

Application of Fuzzy Algorithm for Partial Discharge Analysis

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ABSTRACT

This work involves analyzing partial discharge (PD), which has estimated the detected signal accumulation based on Labview, and analyzing by Fuzzy algorithm. In algorithm, we developed system configuration that detected accumulating PD signal. With practical PD logic implementation of theoretical detected system and hardware implementation, the device for 50kV setup has generated and then has applied with 15k~17kV with 1:1 time probe. Our new class of PD detected algorithm has also compared with PRPDA or Fuzzy algorithm, which has diagnose more conveniently by adding numerical values.

Key-words : Partial Discharge(PD), Fuzzy, Neural Networks.

1. Introduction

Recently, the demand of power energy is rapidly increasing because of magnification of the industry development and scales. Underground power transmission systems, established and operated in big cities have been increasing since 1970, which were technology to diagnose of power cable, is very important. We can forecast life of power cable with detection of partial discharge signal. But, to detect PD signal is difficult because PD signal is very a periodic and non-linear. Also, it is very difficult to work that should separate PD signal from noise [1~7]. However, PD signal has various type forms according to the cause and situation. And PD signal has characteristics that appear in fixed phase repeatedly within cycle. If those PD signals detect and accumulate, it may divide PD signal from outside noise by accumulated shape. Therefore, PRPDA which can

detect accumulated PD signal was developed. Also recently, many studies have been progressing to diagnose PD using Artificial Intelligence algorithm actively by development of measure technology that use computer [4, 5, 9, 10]. However, it is impossible to diagnose PD signal perfectly in present measure technology. Therefore, we emphasize to develop algorithm that can acquire much information than perfect diagnose in this research. For these reason, we developed system that detects accumulated PD signal using Labview and programmed Fuzzy algorithm which can analyze PD signal using Matlab. So, we can diagnose PD signal more conveniently analyzing the compared shape of detected accumulated PD signal by Labview and numerical value that is constructed by Fuzzy algorithm.

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2. Systems embodiment

2.1. Labview PRPDA accumulation program embodiment

PD in power cable occurs by defect of projection or gap in cable mainly. And according to the cause and situation, it has various kinds of form. Also, PD signal has characteristic that appear in fixed phase repeatedly within cycle. Therefore, these researches expresses PRPDA techniques to detect accumulated PD signal because it can express special quality of PD signal which describes in front, constructed PD detection system as Labview.

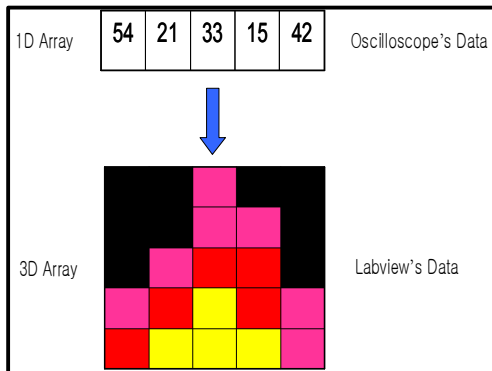


Fig. 1. Converts into 3D array data of 1D array data

So, detecting an accumulated PD signal within cycle, means forming accumulation pattern of PD signal according to status of special quality and discharge amount, and discharge number of times[2,3,4,8]. Principle of PD accumulation detects system to construct through this research, can be expressed on screen because it changes one time circle arrangement by three dimensions array by a word. Oscilloscope's data transited as one-dimensional array by computer like figure 1, received in computer and changes color according to accumulated degree and expressed in three-dimensional array. Data number of figure 1

is numbered randomly.

2.2. Implementation of Fuzzy algorithm

Perfect computer diagnostic of PD signal is judged impossible in present instrumentation system technology. Therefore, these research emphases to embody algorithm that can supply much information within detected signal than fixed diagnosis of PD signal like "YES" or "NO". That is, main purpose to add numerical value is analyze conveniently by Fuzzy algorithm in pattern shape of PD signal which detected by Labview and serviced diagnosis of PD signal a little more. Development tool of Fuzzy algorithm to diagnose PD signal used MATLAB.

Fuzzy rule applied following Fuzzy rule [11].

(1) Simplicity Fuzzy reasoning

R1: If x is Small then y = a10

R2: If x is Big then y = a20

Membership function used 2, 3, 4, 5.

(2) Linear Fuzzy reasoning

R1: If x is Small then y = a10 + a11x.

R2: If x is Big then y = a20 + a21x.

Membership function used 2, 3, 4, 5.

