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Novel Concept of Fault Detection using ANN and 3 Circuit Breakers

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Abstract : In power systems, defensive devices can distinguish fault conditions and work circuit breakers and different devices to restrict the deficiency of administration because of a disappointment. In light of the counterfeit neural network , the fault discovery of microgrid was contemplated. A limited scale demonstrating of the microgrid including sunlight powered chargers , battery energy stockpiling system, burdens and AC framework is recreated in MATLAB. An unexpected change in the worth of auxiliary current I_{Sec} and the heap power PL is the reason for the calculation that identify the fault area. Here we notice the spikes in the diagram of I_{Sec} as the faults .These faults are created physically by turning on every one of the circuit breakers at different snapshots of a day . Likewise the faults were concentrated by keeping just as separating the battery regulator. Having created the information at different occasions of a day and preparing the dataset in ANN brought a respectable exactness of (70%~80 %). So having new information of power, I_{Sec} and time, we can anticipate in case there is a fault or not , and in case there is , the area of the fault not set in stone pretty precisely..

IndexTerms–Fault Detection , Circuit Breakers , ANN.

I. INTRODUCTION

An electric power system is characterized as a network of electrical parts used to supply, move, and burn-through electric power. The stock is done through some type of age (for example a power plant), the exchange is done through a transmission (by means of a transmission line) and circulation system, and the utilization can be through private applications, for example, powering the lights or cooling in your home, or by means of modern applications like the activity of huge engines. [1]

An illustration of a power system is the electrical lattice that gives power to homes and industry inside a drawn out region. The electrical lattice can be extensively partitioned into the generators that supply the power, the transmission system that conveys the power from the producing focuses to the heap communities, and the circulation system that takes care of the power to local homes and industries.[1]

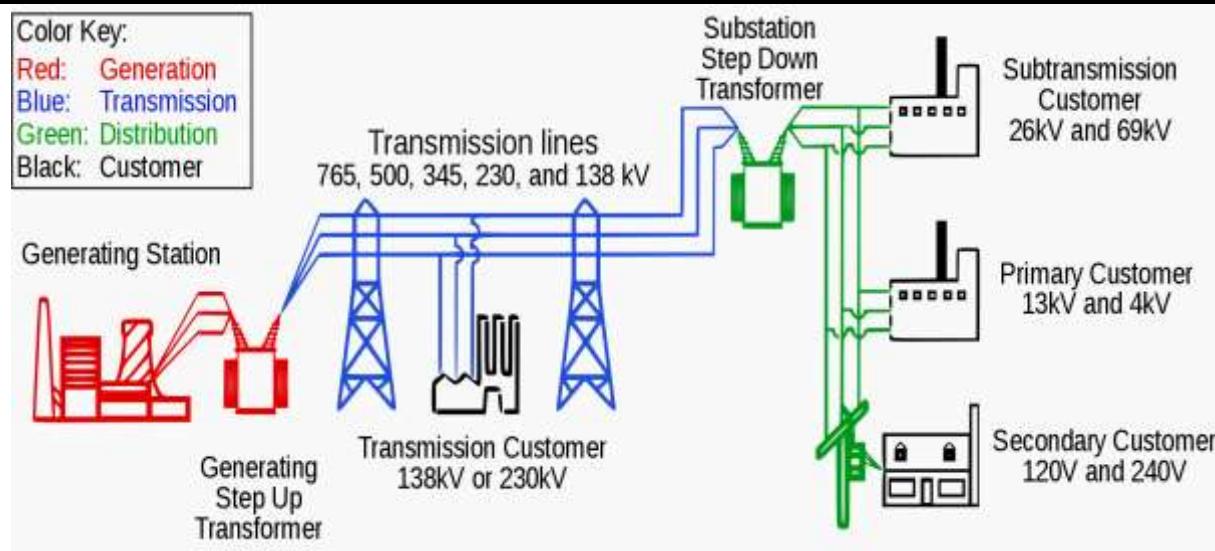


Fig 1 Electrical Power System

More modest power systems are likewise found in industry, emergency clinics, business structures, and homes. Most of these systems depend upon three-stage AC power—the norm for enormous scope power transmission and circulation across the advanced world. Specific power systems that don't generally depend upon three-stage AC power are found in airplane, electric rail systems, sea liners, submarines, and cars. [1]

