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ADVANCE METHOD FOR FAULT CLASSIFICATION IN TRANSMISSION LINE SYSTEM BY KNN ALGORITHM

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Abstract

In this paper the very efficient and highly protective scheme was employed for transmission line system.

Here we used the KNN algorithm technique on input current samples from EMTP data base, to get the acceptable and the fastest response by the relays. The hardware description language called Very high speed integrated circuit (VHDL) is used to execute its hardware realization on FPGA Spartan 3E platform. High frequency current signals are in use from electromagnetic transient program (EMTP) software data base, which is used as an input signal to our system. Wavelet transformation is the highly effective tool for getting the information about its Transient current signals. By taking the knowledge about its input current samples and compared it with test data samples from (EMTP) data base we get the accurate results about its fault recognition and classification by KNN classifier.

Introduction

Transmission line system plays vital role in transmission line network. The accuracy about its fault detection and classification are the most important factors for protection of transmission line. The connection of new generating stations to satisfy this rapid increase in demand requires expanding transmission and distribution facilities. However, investment and environmental constraints and resulting delays in expanding trans-mission facilities force the transmission operators to load the transmission systems close to their transfer limits. The resulting lower stability limits make it important to clear the transmission faults very fast using high-speed protection methods. This has generated a new interest in the transient based protection methods. As per its reliability concern when we face the real world implementation there is possibility of malfunctioned such as switching of lines, capacitor banks and large loads.

The application of different classification and pattern-recognition methods for protection and power-quality (PQ) problems has been studied in previous research [1]-[5].

There are some various techniques to detect and classify the fault from its high frequency transients, so called transient based algorithm techniques, such as Fourier transform, Fast Fourier transform(FFT), artificial neural network(ANN), Fuzzy logic, Fuzzy inference system etc. In such techniques have some disadvantages like ANN required past history of data, with fuzzy logic required expert knowledge [6]. In short all the techniques are computationally intensive, so that it is very difficult to analyze the fault related information by using such techniques.

In the field of signal processing we have different transformation techniques, amongst that wavelet transformation is an important tool for high frequency transient based signals for filtration purpose. While considering its daubechies family it has higher order high pass filters which gives information very efficiently about its coefficients. These filters are very useful to extract information from transient signals.

Generally fault occurs in high frequency transients so that it is very difficult to extract fault related information from signals. In transients several algorithms were reported earlier. Wavelet transformation having time-frequency localization ability as compared with Fourier transform. An effective feature extraction technology using wavelet transform [5] shows that, it is best suited for non-stationary signals measured from protection relays. Wavelet transform can be continues or discrete depending upon the way the dilation and translation parameter are selected. Discrete wavelet transform (DWT) is more advantageous than continues wavelet (CW).because DWT decomposes the signal into direct family of frequency band that do not overlap while in CW where the signal decomposes from its continues family of frequency band that could overlap each other. The wavelet multi-resolution analysis is the computing algorithm used by DWT with moving window technique. Window can be moved in between smaller and larger area for good time as well as good frequency resolution.

The high frequency current signals having both high and low frequency component. Generally occurrence of faults in high frequency transients signals, so that it necessary to detect and extract the high frequency component in current signals. Due to this we have to convert it into digital for wavelet transformation filtering operation. I n this paper we developed fault classification system to detect and classify the fault by the use of wavelet transformation filtering to extract information and adaptive threshold techniques to detect nearest value of fault which was belonging to that type.

Transmission line system can be divided into two types' transmission line and distributed line. Generally fault occurs In high voltage transmission line which is above 25 KV. There are so many numbers of faults like distance protection operated, carrier fail, VT supply fail, auto reclose operated etc. Most occurring faults on three phase transmission line are belonging to distance protection operated fault. Such faults are phase related and ground related. There is 95% occurrence of ground related faults these faults include single line to ground, double line to ground, and line to line fault.

I. WAVELET TRANSFORMATION

The alternating current signals from transmission line system are non-stationary and random signals so it is very difficult to extract hidden information from it. I n previous technologies like Fourier transformation that technique does not reliable in accordance with its exact detection and accurate classification of fault. Because it shows only the frequency component in the current signals and does not able to give the statement about its time spectral component. Wavelet transform which is new tool for caballing both time and frequency information simultaneously.

