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FAULT DETECTION ON RADIAL POWER DISTRIBUTION SYSTEMS USING FUZZY LOGIC.

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ABSTRACT

In this paper a best method of fault locating in a radial power distribution system is discussed. The history associated with fault occurred in power system can be effectively used as a strong database. This database will act as the trainer to the fuzzy expert system. In this paper methodology based on fuzzy expert system is discussed for assistance to the operators for easy fault detection.Electric power distribution systems are expected to function at all times, even under fault conditions. However, when they operate under fault conditions, the system operator receives information which makes it very difficult to make decisions on whether to restore a tripped feeder to normal operation. To cope with this uncertainty in decision making, a fault diagnosis method based on fuzzy logic is proposed. The proposed method aims to ease the burden of decision making on the part of the system operator by presenting a fast and accurate fault diagnosis method to classify and identify the type of fault which occurs on an overhead radial power distribution network.

Keywords: Radial distribution system, fault diagnosis, and fuzzy logic.Fuzzy System, Distribution System, Fault Identification, Trained System.

I. INTRODUCTION

The Distribution of power is one of the important aspects in Power System when it comes to customer's satisfaction. Keeping in view of this power distribution reliability becomes a very important topic to be looked upon in the power system industry. When customer's satisfaction is talked about the basic need for the consumer is continuity of power. Power quality is the desirable trait looked by the consumer. Faults in a complex power system poses challenge to maintain power quality. Faults can only be minimized it cannot be entirely eliminated from the system. To achieve continuity in power supply we can definitely control fault rectification time. Fault clearance time can be minimized once we detect the faulty section quickly. Questions have always been raised on reliability of power distribution, which directly affect the service restoration cost when a fault occurs. In other words power distribution reliability can be mentioned as minimum service restoration time cost.

The distribution system is a very important component of an electric power system which also consists of the generation and transmission systems. "The subject of fault location has been of considerable interest to electric power utility engineers and researchers for over twenty years"

[1] .Fault occurs due to failure of insulation of the distribution system, bridging of energized phase conductors by objects, accidents e.t.c. These events affect the value of the voltage and current on the distribution system and sometimes the entire power system. Considering the fact that most distribution systems are run overhead and have a radial topology, the need for accurate and reliable fault detection system becomes expedient. 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 [2]. "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" [3]. In [4],

the proposed fault detection technique used fuzzy logic-based algorithm to identify ten types of shunt faults in radial, unbalanced distribution system.

The parameters used include fault resistance, fault inception angle, system topology and loading levels.

A hybrid approach of neuro-fuzzy based learning and fault classification approach based on the online learning system was proposed in [5]. In this work, a method of fault location based on the conventional offline neuro controller approach is compared with the suggested hybrid approach for learning and convergent time evaluation for distributed systems.

[6] presents an intelligent fault location and diagnosis system. This system performs fault type identification using a two-step procedure. The first step identifies candidate fault location using an iterative calculation of the load current and the fault current. The second step diagnosed the actual location of the fault by comparing the current waveform pattern with the expected operation of the protective devices and comparing the interrupted load with the real load. They performed various simulations to obtain a satisfactory result.

[7], presents a method for fault diagnosis based on a hierarchy of five agents that cooperate with each other to diagnose a fault.

In [8], an extended impedance-based fault-location formulation for generalized distribution systems was proposed. This method uses only local voltages and currents as input data. The formulation considers load variation effects and different fault types.

II. PROBLEM DEFINATION

The complexity of today"s power system has grown enormously and to have efficient operation of power transmission and distribution network Supervisory Control and data acquisition systems (SCADA) are in use. SCADA is being though widely used in power system but its accuracy has always been a question mark.

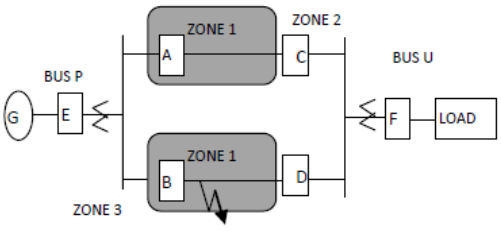

Figure-1 Three step Zone

In the example in Figure 1, zone-one trips for faults from breaker A to 80 percent of the line length toward breaker C. Zone two operates for faults beyond bus U including some percentage of the transmission line between breakers D and B and the transformer supplying the load at bus U. Zone three looks backward toward

the source and covers the step-up transformer, plus a percentage of the transmission line between breaker B and D.

