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A REVIEW - FAULT DETECTION AND CLASSIFICATION IN TRANSMISSION AND DISTRIBUTION LINES

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A REVIEW - FAULT DETECTION AND CLASSIFICATION IN TRANSMISSION AND DISTRIBUTION LINES

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***Abstract*— Fault identification is a critical process in ensuring the reliability and safety of power systems, including electrical grids, mechanical structures, and industrial processes. In this review paper researchers use a various parameter wich is hepful to identify the fault with a minimum duration of time. Those parameters are Hilbert transform (HT), Stockwell transform (ST), Allination Coefficient, and some useful techniques like GSM and IOT based but the most likely topic that's chosen by researcher is single processing technique. This technique effectively captures and analyzes the signal characteristics associated with normal and faulty conditions. By transforming the time-domain signals into frequency or other relevant domains, the technique can isolate features indicative of faults, such as harmonic distortions, transient changes, or shifts in signal patterns. The accuracy of fault detection is enhanced by the technique's ability to filter out noise and focus on the most relevant signal components. This technique is useful in various fields, including power systems, where it helps in identifying electrical faults like short circuits, grounding issues, and equipment failures. This review paper survey all type of techniques which is helpful for those researcher who want to research in this field. Single processing technique is an attractive solution for real-time fault detection and diagnosis, particularly in systems where quick decision-making is essential.**

Keywords—Hilbert transform, Stockwell transform, Allination coefficient, GSM, IOT.

I. INTRODUCTION

Power system protection is a critical operation of electrical engineering that ensures the safe and reliable operation of power systems. It is necessary for various strategies and devices designed to detect faults, isolate affected sections, and minimize damage to equipment while maintaining service continuity. A fault occurs when a component or line fails, resulting in abnormal current flowing through unexpected paths. This can damage equipment and disrupt the power supply. The fault analysis of a power system is required in order to provide information for the selection of switchgear [3], setting of relays and stability of system operation. A power system is not static it may be changes during operation of switching on or off of generators and transmission lines and during planning. And also addition of generators and transmission lines [2]. And most of the cases the faults occur in a power system due to insulation failure, flashover, physical damage or human error. These faults, may either be three phase in nature involving all three phases in a symmetrical manner, or may be asymmetrical where usually only one or two phases may be involved that's are mention in TABLE 1. Faults may also be caused by either short-circuits to earth or between live conductors, or may be caused by broken conductors in one or more phases. Sometimes simultaneous faults may occur involving both short-circuit and broken conductor faults also known as open-circuit faults. Balanced three phase faults may be analysed using an equivalent single phase circuit. With asymmetrical three phase faults, the use of symmetrical components help to reduce the complexity of the calculations as transmission lines and components are by and large symmetrical, although the fault may be asymmetrical. Fault analysis is usually carried out in per-unit quantities which are similar to percentage. Here we discussed a lot of fault in TABLE [1] and their percentage of occurrence.it is clear to see chances of fault single phase to ground is so high

Table1. Percentage of fault

S.no.	Types of fault in power system	Percentage
1.	Single phase to ground fault	70
2.	Phase to phase fault	15
3.	Two phase to ground fault	10
4.	Three phase to ground	2 or 3
5.	All three phase fault	2 or 3

1. (A) SINGLE PHASE TO GROUND FAULT

As shown in given TABLE [1] approximately 70% of all distribution system faults are single-phase to ground this fault happen due to when a single phase either one of three breaks and directly connected to ground as given in FIGURE[1].

(B) DOUBLE PHAGE TO GROUND FAULT

When any two phases of a three-phase line are unexpectedly connected to the ground, a double line-to-ground fault occurs. In this phenomenon, fault current will flow from the affected phases, such as Phase B and Phase C, to the ground shown in FIGURE [2]. That type of fault generally occur at10 to 12 %. As shown in TABLE [1]

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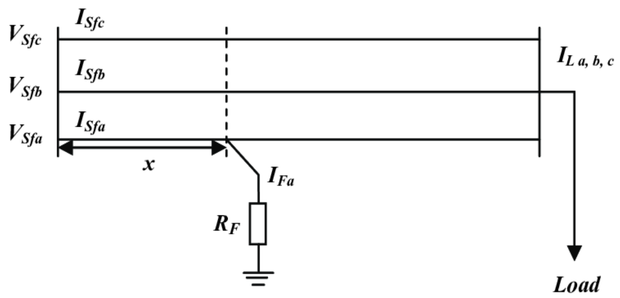

Figure1. Single phase to Ground fault in three phases

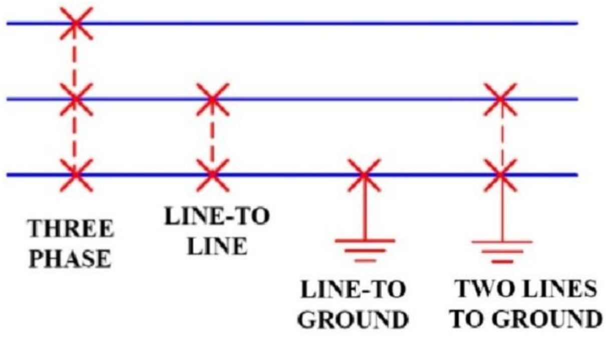

Figure2. Fault detection in three phases

The nature of fault simply implies any abnormal condition which causes a reduction in the basic insulation strength between conductors, or any earth screen surrounding the conductors. or between phase conductor and earth, The reduction of the insulation is not considered as a fault until it produces some major or minor effect on the system i.e. until it results either in an excess current or in the reduction of the impedance between the conductors, and between the conductor and earth to a value below the lowest load impedance normal to the circuit. Power systems mainly consist of generator, switch gear, transformer and distribution system. The probability of failure is more on the power system due to their greater length and exposure to atmosphere.