The mother wavelet ψ (t) is given as [6]:

$$\Psi (i,j)(t) = 2^{-j/2}\, \psi\, (2^{-j}t - k). \quad \textbf{(1)}$$

The coefficient of WT C (m, t) are define by the following Inner product [7]

$$C (m, t) = 1/\sqrt{m} \int s(t)\, W^{t}\, t, m (t)\, dt. \quad \textbf{(2)}$$

Where 'm' is scale factor and's' is translation factor. Generally, WT consists of successive pairs of low- and high-pass filters. For each pair, the high-scale and low frequency components are called approximations, while the low-scale and high-frequency components are called details.

II. K-NEAREST NEIBHOURING ALGORITHM

In this logic we are going to use three phase transmission line system for fault classification. We sampled out the current input signal with high sampling rate for various faults in transmission line. The purpose of the k Nearest Neighbors (KNN) algorithm is to use a database in which the data points are separated into several separate classes to predict the classification of a new sample point. We sampled 10,000 values from fault associated input current signal. Depending upon its threshold value as compared with test signals by standard deviation mathematical formulae we can detect and classify which type of fault will occur in transmission line see stem. The difference actual value and the test signal will give us the nearest threshold value about exact fault information. The proposed logic uses wavelet transform for extracting the hidden information in the current wave forms when a fault occurs, which is then suitably transformed to extract fault signatures and characterize the faults.

A. Analog to digital conversion

The input current signal from power system is analogous In nature so it is necessary to convert into digital form to Perform wavelet transformation filtering technique. Because Our system is performed on extracting information Embedded in it from transient generated during faults and Disturbances. Analog to digital processing is our first step. Because in power system or in sub-stationed they used Digital relays for performing protection operation in transmission line network. For 50 HZ system the 0 to 1000 HZ is more informative. The 2K HZ sampling frequency we need to extract signal from this band. The main component of signal processing are-1) Transducers and isolation 2) Antialiasing filter to
avoid interference 3) sampled and hold 4) multiplexers and 5) A to D conversion.

B. Wavelet decomposition

The three phase signals are fed to the wavelet decomposition filter to extract information from it. In this case we get the results from only single level of decomposition rather than multilevel decomposition. The choice of mother wavelet is very important consideration in WT we used Daubechies (db6) filtration. The output of filter gives high frequency details.

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C. Fault detection and classification

The input to the classification system is three phase current signals. The signal energies associated with different frequency band which are calculated through wavelet decomposition is used as input for KNN classifier. The KNN classification technique for fault detection is based on standard deviation calculation for its threshold value. I n these papers we are implement this logic to detect the fault, if it crosses the maximum threshold value.

The way in which the algorithm decides which of the points from the training set are similar enough to be considered when choosing the class to predict for a new observation is to pick the k closest data points to the new observation, and to take the most common class among these. This is why it is called k nearest neighbour's algorithm. Suppose that for the phase logic amongst three is
Shown below [6]-

DA (n) =1, |HFA (n)-HFA (n-1)|>Thd (3)

0, otherwise

Here HF- high frequency coefficient of phase A. The detection of signal goes high if any one of the three phase current will disrupted. For k nearest neighboring algorithm (KNN) we show the standard deviation formula to get nearest value of threshold which is the value of those faults whose value is on that sample number. Standard deviation=deviation/max deviation X 255 (4) the threshold value can be fixed on the basis of a to d conversion rate, sampling frequency and wavelet used.

III. BLOCK DIGRAM FOR FAULT CLASSIFICATION AND DETECTION

From the below diagram we use three phase current signals as an input for wavelet decomposition tool box. After decomposition operation the extraction of transient's signals can be detect by signal level of decomposition. Then KNN algorithm can be classified accordance with their threshold value, it can choose the nearest possible value for classify the specific type of fault. The entire signal were mixed and processed for information capturing. The fault classifier block classifies that the signal related to ground or phase.