The age plants produce electrical energy at a low voltage level. We keep the age voltage at a low level since it enjoys some particular benefits. Low voltage age makes less weights on the armature of the alternator. Subsequently at low voltage age, we can build a more modest alternator with more slender and lighter protection. From a designing and configuration perspective, more modest alternators are more reasonable. We can not send this low voltage power to the heap places. Low voltage transmission causes more copper misfortune, helpless voltage guidelines, and more establishment expenses of the transmission system. To keep away from these three troubles we need to move forward the voltage to a particular high voltage level.[1]

We can not raise the system voltage past a specific level in light of the fact that past a restriction of voltage the protection cost colossally increments and furthermore to keep sufficient ground leeway the costs of the line supporting constructions additionally unexpectedly increment. The transmission voltage relies upon the amount of power to be communicated. The flood impedance stacking is another boundary which decides the voltage level of the system for communicating a measure of energy.[2]

For moving forward system voltage, we go through advance transformers and their related securities and tasks courses of action at the creating station. We call this an age substation. Toward the finish of the transmission line, we need to venture down the transmission voltage to a lower level for auxiliary transmission and additionally dispersion purposes. Here we use venture down transformers and their related assurance and functional game plans. This is a transmission substation. After essential transmission, the electrical energy goes through optional transmission or essential appropriation. After optional transmission or essential appropriation again we venture down the voltage to an ideal low voltage level to convey at the shopper premises. [2]

This was the fundamental construction of an electrical power system. Despite the fact that, we have not referenced the subtleties of each piece of hardware utilized in an electrical power system. Notwithstanding three fundamental parts alternator, transformer, and transmission line there is various related hardware. A portion of these bits of gear are circuit breaker, lightning arrestor, isolator, current transformer, voltage transformer, capacitor voltage transformer, wave trap, capacitor bank, transferring system, controlling course of action, the earthing plan of the line and substation hardware, and so on [2]

Electrical networks, machines and equipments are frequently exposed to different kinds of faults while they are in activity. At the point when a fault happens, the trademark esteems (like impedance) of the machines might change from existing qualities to various qualities till the fault is cleared. [3]

There might be parcel of probabilities of faults to show up in the power system network, including lighting, wind, tree falling on lines, mechanical assembly disappointment, etc.[3]



Fig 2 Electrical Faults

A fault in an electric power system can be characterized as , any strange state of the system that includes the electrical disappointment of the gear, for example, , transformers, generators, busbars, and so on [3]

The fault beginning additionally includes in protection disappointments and directing way disappointments which results short circuit and open circuit of conductors.[3]

Under typical or safe working conditions, the electric equipments in a power system network work at ordinary voltage and current appraisals. When the fault happens in a circuit or device, voltage and current qualities goes astray from their ostensible reaches.

The faults in power system causes over current, under voltage, unbalance of the stages, turned around power and high voltage floods. This outcomes in the interference of the typical activity of the network, disappointment of equipments, electrical fires, and so on [4]

Normally power system networks are ensured with switchgear security gear's, for example, circuit breakers and transfers to restrict the deficiency of administration because of the electrical disappointments.

The fault in the power system is characterized as the deformity in the power system because of which the current is diverted from the planned way. The fault makes the strange condition which lessens the protection strength between the conductors. The decrease in protection makes unnecessary harm the system. The fault in the power system is mostly classified into two sorts they are

1. Open Circuit Fault
2. Short Circuit Fault.

The various kinds of power system fault are displayed beneath in the image.[4]

