Protection and Controlling of Transmission Lines by using Machine Learning Techinique

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Abstract— Now a day's electrical system is at intervals the tactic to convert into smart power system with interconnected national and regional grids. wattage system is growing, and quality in all sectors like generation, transmission, distribution and lading systems. Faults like tangency condition lands up in severe economic losses & reduces responsibility of the electrical system. These faults cause interruption to electrical flows, instrumentality damages & even cause death of humans, birds & animals. For avoiding these styles of things, we've got to clear or nullify the fault. Fault clearing is also an important task in facility network. It is often done by exploitation protecting devices like switch gears. Protection plays a very important role in fashionable facility network, right from generation through transmission to distribution end. Multi useful relay additionally put in in fashionable power grid network for cover of conductor, generator protection, motor protection, real time fault location, protection of bus bar and totally different necessary equipment's. A reliable, continuous give of electricity is very important for functioning of today's modern sophisticated advanced society. it's usually obtained by providing protection against to the faults in grid. This paper is devoted to abnormal system behaviour below conditions of faults in power transmission lines exploitation MATLAB Simulation and planned for fault detection, classification & location by exploitation ANN (Artificial Neural Networks).

Key words: conductor Protection, Faults classification & detection, Artificial neural network.

I. INTRODUCTION

Three section power conductors are that the soul of the facility system. Power transmission is that the major issue in EE once generation. If any fault or disturbance occurred within the conductor and isn't detected, placed and eliminated quickly, it's planning to cause instability among the system. to clear fault quickly and restore power give as presently as potential with minimum interruption, (1,2) fault detection and finding precise location is extremely necessary. For this we tend to area unit going for cover of conductor. power grid conductor protection has nice impact on economical thought of the state or country.

The fault associate degree analysis of an influence system is required thus on turn out information for the choice of switch gear, setting of relays and stability of system operation. Thus, fault studies should be compelled to be habitually performed by utility engineers. this may be necessary for reliable operation of power instrumentality and satisfaction of shopper.

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Faults usually occur throughout a awfully facility as a results of either insulation failure, flash over, physical injury or human error. These faults would possibly either be 3 phases in nature involving all three phases in associate extremely symmetrical manner or is additionally asymmetrical where generally only one or two phases is additionally involved. Faults would possibly additionally be caused by either short-circuits to earth or between live conductors or would possibly even be caused by broken conductors in one or plenty of phases.(3) usually synchronic faults would possibly occur involving each short-circuit and broken conductor faults (also mentioned as open-circuit faults).

II. FAULTS IN POWER SYSTEM

In degree electrical power grid, a fault or fault current is any abnormal current. as an example, a quick circuit is also a fault at intervals that current bypasses the standard load. degree open-circuit fault happens if a circuit is interrupted by some failure. In three-phase systems, a fault would possibly involve one or a great deal of phases and ground or would possibly occur alone between phases. in AN passing "ground fault" or "earth fault", current flows into the planet. the doable contact current of a inevitable fault unit of measurement generally calculated for many things. In power systems, protective devices can observe fault conditions and operate circuit breakers and totally different devices to limit the loss of service due to a failure. Fault is degree unwanted SC condition that happens either between 2 sections of wires or between a district of wire and ground. tangency is that the riskiest fault kind as flow of nice currents will cause heating or prove mechanical forces which can injury equipment's and fully totally different components of facility.

In a poly-phase system, a fault would possibly influence all phases equally which will be a "symmetrical fault". If simply some phases ar affected, the following "asymmetrical fault" (3,4)becomes a great deal of subtle to research. The analysis of those varieties of faults is sometimes simplified by exploitation ways in which like symmetrical components. There are a unit eleven potential faults in an exceedingly three-phase conductor, namely RG, YG, BG, RY, YB, RB, RYG, YBG, RBG, RYB, RYBG. These all area unit classified as fallows.

