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INTELLIGENT AGENT BASED LONG DISTANCE TRANSMISSION LINE PROTECTION SCHEME FOR 300KV LINE IN NIGERIA

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Abstract

Most often circuit breakers which to relaying logic to protect transmission lines, trip falsely. Part of the problem may be due to incorrect relay operation sometimes associated with conventional classical-logic based protection schemes. In this paper an intelligence based protection scheme on fuzzy logic been develop. This approach is motivated by the fact that input impedance to which distance relays respond may not always be very clear and distinct. The technique cases the line operational data, fault impedance and experiences of the line operators to formulate fuzzy rules, which are their formulated, using logic toolbox in MATLAB. The proposed fuzzy set approach is well suited for the development of a strategy for tripping the breaker correctly, in an event a fault occurs.

Keywords: Intelligent Agent, Transmission Line, Fault Dictation, Fuzzy-Logic, Power System.

Introduction

"Everything is vague to a degree, you do not realize, till you have tried to make it precise". Kishan, K et al, (1992). The reliable operation of large power systems with small stability margin is highly dependent on control systems and protection devices. In the past several decades, there has been a rapid growth in the power system all over the world. This as a matter of fact led to the installation of huge number of new transmission and distribution lines. More so, the introduction of new marketing concepts such as deregulation and the ongoing privatization has increased the need for reliable and uninterrupted power supply to the end users who are very sensitive to power outages. Das R, Novosel D, (2000). One of the most important factors that hinder the continuous supply of electricity and power is a fault in the power system. IEE Power Engr. Society, (2005). Any abnormal flow of current in a power system's components is called a fault. These faults cannot be completely avoided since a portion of these faults also occur due to natural reasons which are far beyond the control of mankind. Stevenson, (1982). Hence, it is very important to have a well co-ordinated protection system that detects any kind of abnormal flow of current in the power system, identifies the type of fault and then accurately locates the position of the fault in the power. The faults are usually taken care of by devices that detect occurrence of a fault and eventually isolate the faulty section from the rest of the power system.

The application of microprocessor based (numeric) relaying protection has improved performance over the years. However, even these benefits have not led to a major impact on speed, sensitivity and selectivity of primary protective relays, and the gains are only marginal. These gains can be improved if the decision making is based on elements of Artificial Intelligence (AI). Kaehler S.D, (2005). Since the last two decades, much of the efforts in power system analysis (control and protection) have turned away from the methodology of formal mathematical modeling to the less rigorous techniques of Artificial Intelligence (AI). Agarwal et al, (1995). Intelligent based methods are being used in the process of fault detection and location. Three major artificial intelligence based techniques that have been widely used in the power and automation industries are sector includes:

- Expert system techniques (XPSs)
- Artificial Neural Networks (ANNs)
- Fuzzy Logic System (FLS)

Among these available techniques, focus is on the application of Fuzzy logic system (FLS) and it has been used extensively in this research work for fault location of distance transmission line (Onitsha/Enugu 330K line). This linguistic input can be expressed direct by fuzzy system. Therefore, the natural format greatly eases the interface between the knowledge engineer and the domain expert. Thus, a fuzzy system can represent knowledge in which an expert system may have difficulty (or need a large set of rulers). Fuzzy and expert systems differ in one critical respect

Song and Johns, (1997). Fuzzy systems allow the representation of imprecise human knowledge in a natural, logical way rather than forcing the use of precise statements, then softening them with confidence values as in expert systems. Fuzzy systems allow the approximate terms that are nearly always employed by humans to express their judgments, thereby permitting more accurate knowledge representations. Thus, fuzzy systems are more robust, more compact and simpler.

Fuzzy Logic Fault Classification Scheme For Distance Protection

In the foregoing presentation Alessandro et al, (1995), the researchers only identified the nature of fault (whether line-to-ground (LG) or LLG), along with the credibility factor (CF); but the phases involved in the fault were not explicitly determined. Also no line-to-line (LL) fault has been considered. To address the above limitation, Biswarup and Vital, (2005) in their paper, proposed an improved fuzzy logic based fault classification scheme, which is able to determine accurately, all ten types of possible short-circuit faults (for instance, a-g, b-g, c-g, a-b, b-c, c-a, a –b-g, b-c-g, c-a-g, a-b-c/a-b-c-g). Where a, b, c, and g are the phases and ground respectively. The fault classification algorithm is based on the angular differences among the sequence components of the fundamental during fault current as well as on their relative magnitude Biswarup and Vittal, (2005). In this scheme, a fuzzy rule base was developed based on the fuzzification for live inputs to identify the fault type. The five inputs used include; faults angle-Ang A, Ang B, Ang C, negative and zero sequence fault resistance R2f and Rof, which are calculated from the sampled values of the fault currents of phases a, b, and c. The simulation was carried out using the fuzzy-tool box in MATLAB. The results obtained showed that the proposed method is able to identify all ten types of short-circuit faults accurately, within 10ms (for a 50Hz system), with accuracy of 97%. And it is quite effective over a wide range of a pre-fault power level, fault resistance, and fault inception angle.