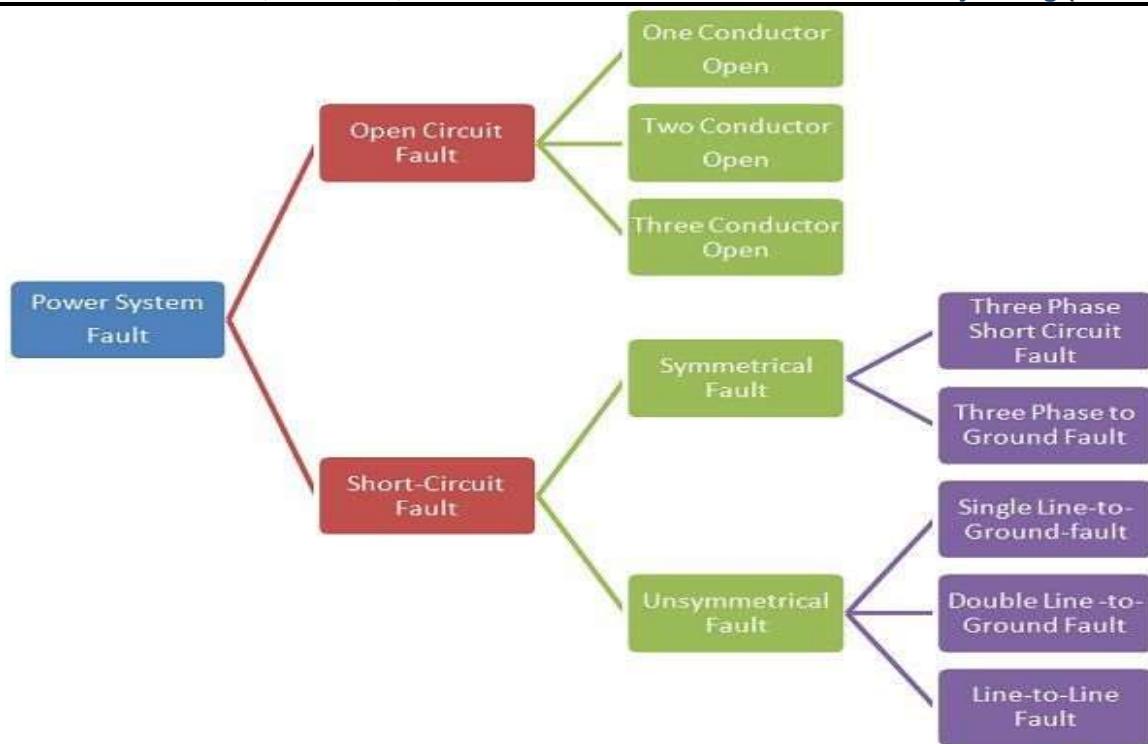


Fig 3 Fault Types

The faults in the power system might happen in view of the quantity of regular aggravations like lightning, fast breezes, tremor, and so on. It might likewise happen in view of certain mishaps like tumbling off a tree, vehicle crashing, with supporting construction, aero plane slamming, and so forth.

II. LITERATURE SURVEY

F. Xu, W. Huang, L. Zhou, N. Tai, J. Wen and L. Cao [5] High-impedance faults are truly challenging to be distinguished and confined in view of the insignificant fault current and irregular cycle. This paper proposes a fault distinguishing proof technique for irregular high-impedance faults dependent on transient power heading location and discontinuity recognition. The definite system of HIF recognizable proof technique, which is produced for grounded circulation networks, is additionally explained. To test the presentation of the proposed technique, both Peterson model and Peterson-Slepian model of HIF circular segment are set up in EMTP. The outcomes show the reasonable worth of fault distinguishing proof strategy thinking about its specialized help for HIF identification and disengagement.

P. Xi, P. Feilai, L. Yongchao, L. Zhiping and L. Long [6] With the future improvement of substation, the exploration of power fault identification calculation has vital hypothetical importance and wide application possibilities. To work on the acknowledgment of power line fault location, one demonstrating technique dependent on inadequate self-encoding neural network is proposed. The db3 wavelet is utilized to deteriorate the fault sign, and afterward the sub-band energy is determined as boundaries for the profound learning neural network. By the pre-preparing analysis and displaying for the trait of fault signal, the profound learning neural network is utilized as the fault acknowledgment classifier. The reenactment explore dependent on IEEE 34 shows that the fault acknowledgment rate surpasses almost 100%.

J. Kumar and P. Jena [7] In this paper, location of fault in a series remunerated line during power swing is thought of. Voltage and current signs contain non-basic parts because of fault in a series repaid line during power swing. Presence of drifters because of MOV and airgap activity, sub simultaneous reverberation, voltage and current reversals further make the fault location measure more perplexing. There are numerous customary plans accessible in writing to recognize the fault during power swing. During power swing, both dynamic and responsive powers sway inside sure and negative locales, while the clear power wavers inside sure area as it were. In this work, a superimposed clear power based procedure is proposed to recognize the fault during power swing in a series remunerated line. A 400 kV power system is reenacted utilizing EMTDC/PSCAD programming. The exhibition of the procedure has been considered for balanced fault, lopsided fault, far-end fault, high obstruction fault, and single shaft stumbling circumstance during power swing in a series remunerated line. Execution of the proposed procedure is acceptable and precise.

