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Analysis of Layout of Disturbances in 20 KV Distribution Channels using Artificial Immune System through Negative Selection

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Abstract--- To find out the exact location of the disturbance, so that there is no prolonged blackout on the 20 kV distribution channel, then in the study we aim to find out the location of the disturbances that occur in the electricity distribution system using the Artificial Immune System through Negative Selection. The frequent disruption is a single phase to ground short circuit, two phases to the ground, three phases to the ground, and between phases. In testing the system tested is the time needed for the detection system to generate a detector and the ability to detect short circuit faults. The simulation results show the speed of information delivery time of the disturbance between 0.0051 - 0.0203 seconds, so that there is still enough time to send a signal to the security system to localize the interference. Increasing the speed of sending information on the location of the disturbance makes the repair time faster.

Keywords--- disruption of distribution channels, artificial immune system, negative selection

I. Introduction

The electricity distribution channel is one component that distributes electrical energy from the substation to the load centre or consumer [1]. In the distribution of electric power must be tried as best as possible, for that interference that occurs in the distribution system must be completed accurately and quickly. Because these disturbances can cause blackouts, so as to reduce continuity and quality of distribution of electricity for consumers.

In the electric power distribution system, the frequent interference is a short circuit. Short circuit faults occur due to the direct connection of the phase cable to the ground or through a resistance, and the type of short circuit interference that occurs is grouped as follows; single phase to ground disturbance (L-G), two phase to ground interference (LLG), three phase to ground (LLLG) interference, inter phase (LL) interference, and three phase symmetry interference. The short circuit disturbance affects other systems (the stability of the power system is lacking, unbalanced current, voltage drops and damage to equipment that is close to the location of the interference), this can happen if the security (relay) does not work properly.

Short circuit failure is a disturbance caused by a relationship or direct contact between the conductor and the ground or neutral path. Disorders that often occur in the distribution channel are short circuit disturbances, the disturbance occurs because it is caused by several causes and grouped, among others; interference in the system (damage to the panel due to overload, faulty isolator, broken line, broken jumper, connector damage), and interference outside the system (fallen tree trunk, lightning strike, collapsed channel pole).

The problem that occurs when the short circuit is the voltage and current in each phase becomes asymmetrical and the current flowing in the disturbed phase will increase, the magnitude of the fault current is determined by: source voltage, system impedance, interference impedance, type of short circuit fault (one phase to ground, two phases to ground, three phases to ground, between phases, and three phase symmetry disturbances).

Security systems in electric power distribution channels use overcurrent relays and directed ground relays. If an interruption occurs in one of the relay distribution channels, the system and location of the fault can be determined by checking the substations, if the distribution system is equipped with a Distribution Control Centre (DCC) in several substations, the location of the fault location is easier, but there is a disturbance. the exact location is unknown.

To find out the exact location of the disturbance, so that there is no blackout that is too long at this time is still an obstacle. Previous research that has been done is the identification of the location of short circuit disturbances in the electric power distribution system using the Neural Networks method [2][3]. In this study in determining the location of the disturbance still requires a long time, because the system determines the location of interference using a repetitive process. Therefore, it is proposed to use the Artificial Immune System (AIS) method to detect the location of disturbances that occur in the electric power distribution system. AIS is one of the concepts based on artificial intelligence that is inspired by the concept of immunology.

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II. Research Method

Lately, many researchers are interested in learning a system inspired by the biological system of Artificial Immune System (AIS) [4]. Computer experts, engineers, mathematicians, philosophers and other researchers are very interested in the ability of this system. These systems are artificial neural networks [5][6][7][8][9], evolutionary computation, DNA computation and now artificial immune systems. The immune system (immune system) is a complex cell, molecule and organ that has the ability to perform several pattern recognition tasks, learning, memory acquisition, generalization, distribution of detection and optimization. The basic principles of the immune system are developed into new computational techniques to solve various problems. This study discusses the immune system that presents models of receptor molecules and examples of the use of immunological phenomenon to develop computational design and techniques. This discussion focuses more on the systematic description of the immune system, which is related to the principle of negative selection, hyper mutation, immune response when affinity maturation.

In this study, AIS is applied to determine the location of interference in the 20 kV electric power distribution channel, which is caused by a short circuit. In this case the electricity distribution channel is monitored using AIS.