III. CATEGORIES OF FAULTS

Faults can also be classified into 3 varieties, that is, symmetrical faults, unsymmetrical faults, and circuit faults.

A. Symmetrical Faults

The fault that ends up in symmetrical fault currents (i.e. equal currents with 100 twenty displacements) is known as a symmetrical fault. Three-phase fault is Associate in Nursing example of symmetrical fault where all three phases unit of measurement short circuited with or whereas not involving very cheap.

B. Unsymmetrical Faults

Samples of entirely completely different unsymmetrical faults unit of measurement single half to ground, 2 phases to ground, and half to half short circuits. the most points of these shunt fault varieties which is able to occur in line unit of measurement delineated as follows.

C. Electrical Faults

This kind of shortcoming is brought about by breaking of directing way. Such issue happens once one or stacks of periods of conductor break or a line joint (at the strain tower area) on Associate in Nursing overhead line comes up short. Such things could emerge once circuit breakers or isolators open yet neglect to skirt one or loads of stages. all through the circuit of one of the two stages, lopsided current streams among the framework, along these lines warming turning machines. defensive plans should be given to arrangement such strange conditions.

IV. NEED OF PROTECTION

Insurance framework for power link has been created to weaken the damage and to ensure offer in safe condition, unremittingly and monetarily. There unit shifted obligations insurance framework close to seclude the solid framework from flawed framework. The benefit of uninfected a framework issue as fast as conceivable epitomize wellbeing for work force and open, limiting damage to powerhouse and limiting impacts on framework dependability. the ability system maintains its steady state chiefly attributable to the right remedial action taken by the protecting relaying instrumentation. Relay is in an one of the foremost necessary parts in a protection system.

V. PROTECTING RELAYS

Relay is one in every of the foremost necessary parts in protection system. There square measure many styles of relay that every kind has own characteristics. A relay is device that creates a measuring or receives a proof that causes it to work and to impact the operation of different instrumentation. It responds to Associate in Nursing condition in faulty section of the line with the minimum interruption of provide. Whenever a fault occurred on power line, one in every of the relays ought to be operated.

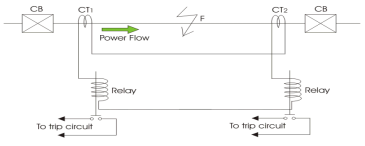

Fig 1: Single line diagram of protection of conductor

A standout amongst the foremost important segments of an influence protection system is that the relay. protecting relay uses current and voltage signals to notice, classify, and find the fault in conductor. a visit signal is going to be sent by the relay to a fuse with the aim of disconnecting the faulted line from the rest of the framework just if there should be an occurrence of an unsettling influence for keeping up the relentlessness of the staying sound framework. Relays square measure classified supported their characteristic, logic, on activating parameter and in operation mechanism.

A. Impedance relay

It's part fault relay & voltage restraining over current relay. It is having in operation force created by this, restraining force created by the voltage. it's not inherently directional relay however may be created, therefore by employing a directional component with it. In medium transmission lines Impedance relay with value-added directional property component is employed instead of the S relay because of the price issue.

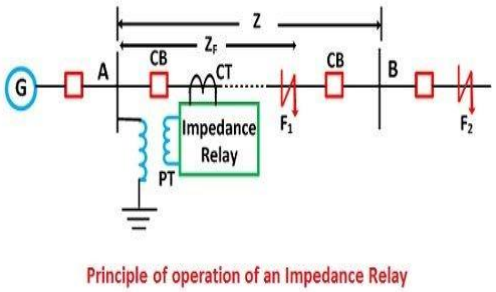

Fig 2: Impedance relay

B. Reactance relay

Reactance relay is earth fault relay and current restraining over current relay. The in-operation force is created by this, restraining force is created by this & voltage. It doesn't have directional feature nor may be created directional mistreatment directional unit. Ground faults square measure extremely subjected in brief transmission lines owing to the trees falling down throughout significant winds. therefore, fault resistance will impact in estimating the reach of the gap relay. Reactance relay is proof against the fault resistance and additionally unstable at traditional load.

