\delta l})/2$

Equations (3.26) and (3.27) can also be rewritten as

$V_S = V_R\cosh\delta l + Z_C I_R \sinh\delta l$

$I_S = (V_R \sinh\delta l)/Z_C + I_R\cosh\delta l$

By comparing the ABCD parameters of a long transmission line to the general circuit parameters equation, the ABCD parameters of a long transmission line are as follows:

$A = \cosh\delta l$

$B = Z_C \sinh\delta l$

$C = \sinh\delta l/Z_C$

$D = \cosh\delta l$

Resistance

R=ρL/A

R=resistance

L=length

Resistivity=ρ

A=cross sectional area

A = πr^2"

This study will not only add to the existing body of knowledge on electrical fault detection and mitigation techniques on Nigerian 132KV transmission lines", but it will also provide Electrical engineers with an opportunity to appreciate the dynamic and relevance of the need to apply appropriate fault detection and mitigation techniques in transmission lines.

V. CONCLUSION

When it comes to fault analysis in power system engineering, it's all about getting the problem rectified as soon as feasible so that the power system can be restored as soon as possible with the least amount of downtime. However, "finding and researching the issue that interrupts the transmission line is a challenging process that must be completed the system. Because of the transmission line, the entire power system is at jeopardy. As large-scale smart grid development develops", complex networks with insufficient measurement points are likely to become more common, offering wide-area approaches a lot of promise for wider adoption in the future.

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