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Fault Identification in Power System Network by using Rule based Fuzzy Logic

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Abstract: In this paper, the fuzzy logic is employed to Fault Identification in grid Network by Using Rule-based fuzzy-logic. The reliability of power supply is mostly full of the occurrence of faults within the power system network. Recent advances within the field of fuzzy logic systems and variety of successful applications in electric power (wattage) systems show that logic is efficiently applied to house imprecision, ambiguity and probabilistic information in the input file to scale back the time of power outages and for the immediate restoration, the fault identification method must be very effective. In case of a fault, the system operator gets very difficult information to choose on restoring the tripped feeder in normal operation. Therefore, in order to effectively build the ability to make decisions, a fuzzy logic-based fault diagnosis method has been introduced in this research. This method can identify the types of faults that occur in the radial-topology of the power system network. In that method, three-phase feeder current, phase voltage, and neutral current are used as fuzzy-inference system (FIS) input.
Keywords: Distribution system network, fault diagnosis, and Rule based fuzzy logic.

I. INTRODUCTION

Nowadays, the substantive increase in complexity and variety of the consuming market, the electrical power grid has been demanding considerable updating and also a big improvement within the monitoring, control, and protection equipment. On the distribution system, faulty space is usually estimated based on the knowledge provided by the customer and also the accumulated experience in the technical field, which helps guide the support team in suspicious places. The faults of the facility system affect the general performance of the facility system. The factor like lightning, equipment damage, tree, animal, natural disaster, and human affect the facility system operation. These factors aren't predictable. When outages occur, fast and proper restoration of the feeder is vital to take care of the great power quality and customer satisfaction. Hence, to scale back the time of outages and immediate restoration, the expert systems are needed to spot the faults of the facility system.

Failure of insulation of distribution system, bridging of excited phase conductors by objects, accident e.t.c. These events affect the voltage and current value of the distribution system and sometimes the entire power system. Given the fact that bulk distribution systems are overhead and have radial topologies, the need for accurate and reliable fault detection systems becomes much easier. In recent times, researchers have become more interested in finding solutions to ambiguities, incomplete fault information, errors in fault data, and knowledge redundancies [1].

Faults are usually taken care of by the interconnection of protection devices like relays, Current transformers, Voltage Transformers, Circuit Breakers, and fuses that detect the fault and eventually isolate the affected sections from the whole power grid. Faults are often of varied types and their detection and clearing approach may differ [2].

Voltage & current sensors have installed on the transmission line for real-time implementation and their cost is high. Matlab 7.5 for finding and analyzing defects in facility distribution network. The software has developed an Artificial neural network (ANN) based program, designed to detect defects [3]. Power grids round the globe are undergoing a huge transformation towards smart power grids with the assistance of rapidly developing monitoring and control methodology. Among these detecting, the fault and therefore the phase which underwent the fault is of great importance. Classification of the fault has the world of interest for varied researchers and as an outcome; several fault classification methods are implemented over time. a number of the prominent methods are Neural network-based technique, wavelet transforms based technique, fuzzy and fuzzy-network based technique, etc[4].

it's generally independent of protective relaying. Protecting assets through short-term generation of visit signals is not the key to reducing the workload of a missed department as quickly as possible. The goal is to provide information to the grid operator about errors prior to on-site inspections. Transmission lines are most susceptible to the occurrence of the fault. Fault detection, direction estimation, and faulty phase selection play a critical role within the protection of a cable. Accurate and fast fault detection and classification under a spread of fault conditions are important requirements of any protective relaying scheme [5].

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A. Objective

The objective of this project is

1) Determine what's the possible fault will occur in Power Distribution System
2) Find accurate and efficient thanks to analyzing the facility Distribution System when the fault is happening.
3) Develop a standalone program to exchange the human manual calculation to do the fault analysis in order that the fault diagnosis is simpler.

II. POWER DISTRIBUTION SYSTEM FAULT

Most of the faults on the power system lead to a short-circuit condition. When this condition occurs, a heavy current will flow through the equipment. This will cause the equipment damage and interruption of the supply electricity. The fault occurs in power system basically are divided to two types i.e. Symmetrical Fault and Unsymmetrical Fault. The great majority of faults on power system are of unsymmetrical nature and the most common type being is a short -circuit from single line- to-ground (S-L-G).