Simple Fuzzy Inference uses a constant as second half variable, and have advantages that inference engine is simple and result can be acquired early. Linear Fuzzy Inference uses linear formula as second half variable, and it has advantages that can solve difficulty of causal acquisition. Two fuzzy inferences are suitable for reasoning in non-linear signal as all representative direction [11]. It applies each membership function 2, 3, 4, 5 to two Fuzzy reasoning to explain in front. And best performance drew good Fuzzy rule.

In this study, Fuzzy algorithm programmed as

similar signal repeats in correct phase so that good result may appear.

3. Experiments and result

We detected accumulation by Labview system generating PD signal by Calibrator to confirm whether constructed Labview system run properly. Figure 2 is the result. If examine figure 2, we can know that values that is transmitted from oscilloscope appear being accumulated in correct phase. Through result of figure 2, we could know that constructed Labview system was worked properly.

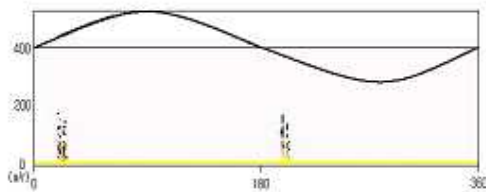
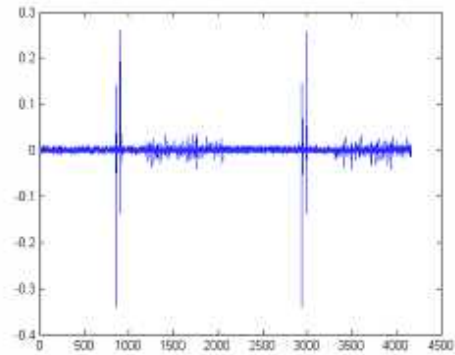
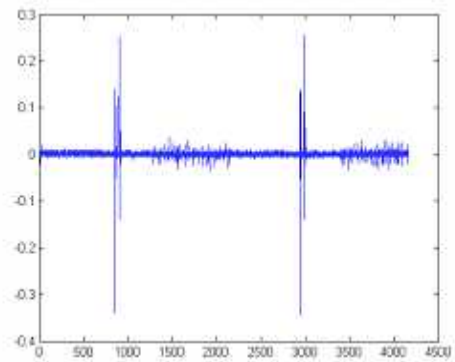


Fig. 2. Accumulates after having generated a PD signal with Calibrator

Figure 3 the result of applying Fuzzy algorithm to data of figure 2. Figure 3 of (a) is graph that express Training process and (b) is a graph that express Testing process. Training value and Testing value of figure 3 recorded all 0 in all Fuzzy rules. Therefore, we could confirm again through Fuzzy algorithm that generated signal by calibrator is very correct PD signal.



(a) Training graph



(b) Testing graph

Fig. 3. Fuzzy model's Training, Testing data of a PD signal that generated by Calibrator

After confirming that Labview system run properly, we apply 15kV to sample and detects generated signal by Labview system. Figure 4 is the result. If examine figure 4, signal occurred in 90° and 180° mainly. Specially, signals that occurred in 90° occurred in form of equal candlepin shape. For these reason, we estimate that detected signal is a noise which is made by corona discharge. However, we could not overlook the possibilities that PD signal couldn't be hidden cause of corona discharge. So, we detected signal again in same condition after we control noise in oil. As a result, we could get very clean accumulation form has no more. That is, we could know that PD signal did not occur.

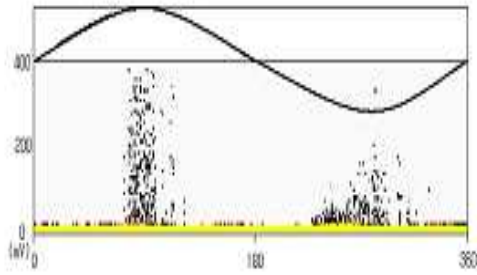


Fig. 4. Applied a 15k Voltage and generate interface discharge

Therefore, we could confirm too that figure 4 is accumulation pattern by corona discharge. When is same, after is accumulated more for 5 minutes, we could get result of figure 5.