T. K. Patel, S. K. Mohanty and S. Mohapatra[8] Any unsettling influence in power system ought to be perceived by the hand-off put in the network proficiently. By and large the fault discovery is the significant issue in the power network, and in the event that this fault happens during the power swing, the recognition of this fault is troublesome. Stage examination of line current procedure is an exceptional type of current differential security. Here the stage point of each stage current plays an essential job to choose the huge change in the power network like fault, climate it is inward or outer faults. This method is additionally used to get the steady and unsteady power swings by utilizing PSCAD programming in a 2-transport system. Here by taking the distinctive level of transmission line length at the fault point, the fault during power swing is dissected. This method is quicker and exact. This strategy is likewise tried in 9-transport 3-machine WSCC power system model.

T. Wu, G. Tu, Z. Q. Bo and A. Klimek [10] The fault recognition and analysis for power transformer are the critical measures to work on the security of power systems and the dependability of power supply. Because of the complicity of the power transformer structure and the varieties in working conditions, the event of a fault inside power transformer is unsure and arbitrary. As of not long ago, the fault insights of power transformer is extremely restricted because of the low fault rate. A clever fault tree analysis strategy dependent on fluffy set hypothesis is proposed for power transformer. Utilizing this strategy, the record of fault rate can be changed over into fluffy number of fault rate. The strategy for master evaluating can be utilized to play out the likelihood of fault assessment without the necessity for comparing measurements data. The subtleties of fluffy number plan are portrayed in the paper and an application illustration of the technique is additionally given. The outcomes show that the proposed fluffy fault tree analysis technique is adaptable and versatile for fault analyze of power transformer. Thusly, it is a helpful designing apparatus for the fault analysis and counteraction of power transformer.

A. Pradhan and G. Rao [11] Summary structure just given. Distance transfers are obstructed during power swing to guarantee unwavering quality of the power system. Be that as it may, if a fault happens during power swing, it ought to be recognized and unblocking capacity ought to be conjured to clear the fault as quickly as time permits. Because of symmetric nature of signs during power swing, balanced faults are hard to be recognized. In this paper, a differential power based fault recognition strategy is proposed for discovery of even faults during power swing. The differential power is determined from the distinction in anticipated and real examples of voltage and current. The anticipated voltage and current examples are gotten utilizing autoregression strategy. The proposed strategy is tried for various fault conditions and the outcomes are contrasted and the accessible technique. Proposed strategy is found to distinguish even faults precisely during slow and quick power swings for various power systems.

Furqan Asghar, Muhammad Talha, and Sung Ho Kim, [12] as of late, inverters are considered as the fundamental structure block in an electrical drive system utilized broadly in numerous mechanical drive applications. Be that as it may, the dependability of these inverters is for the most part influenced by the disappointment of power electronic switches. Different faults in inverter might impact the system activity by surprising upkeep, which builds the expense factor and lessen in general productivity. In this paper, similar investigation of three distinctive fault identification and analysis systems for three stage inverter is introduced. The fundamental reason for these fault location and analysis systems is to distinguish single or numerous faults effectively. These procedures depend on the neural network for fault location and determination by utilizing Clarke changed two-dimensional components extraction, three-dimensional elements extraction and elements extraction utilizing discrete wavelet change (DWT) with an alternate number of elements in every strategy. A few components are removed utilizing various instruments and utilized in the neural network as contribution for fault discovery and determination. Moreover, a recreation study is completed to examine the fault recognition and analysis reaction of these strategies. Additionally, a relative report has been performed by considering fault identification time and exactness. Examination results demonstrate the incomparability of three-dimensional element extraction procedure over other two methods as it can identify and analyze single, twofold and triple faults in a solitary cycle with high exactness when contrasted with other two strategies multi-cycles identification.

III. PROPOSED WORK

The extension of environmentally friendly power sources has been a worry as of late. Despite the fact that these regular energy systems are proper replacements for old power systems, impediments and challenges in power age and appropriation, for example, overvoltage, fault assurance and recurrence changes are obstructions that ought to be addressed too.