A. Symmetrical Fault

That fault on the power system which gives rise to symmetrical fault currents (equal fault currents in the lines with 120° displacement) is called a Symmetrical Fault as shown in Figure 2.1 The symmetrical fault occurs when three phase-line are link together simultaneously into a short-circuit condition. The current in each line will be equal in magnitude with 120° displacement among them. The following points may be particularly noted :

1) The symmetrical fault rarely occurs in practice.
2) Only one phase be consider in calculation because of balanced nature of fault other two phases will be similar.
3) The symmetrical fault is the most severe and imposes more heavy duty on circuit breaker

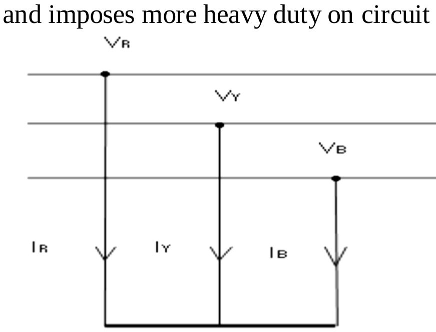

Figure:2.1 Symmetrical Fault

B. Unsymmetrical Fault

Those faults on power system which give rise to unsymmetrical fault currents (unequal fault currents in the line with unequal phase displacement) are known as Unsymmetrical Fault as shown in Figure 2.2. On the occurrence of unsymmetrical fault, the currents and the phase displacement in the three phase line are unequal among each other. However the system impedance and the source voltage are always symmetrical. There are three types of unsymmetrical faults may occur in power system :

1) Single line-to-ground fault (L-G)
2) Line –to-line fault (L-L)
3) Double line-to-ground fault (L-L-G)

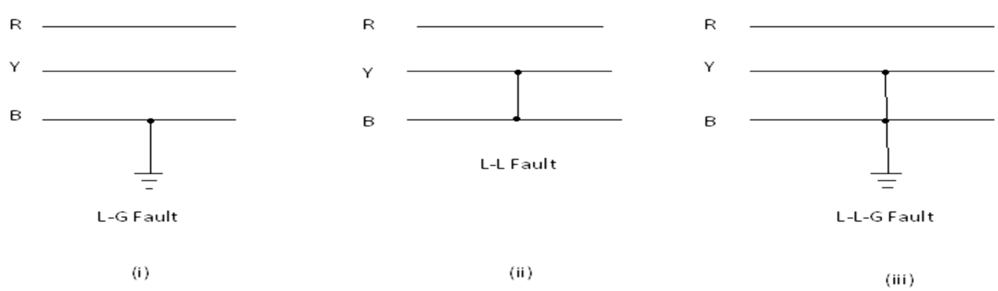

Figure 2.2: Unsymmetrical Fault

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III.FAULT IDENTIFICATION USING FUZZY LOGIC SYSTEM

In recent times, researchers are more interested in finding solutions to the problem of vagueness, incomplete fault information, error in fault data and information redundancy. "The use of fuzzy logic enables the fault detection system to cope with uncertainties that occur during the location of fault in electrical distribution networks". In, the proposed fault detection technique used fuzzy logic-based algorithm to identify ten types of shunt faults in radial, unbalanced distribution system.

A. Membership Functions

Membership Functions Different levels of the fault currents and voltages for various fault conditions on the distribution lines are classified into different degrees of membership functions- Low, Normal, and High

