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Automatic Transmission Line Fault Detection & Calculation

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ABSTRACT: Power transmission and distribution lines play vital roles in power grid. It's to achieve the essential continuity of service of electric power to the top users. Transmission lines connect the generating stations and cargo centers. As the generating stations are distant from the load centers they run over many kilometers. Hence, the probability of fault occurrences in transmission lines is extremely high. Since faults can destabilize the power system, it must be isolated immediately for restoration of power supply. Fault analysis is a very important issue in power system engineering so as to clear faults quickly and restore power supply as soon as possible with minimum interruption. We have designed a system which can detect and classify the different shunt and series faults on a transmission line for quick and reliable operation of protection schemes. Discrimination among different types of faults (like LG, LL, LLG, LLL and 1 phase Open Circuit, 2 phase Open circuit fault) on the transmission lines is achieved by application of evolutionary programming tools. Our system is also capable of calculating fault parameters like fault current and Fault MVA. During Fault, system parameters change as compared to normal condition parameters. Our system will detect this change in parameters (voltage, Current) and system condition. With the help of this data, the system detects the fault, classifies them and calculates the fault parameters. This data will be displayed on screen and sent to an authorized person with the help of Display and GSM module.

KEYWORDS: Power System, Transmission Line Fault, Automatic Detection, GSM Module, Smart Communication, Fault Classification, Fault Analysis.

I. INTRODUCTION

The Electric power grid is split into many various sections. One of which is transmission, where power is transmitted from generating stations and substations via transmission lines into consumers. Both methods could encounter various sorts of malfunctions, typically mentioned as a "Fault". The fault is simply defined as the variety of undesirable but unavoidable incidents that can temporarily disturb the stable condition of the power system. During a fault, the parameters of transmission change especially voltage and current. Value of fault current during short circuit fault can be 5 to 8 times of normal rating. Which is very dangerous. When the fault occurs, it is necessary to know the fault's values so engineers can take further action to remove the fault. Usually, it takes time to detect and calculate faults. The main aim of this project is to reduce this delay and provide required information to engineers as soon as possible. To resolve this problem, we have designed a system that can detect the different types of faults and measure the fault current and fault MVA during fault. The system is also able to transfer this information to authorize engineers for further actions.

II. RELATED WORK

Fault analysis is a crucial process. It shows the system's capability to detect, classify and take preventive measures to guard the remaining equipment of the facility system. One of the foremost important pieces of equipment within the protection of cable is that the protective relay. The detection, classification, and site of faults using different protective relays have become a major area of research historically [1].

The digital relays operate supported fast accurate algorithms for fault detection, classification, and location. Due to the dynamic nature of fault transients, recent studies show that frequency-domain analysis must be used to capture the

transient frequency components for accurate detection of fault [2-5]. Elhaffar et al proposed that the Fourier transform is the basic transform in frequency domain analysis applied for fault analysis [6]. The authors have used Fourier transform to extract the elemental frequency component for fault analysis. The problem with Fourier transform was fixed, thereby limiting the flexibility of analysis which is frequency- localized. The Short-Time Fourier transform (STFT) was another solution where the framework size is dynamic, but this system requires the knowledge of window size and isn't entirely useful in providing good resolution [7]. Therefore, a more efficient method for fault analysis was required, which overcame these problems, and this led to the planning of a dynamic signal processing tool called wavelet. Robertson et Al [8] have presented a comparative study of fault analysis using Fourier transform analysis and continuous wavelet transform analysis has presented By Robertson et Al [8]. The authors have shown the superiority of wavelet transform for better fault analysis. The process of extracting the particular wavelet features of the system during fault occurrence has been explained. Mallat et al. proposed discrete wavelet transform (DWT) using multi-resolution analysis (MRA) for signal decomposition [9]. The authors have proposed the MRA technique which divides the given signal into bands of frequency using the high pass and low pass filtering operation. This type of analysis is employed to unravel the resolution issues with FT and STFT for better fault analysis. Wavelet MRA has been developed for fault analysis. MRA coefficients are derived to extract the transient frequency components occurring during the fault. These extracted wavelet features are used for fault analysis.

Artificial Neural Networks are recently developed tools in engineering technology, capable of machine learning and pattern recognition employing a suitable interconnected layer. The learning process involves updating the weights of interconnections between adjacent layers. These networks can be trained using sample data and are capable of recognizing unique patterns or occurrences of events. It is this feature of neural networks that makes them highly suitable for implementation in cable fault analysis techniques.

III. METHODOLOGY

The system uses a current transformer, a voltage transformer, Arduino Uno Microcontroller, and a GSM modem. The current and Voltage sensors measure the values from the Transmission Lines and further sends these values to the Micro-controller. The system automatically detects faults by comparing the values of currents and voltages with the Reference values provided with the help of the Microcontroller, analyses the condition of the fault if occurs, and classifies these faults according to the Respective conditions into the L-L Fault, L-G Fault, L-L-G Fault, and L-L-L Fault and then, calculates the fault Parameters from the control room using Fault Detection algorithm method. If any kind of Fault occurs in the Transmission Lines, the system Sends the Alert message which includes the Type of Fault and Fault Parameters to the respective working in charge with the help of the GSM Modem.

working of system can be classified into following stages:

Stage 1: Data Input stage

In this stage user have to enter parameters of transmission line system

Ex-

1. Generator
 - i. Voltage rating in KV
 - ii. Generator rating in MVA Rated Current
 - iii. phase Current
 - iv. Voltage rating in KV
 - v. Generator rating in MVA
 - vi. Phase voltage
 - vii. Positive sequence reactance

2. Transformer
 - i. Power Rating in MVA
 - ii. Primary side voltage
 - iii. Secondary side voltage
 - iv. PU impedance

3. Transmission line
 - i. Voltage rating

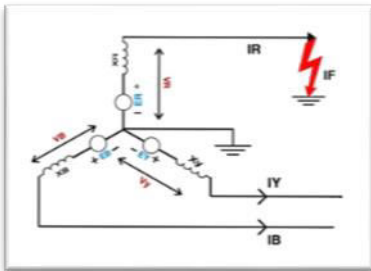


- ii. PU impedance
- 4. Base MVA and Base KV

Stage 2: Fault Detection

With the help of current and voltage values measured by current and voltage sensors system will detect the fault and classified them into L-G, L-L, L-L-G and L-L-L faults.