C. Mho relay

Mho relay is section fault and voltage restraining over current relay. The in-operation torsion made by the voltage & current, restraining torsion made by the voltage. It incorporates options of Reactance relay with associate addition that it's inherently directional. Since long transmission lines ar extremely subjected to power swings (load shedding additive impact adds on effects the long transmission line majorly). It will shield from power swing higher than resistivity relay.

VI. MATLAB SIMULATION ON FAULT ANALYSIS

A. Fault Analysis

Fault incidence are often simply detected with abrupt decrease in resistivity of the road thanks to high current throughout fault. The resistivity drops from vary of thousands to a whole bunch and current will increase from a whole bunch to thousands throughout fault condition betting on the fault resistance and distance to fault. These values conjointly modification thanks to modification of load. correct point should be chosen for correct differentiation between fault and overload.

B. Circuit model for three section faults in installation

The implementation deals with the model created in MATLAB exploitation the Sim Power Systems Tool, the GUI. Through this advanced information simulation model fault analysis of any installation network are usually simulated with ease and its fault analysis are usually applied.

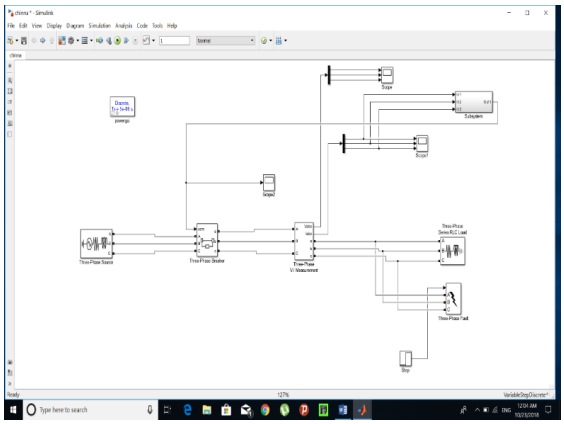

Fig 4: Simulation model three phase fault analysis

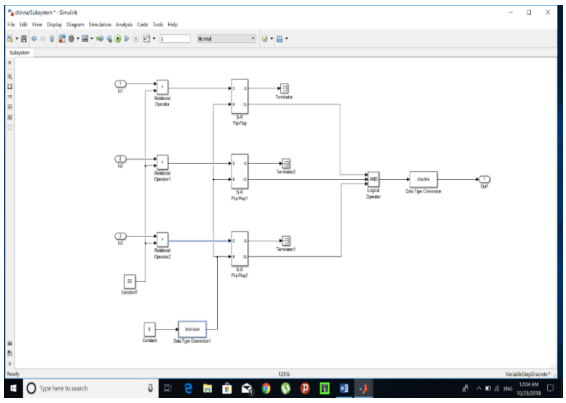

Fig 3.: Relay Subsystem

A. Simulation Results

During this case, the transmission model is keeps running for a Line to Ground Fault. The reproduction is finished for one sec, so as that the waveforms territory unit for the most part observed a lot of plainly. The recurrence is taken to be fifty rate. The framework voltage is taken as eleven. Issue is begun at zero.5 secs and cleared at zero.52 secs as appeared in Fig.4. These parameters region unit whole steady for different cross-check cases be that as it may. Fig.4 and Fig.5, shows the current and voltage waveforms for the given determinations. After infusing these signs to the relay it has been seen that the transfer travels the breaker and furthermore the remaining of its loop is appeared inside the reproduced outcomes. As {this is this is normally this can be} frequently a self-reset hand-off, the outing standing returns to zero after clearing the issue, beside a manual reset hand-off, it remains one till the switch is smooth physically. The arranged MATLAB model territory unit typically running independent or on the interface to show up at the plots.