Hardware And Software Method

A fuzzy consist of mainly three parts namely, a fuzzification of the input signals, an interencing mechanism and a defuzzication process and hardware combination available for implementation. A typical example is the TMS20C30 Digital signal processor (DSP) chip from Texas Instruments, with powerful instrument set Kishan et al (1992) which can be installed in a computer to realize the objective of the fuzzy controller. The fuzzy controller can also be realized with some software packages like, C language and MAT LAB fuzzy logic toolbox etc. In this work, the software implementation using Matlab fuzzy logic toolbox is applied for the simulation.

Fuzzy Logic Based Distance Protection Solution Procedure

Below is a series of steps showing the solution procedure followed in designing our scheme?
Step 1: Choose appropriate input variables: Impedance Z in this case.
Step II: Convert the input variables to fuzzy sets (Fuzzification).
Step III: Determine the fuzzy matrix (knowledge base) and draw the membership functions (for our design, MATLAB code are used).
Step IV: Design the fuzzy inference – decision making (Rule base) and simulate with appropriate program (like MATLAB).
Step V: Devise an appropriate transformation of fuzzy trip actions into crisp trip actions (defuzzification).

Parameters of the Transmission Line

An electric transmission line has four parameters, which affects its ability to fulfill its function as part of a power system. These include resistance (R), inductance (L), capacitance (C) and conductance (G). The first three parameters have serious influence on performance of transmission lines. Conductance accounts for the leakage current at the insulators of overhead lines which is negligible compared to the line current, hence (G) is assumed to be zero.

The Enugu/Onitsha 330KV Line Parameters

Voltage Rating	-	330KV
Current rating	-	1360A
Line Length	-	96KM (Long Line)
Surge Impedance	-	300Ω

Positive sequence impedance: $Z_1 = R_1 + jX1 = 0.00377300275 + j0.026377$
=> $Z1 = 0.02665\Omega/km$
Zero sequence impedance $Z_0 = R_0 + jX_0$

The value Z_x = 0.533 represents the normal value of impedance setting of relay used for our design. Figure 1 shows the flow chart for the fuzzy logic scheme used in this research work.