III. FUZZY LOGIC

To successfully design a fault detection system using fuzzy logic, an understanding of the basic components of a fuzzy decision system is important. These include fuzzy logic concepts such as fuzzy sets and their properties, fuzzy rule base, and fuzzy inference system.

The Algorithm for the Design of the Fuzzy Inference System It includes the following:

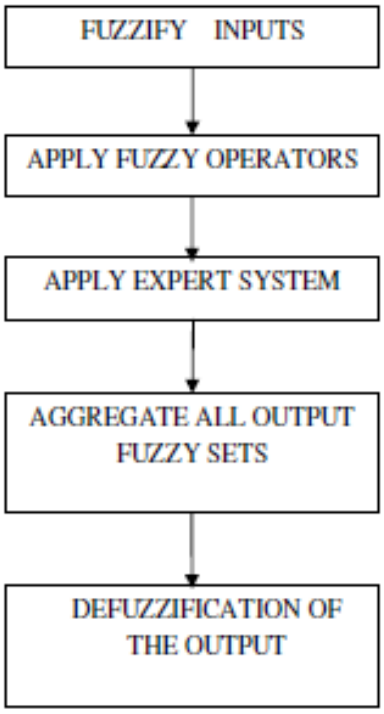

Figure 2.Algorithm for the Fuzzy Inference System

IV. PROPOSED METHODOLOGY

This method of fault detection applies the three phase (A, B, and C) feeder currents and phase voltages as the inputs to the fuzzy inference system (FIS).

4.1 Membership Functions

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

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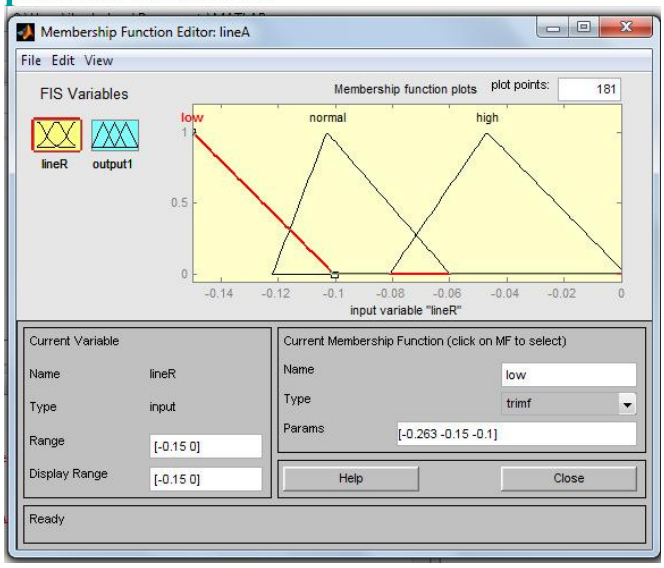

Figure 2. Input Membership Function for the Line Currents and Voltages for the FIS

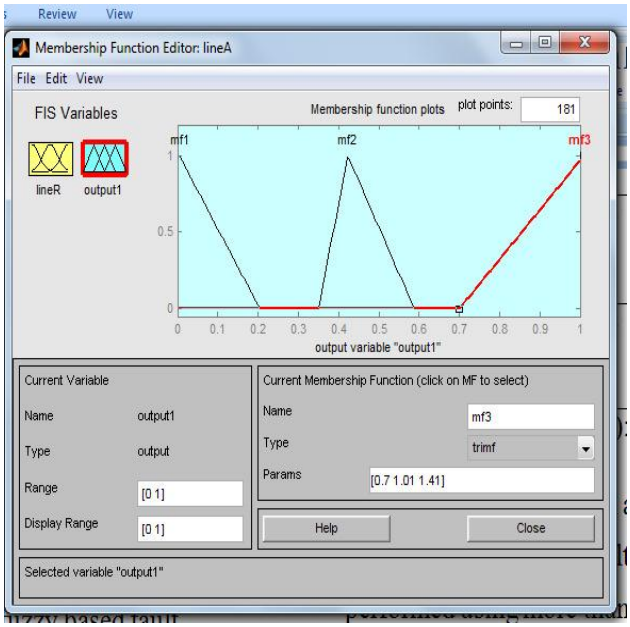

Figure 3.Output Membership Functions for the FIS

V. SIMULATION

5.1 Line Model for the Simulation

The relatively short lengths of the medium voltage (MV) and low voltage (LV) distribution circuits enable simple modeling techniques to be used for lines. The radial network configuration is used to make to simplify the network model, hence large matrix model are seldom necessary.