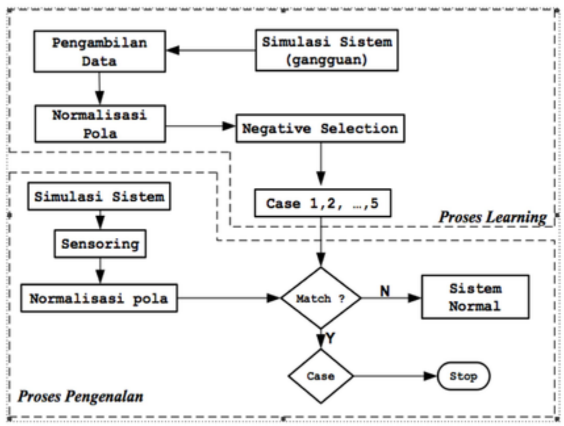

Fig. 1. Flowchart of a short circuit detection system on a distribution channel using AIS

To detect interference caused by a short circuit, AIS compares the detector pattern with the pattern of the monitored system. The detector pattern is obtained from the negative selection process on the normal pattern, that is the system pattern in normal conditions there is no interference. This is illustrated in Fig. 1.

III. The Results Achieved

By using the Simulink program in Mat lab, we can simulate the distribution system and the short circuit that occurs. The simulated short circuit phase and phase to ground disturbance occurs on a 20 kV distribution channel using fault components on Simulink. To get measurement data to be analysed, data is taken from the distribution channel. Data taken are current signals, and current signal forms under normal conditions are shown in Fig 2.

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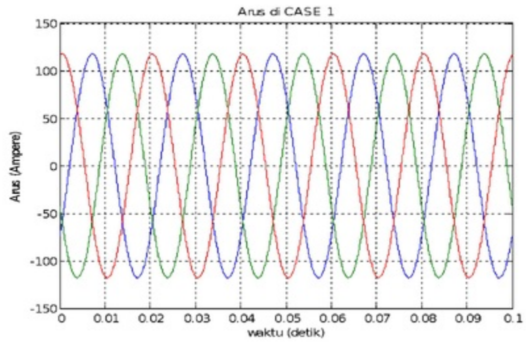

Fig. 2. Current signals in normal conditions

When a simulated short circuit occurs in case 2 for 0.0203 seconds, and the current signal in the system the state of short circuit interference can be seen in Fig. (3-6). The data obtained is continuous analog data, and to be analysed by the short circuit detection program. The continuous data is discredited by sampling the data. The sampling frequency used is 50 Hz, the sampling data is then saved into a file. Simulations made to obtain data are twofold, namely system simulation in an uninterrupted state and system simulation in the event of interference. System condition data in normal conditions is stored in the "Normal system" data file and the data in the fault state is stored in the file "Dataself.mat".