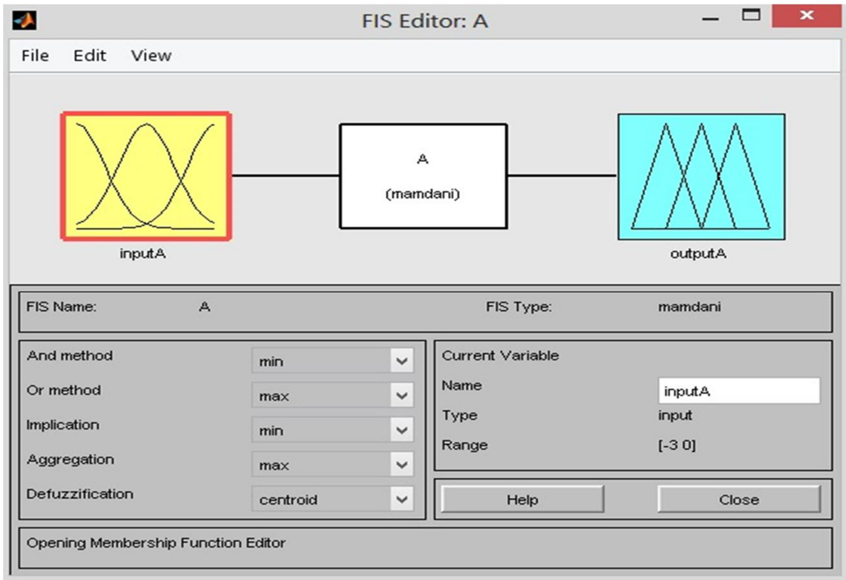

Figure 3.1 Input Output for the FIS

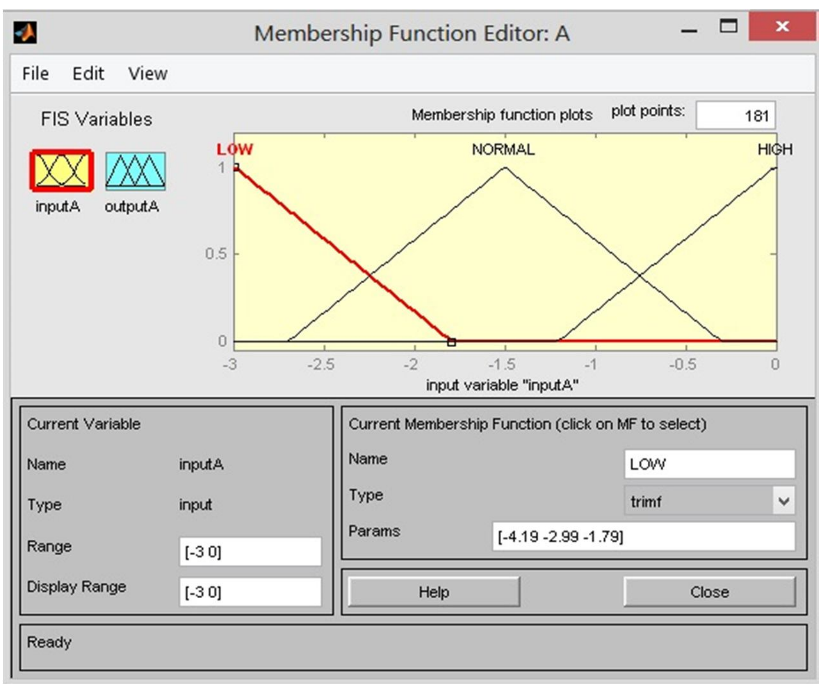

Figure 3.2 Input MF for the Line currents and voltages for the FIS

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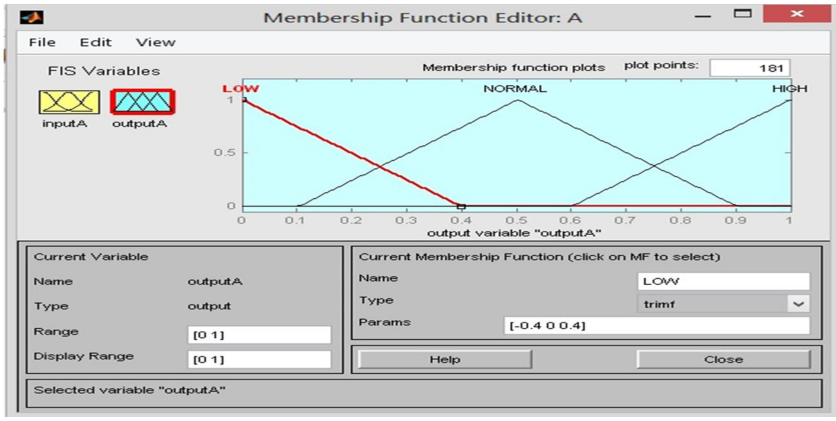

Figure 3.4 Output membership functions for the FIS

These membership functions are used in forming the rule base for the fuzzy logic fault detection system. Below shows the rule base formulation for the fuzzy based fault detection system.