It is usually sufficient to represent a distribution circuit by a series impedance and ignore its apacitance, except when carrying out voltage calculations on a long cable for example, when aor T equivalent circuit with capacitance shunt branches should be used. Figure 4 represents a line model for power distribution systems.

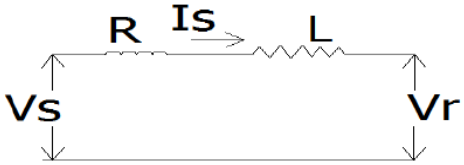

Figure 4. Radial distribution line model

Where,

Vs = the sending end voltage.

Vr = the receiving end current,

R = line resistance, and

L = line inductance

5.2 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 [14]. It provides an interactive graphical environment and a customizable set ofblock libraries that let you design, simulate, implement and test a variety of time-varying systems including power, communications, controls, signal processing, e.t.c.

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.

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.

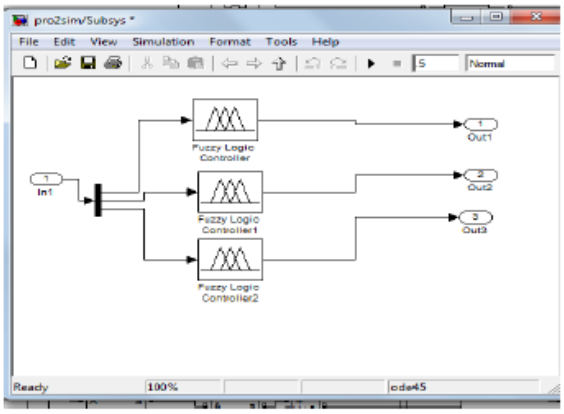

Figure 6(b). Fuzzy Fault Detection Block (Subsystem)

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

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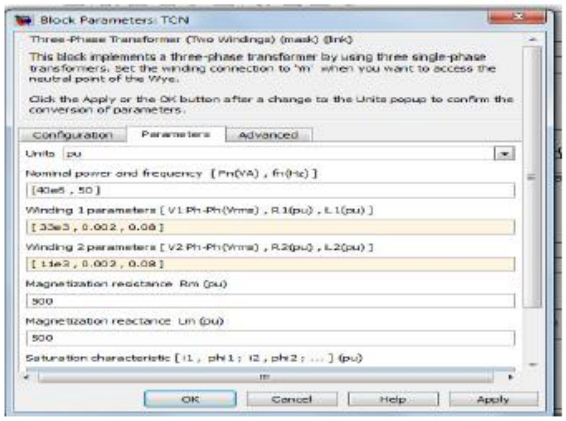

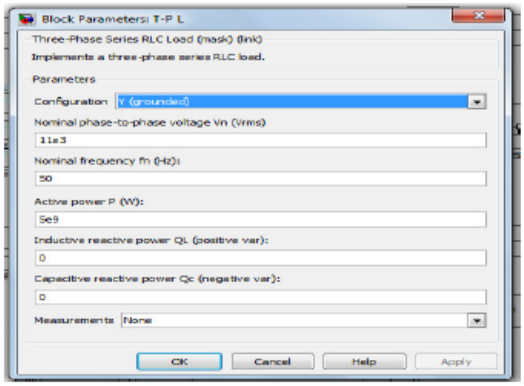

Figure6(c). Three Phase Block **Figure 6(d) Three Phase Load Block**

The three phase load block implements a three phase load, which is either purely resistive or inductive. Other blocks such as the display block, scope, circuit breakers and measurement blocks were also used in building the logical model for simulation [14].