1. Detection of L-G Fault



(a)

When L-G fault occurs fault current (I_f) will flow in corresponding phase. Example. L-G Fault takes place in R phase, Then

$$I_R = I_f$$

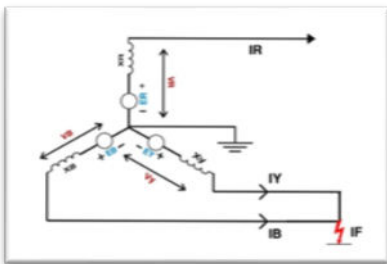
The values of current in fault phase will be more and as compare to other two phases, also voltage in that will be zero. So, during L-G fault current in

$$\text{Fault Phase} = \text{Fault Current}$$

$$\text{Also, Voltage in Faulty Phase} = 0$$

With the help of this information system will detect L-G fault in transmission Line.

2. Detection of L-L Fault



(b)

In this fault any 2-phases will get short circuited. There are many natural reasons behind that like falling a tree, swinging of lines due to winds etc.

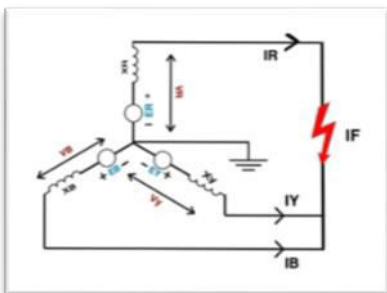
Example. R and Y phases get short circuited,

During L-L Voltage of those 2-phases will be equal $V_R = V_B$, and current through those 2-phases will have same magnitude but with opposite polarity,

$$I_f = I_R = -I_B$$

With the help of this information system will detect L-L fault in transmission Line.

3. Detection of L-L-G Fault



In this fault any 2-phases gets short circuited and gets grounded. During this fault those 2-phases will have zero voltage and fault current will be addition of current to those 2-phases

Example. Y and B phases gets short circuited and grounded to,

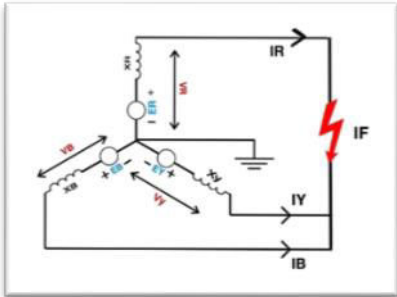
$$V_Y = 0$$

$$V_B = 0$$

$$I_Y + I_B = I_f$$

With this information we can easily detect L-L-G Fault in transmission Line.

4. Detection of L-L-L Fault



(d)

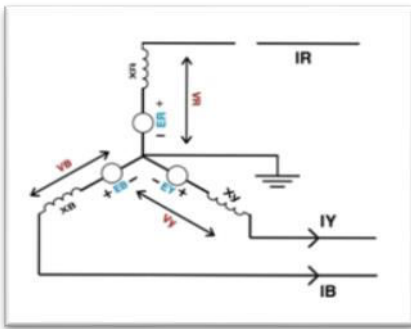
In this fault all 3-phases will get short circuit and voltage of all 3-phases will be equal and the value of voltages will be different than usual voltage value.

Eg. R, Y and B phases gets short circuited,

$$V_R = V_Y = V_B$$

With this information we can easily detect L-L-L Fault in transmission Line.

5. Single-phase Open Circuit Fault

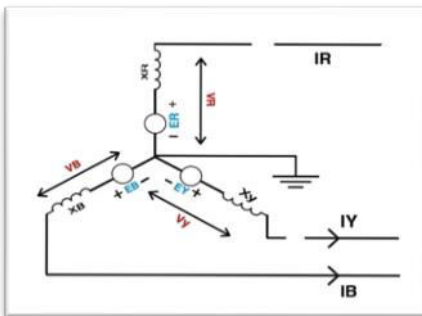


(e)

During single phase open circuit fault one of the phases get open. In that phase voltage may be present but there will be no current flow through the open circuit section of the circuit. So Current sensor will not receive any current. If anyone current sensor did not receive any current and voltage in that phase is not zero then system will declare it as single-phase open circuit fault.

$$I_R = 0$$

6. Two-phase Open Circuit Fault



(f)

During two phase open circuit fault any two phases gets open. In that phase voltage may be present but there will be no current flow through the open circuit section of the circuit. So Current sensor will not receive any current. If any two current sensors did not receive any current and voltage in those two phases is not zero then system will declare it as two-phase open circuit fault.

$$I_Y = I_R = 0$$

Stage 3: Calculation of Fault

After detection and fault system will calculate the fault parameters given below

1. Fault current (If)
2. Fault MVA

IV. EXPERIMENTAL RESULTS

Fig (g) shows that the system has successfully Detect the LG fault in the B phase of the transmission line and Display the corresponding voltage values

Fig (h) shows detection of the Open circuit fault



(g)



(h)

V. CONCLUSION

This paper presents a system which can detect the various transmission line fault by comparing various system conditions. It also calculates the fault parameter and alert the respective officials. With the help of this system, we can easily maintain record of faults with accurate parameters.

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