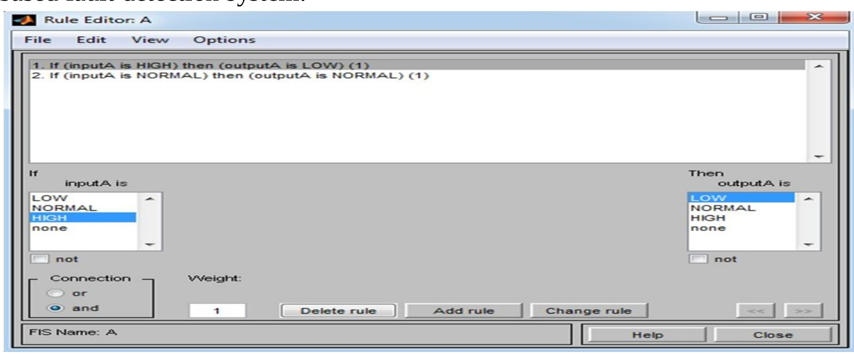

Figure 3.5 Rule table for fuzzy controller

IV. SIMULATION MODEL

The system model was performed using the Matlab/Simulink software version 7.7. Simulink is an environment for multi domain simulation and model-based design for dynamic and embedded systems. It provides an interactive graphical environment and a customizable set of block libraries that let you design, simulate, implement and test a variety of time-varying systems including power, communications, controls, signal processing, etc. The simulations for the various types of faults were carried performed and the various values for both faulted and non-faulted current were taken and recorded. The following blocks were used in building the logical model for fault detection.

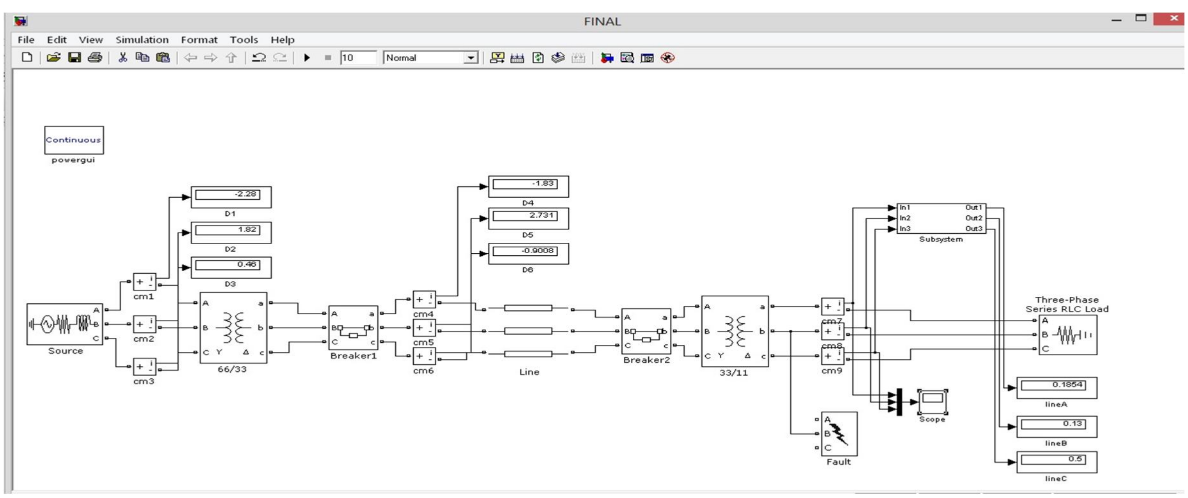

Figure 4.1 Logical model for the simulation

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In the transformer block, we specify the required parameters of the two winding transformer. This block represents a real step down transformer on the distribution network. The values are set to the per unit system