During this bestowed simulation model analysis is just in dire straits L-G fault. By dynamical the fault block we can analyse all the faults. supported the output results we are able to choose and develop a far better for cover purpose. this method opens the thanks to select and design the higher protection theme for transmission line in step with its results.

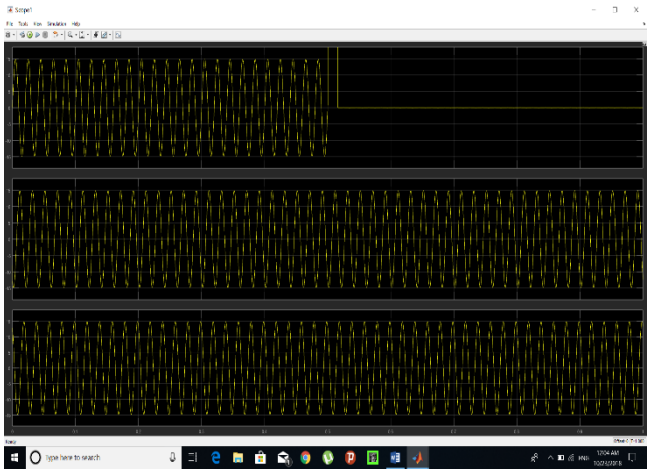

Fig5 : L-G Fault current waveform

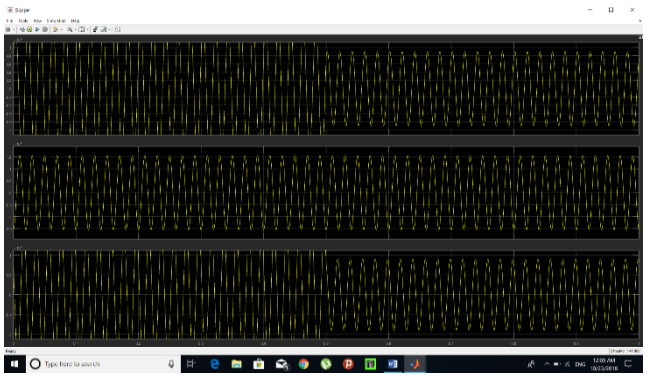

Fig 5: L-G Fault voltage wave form

VII. ARTIFICIAL NEURAL NETWORK

A. Introduction

There's no issue free framework and it's neither brilliant nor conservative to shape a deficiency free framework. the various instances of unusual conditions like common occasions, physical mishaps, disappointment, and miss activity create flaws at interim's the establishment. the ramifications of shortcomings territory unit awful intensification of current stream, expanding warmth made at interim's the conductors prompting the

key purpose for harm. the size of deficiency relies upon protection from stream and fluctuated obstruction between the flaw and hence the arrangement of intensity gives. Complete opposition contains of deficiency obstruction, opposition and electrical wonder of line transmitters. because of the neural system-based standard incorporates a store of capacity and is maybe advancing to be heaps of right, shifted analysts utilized it for establishment insurance that is that the primary focus of this examination. sort of prime capacities and uses of ANN territory unit open at interim's the literary works those will help to recognize the view of acceptive it as a device for flaw location, arrangement, and confinement on conductor of the power frameworks.

A. Artificial Neural Network

For detection and classification of the faults on electrical power conductor practice artificial neural network, the three section currents and voltages of one end area unit taken as inputs at intervals the planned theme. Utterly completely different completely different} the various} faults area unit simulated with different parameters to look at the pliability of the strategy. The planned methodology are (7,8) going to be extended to the Distribution network of the power System. the various simulations and analysis of signals is finished at intervals the MATLAB setting.

Artificial neural network (ANN) has been outfitted with uniqueness of data process, nonlinear mapping, agreeable memory, and separated and on-line learning capacities. The wide vocations of ANN with its seizure results produce it a genuine definite mean in power systems. Its skilfulness with enormous number significance will be found in a couple of districts of science and structuring examination. it's an extreme arrangement of interconnected neurons wherever ending of electrical pulses by methods for its affiliations ends up in data spread. Figure.6 addresses the coordinated arrangement of ANN.