(C). PHASE TO PHASE FAULT

Phase to phase fault occur when any one of three phase break and directly connected one of the two phase which is shown in FIGURE[2] chances of fault occur phase to phase is 15% as shown in TABLE[1].

(D). THREE PHASE TO GROUND FAULT

Three phase to ground fault occur when one of three phase break and connected to both of rest phase and then it connected to ground the chances of these type of fault is least shown in TABLE[1] AND given in FIGURE[2].

(E). THREE PHASE FAULT

Three phase fault occur when any one of the phase break and connected to rest of two as given in FIGURE [2] the chances of these type of fault is very small as given in TABLE [1].

II. METHODS OF IDENTIYING FAULT AT MINIMUM TIME

(A). IDENTIFICATION OF FAULT BY USING GSM TECHNOLOGY

The fault detection and location in power system using GSM [1] will ensure shorter response time for technical crew to rectify these fault and thus help damage of transformer and also for big disaster. In this technique there is lot of components are required that's components are current transformer. Voltage transformer, PIC controller, RS-232 connector and GSM modem.

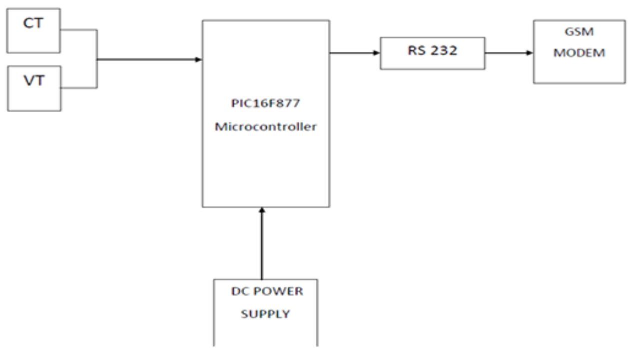

Figure3. Block diagram of proposed fault detection and location system

In FIGURE [3] given block diagram of GSM technique which working principle is given in which the set up or field device consists of 3 major components, instrument transformer (CT and VT), GSM modem and microcontroller. The primaries of the CT and VT which are connected to the line sense the corresponding current and voltage values of the system and feed the output to the ADC of the microcontroller which converts the signal to a digital form in order to be processed by the CPU of the microcontroller. The microcontroller serves as the central point of the set up. It contains a set of programming codes which have been stored in the EEPROM which enables it to classify the fault type based on the voltage and current values. Based on the program, the microcontroller compares these values to see whether they are within the range required. If the voltage and current values are out of range as compared to the reference, it gives an indication of a fault. The microcontroller also calculates the fault distance, relative to the device based on an impedance-based algorithm and then relays this information to the modem for transmission. In summary, the microcontroller classifies, calculates the fault distance and relays the information to the modem for transmission via the serial communication interface (SCI) which serves as an interface between the microcontroller and the modem. The RS-232 serves as the connector between the microcontroller's serial communication port and the modem. The device is placed in the boundary of the sectionalized regions in the transmission system and the location of the fault is calculated relative to the position of the device.

(B). PROTECTION OF TRANSMISSION LINE USING HYBRIDIZATION OF STOCK WELL AND WINGER TRANSFORM

The double end transmission link model as described in Figure 4 is utilized to implement the developed technique.

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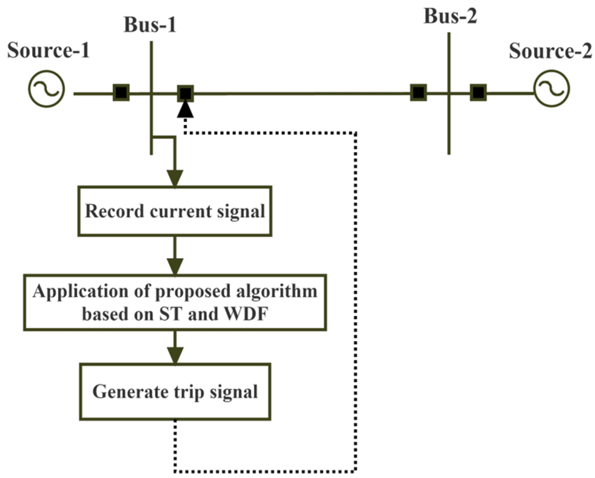
The transmission link is connected between Buses 1 and 2. Sources 1 and 2 represent the large area utility grids. Buses 1 and 2 are considered as the sending and receiving end buses, respectively. Table [2] presents the various system parameters utilized in this study [2]. The proposed technique can be incorporated into the relay, which is located on the side of Bus 1 of the transmission link to trip the link at the moment of fault incidence. The developed technique can be implemented at the sending terminal of the transmission line. However, for the ring main feeders, it can be utilized at both terminals. The recoded current signals are processed by utilizing the developed technique to generate the trip command signal to the circuit breaker for the outage of the transmission line during the fault event