All the signal processing were done in MATLAB simulation, because matlab has wavelet transformation tool boxes, which plays very crucial role for extraction of signals from high frequency transients. By using KNN we can able to classify the type of fault. It will very helpful for prevention of transmission line as early as possible. KNN take very less time to classify the fault approximately in microseconds. While compare it will others technologies
KNN gives fastest response and no computational
Complexity is required.

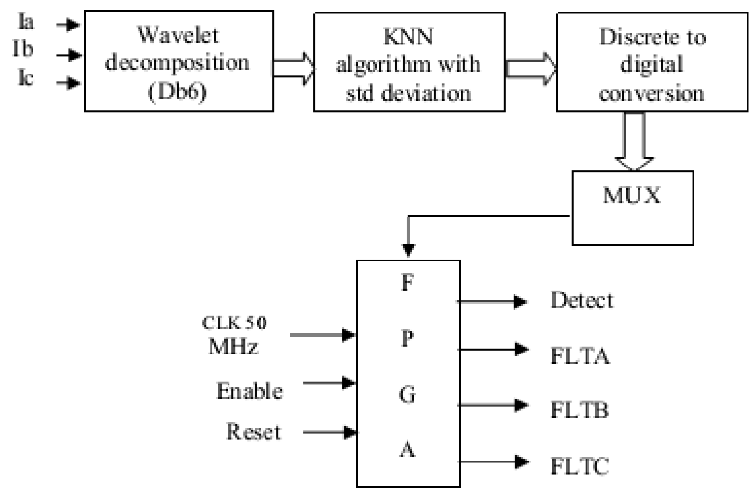

Figure1. Block diagram of fault classifier [6]

IV. EXPERIMENTAL RESULTS

The following table1 shows the different fault associated current input signals at different sampled values. The test data and the different types of fault values can with each other by KNN algorithm. By using knowledge of this difference we can get the best nearest threshold value for various faults. We perform operation on 10,000 sampled values to get best results by KNN classification technique.

Table no.1 Projected sampled values for fault signal

Sample no.	Line to gnd	Double line to gnd	double Line to line	Test data
8500	0.056003	0.056711	0.012654	0.057533
8600	0.057484	0.058144	0.009762	0.056301
9000	0.058850	0.059561	0.006841	0.055055
9999	0.060222	0.060973	0.004000	0.053796

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V. SIMULATION RESULTS

Ones we take the sampled values from EMTP software And places in the excel sheet, we get some waveforms associated by the fault. The following diagram shows the input current waveform which we given as an input to our system. By comparing this signal with test data signal, which was already predefined, then we will get the nearest threshold value which was belonging to that type of fault. All this comparison was done by KNN algorithm and output will show on model-sim software.

Figure.2 Test data waveform from (EMTP data base)

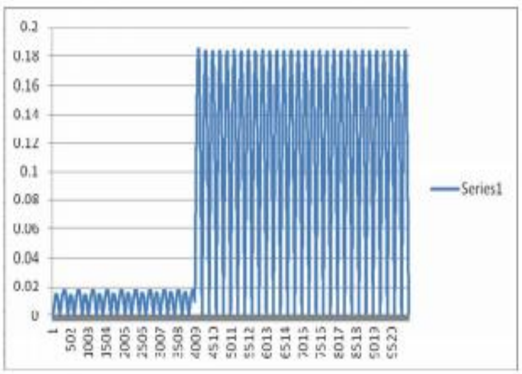
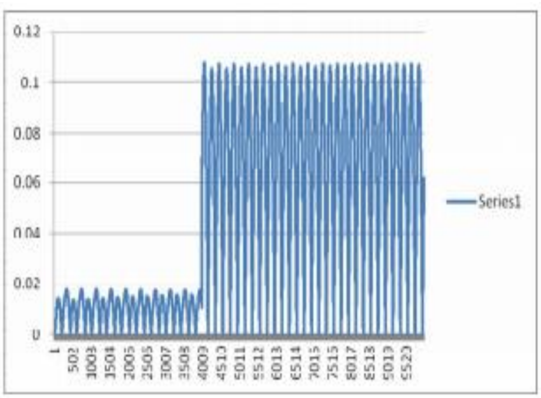
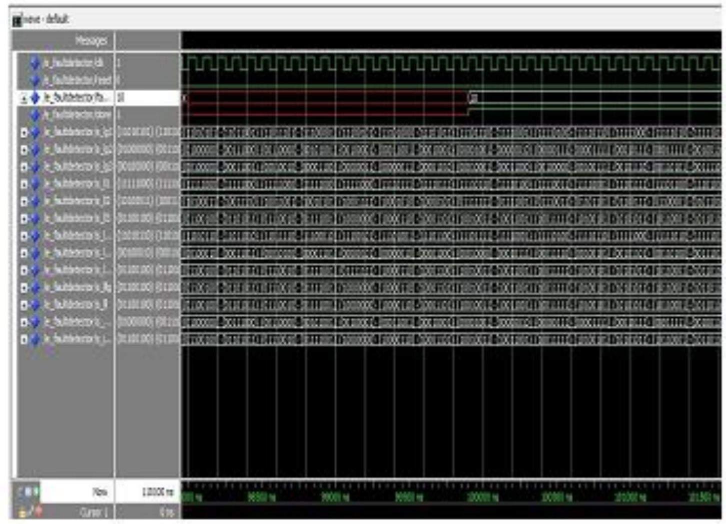