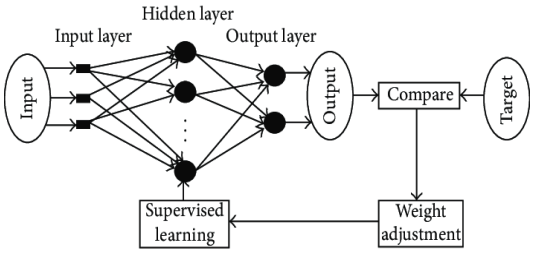

Fig 6: Supervised architecture of ANN.

Blunder back propagation (BP) neural system was connected for assignment of deficiency in framework. Any way moderate speed training work and furthermore the weaknesses of local optima cause the presentation of extra force issue for disservice goals. Radial basis operates (RBF) neural system envelops a quicker learning pace and also the adaptability of optional work estimation. (6,7) For resolution improper problems, neural network topologies square measure to be altered and there is a necessity to retrain the network. we tend to square measure able to use beingness capability of multilayer perception (MLP) and generalized regression neural network (GRNN) for fault estimation in grid.

C. Algorithm

Artificial neural network (ANN) is connected to blame recognition and arrangement successfully as a consequence of it is a programming procedure, proficient to determine the nonlinear issues simply. the issues at interims that the information available is and in mammoth kind is tended to. style of line design square measure conceivable as there's any likelihood from short length, long length, single circuit line to twofold circuit transmission lines, and so forth.

- The states of the office framework change once every unsettling influence. thus, a neural system is able to consolidate the dynamic changes at interims the office frameworks.
- The ANN yield is exceptionally quick, solid and appropriate contingent upon the instructing work, as a consequence of its in task relies on a progression of extremely basic activities.

The algorithmic program that utilized ANNs programming offers numerous favours, yet it together endures with numerous burdens, that square measure extremely troublesome in nature. numerous the significant factors square measure the choice of support of system, style of the system. The neural system depends on the all out six style of sources of info, for example the voltages and flows of numerous three stages. The neural system is prepared by training these six information sources. the complete style of yields of the neural system is four in numbers, for example 3 stages A, B, C and fourth is ground of 3-phaseline.

VIII. FAULT DETECTION

A. ANN design

One considers choosing the correct size and structure for the system is that the differ of information sources and yields that it need. The lower the number of sources of info, the littler the system may even be. Be that as it may, sufficient information document to describe the trouble should be guaranteed. The contributions to plain separation hand-off square measure fundamentally the voltages and flows. In this way, the system sources of info picked here square measure the sizes of the natural components (50 Hz) of three segment voltages and three area flows estimated at the hand-off area. alone the sizes recorded at the tip of line square measure utilized. because of the basic errand of flaw order is to see the kind of shortcoming at the aspect of the segment, four yields taking after three stages and ground/nonpartisan were thought of as yields given by the system. In this manner, the system input X thus the yield Y are:

$$X = [Va, Vb, Vc, Ia, Ib, Ic];$$

$$Y = [A, B, C, G];$$

When it had been set what style of data sources and yields the system need, sum |the quantity} of concealed layers thus the measure of neurons per layer were thought of. Bolstered consequences of study, it had been set to utilize a neural system with 3 layers (one shrouded layer), with twelve neurons inside the information

layer, thirty neurons inside the concealed layer and 7 inside the yield layer. a definitive word assurance of the neural system wishes the pertinent exchange capacities to be built up. Once breaking down the different potential creations of exchange works once in a while utilized, as logsig, tansig and direct capacities, the tansig work was picked as exchange work for the shrouded layer, thus the purelin work inside the yield layer.