FIGUE4. MODIFY CASE STUDY

S-transform having the minimum influence of noise and the WDF analyzing the data over a specified window width are combined in this approach. The proposed S-index calculated from the S-transform depending on the decomposition of the current signal and the W-index obtained from the WDF of the current signal over a quarter cycle are combined to obtain the FI. This FI is utilized to detect different fault conditions by comparing the peak values with the threshold. Faults' categorization is obtained using the number of fault phases in an event. The classification of the LL fault and the LL-G fault is achieved using the proposed GFI, which is based on the WD of the zero sequence current over the quarter cycle.

TABLE[2]. SYSTEM PARAMETER

System Parameter	Simulated Parameter
Line length	230 km
Generator 1 voltage	500 ∠ 20° kV
Generator 2 voltage	500 ∠ 0° kV
Generator 1 impedance (equivalent)	17.177 + j45.529 Ω
Generator 2 impedance (equivalent)	15.31 + j45.925 Ω
Transmission link positive sequence impedance	4.983 + j117.83 Ω
Transmission link zero sequence impedance	12.682 + j364.196 Ω
Transmission link admittance (positive sequence)	j1.468 m℧
Transmission link zero sequence admittance	j1.099 m℧
Transmission link rated power (apparent)	433.63 + j294.52 MVA

(C). FAULT LOCATION USING DISTANCE AND IMPEDENCE RELAY

Troubleshooting transmission errors while checking system integrity is a difficult task. This fault can be caused by man-made power or by the use of synchronous wave in the power distribution line. This study focuses on two areas to solve the problem of the power transmission line, which can change the previous information. An intelligent approach to monitoring and controlling line faults is used to improve equipment accuracy[3] in transmission line fault detection. After many repetitions of the method, the combination of the line and the main part will improve the accuracy and reliability of the system. The main unit identifies the fault nodes in the network based on the current and voltage changes of each node and calculates the distance between the hub and the fault node to reduce the potential a- hands In the proposed work, several sensors are used to detect the line fault in the network by setting the correct signal. Web communications can be transferred to an authorized person or entity after multiple iterations by known entities. The error status of the post information is displayed in the control unit by a display unit that contains an alarm unit to activate the corresponding unit using ZigBee methods. A GSM[1] device provides one-to-one error control.

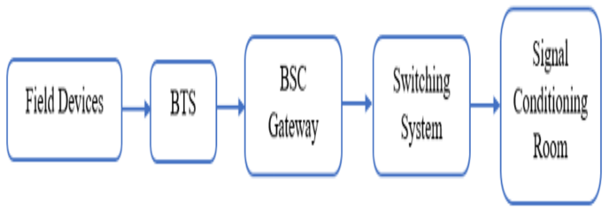


Figure5. Block diagram of fault location using impedence relay

As given in FIGURE [5] parameters are considered in our proposed structure to construct the communication protocol for fault detection between poles. The proposed system comprises identifying a faulty pole, a faulty lamp in the pole, and the distance between poles. Figure 5 depicts the preliminary work of our proposed system. Field devices are active poles and it's connected with Base Transceiver Station (BTS) which is used to receive and collect the signal from field station called a base station. Base Station Control (BSC) operates based on the activities of the transmission line that can be categorized and provides the switching system for the further classified process. The signal conditioning unit is controlling the incoming signal to better transmission

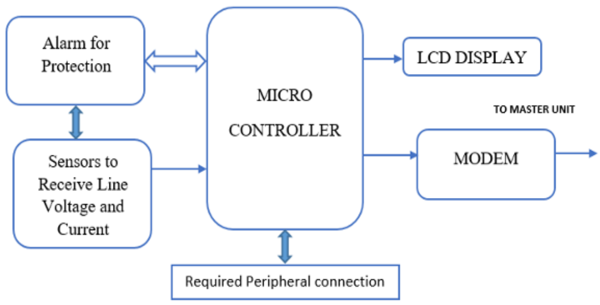


Figure6. Connected component of microcontroller of line unit

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This procedure is functioning with high frequency with a traveling waveguide signal for identifying the fault generation pole. But the implementation of this procedure is very complex in the power network. This reflection-based transmission is providing high accuracy and the cost is very high. Our proposed method can be upgradeable to GSM and Sigsbee [1] technologies as shown in figure 6. The installation of the GPS is comprised of many transient sensors to detect and display software tools. But this fault transient is very big complex to detect in the field. The proposed approach is based on knowledge-oriented such as statistical analysis with microcontroller unit. The probability can be a support to detect the future prediction of the fault that occurs due to circuit break due to high voltage, an abnormal condition of the power line feeders, short circuit due to internal signal conditioning unit. The faulty pole is identified and used to calculate the distance between the source and the destination of the pole. This method is used to achieve an accurate finding with an estimation of the faulted unit. Fault distance measurement at the substation is computed by a combination of estimation and accurate sensor output. Threshold values can be assigned to the default values of poles in a network when they are in normal condition.