The future electricity network should oblige huge size of dispersed age units (DGs) and work with the association of fantastic size of concentrated age at appropriate areas. Microgrid has been considered as a powerful method to deal with the DGs and other appropriated energy assets (DERs) on the dissemination system level and the client level. Microgrids give proficient, minimal expense and clean energy. These are basic foundation that expands dependability and versatility. Likewise diminish lattice "blockage" and pinnacle loads. All things considered, the insurance of these microgrids stays a hazardous issue. At the point when a fault happens in the system, it makes a gigantic current that could influence the whole system working, and it could stop the entire system. The chance of finding faults rapidly and disengaging that part from different pieces of the system would permit the remainder of the power microgrid to keep working.

3.3.1 Specifications

The miniature matrix is a solitary stage AC network. Energy sources are an electricity network, a sun oriented power age system and a capacity battery. The capacity battery is constrained by a battery regulator. It retains excess power when there is overabundance energy in the miniature network, and gives extra power in case there is a power shortage in the miniature network. Three standard houses devour energy (limit of 2.5 kW) as electric charges. The miniature cluster is associated with the power network through a transformer mounted on a post which brings down the voltage of 6.6 kV to 200 V. The sun based power age and capacity battery are DC power sources that are changed over to single-stage AC. The control methodology accepts that the microarray doesn't rely completely upon the power provided by the power lattice, and the power provided by the sun oriented power age and capacity are adequate consistently.

3.3.2 Types of Faults

There are extensively two kinds of faults which happen in a microgrid, Line to Line Fault and Line to Ground Fault.

Most of these faults are line to ground fault because of the part or section disappointment or lightning. At the point when a short circuit fault occurs in the microgrid, the fault opposition will in general zero and the current will in general become boundless..

$$I_f \rightarrow \infty, R_f \rightarrow 0$$

Here I_f is the fault current and R_f is the fault resistance.