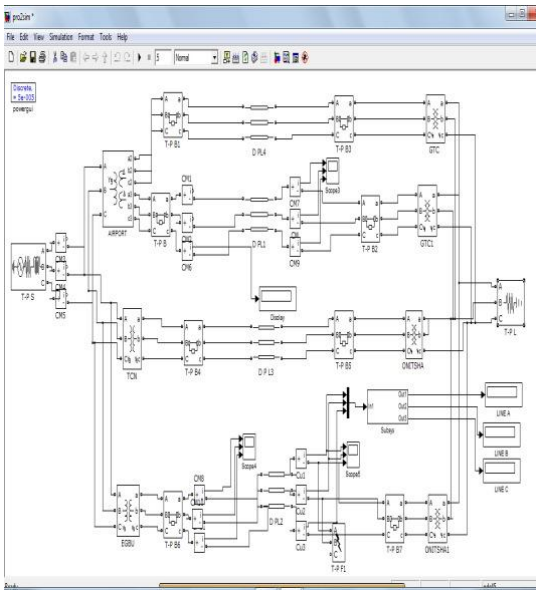

Figure 6(e) Logical Model for the Simulation

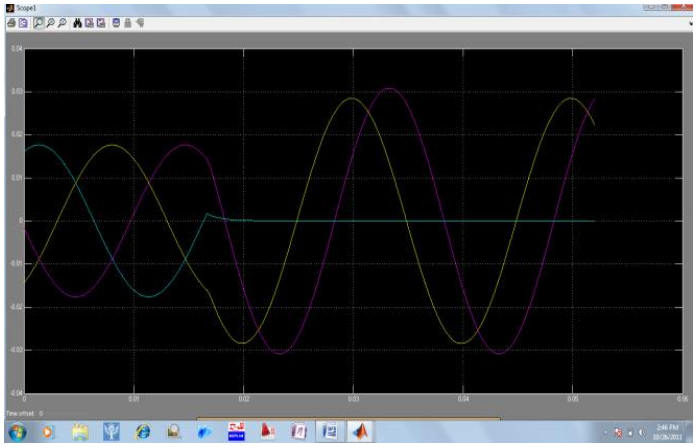

Figure 7(a). Single Line- Ground Fault (C-G)

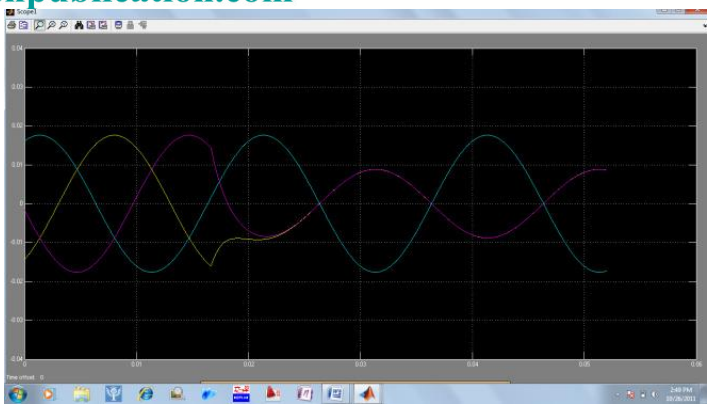

Figure 7(b). Double Line- Fault (A-B)

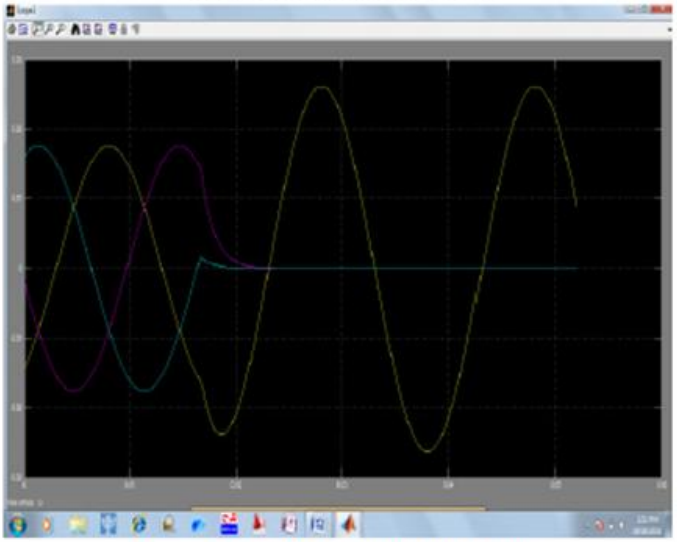

Figure 7(c). Double line -ground fault (AB-G)

VI. CONCLUSION

A fault detection system based on fuzzy logic has been designed in this work. This design wastested on a real radial power distribution network using real data and Matlab/Simulinksoftware.It was able to detect single line to ground fault, phase to phase fault, double line to ground fault,and three phase fault. It has been shown that faults could occur in radial distribution systemswith all possible combinations; hence the importance of the fuzzy membership functions incapturing the various combinations. The simplicity of this design based on fuzzy logic, means adrastic reduction in load loss and energy loss on distribution systems due to prolonged outagesleading to longer feeder downtime during faulted conditions.

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