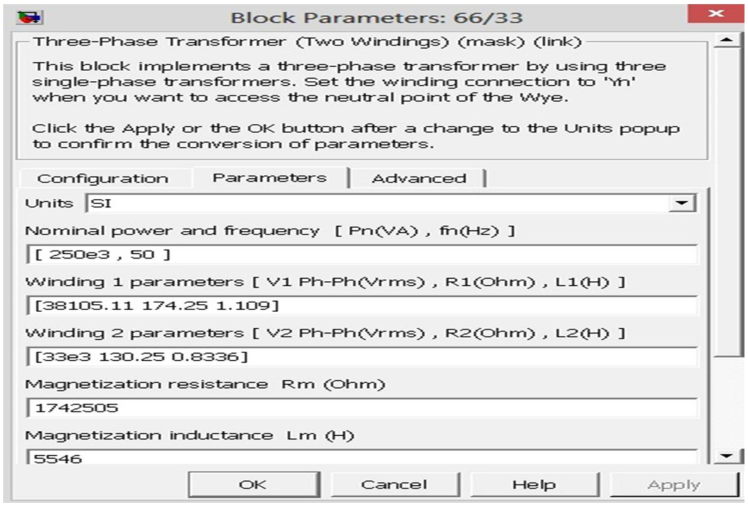

Figure 4.2 The Transformer 66/33 kv Parameter

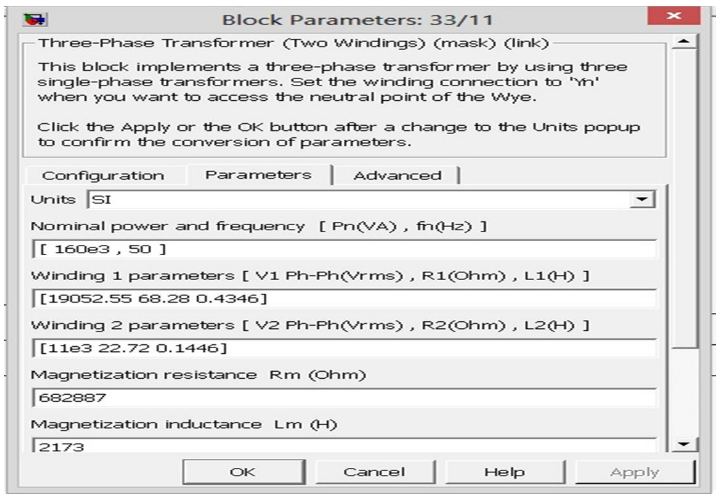

Figure 4.3 The Transformer 33/11 kv Parameter

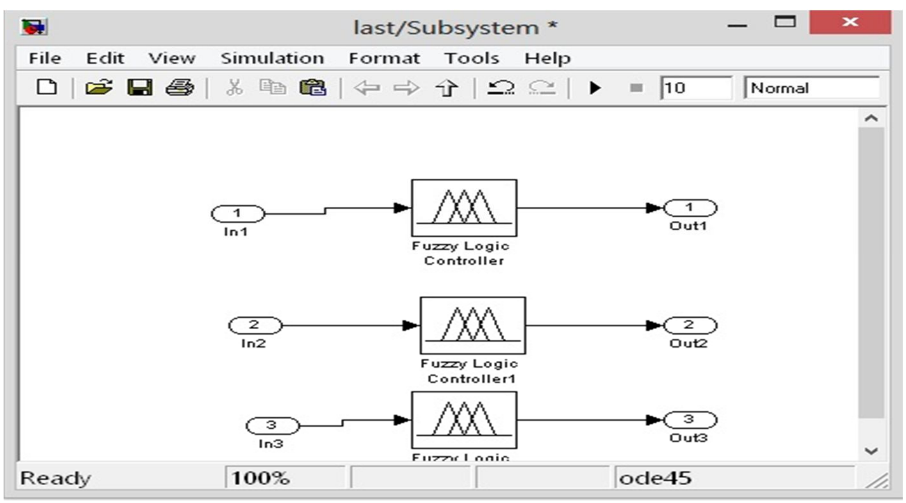

Figure 4.4 Fuzzy Fault detection block (Subsystem)

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The fuzzy fault system block in the figure above, houses the simulation of the fuzzy logic fault detection system.

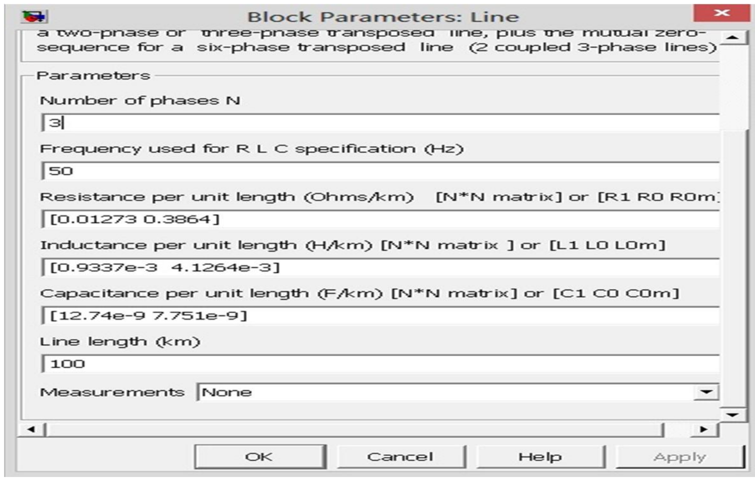

Figure 4.5 The line Parameters

Figure 4.5 implements a three phase Line for the distribution system.