Figure.3 Input signal for line to ground fault



The following waveform shows the results of double line to ground fault. By giving the sample value from 8000 to 9000 we get these results. Likewise we may put different values into matlab; upto 10,000 samples then we will get different types of faults.

Figure.4 Fault classification output in model-sim



VI. HARDWARE IMPLEMENTATION

The hardware realization of the proposed algorithm was done using FPGA. FPGA contains a matrix of logic elements which can be interconnected in any desired configuration by the user to implement a given application.

In this way, one can devise special purpose functional units that are highly efficient for the desired task. As FPGAs can be reconfigured dynamically, it is speeds that are higher than what can be achieved with general purpose processors. FPGAs come in a wide variety of sizes with advanced features. An FPGA is generally composed of three types of elements: configurable logic blocks (CLBs), input/output blocks (IOBs), and programmable interconnects (PIs). The user can implement logic functions for a given application through CLBs, by interfacing the external package pins to the internal logic using IOBs and routing the paths for connecting the CLBs and IOBs into networks with the PIs.

- FPGA Design Flow

A typical FPGA design flow consists of design entry, synthesis, and implementation and FPGA device programming. At the design entry stage, the intended behavior of the FPGA device is described by means of a hardware description language (HDL) like Very high speed integrated circuit HDL or Verilog. The design is synthesized to get an intermediate file, called a net list. The net list is translated and mapped, which fits the design into the available resources on the tar

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Get device. The place and route tool then places and routes the design according to the timing constraints. Programming File generation tool creates a bits stream file, referred as bitmap that can be downloaded to the device. Design verification, which includes both functional and timing verifications, can be done at different points during the Design flow.

An ability to construct highly parallel structures, for processing data, is the main advantage of FPGAs. Unlike a microprocessor or DSP, FPGA performance is not tied to the clock rate but to the amount of parallelism that can be brought in the algorithms. The configurability of FPGAs, which allows a design to be modified even after deployment in an end application, is another highlight. FPGA has many degrees of freedom in implementing signal processing functions. The same system can be implemented in different ways to meet the time-resource constraints. An FPGA provides considerable flexibility in defining the arithmetic precision throughout a computation. The software support for FPGA design tools is another important consideration. The Xilinx: ISE Web PACK series provides a freely downloadable full-fledged FPGA design environment.

VIII. CONCLUSION

A novel fault detection and classification technique for transmission lines is anticipated. The logic uses k-nearest neibhouring algorithm for fault classification. By using this technique we are able to classify the high frequency transient fault very rapid and capable manner. The important features are in real time implementation, we required only single high pass wavelet filter and no complex transient's energy calculation is required. The difference between various faults with test data will gives us the nearby value by using KNN algorithm. The logic is fully deterministic and easy to recognize, and implemented using SPARTAN 3E FPGA board. Since FPGAs are reusable, in case design problems are detected at the testing stage, the chip can be reprogrammed after alterations are made in the design.

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