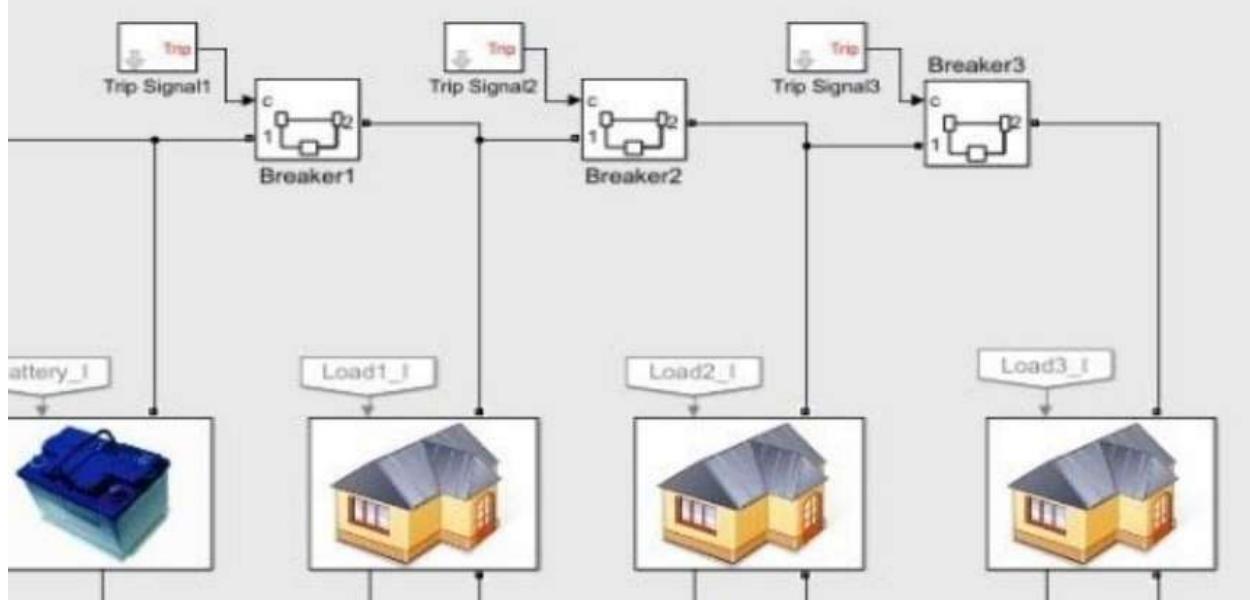


Fig 4 Circuit Breakers

For this situation, three circuit breakers are presented in the circuits before each house as displayed in the figure beneath . They act as the faults. The properties of breakers are as per the following: Breaker Resistance - 0.001 ohm, Snubber Resistance - 1e6 ohm, snubber capacitance - inf. The breakers are at first at state 1 i.e., not enacted. Presently they are enacted individually for thirty minutes each an ideal opportunity to get the dataset. Every breaker is initiated at all day long. So in absolute we get the all out of 96 information focuses. At whatever point a fault occurs in any piece of the system, the upsides of secondary current I and Load Power changes radically. These changed qualities assume a focal part in our model. At each point secondary current(I_{Sec}) and load power esteem is thought about alongside their season of actuation. The hour of fault assumes a significant part due to the idea of the circuit.

1. The proposed idea will identify and break down the Line-to-Line fault and Line to Ground Fault for a given Positive, Negative and Zero arrangement Impedance and KVA and KV of the given System.
2. Utilizing the ANN Artificial Neural Network we will likewise attempt to identify and discover the area of the fault before it can make influences different pieces of the system. In the proposed idea we can zero in on the discovery of the area of the faults on electric power transmission lines in the power microgrid network.

IV. RESULT ANALYSIS

We measure the upsides of secondary current (I), Load power (P) devoured by the sec Lloads and the time at which this information is estimated for a time of 24 hours estimating after like clockwork. In this manner we get 23 arrangements of upsides of this load of boundaries. We train this dataset (interface underneath) in our ANN model. Presently utilizing this prepared dataset the area can be known as the fault before the main house or the subsequent house or thereabouts on. Here the model comprises of three houses, so the dataset got isn't exceptionally huge however an enormous dataset can be acquired by including more loads i.e., houses.

From 20h to 4h, the sun oriented power age is 0 W. It arrives at the pinnacle sum (5 kW) from 14h to 15h. As a normal load change in standard houses, the measure of electric power load arrives at top utilization at 9h (6,500 W), 19h, and 22h (7,500 W). From 0h to 12h and from 18h to 24h, battery control is performed by the battery regulator. The battery control performs following control of the current with the goal that dynamic power which streams into system power from the secondary side of the post transformer is set to 0.