Table3. Performance comparison results obtained by Hybrid Model

S. No.	MESURING METRICS	IMPEDENCE BASED METHOD	HYBRID METHOD
1.	Accuracy	LOW	HIGH
2.	Reliability	LOW	HIGH
3.	Computation time	HIGH	LOW
4.	Authorization unit	NO	YES
5.	Distance calculation	NO	YES
6.	Overall efficiency	LOW	HIGH

Our hybrid method is relatively low in computation time compared to existing methods. It is concluding that the system is faster than other system performance. It can be appended with more reliable nodes in its network with new up-gradation. Besides, the authorized units incorporate the hybrid model in order to improve the accuracy and reliability of the system shown in Table3.

(D). IOT BASED FAULT ANALYSIS

There are a lot off distinct components that make up the electrical system complex. One of these is the transmission system, which uses power lines to transport electricity from substations to consumers. An overview of current research on Internet of Things-based transmission line failure detection can control through a particular location. The Internet of Things (IoT) refers to a network of interconnected smart [5] devices that use embedded systems, such as processors, sensors, and communication hardware, to collect and respond to data from their surroundings. The concept behind IoT is to link any device with an ON/OFF switch to the internet, enabling it to gather information, communicate with other devices, and perform specific actions based on the data it receives. IoT based transmission line fault analysis provide a faster response more efficient to all of fault analyzer and identifier techniques,

(E). TRANSMISSION LINE FAULT DETECTION

Significant electricity is used by transmission lines. Over time, the demand for power and its corresponding dependence have increased simultaneously. The gap between extremely high demand and restricted supply has made reducing power losses very-very important. Transmission loss is one type of loss that can range from severe technical losses to conjectural variables like physical or environmental losses. Long-distance power transmission lines and strained conditions. It generates relevant queries about potential improvements in the existing study, allowing unresolved issues to surface and clearly delineating all boundaries related to the research project's development. A substantial amount of literature has been reviewed concerning the detection of faults in transmission lines. To enhance the power quality of transmission lines, compensation circuits are integrated. To improve system reliability and restore power supply promptly, it is crucial to rapidly classify and locate faults and accurately isolate the faulty section

(F). FAULT DETECTION AND CLASSIFICATION ON A TRANSMISSION LINE USING WAVELET MULTI RESOLUTION ANALYSIS AND NEURAL NETWORK

(A). NEURAL NETWORK

A neural network is a parallel system, capable of resolving paradigms that linear computing cannot. They are used for applications where formal analysis is difficult or impossible such as pattern recognition and nonlinear system identification and control in power system analysis.

(B). DISCRETE WAVELET TRANSFORM

DISCRETE WAVELET TRANSFORM International Journal of Computer Applications (0975 – 8887) Volume 47– No.22, June 2012 Transient voltages and currents during fault carry high frequency component or harmonics which carry important information regarding type and location of fault. Wavelets can be very effectively used in analysing 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 signal called approximations and high frequency signals called detail

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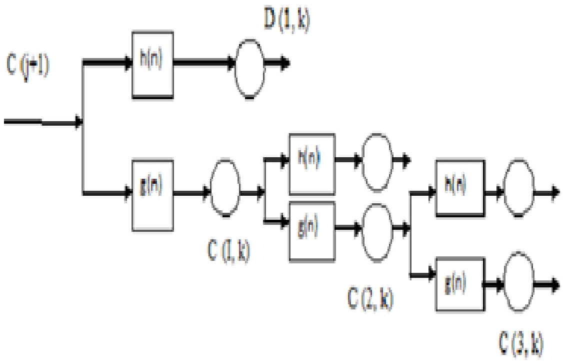

Figure7. Multiple level decomposition of the signal.

s. The important elements in analyzing transient signal using wavelet transform are to select mother wavelet and to decide the number of multiple decomposition steps. The number of decomposition steps is influenced from the sampling frequency of the original signals. In the first decomposition step the signal is decomposed into D1 component of high frequency band and A1 component of low frequency band. The frequency band of D1 component is (fs /2-fs/4) Hz and A1 component is (fs/4-0), fs being the sampling frequency. In the second decomposition step, A1 component extracted from the first decomposition step is again decomposed. Thus, D2 component of high frequency band and A2 component of low frequency band is achieved. The frequency band of D2 component is (fs/4-fs/8) Hz and the frequency band of A2 component is (fs/8-0) Hz. 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. 1 shows the multi resolution steps of the signal c (j+1).

(G). FAULT IDENTIFICATION USING SIGNAL PROCESSING TECHNIQUE.

Protection mechanism for utility networks with high concentrations of renewable energy, generation by fusing the Hilbert transform , Stockwell transform , and Alienation coefficient. The creation of a hybrid fault detection index makes use of features taken from both voltage and current signals to identify fault events. The comparison between the peak magnitude of a threshold magnitude is utilized to identify fault events and differentiate them from operational events. Hybrid ground fault index and defective phase numbers are used to categorize faults[7]. The application of ST processes zero sequence voltage and zero sequence current to compute , which successfully detects the presence of ground during fault event. Utility grid performance is used to verify protective strategy effectiveness .