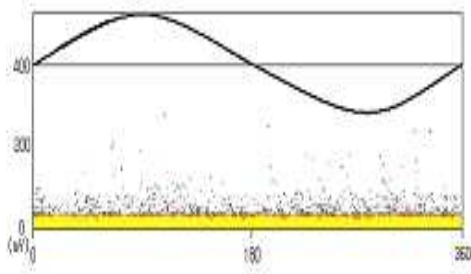
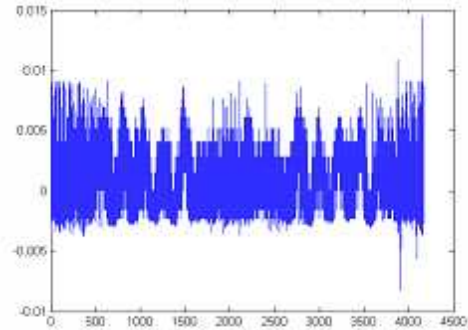
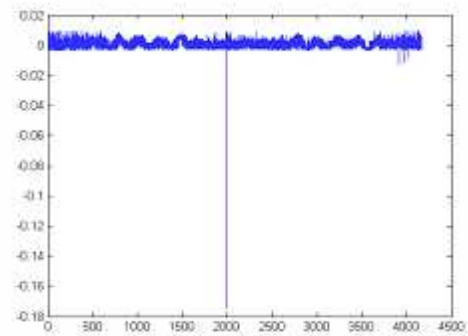


Fig. 5. Applied a 15k Voltage and Discharge signal detection in ole

Figure 6 is as result that apply signal of figure 5 in Fuzzy algorithm. Training value of (a) displayed 0.004265 and testing value of (b) displayed 0.004273. He shows the Training value and testing value are no difference particularly through result of figure 6. Also, if except the 2000th data in (b) and set ratio of y axis, we can know that (a) graph and (b) graph are almost similar. Therefore, we can know that data of figure 5 is signal that similar values are repeated. That is, data of figure 5 may be PD signal. Figure 6 is result of when use Linear Fuzzy reasoning and applied 4 membership functions.



(a) Training graph



(b) Testing graph

Fig. 6. Fuzzy model application results to data that is applied at 15k Voltage in sample LDPE

Raise and applied from 15kV to 17kV to heighten the pulse number of discharge and magnitude of discharge. Figure 7 is the result. Accumulation shape of figure 7 is form such as PD pattern that show much in interface of generator [2].

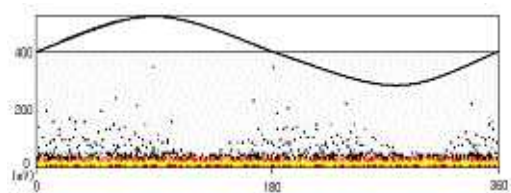
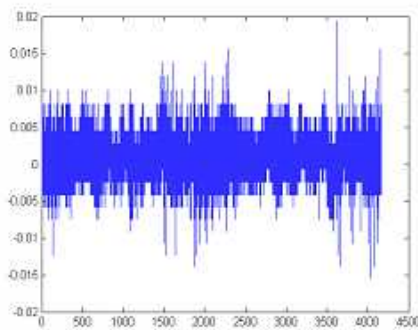
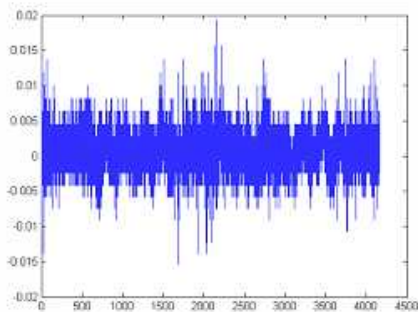


Fig. 7. Applied a 17kV and generate interface discharge

Figure 8 is as result that apply signal of figure 7 in Fuzzy algorithm. Training value of (a) displayed 0.003904 and testing value of (b) displayed 0.003907. If examine result of figure 8, Training value and Testing value of figure 8 are lower than Training value and Testing value of figure 6. These result means that signal of figure 8 is more similar with PD signal than signal of figure 6. Figure 8 is result of when use Linear Fuzzy reasoning and applied 5 membership functions.



(a) Training graph



(b) Testing graph

Fig. 8. Fuzzy model application results to data that is applied at 17k Voltage in sample LDPE

5. Conclusion

In this study, we developed system configuration that detected accumulating PD

signal using by Labview and programmed Fuzzy algorithm can be analyzed the PD signal.

We confirmed that display good result pulse number of discharge and magnitude of discharge are much through figure 6 and figure 8. And Fuzzy algorithm can confirm that display good result when formed correct accumulation pattern by comparing result of figure 5, figure 6, figure 7, figure 8. Through such result, we confirmed that can diagnose partial discharge little more conveniently if we use accumulation detection of Labview system and analysis of Fuzzy algorithm together.

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