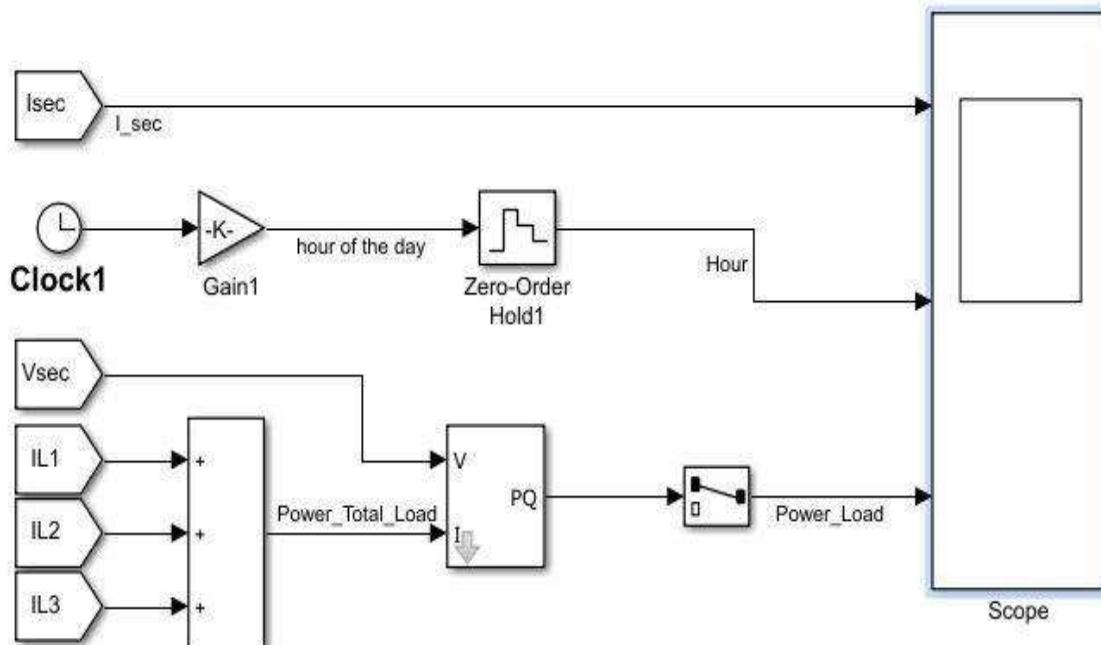


Fig 5 Simulation Model

The base paper,

Furqan Asghar, Muhammad Talha, and Sung Ho Kim, "Comparative Study of Three Fault Diagnostic Methods for Three Phase Inverter with Induction Motor", Int. J. Fuzzy Log. Intell. Syst. 2017;17(4):245-256

The idea proposed is three-dimensional component extraction strategy which is contrasted and different methods, it can distinguish and analyze single, twofold and triple faults in a solitary cycle with high precision when contrasted with other two strategies multi-cycles discovery. The most extreme discovery precision accomplished is 70%.

Table 1 Accuracy of Fault Detection using Proposed Work

Pass	Location	Accuracy
1	222 us/step	78.26
2	183 us/step	69.57
3	186 us/step	71.74
4	213 us/step	77.17
5	182 us/step	70.65
6	200 us/step	72.83
7	190 us/step	73.91
8	180 us/step	68.48
9	163 us/step	76.09
10	179 us/step	66.30
11	204 us/step	69.57
12	195 us/step	76.09
13	193 us/step	80.43
14	180 us/step	78.26

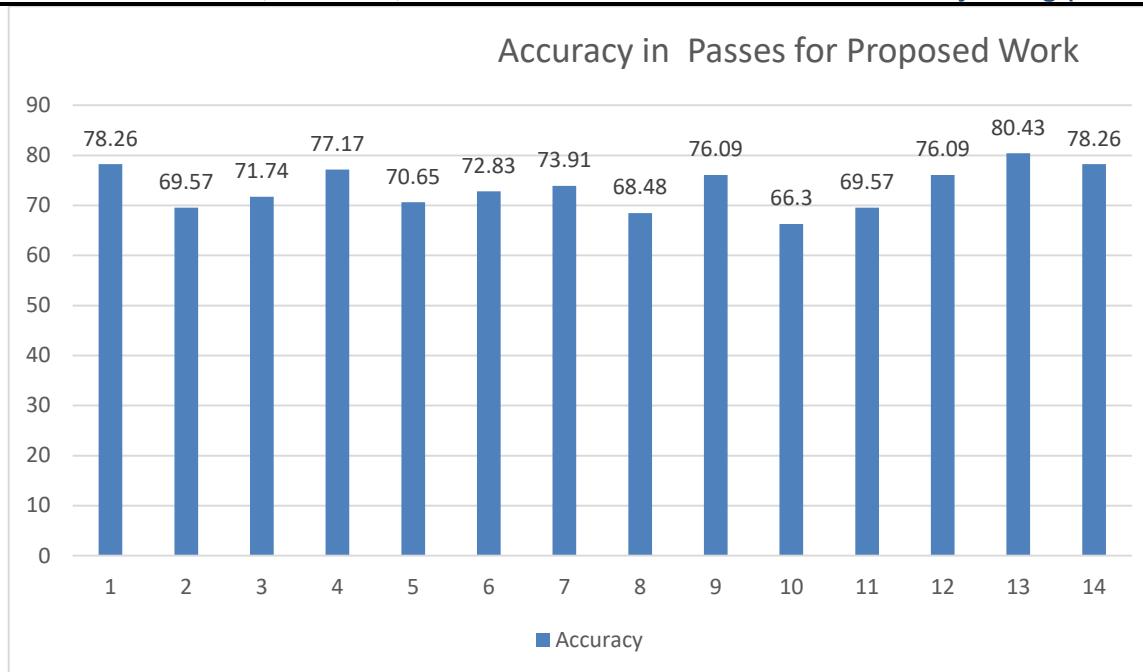


Fig 6 Accuracy Graph for Passes in Proposed Work

On the basis of the Fig 6 , the detection accuracy is 78.26% in the prediction and location of fault.

	Base Paper	Proposed Work
Accuracy	70%	78.6%

So using the concept of the fault prediction and location in the proposed work , 8.6% is the overall improvement.