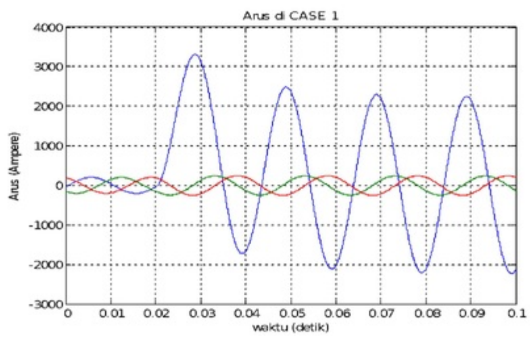

Fig. 3. Current profile when a single phase to ground short circuit fault

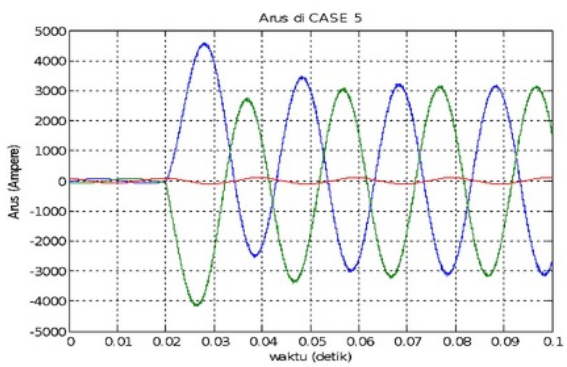

Fig. 4. Current profile when a two phase to ground short circuit fault

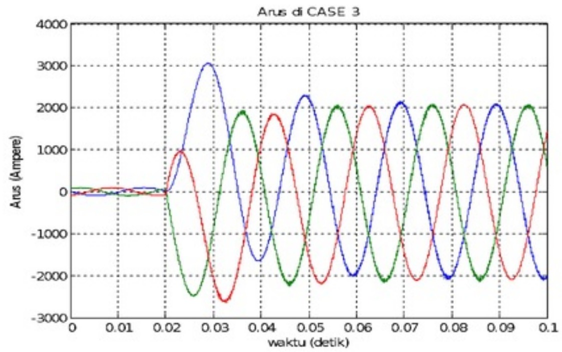

Fig. 5. Current profile when a three phase to ground short circuit fault

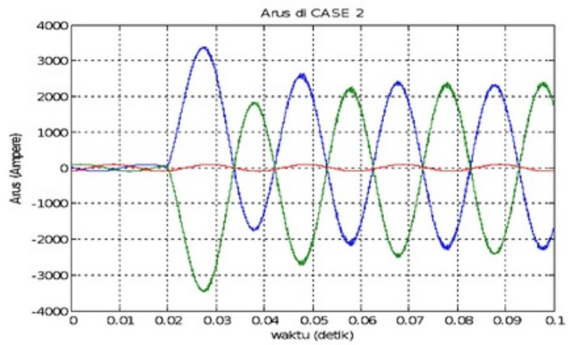

Fig. 6. Current signal in the inner system inter-phase interference state

Input detection system is the output data from the simulation of electric power distribution system, while data simulation output data is real data. The steps in normalizing the flowchart pattern shown in Fig. 8 are as follows:

1. Load data.
2. Determine the data range (Max and Min) and the pattern length ℓ.
3. Calculate the value Val = Pattern - Min
4. Calculate the divider value FbinSize = (Max - Min) / itung
5. Calculate the normalization pattern and round up the value to be an integer. NormSet = Ceil (Val / FbinSize).

In Fig. 7 a function is used to normalize data with double input data and the return value of the function is an integer number between 0 and ℓ.