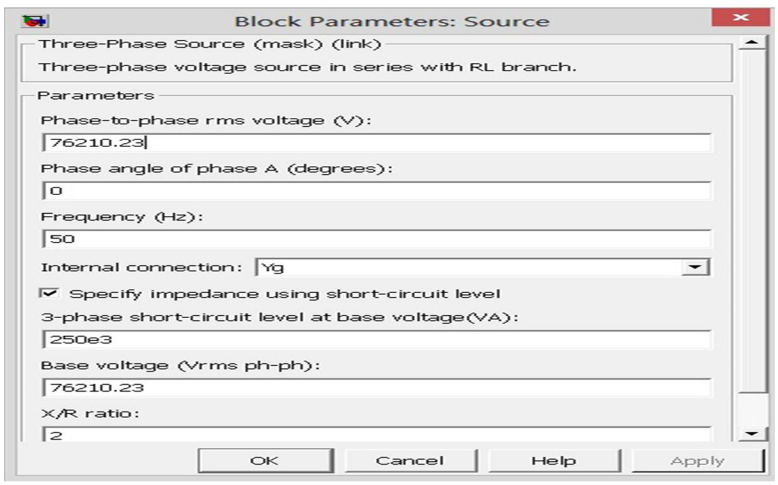

Figure 4.6 Three phase Source block

Figure 4.6 implements a three phase source for the distribution system.

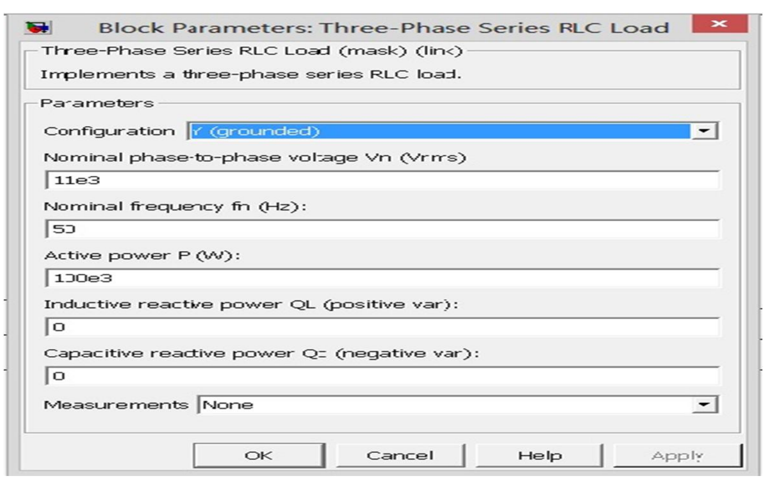

Figure 4.7 Three phase load block

Figure 4.7 implements a three phase Load for the distribution system.

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V. SIMULATION RESULTS

TABLE 1 FAULT CURRENT AT VARIOUS FAULT

SR.NO	TYPE OF FAULT	CURRENT LINE A	CURRENT LINE B	CURRENT LINE C
1	NO FAULT	1.842	0.8848	2.2956
2	Line A-G	-0.000005255	0.8848	2.295
3	Line B-G	1.842	0.000001976	-3.08
4	Line C-G	2.992	1.385	-0.0000072
5	Line AB	-0.808	-0.808	1.617
6	Line BC	0.5225	-0.2611	-0.2611
7	Line CA	0.1277	-0.2556	0.1277
8	Line AB-G	-0.000004869	-0.00000364	3.432
9	Line BC-g	0.7436	0.00000162	-0.00000348
10	Line AC-G	-0.000004255	2.89	-0.0000029
11	Line ABC	0.000001738	0.00000178	-0.0000035

TABLE 2 OUTPUT CRISP VALUES FROM THE FUZZY FAULT DETECTION SYSTEM

SR.NO	TYPE OF FAULT	CURRENT LINE A	CURRENT LINE B	CURRENT LINE C
1	NO FAULT	0.4026	0.366	0.4236
2	Line A-G	0.13	0.5	0.5
3	Line B-G	0.502	0.13	0.523
4	Line C-G	0.504	0.502	0.13
5	Line AB	0.1449	0.1449	0.4532
6	Line BC	0.4237	0.1449	0.1449
7	Line CA	0.1449	0.4230	0.1449
8	Line AB-G	0.13	0.13	0.5027
9	Line BC-g	0.5027	0.13	0.13
10	Line AC-G	0.13	0.5027	0.13
11	Line ABC	0.13	0.13	0.13