The Spikes are detected of I_{sec} (I_{sec} is the sudden change in the value of the secondary current) are detected as faults.

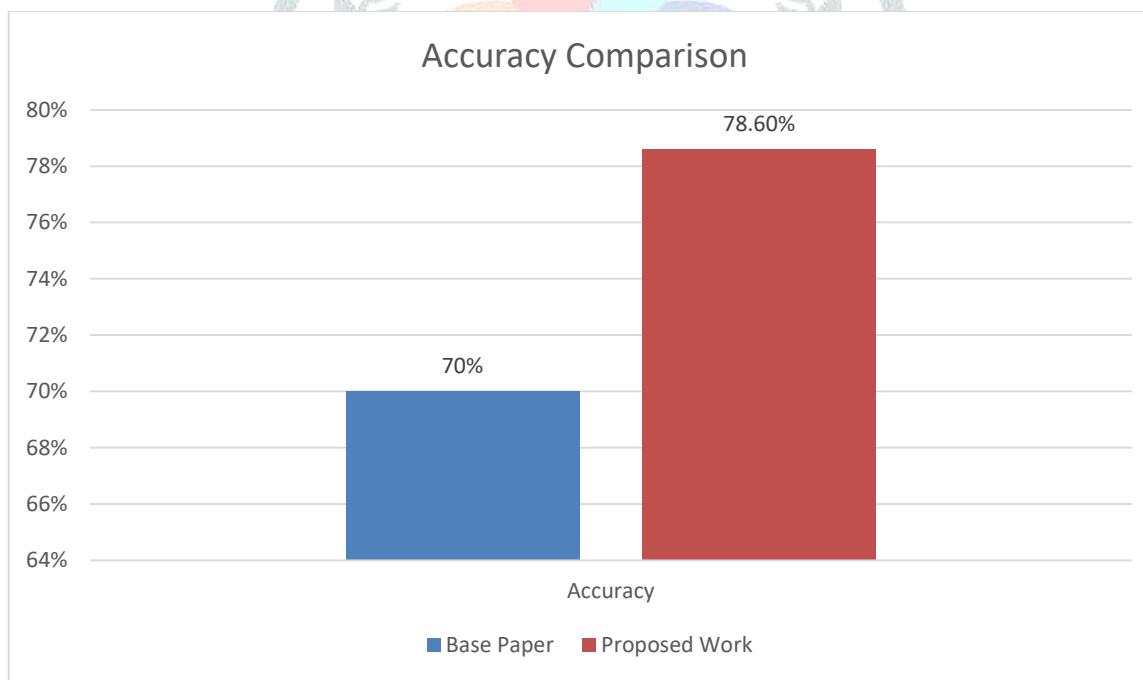


Fig 7 Accuracy Comparison Graph

IV. CONCLUSION

The fault investigation of a power system is needed to give data to the choice of switchgear, setting of transfers and strength of system activity. Here and there concurrent faults might happen including both short out and broken-conveyor faults (otherwise called open-circuit faults).In an electric power system, a fault or fault flow is any strange electric flow. For instance, a short out is a fault where current detours the ordinary burden. An open-circuit fault happens if a circuit is hindered by some disappointment.

In three-stage systems, a fault might include at least one stages and ground, or may happen just between stages. In a "ground fault" or "earth fault", current streams into the earth. The planned short out current of an anticipated fault can be determined for most circumstances. In power systems, defensive gadgets can distinguish fault conditions and work circuit breakers and different gadgets to restrict the deficiency of administration because of a disappointment. In view of the counterfeit neural organization , the fault recognition of microgrid was considered. A limited scale displaying of the microgrid including sunlight powered chargers , battery energy stockpiling system, burdens and AC matrix is reenacted in MATLAB. An abrupt change in the worth of auxiliary current I_{Sec} and the heap power PL is the reason for the calculation that distinguish the fault area. Here we notice the spikes in the diagram of I_{Sec} as the faults .These faults are produced physically by turning on every one of the circuit breakers at different snapshots of a day . Additionally the faults were concentrated by keeping just as disengaging the battery regulator. Having created the information at different occasions of a day and preparing the dataset in ANN got a good exactness of (70%~80 %). So having new information of power, ISecand time , we can foresee in case there is a fault or not , and in case there is , the area of the fault not really settled pretty precisely

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