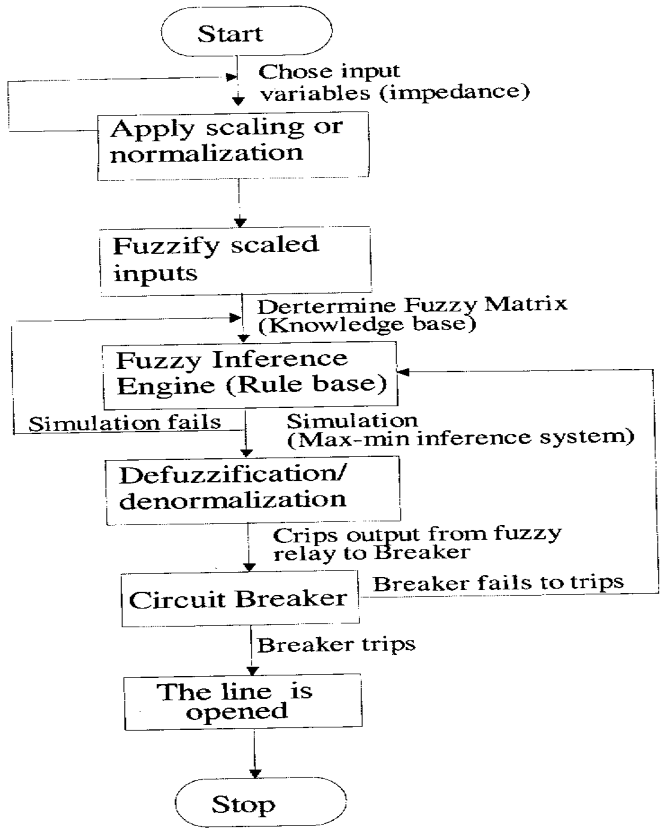

Figure 3.1: Flow Chart for the Fuzzy Logic Scheme

Observations/Results

Z \ B	AT	PT	PN	NT	AN
VS	10	0	0	0	0
SV	0	30	0	0	0
NV	0	0	50	0	0
LV	0	0	0	70	0
VL	0	0	0	0	9090

Table 4.1: Fuzzy rule matrix for inputs/output fuzzy sets

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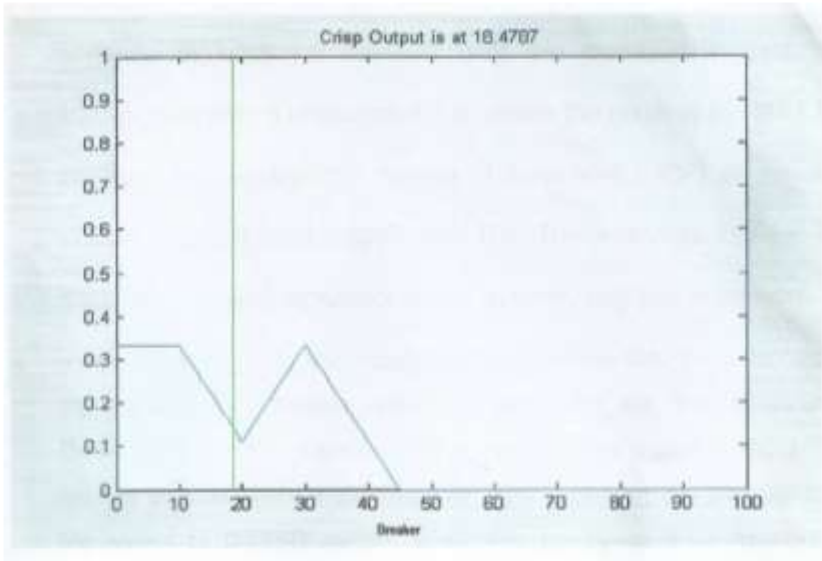

Figure 4. 2: Result of a Defuzzified Output to breaker

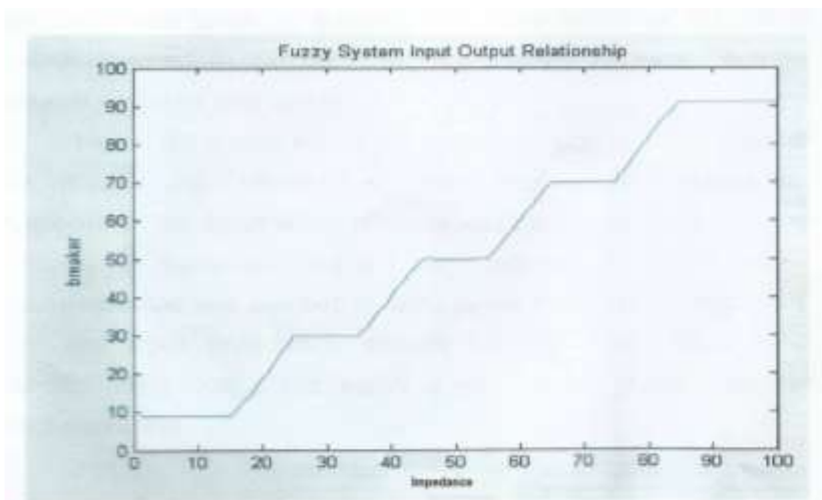

Figure 4.3: Input/output relationship of the fuzzy system

From Figure 4.2, the results obtained show that the crisp output trip signal to the beaker when the five rules are fired is given by B=18.4787%. This translates to approximately equal 0.185Ω. This means that for input impedance of 20% (used for the simulation), a trip signal of 0.185Ω would be sent to the breaker for appropriate operation. This represents the impedance seen by the fuzzy relay. Recall that our calculated threshold value of impedance setting of the relay was given as 0.533Ω. The crisp output of 0.185Ω is definitely much less than the impedance setting. This means that the breaker would be told to trip.

Figure 4.3 clearly shows the output trip signals to the breaker for different input impedances. From this, we can deduce the response of the breaker for different input impedances, within the universe of discourse. This last step depicted in Figure 4.3 clearly accommodates any number of simulations that may be desirable. For any input impedance desired for simulation, there is a corresponding output trip signal which can be read from the response curve.

Conclusion

An artificial intelligence base distance Transmission protection scheme for tripping the line circuit breaker in an event of a fault occurrence has been studied. It is a strategy that replaces a conventional relay with a fuzzy relay. The approach was effective in implementing a simple fuzzy procedure (5 rules) to solve a problem that requires rigorous mathematical operations, when the conventional approach is used. Only the impedance of the line to fault is sufficient to implement this technique. The system simulation shows that the proposed approach is able to make tripping decisions and serve as logic for the breaker, which acts on this logic to protect the line, by way of isolating a faulty section.

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