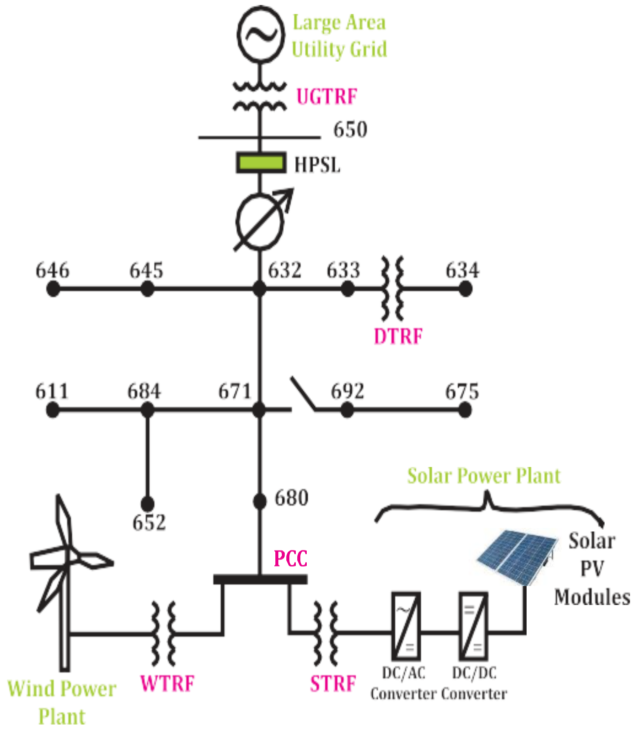

Figure8. Test utility grid network of IEEE-13 node system.

The test equipment network made by installing a 1 MW solar power plant and 1.5MW in wind power plant in IEEE-13 node test system describe in figure (8) it operate at 5 MVA and 60 Hz frequency, voltage 0.48kv in this study the renewable energy penetration level of 50%was used An electric transformer is used to integrate a test grid into a large power plant operating at 115kv overall output is 1MW. Is interfaced on 680 node with the help of STRF transformer and modelled using the parameters wind power plant reported rated at 1.5MW is integrated with the help of WTRF transformer. WPP is modelled using parameter. Node 671 of test utility grid is taken as fault inductance node. Current and voltage are monitored and recorded at node 650 test which is designed as hybrid protection scheme location point distribution transformer is used to operate 634 at 0.48kv and all other nodes are operate 4.16kv. A protection schemes for utility grid with high penetration of RE generation based on feature computed from voltage and current signals using HT, ST, and Alienation coefficient to detect fault events with the help of HFDI is presented in this paper. Fault classification is achieved using faulty phase numbers and a HGFI. It is concluded that protection schemes effectively detect fault events such as AGF, ABF, ABGF, ABCF, and ABCGF incident on a utility grid of IEEE-13 bus test system with 50% RE penetration. Algorithm is effective to detect faults incident at different nodes of test grid, different fault impedance, and different angles of fault incidence. Protection scheme is effective to detect faults with high noise levels of 20dB SNR. Protection scheme is effective to discriminate the operational events from the faulty ones. This is also concluded that protection scheme effectively detects the faults incident on a practical distribution network with RE penetration of 57%. This is also concluded that protection scheme is better relative to Alienation coefficient based protection.

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(H). A MULTIVARIABLE TRANSMISSION LINE PROTECTION SCHEME USING SIGNAL PROCESSING TECHNIQUES.

In [9] introduced an advanced algorithm making hybrid use of Stockwell transform (ST), Hilbert transform (HT) and Alienation coefficient (ACF) for identification, classifi cation and to locate faulty events on transmission line. Signals of Current are processed by application of ST, HT and ACF for computing S-index, H-index and A-index, respectively. These indices are multiplied element by element to compute proposed fault index (FI). A threshold magnitude is decided after testing the algorithm during different fault scenar ios and faulty events are recognized when FI exceeds this threshold magnitude. Faults are categorized by identifying the number of phases which are faulty in nature and a ground fault index (GFI). GFI is designed by processing the zero sequence current using ST[8] and used to identify involvement of ground during fault event. A mathematical formulation is framed to estimate location of faults on transmission line. Fault location has been esti mated with a mean error less than 1%. Investigated faults include phase to ground (PGF), double phase (PPF), double phase to ground (PPGF) and three phase to ground (TPGF). Algorithm is found effective for faulty scenario such as fault impedance variations, fault incidence angle (FIA) variations, reverse power flow, effect of line loading, effect of noise, transient faults, off-nominal frequency, and presence of harmonic components. Algorithm is also effective for discriminating switching transients from faulty conditions. Effective performance of the algorithm is established by comparing with fault detection and classification approach based on alienation coefficients, discrete Fourier transform (DFT) and time-frequency approach. Study is performed on a two terminal transmission line in MAT LAB/Simulink environment. Effectiveness of the algorithm is also established on a real time transmission grid of Rajasthan state of India.

(a) HYBRID HILBERT INDEX

The hybrid Hilbert index is formulated by processing bothcurrent and voltage singles by application of Hilbert transform with sampling frequency of 3.84 kHz current is processed by the application of Hilbert transform for computation of absolute value values of output matrix which is design as HT current index.