Here fault can be identify by the crisp output value such as given by the above table

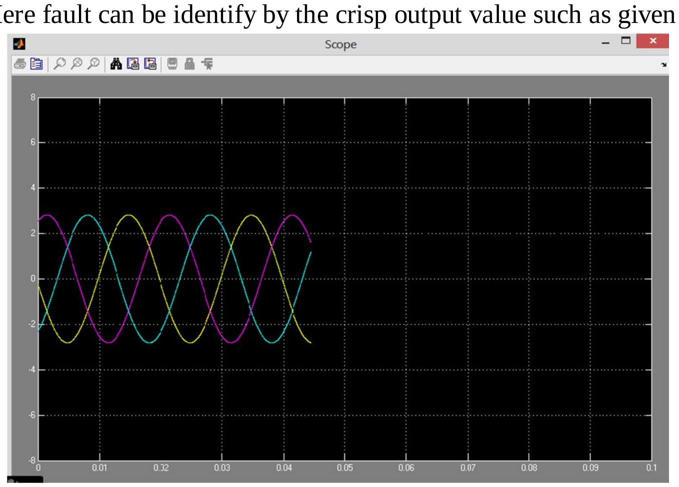

Figure 5.1 No Fault

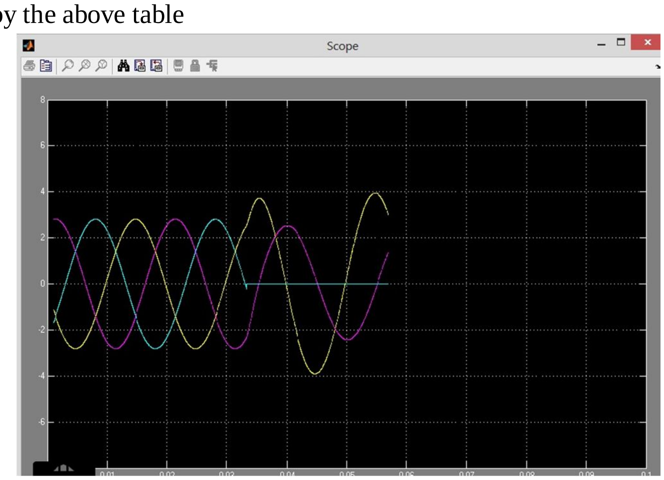

Figure 5.2 Single line- ground fault (A-G)

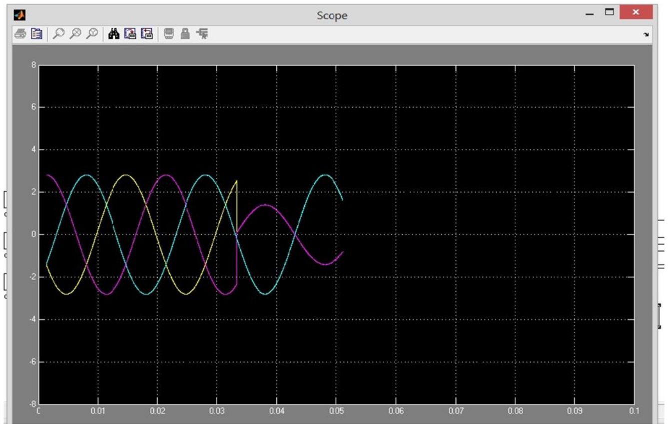

Figure 5.3 Double line- fault (A-B)

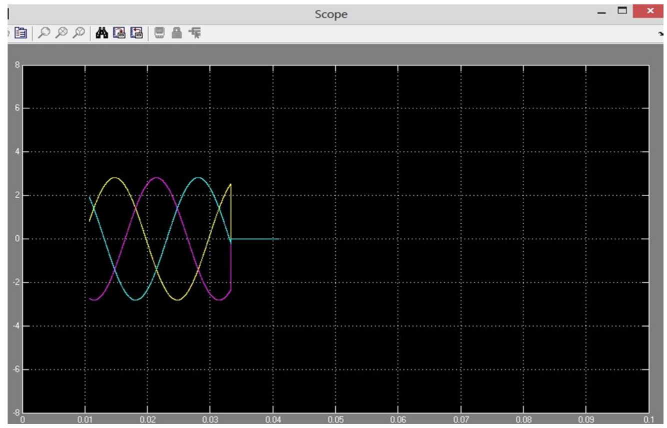

Figure 5.4 Three line- fault (ABC)

VI. CONCLUSION

In this proposed research work, the fuzzy logic-based is extremely suitable for the identification and classification of the fault within the facility network. The proposed technique required considering the post fault voltage and current of all three-phase at one end of the transmission. This can be because of the probabilistic approach within the sort of fuzzy rule the identification of the fault and direction is predicated on a comparison of the credibility of every fault specific rule composition. Also, this approach can take any available and calculated input value into consideration and their accuracy is regulated by an appropriated membership function.