B. Fault Detection by Pattern Recognition

The neural system way to deal with issue location may even be uncovering as an example acknowledgment detriment the ANN is prepared to recognize unadulterated snakelike flag as pointers of a standard framework condition unexpected changes of abundancy or segment, or the nearness of transient components unit utilized as markers of shortcoming start. Current and voltage sign may even be utilized for issue discovery; anyway, current sign is generally touchier than voltage to blame beginning. Plentifulness and area changes unit bigger for current sign than for voltage signals: additionally, the dc-balance of issue current might be an unmistakable marker of the different flaw conditions. Hence, current sign may even be picked as sign to the indicator all through this work. The structure of the ANN-based issue locator is appeared in Fig. 3. Information current is low pass separated before a lot of successive examples of current sign kind the: contribution to the neural system. By utilizing a 1kHz rate (10 tests for every fifty Hertz cycle), data windows with by and large completely totally various quantities of tests were assessed. The outcomes unit of estimating exhibited for data windows containing twenty examples (20 contributions to the ANN for recreation). alone a consolidate of shrouded layers were observed to be vital for this application. The yield layer needs just a single cell, with a two-state output. (5,7,9)

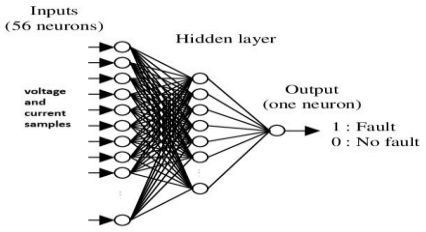

Fig 7: Fault detection ANN structure

C. Application of ANN on conductor Protection

This segment shows the examinations on use of ANN for flaw discovery, order, area, heading segregation, and broken segment decision on conductor.

D. Studies on "Fault Detection and Classification"

It is important to recognize the shortcoming and arrange its sort with the point of structure wellbeing and security of the power framework. Their framework demonstrated tasteful presentation in flaw order by abuse each the MLP (multiplayer perception) and ART (versatile reverberation hypothesis) classifiers. A near investigation of differed ANN based issue location and order plans is given in Table one features the manners by which utilized, their interim, and ANN decisions at the part of its exactness.

E. Studies on "Fault Detection and Classification and Location"

it's totally essential to identify and notice the transmission faults for maintaining the skilful and trustworthy operation of power systems. For estimation of the fault location, there are a unit sort of mathematical and intelligent ways in which accessible inside the literature. However, the broad variations in operational conditions like system loading level, fault origination instance, fault resistance and dc offset, and harmonics contents inside the transient signal of the faulty conductor make to inadequate results.

F. Fault direction & discrimination

Deficiency course estimation on conductor is terribly urgent for improving the exhibition of framework. Headway of immense creating stations and strongly interconnected power frameworks involves less shortcoming clearing times. The methodology of ANN has been completely utilized for the development of a significant number of the quality capacities that unit of mensuration worked in transmission lines. The exactness of A PC, static, or a microchip-based separation hand-off is stricken by out and out absolutely totally unique issue conditions and system arrangement changes. Along these lines, the course of the flaw must be segregated to stay up the customary task of the office framework.

ANN method at home with gauge the deficiency area strategy by suggests that of directional separation. they have to extend a neural system to assess the heading of the shortcoming. Creators utilized neural system for emerging with 2 inside and out absolutely totally unique shortcoming heading separation modules for prime speed conductor and settled that issue bearing unit normally outstanding rapidly and precisely from their outcomes. Features the various plans utilized for flaw bearing estimation with its reaction amount and determinations of ANN next to comments.