Hilbert Current Index (HCI)= abs$\left(\frac{1}{\pi} PV \int_{-\infty}^{+\infty} \frac{i(\tau)}{t-\tau} d\tau\right)$

Here, PV,τ and t are the values of Cauchy principle integeral time and time period voltage is processed using Hilbert transform as detail below to compute absolute values of output matrix which is consider Hilbert transform voltage.

Hilbert Voltage Index(HVI) = abs$\left(\frac{1}{\pi} PV \int_{-\infty}^{+\infty} \frac{v(\tau)}{t-\tau} d\tau\right)$

Multiplying both Hilbert current and Hilbert voltage index we got a another index Hilbert current voltage index (HVI).

HHI = (HVI)×(HCI)

HVI has high magnitude of fault period and least effect of noise.

Multiplying both Hilbert current and Hilbert voltage index we got HHI

(b) HYBRID STOCKWELL INDEX

Process the current signal using stockwell transform considering 3.84 kHz sampling frequency to compute output matrix with absolute values as detail below compute summation of every element of a column of the matrix SATMI and take co-varience for computing co-varience factor as describe below

STAMI $(\tau, f) = \left(\int_{-\infty}^{+\infty} i(t) \frac{|f|}{\sqrt{2\pi}} e^{-\frac{f^2(\tau-t)^2}{2}} e^{-j2\pi f t} dt\right)$

Here t, f and g(t) indicate spectral localization time, fourier frequency and Gaussian window function respectively. Compute the summation of all elements in a column of the matrix STAMI and then take co-variance factor.

COVF = cov(sum(STAMI))

Compute the summation of all elements in a column of the matrix STAMI with the application given below.

VAI = sum (STAMI)

Process the voltage signal v(t) using ST with considering 3.84kHz sampling frequency and output matrix with absolute values (STAMV) is output as detailed below

STAMV $(\tau, f) = \left(\int_{-\infty}^{+\infty} i(t) \frac{|f|}{\sqrt{2\pi}} e^{-\frac{f^2(\tau-t)^2}{2}} e^{-j2\pi f t} dt\right)$

Compute summation of all elements in a column of the matrix STAMV applying the below detailed relation.

VAV = sum (STAMV)

Compute the median of the matrix STAMV applying below relation.

MV = median(STAMV)

Hybrid Stockwell index(HSI) is computed by multiplication of VAI, VAV, MV and COVF using following relation.

HIS = VAI×VAV×MV×COVF

(c) ALIENATION INDEX

Following relation is applied to compute correlation coefficient (CORC) of current sample i1 and i2 at an interval of quarter cycle.

$$\text{CORC} = \frac{N_S \sum i_1 i_2 - (\sum i_1)(\sum i_2)}{\sqrt{[N_S \sum i_1^2 - (\sum i_1^2)^2][N_S \sum i_2^2 - ((\sum i_2^2)^2]}}$$

Here, Ns is the total sample in a cycle (Ns=64 are considered in this study); i_1: current sample at time t_0, i_2 current sample at time $-T_0 + t_0$, T: time period of the current wave form

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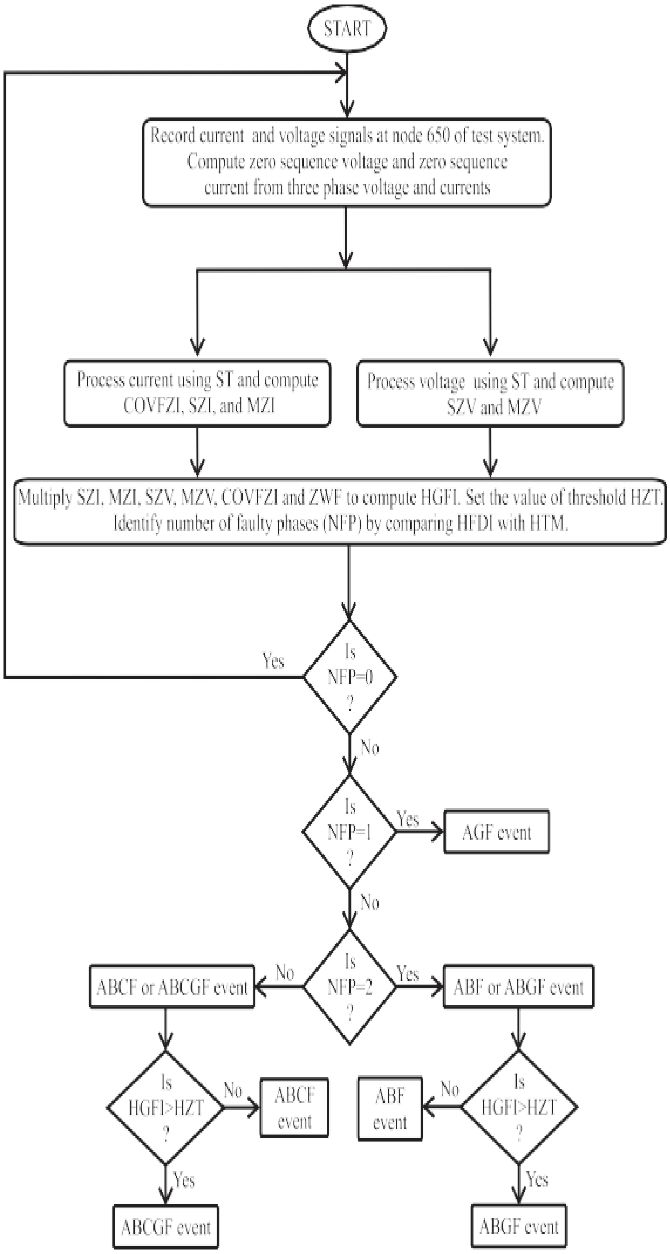

Figure9. Algorithm of fault classification

The alienation index (A-index) is derived from CORC applying the below detailed relation.