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```
%nilai maximum
imaa1=max(tempia1(i,:));
imab1=max(tempib1(i,:));
imac1=max(tempic1(i,:));
%nilai minimum
imia1=min(tempia1(i,:));
imib1=min(tempib1(i,:));
imic1=min(tempic1(i,:));
inorma1(i,:)=(tempia1(i,:)-imia1);
inormb1(i,:)=(tempib1(i,:)-imib1);
inormc1(i,:)=(tempic1(i,:)-imic1);
idifa1=(imaa1-imia1)/10;
idifb1=(imab1-imib1)/10;
idifc1=(imac1-imic1)/10;
iselfa1(i,:)=round(inorma1(i,:)/idifa1);
iselfb1(i,:)=round(inormb1(i,:)/idifb1);
iselfc1(i,:)=round(inormc1(i,:)/idifc1);
```

Fig. 7. Program code for data normalization

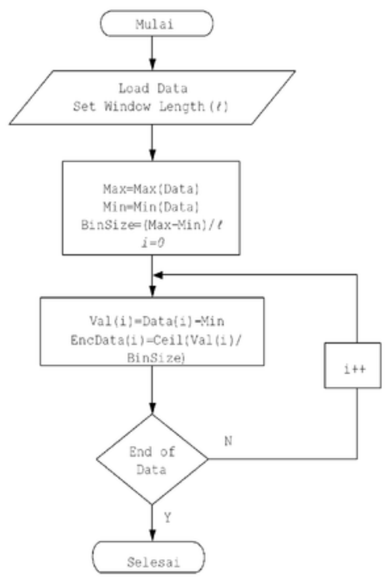

Fig. 8. Flowchart pattern normalization

In testing the system tested is the time needed for the detection system to generate a detector and the ability to detect interference with various disorders. The procedure for running the system is as follows:

1. Run a power system simulation ("thesis.mdl") with possible interference.
2. Run the file "PolaSelf_H.m" to learn the system with interference.
3. To detect interference running a power system simulation, the file "thesis.mdl" is good with no interference.
4. Run the "PolaNonSelf_H.m" file to detect interference.
5. Detection results will appear in the mat lab command window.
6. Repeat processes 3 through 5 with different system parameter values.

In running the Simulink program to detect interference, we first determine the channel impedance value or the Immune System parameter, namely the pattern length (L), Affinity Threshold (R), and the number of detectors (N) contained in the file "data_H.m". The next process is to learn the system from several types of short circuit problems, and then save the file "DataSelf.mat". To find out the location of the interference and the detection time is by making a disruption to the system, then we do the learning process then run the file "PolaSelf_H.m" after that we learn again and then run the file "PolaNonSelf_H.m". If the current signal is detected interference, the system on the matlab monitor will display information that there is a short circuit on the channel that has a fault and the detection time and the interference distance (see Fig. 9).

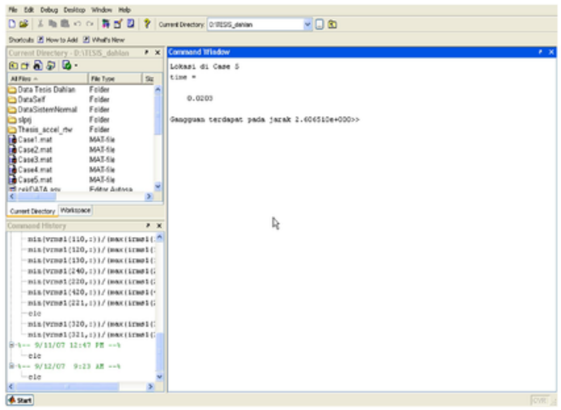

Fig. 9. Display monitor time of disturbance

To determine the location and timing of short circuit fault detection obtained in AIS simulation, that is by comparing the detector pattern with the pattern of the monitored system. The detector pattern is obtained from the negative selection process on the normal pattern, that is the system pattern under normal conditions there is no interference, and the process of detecting interference conditions by comparing input patterns (monitored current flow patterns) with detector patterns. If the monitored current pattern indicates a non-cellular pattern, then a channel is detected, and the system will provide information that there has been a disturbance by showing the location of the disturbed channel and the detection time, the speed of detection time depends on the number of sampling from disturbance to the sampling point of time Anomalies are recognized multiplied by the sampling period (in seconds). If written in the following formula; $T = (\Sigma n - 1)\, x\, Ts$, for T is the detection time, n is the sampling point starting from the disturbance until the last point of the sampling detected detection, and Ts is the sampling period (seconds).

Whereas to get the distance of interference displayed in the monitor, it can also be calculated using the interference distance determination formula as follows;

For 3 phase disturbances

$$Zr = \frac{Ur}{Ir} = \sqrt{3}.Z\square$$

$$Z\square = \frac{Zr}{\sqrt{3}} = \frac{Ur}{Ir}.\frac{1}{\sqrt{3}}$$

$$S = \frac{Z\square}{Za} \text{ ....km.}$$

For 2 phase disturbances

$$Zr = \frac{Ur}{Ir} = 2.Z\square$$

$$Z\square = \frac{Zr}{2} = \frac{Ur}{Ir}.\frac{1}{2}$$

$$S = \frac{Z\square}{Za} \text{ ....km.}$$

For 1 phase interference

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$$Zr = \frac{Ur}{Ir} = Z\ell$$

$$Z\ell = Zr = \frac{Ur}{Ir}$$

$$S = \frac{Z\ell}{Za} \text{ ....km.}$$

for: Ur = censored voltage censored
Ir =current
Zr = impedance of the ratio of voltage and current
Zℓ = impedance that represents the channel
Za = impedance of percilometer
S = distance of interference.

Suppose that in a distribution channel there is a short circuit of 2 phases to the ground, and the channel uses 240 mmAAAC phase conductor2 with 19 conductor veins, and the neutral conductor uses 120 mmAAAC2 with 10 km channel length, and the current and voltage on the sensor when the disturbance is 4500 amperes and 17.5 kV, the length of the disturbance is:

Known: - perimeter impedance (AAAC 240mm2 vein 19) = 0.1344 + j0,3158 km / km.
Ur = 17.5 kV
Ir = 4500 amperes

Then:

$$Z\ell = \frac{Ur}{Ir} \cdot \frac{1}{2} = \frac{17.500}{4500} \cdot \frac{1}{2} = 3{,}8 \; x \; 0{,}5 = 1{,}9 \quad \Omega$$