G. Faulty section alternative

Fault part choice, a very important a part of fault identification, is applied by activity faulty line parameters. altogether completely different grid faults like LG, LL, LLG, LLL, and LLLG on a protected conductor need to be detected, classified, and located and faulty part need to be elect for activity the normal system operation. The summarized study of varied ANN primarily based fault part alternative schemes highlight the ways in which used, their response amount, and ANN choices beside remarks

IX. FAULT CLASSIFICATION

The essential though behind relays remains identical, the digital technology has had a heavy influence on the implies that relays operate and have offered many enhancements over ancient automaton relays. In ANN based technique, the complete information that's collected is split into 3 sets considerably the utilization, validation and then the testing

information sets. the primary step within the manoeuvre is fault detection. Once we tend to tend to any or all acknowledge that a fault has occurred on the conductor, consecutive step is to classify the fault into the various classes supported the phases that unit of measure faulted. The aim of this paper is to propose AN integrated technique to perform every of those tasks' victimization every of those steps has been delineate within the programming language shown in Figure.8.

The flow chart explains the essential procedure that was accustomed implement the ANN based mostly completely fault detection and classification in conductor. throughout Pre-processing, three current input signals were sampled at a frequency of 1kHz and any processed by low-pass filter. Then one full cycle separate Fourier rework is employed to calculate the energy output of 3 currents. The input signals were normalized therefore on kind the ANN input level between +1 or zero. the foremost necessary aspects of the fault location systems unit of activity specification, choice of learning rule, employment methodology, and testing the fault surveyor supported ANN.

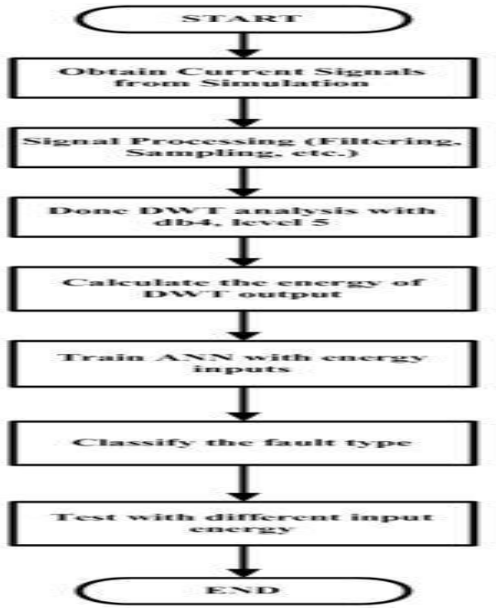

Fig 8: Flow chart of ANN primarily based define(3,4)

X. EXECUTION AND CLASSIFICATION OF FAULT

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Parameter	Set Type
Fault Type	AG, BG, CG, ABG, BCG, ACG, AB, BC, AC, ABC;
Fault Location in percent	5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95;
Fault Resistance(Ω)	0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50;

Table 1. Input Data for ANN Training

Consistent with Table.1, 1900 input coaching information area unit obtained for ANN primarily based fault classification. There are a unit four outputs from ANN as figure. Then (1900 × 3) input data and (1900 × 4) target data area unit fed to 'nprtool' (Neural network pattern-recognition tool). From 400 input file, seventieth area unit used for coaching, 20% for validation and 10% for testing. within the ANN coaching, two layers with fifty neurons area unit set because the basic parameters. the burden and bias area unit set random consistent with default chest parameter. The sample input and target information for silver fault with twenty Ω fault resistance with varied fault distances area unit portrayed in Table.2

Just to get correct outputs for fault classification, many trainings area unit disbursed throughout simulations. Once trained, the networks performance was tested employing a validation information set. the acceptable network that showed satisfactory results was finally selected. once acceptable output and negligible error is obtained, Simulink model output for fault classification is generated from 'nprtool'. consistent with the ANN coaching, the ensuing Simulink block for fault classification.