ALIENATION INDEX $= 1 - \text{CORC}^2$

(d) HYBRID FAULT DETECTION INDEX

HFDI is evaluated by multiplication of HH-index, HS-index, A-index and a hybrid weight factor (HWF).

$HFDI = HHindex \times Aindex \times HSindex \times HWF$

Hybrid threshold magnitude (HTM) of 20000 is considered for HFDI to detect the fault events. This also discriminate the faults from healthy events. During faulty events, the magni- tude HFDI is higher compared to the HTM and during the operational events this magnitude is lower compared to HTM.

(E) FAULT EVENT CLASSIFICATION

Fault classification algorithm is described in Fig. 3. Fault events are classified and discriminated from each other using faulty phase numbers. To categorize the two phases fault and two phases to ground fault, a hybrid ground fault index (HGFI) is designed. HGFI also discriminates the three phase fault event with and without ground involvement. HGFI is computed by processing both the zero sequence voltage and current applying the ST. Following procedures is used to compute HGFI.

Calculate zero sequence current(I_0) using currents of all phases.

$$I_0 = \frac{(I_1 + I_1 + I_3)}{3}$$

Calculate zero sequence voltage (V_0) using voltage of all phase record on node 650 of test grid.

$$V_0 = \frac{(V_1 + V_1 + V_3)}{3}$$

Decompose zero sequence current using ST and obtain output matrix as detail below.

$$STZI = \left(\int_{-\infty}^{+\infty} I_0 \frac{|f|}{\sqrt{2\pi}} e^{-\frac{f^2(\tau - T)^2}{2}} e^{-j2\pi f t} dt \right)$$

Decompose zero sequence voltage using ST and obtained output matrix as detail below.

$$STVI = \left(\int_{-\infty}^{+\infty} V_0 \frac{|f|}{\sqrt{2\pi}} e^{-\frac{f^2(\tau - T)^2}{2}} e^{-j2\pi f t} dt \right)$$

Compute the co-variance of summation of every column of STZI to compute zero sequence current covariance factor.

(e) FAULT SIMULATION RESULT

This section discussed the investigated fault events includ- ing phase-A to ground fault (AGF), phase-A and phase-B fault (ABF), phase-A and phase-B fault with involvement of

(f)GROUND AND THREE PHASE FAULT

This section discussed the investigated fault events including phase-A to ground fault (AGF), phase-A and phase-B fault(ABF),phase-A and phase-B fault with involvement of ground(ABGF), three phase fault (ABCF),and three phase fault with ground(ABCGF).

A. AGF EVENT

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An AGF event is incident on 671 node of test network at 6th cycle. Current and voltage are measured on HPSL point of test system and detailed in Figure10 (a) and (b) respectively. These current and voltage are processed applying HT for computation of HH-index which is elaborated in Figure 10 (c). Current and voltage are also processed using ST to computed HS-index which is shown in Figure.10 (d). Current is processed using Alienation co-efcient for computation of A-index which is detailed in Figure10 (e). Proposed HFDI is computed by multiplying the HH-index, HS-index, A-index and HWF which is illustrated in Figure10 (f). Time of fault detection and peak magnitude of HFDI for AGF event are included in Figure10 (a) indicates that current of fault phase-A is increased due to fault incidence at 6th cycle. Figure10 (b) indicates that voltage of all phases decreased by small magnitude due to fault occurrence. However, decrease in magnitude of voltage of faulty Phase-A is more. Figure10 (c) indicates that HH-index magnitude of faulty phase-A increases due to fault occurrence at 6th cycle. Further, magnitude of HH-index associated with healthy phases-A & B is increased slightly. Figure10 (d) indicates that HS-index magnitude of all phases has increased due to fault occurrence at 6th cycle. Further, magnitude of faulty phase-A is more pronounced compared to healthy phases. Figure 10 (e) indicates that A-index magnitude of all phases has increased to unity due to fault occurrence at 6th cycle. Figure10 (f) indicates that HFDI magnitude of faulty phase is increased and becomes high in comparison to threshold. However, magnitude of healthy phases-B & C is low in comparison to threshold. Hence, AGF event has been effectively identified using the proposed algorithm indicates that AGF event is detected in small time interval.