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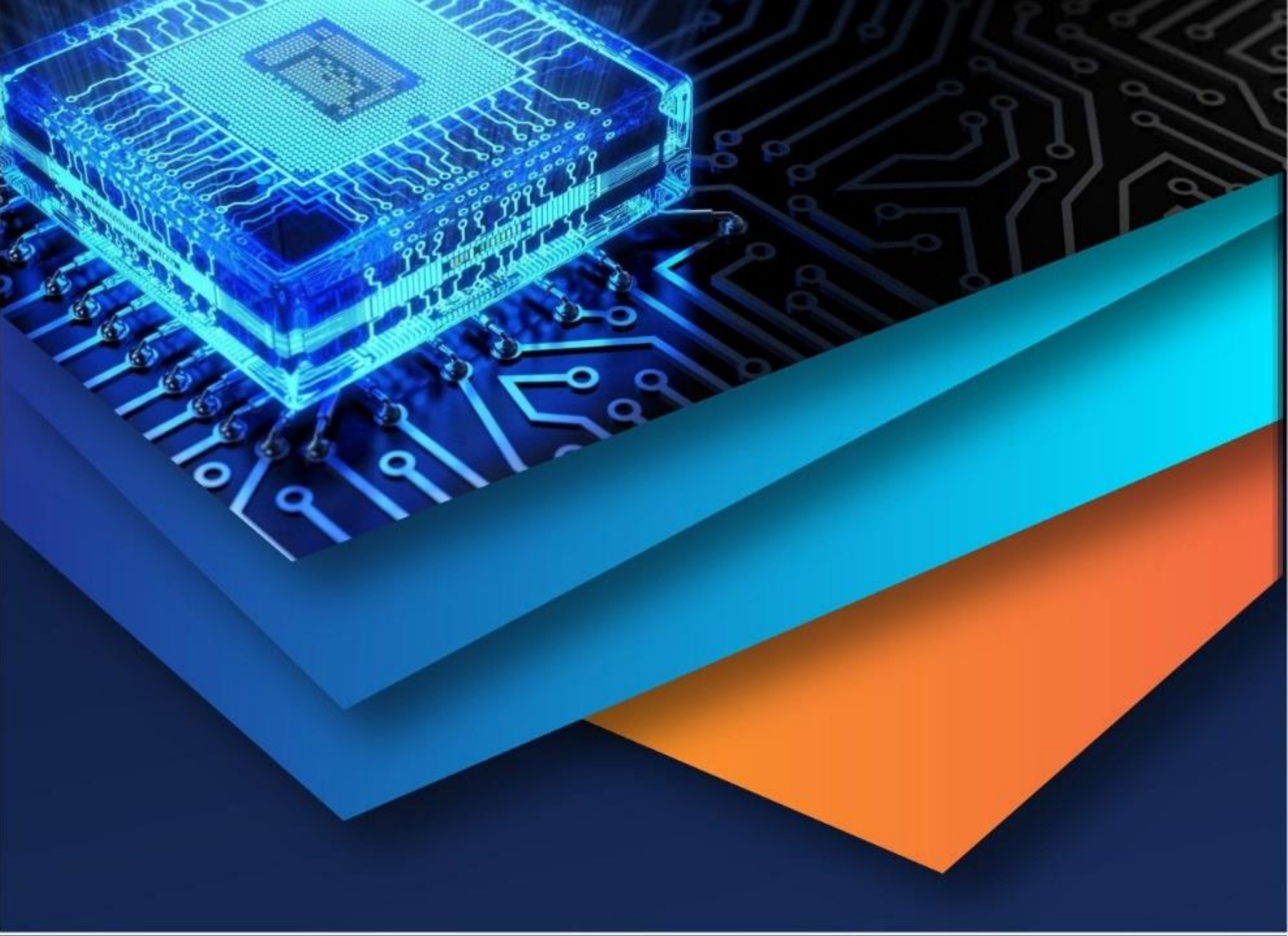

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