Fault Type	Distance (%)	Input (Energy)			Output			
		Ya	Yb	Yc	A	B	C	G
AG	5.0	54.1277	120.7274	116.9482	1	0	0	1
AG	10	52.0354	118.0951	114.3549	1	0	0	1
AG	15	54.0901	113.4338	109.7657	1	0	0	1
AG	20	52.5765	112.1197	108.4739	1	0	0	1
AG	25	81.2352	125.072	121.2121	1	0	0	1
AG	30	235.4797	129.7165	133.0255	1	0	0	1
AG	35	396.2904	151.9349	155.5067	1	0	0	1
AG	40	432.0988	133.0745	136.3948	1	0	0	1
AG	45	394.4423	128.9449	125.0358	1	0	0	1
AG	50	375.338	56.4228	53.8582	1	0	0	1
AG	55	266.2426	34.2566	34.1284	1	0	0	1
AG	60	103.6569	30.0762	32.0047	1	0	0	1
AG	65	154.5392	101.1157	104.6326	1	0	0	1
AG	70	345.0859	129.9974	133.9842	1	0	0	1
AG	75	316.3685	101.0683	104.2924	1	0	0	1
AG	80	421.6305	88.7826	91.6339	1	0	0	1
AG	85	415.235	95.3516	98.2895	1	0	0	1
AG	90	370.0323	95.6632	98.6147	1	0	0	1
AG	95	301.2343	90.869	93.7549	1	0	0	1

Table 2. Input and Target Data for AG Fault with 20 Ω Fault Resistance with Various Fault Distances. (7,8)

XI. RESULT ANALYSIS

The trained ANN primarily based fault classifier modules were then extensively tested mistreatment freelance information sets consisting of fault situations never used previously in coaching. Fault type, fault location and fault time were modified to research the consequences of those factors on the performance of the planned formula. Table three offers some examples for the look at results. The left four columns area unit the specified outputs and the right four columns area unit the outputs of the ANNs.

Simulation results for fault kind classification shown in Table. 3. consistent with the simulation results, the Neural Network application for classification of faults is consistent. just in case of fault classification, ANN output shows same result as desired output.

SNO	Fault Resistance (ohm)	Fault Type	Fault Distance (%)	Desired Output				ANN Output			
				A	B	C	G	A	B	C	G
1	2	AG	5	1	0	0	1	1	0	0	1
2	5	BG	10	0	1	0	1	0	1	0	1
3	10	CG	15	0	0	1	1	0	0	1	1
4	20	ABG	20	1	1	0	1	1	1	0	1
5	2	BCG	25	0	1	1	1	0	1	1	1
6	5	ACG	30	1	0	1	1	1	0	1	1
7	10	AB	35	1	1	0	0	1	1	0	0
8	20	BC	40	0	1	1	0	0	1	1	0
9	2	AC	50	1	0	1	0	1	0	1	0
10	5	ABC	90	1	1	1	0	1	1	1	0

Table 3. Desired Outputs and Actual Outputs of the ANN.

XII. CONCLUSION

During this paper we've considered the applying of counterfeit neural systems for the identification and arrangement of deficiencies on a three area transmission lines framework. the technique created uses the three area voltages and three segment flows as contributions to the neural systems. The sources of info were standardized with association their pre-issue esteems severally blame. All the substitute neural systems examined here received the back-spread neural depiction. The reproduction results acquired demonstrate that the agreeable presentation has been accomplished by all the arranged neural systems and unit rich implementable. The significance of choosing the premier adequate ANN design, so on prompt the least difficult presentation from the system, has been worried upon all through this work. Some important ends which can be drawn from the investigation unit

1. Fake neural systems unit a dependable partner degreed compelling philosophy for Associate in Nursing electric power lattice link flaw characterization and identification strikingly observe prepared of the expanding dynamic property of the elegant power transmission frameworks.
2. The exhibition of a fake neural system ought to be constrained to be investigated appropriately and explicit neural system structure and learning equation before choosing it for a usage.
3. Back proliferation neural systems convey savvy execution, after they unit prepared with gigantic work data set, that is well available in power frameworks at that point back spread systems are picked for arranged approach. The extent of ANN is wide enough and should generally be investigated many. The flaw recognition and characterization is made wise normally by creating relevant savvy procedures. may this may} be accomplished on the off chance that we've the PCs that could deal with mass of learning and set aside least effort for counts

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