$$Za = \sqrt{0{,}1344^2 + 0{,}3158^2} = \sqrt{0{,}01806 + 0{,}0997} = 0{,}343 \quad \Omega / km$$

$$S = \frac{Z\ell}{Za} = \frac{1{,}9}{0{,}343} = 5{,}5 \quad km$$

The test results on the system to determine the location of the disturbance with 48 times of experiment, the detection time and the distance of the short circuit with different parameters can be seen in Tables 1 and 2.

Table 1 Simulation simulation results for N = 1000, L = 6, R = 4

Channel Length (Km)	**Disruption Layout and Detection Time (seconds)**							
	Case 1 1 phase disturbance to ground		Case 5 2 phase interference to ground		Case 3 3 phase interference to ground		Case 2 Interference between Phase	
	Time	Distance (Km)	Time	Distance (Km)	time	Distance (Km)	time	Distance
						(Km) 5		

						0.0183 3.66 0.0203 3.73 0.0203 3.19		
					, 0203	3.55	0.0203	2.38
15	0.0203	4.52	0.0203	2.60	0.0203	4.55	0.0203	2.87
20	0.0203	5.37	0.0203	1.95	0 0203	5.67	0.0203	3.35
25	0.0051	6.25	0.0051	1.62	0.0051	6.87	0.0051	3.80
30	0.0082	7.21	0.0082	1.82	0 , 0082	8.15	0.0082	4.31

Table 2 The simulation results of interference for N = 1000, L = 10, R = 4

Channel Length (Km)	**Disruption Layout and Detection Time (seconds)**							
	Case 1 1 phase disturbance tog round		Case 5 2 phase to t interference		Case 3 Disturbance 3 phase to ground		Case 2 Interference between phases	
	Time	Distance (Km)	Time	Distance (Km)	Time	Distance (Km)	Time	Distance (Km)
5	0.0203	3.66	0.0203	3.73	0.0203	3 , 19	0.0203	2.19
10	0.0203	3.50	0.0203	3.43	0.0203	3.55	0.0203	2.38
15	0.0203	4.52	0.0203	2.60	0.0203	4 , 55	0.0203	2.87
20	0.0203	5.37	0.0203	1.95	0.0203	5.67	0.0203	3.35
25	0.0203	6.25	0.0203	1.62	0.0203	6 , 87	0.0203	3.80
30	0.0203	7.21	0.0203	1.82	0.0203	8.15	0.0203	4.31

Based on the simulation results, AIS can determine the location of the disturbance that occurs in the distribution system. And the time to find out the location of the interference quickly so that the AIS has enough time to send the interference signal to the security system, from the test results ranged from 0.0051 to 0.0203 seconds.

From the results of Table 4.1 and Table 4.2, AIS can determine the location of disturbances that occur in a 20 kV distribution system. With the pattern length (L) parameter value and different channel length values obtained different results in the time of detection, but with the change in the parameter Affinity Threshold (R), and the number of detectors (N) obtained the same detection time results as in Table 4.1, p. This shows that with a longer pattern, it will take time to find out the interference will be longer. It is possible that some AIS interference simulations are unable to detect the disturbance that occurs, this is because the measured current signal is almost the same as the current signal when normal. In addition to the almost identical signal form, it is also known that failure in the recognition process is affected by setting the AIS parameter values, and to get the right parameters is done through a process trial and error.

From the results of the distance simulation simulation data when compared with the results of calculations with the same data, the percentage of simulation results is ± 62.3% of the results of the calculation. Based on the results of the simulation above, a conclusion can be drawn there is a when disturbance arising AIS can find out where the disturbance is happening quickly. The time needed for AIS to determine the location of the disturbance is between 0.0051 - 0.0203 seconds, so that the AIS has enough time to send the interference signal to the security system to localize the interference. With changes and differences in the size or length of the channel length parameter (channel impedance) and the pattern length parameter (L), Affinity Threshold (R), and the number of detectors (N), there is no significant effect on the change in time to determine the location of the interference, so it will make this program better and have high flexibility to change parameters.

*Corresponding Author: Mohammad Dahlan,
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IV. Conclusion

From the results of the simulation and analysis, the following conclusions can be drawn: Artificial Immune System can be used to determine the location of interference on the 20 kV distribution channel. Secondly, AIS is able to detect interference quickly, with a time of 0.0051 - 0.0203 seconds, so that there is still time to send a signal to the security system to localize the interference. Furthermore, the channel length (channel impedance) does not have a significant effect on the detection time process. From the results of interference simulation, it can be concluded that the AIS parameter values are very influential on the detection of interference.

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6

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