B. ABF EVENT

An ABF event between phases-A&B is incident on671 node of test system at 6th cycle. Current and voltage are measured on 650 node of test system and depicted in Figure 11 (a) and (b ABF event (a) current (b) voltage (c) HH-index (d) HS-index (e) A-index (f) HFDI. respectively. These current and voltage are processed using HT for computation of HH-index which is depicted in Figure11 (c). Current and voltage are also processed using ST for computation of HS-index which is shown in Figure11 (d). Current signal is processed using Alienation co-efficient and A-index is computed which is detailed in Figure11 (e). Proposed HFDI is computed by multiplication of HH-index, HS-index, A-index and HWF which is illustrated in Figure 11 (f). Time of fault detection and peak magnitude of HFDI of ABF event are included in Figure11 (a) indicates that current of fault phases-A & B is increased due to fault incidence at 6th cycle. Figure 11(b) indicates that voltage of all phases decreased by small magnitude due to fault occurrence. However, decrease in magnitude of voltage of faulty phases-A & B is more. Figure 11 (c) indicates that HH-index magnitude of fault phases-A & B has pronounced due to fault occurrence at 6th cycle. Further, magnitude of HH-index corresponding to healthy phase-C is increased slightly. Figure 11 (d) indicates that HS-index magnitude of fault phases-A & B has pronounced due to fault occurrence at 6th cycle. However, magnitude of healthy phase-C increased by small amount compared to faulty phases. Figure11 (e) indicates that A-index magnitude of all phases has increased due to fault occurrence at 6th cycle. Figure11(f) indicates that HFDI magnitude of faulty phases-A & B is increased and becomes higher compared to threshold. However, magnitude of healthy phase-C is lower relative to threshold. Hence, AGF event is effectively identified using the proposed algorithm. indicates that AGF event is detected in small time interval.

C. ABGF EVENT

An ABGF event between phase-A and phase-B with ground involvement is incident on 671 node of test network at 6th cycle. Current and voltage are measured on 650 node of test network. These current and voltage are processed applying HT for computation of HH-index Current and voltage are also processed using ST to computed HS-index.

D. ABCF EVENT

An ABCF event between all phases is incident on 671 node of test system at 6th cycle. Current and voltage are measured on 650 node of test system

DETECTION OF FAULT AND SIMULATION RESULT

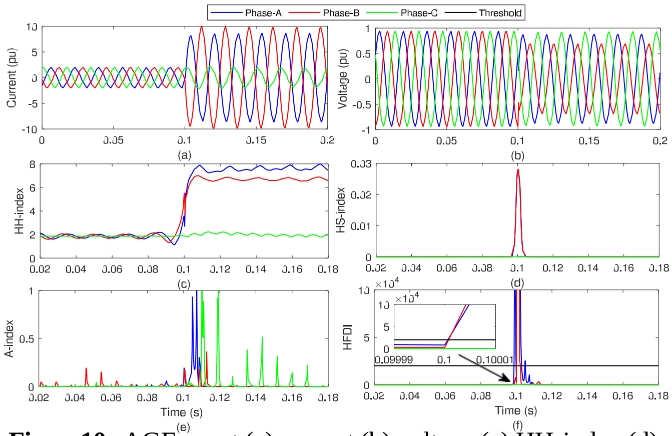

Figure10. AGF event (a) current (b) voltage (c) HH-index (d) HS-index (e) A-index (f) HDFI

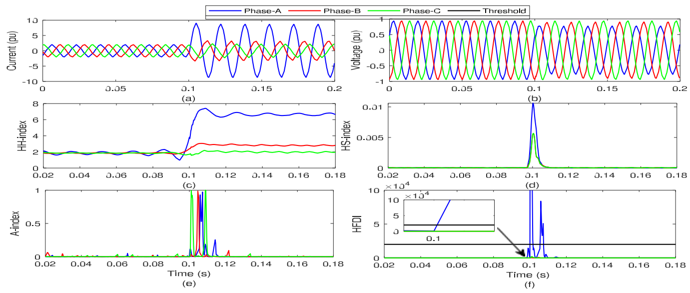

Figure11. ABF event (a) current (b) voltage (c) HH-index (d) HS-index (e) A-index (f) HFDI.

COMPARATIVE ANALYSIS

TABLE4.COMPARASION BETWEEN DIFFERENT TECHNIQUES

TECHNOLOGY	ADVANTAGE	DISADVANTAGE

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ANN Technique[9]	The accuracy of ANN in detecting the specific type of fault is rather high, and its execution is uncomplicated	Dimension issue training method is fairly, complicated
	It is simple to use, and just a few variables need to be tweaked	The gradient-based back propagation neural approach for non-linear segmented pattern recognition provides a local optimal solution
	It may be used to solve a variety of real word challanges	In the BP method, ANN provided gradual convergence
	There is no need to re-programme ANN science it learn	The choice of the initial amount of weight limit network-connected determines convergence
Fuzzy Methods[10]	To handle ambiguity concerns, a basic 'if-then' relationship is utilised.	There is no evidence of robustness. For big training data, specialists are required to define the membership function and fuzzy rules. In power systems, PMU installation is a difficult task.
Wide-area Fault Location [11]	Its functions include both surveillance and controlling.	For big training data, specialists are required to define the membership function and fuzzy rules. In power systems, PMU installation is a difficult task.
Differential protection[12]	This method is dependable	Complex calculation
Distance protection[13]	This method is dependable and secure. Avoids phase signals This method is dependable and secure	Complex calculation and requires a good method to filter the signal

CONCLUSION

In this review paper we discuss about the very important topic and major problems in power system that is protection of power transmission line how to protect the transmission line that's are done by lot of techniques by lot of researchers which all of these a single processing technique is very efficient it identify the fault in very least interval of time and resolve it very quickly.

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