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TRANSMISSION LINES FAULT DETECTION USING DISCRETE WAVELET TRANSFORM AND ARTIFICIAL NEURAL NETWORK ALGORITHM

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ABSTRACT

This paper proposes a novel approach for fault discovery of three-phase transmission line, which is primarily based upon the discrete wavelet transformation (DFT) and back propagation neural network algorithm. Three phase currents of most effective one end are measured, and discrete features are extracted using discrete wavelet transform. Those features are then used as inputs to the back propagation neural network algorithm. The training data set for back propagation neural network algorithm is obtained by way of simulating the ten extraordinary kinds of faults the use of diverse values of fault inception angles and fault resistances, so that the actual consequences may be received. The proposed back propagation neural network algorithm employs twenty inputs and best one output for classifying the faults. The distinctiveness of the proposed approach is that all the features, data used in developing the algorithm are normalized, so that the method may be used for any system with none significant changes. The simulation of the three-phase transmission line network and discrete wavelet transformation analysis are achieved inside the toolboxes of MATLAB®, and back propagation neural network algorithm codes also are written in MATLAB®.

Keywords: transmission lines, wavelet transform, fault analysis, neural network.

1. INTRODUCTION

The dependability and security of any electrical power are usually dominated via the fastness of fault detection, curing and category/removal of the faulty stage. This right now is not greatest impacts the power quality of electric power provides to the customer but additionally enhances the low stability of the electrical power system. The finding of quick digital computer systems and sizeable information storage space system devices offers digitalized the total energy system. The strategies of fault recognition are changing from analog to digital; therefore the algorithms for Fault recognition possess to become altered for that cause. A few standard approaches which are centered upon the energy frequency additives of three-phase voltage and current signals (at e.g. more than cutting-edge, range, underneath/over voltage, differential, and therefore on.) are well-acknowledged strategies of fault recognition. But those methods are experienced from their natural limitations and are system structured.

The technique of fault recognition and category starts with the dimension of three phase voltages and currents. The suggested strategy uses the stage current of particular three amounts at one element of transmitting network. The following extremely crucial component is usually collecting the information from the regarded as voltage/stage current examples. The pursuing methods are typically utilized for this cause: wavelet transform [5], wavelet transformation [5], [8], [9], H transformation [4], etc. The wavelet transformation analyzes the entire signals in period domain highest. Therefore the limited figures can end up being taken out from this evaluation tool. The localization of sign in wavelet transformation is usually also not practical; this absence of capability torments the precision of technique. The T transformation is clearly current device in the electric power system; the validity and dependability of this method continue to be a subject matter of appearing at. The suggested research paper makes utilization of the discrete wavelet transform (DWT) for the evaluation of the tested signals, which can be an entirely founded device in energy system and is undoubtedly in utilized for years. The DWT transformation can evaluate the signals not most efficient in the period but also in regularity domain.

Credited to the truth the localization of the transmission is usually also feasible by using windowing feature of the DWT. As a result, the needed evaluation may become achieved efficiently. The sample of required entire signals produces large quantity details, and it isn't very feasible to study this data with no sensitive processing technique.

Several smooth processing strategies (elizab e.g., fluffy reasoning, artificial neural network, back propagation neural network algorithms) are to end up being experienced for learning the data and also to declare the significant summary from the tested data arranged. Plenty of analysis on the artificial neural network (ANN) related to fault recognition and type provides been reported in the books [3], [6], [8]. The suggested research study used the back propagation neural network algorithm for fault recognition and category in three-phase transmitting network. The overall performance of any back propagation neural network algorithm strategy network depends upon the teaching and screening of the advanced back propagation neural network protocol. The demanding teaching and looking at out makes the usage of back propagation neural network protocol quite smooth, reliable and efficient.

The technique may become extremely clean, and no guidelines are needed for recognition and category of different types of faults. Except this the system can end up being created for any kinds of three-phase transmitting collection fault with none tolerance price; the unique complications connected with the variants in electrical power system guidelines are also treated. This paper is evaluated into 5 Chapters: the 1st component includes the quick intro of the related research function currently completed and launch of the suggested strategy, in the second section discrete wavelet transformation, and in its software system in fault category is usually talked about. The third section is generally about the fundamental concepts of back propagation neural network algorithm, it's training, in 4th part model beneath concern and its results are pointed out, the 5th section is the bottom line of this paper. The general twenty pieces of advice are utilized as advice, and one consequence is usually designated in purchase to recognition and category of the errors by the method of back propagation neural network protocol. The results of simulation established up the validity of suggested approach.

A. Processing of signals and fault information collection

Control of signals and fault information collection is the initial stage in the process of Fault category of 3 stage transmitting network is to collect the proper electrical transmission, that's used in the way of fault recognition and classification. The information received from the evaluation produce the signal is usually helpful in keeping the type of fault. Any electrical three-phase transmitting network offers purest two signals that can become received and appropriately examined. The 1st is usually voltage and second is usually stage current. In this paper, the stage current of particular three phases of transmitting network at bus one is assessed. The suggested technique makes utilization of the signals of 1 area handiest. The constant wavelet transform (CWT) can be a compelling system for reading any electrical signal. The CWT can examine the signals in the period domain as correctly in the frequency region, as it can decompose the signal into one of a kind regularity runs through the utilization of set Wavelet function known to as parent Wavelet with the aid of translation and dilation belongings. Loads possess been on the Wavelet transformation, nonetheless, quick idea about CWT is certainly offered right here to make the suggested technique clean for visitors. The CWT of any signal f(t) is normally displayed by

$$CWT(a,b) = \frac{1}{\sqrt{|a|}} \int_{-\infty}^{\infty} f(t)\psi(\frac{t-b}{a})dt$$

Using in which, (t) is usually parent Wavelet, which essentially is a windowing quality, t is usually period, a and b are the dilation and translation guidelines respectively. The variables a and b each are constant guidelines with value to the period [11]. The practical deals of CWT are limited as to become experienced signals might also vary in nature, e.g., stationary destined to nonstationary guaranteed. Besides this, the information offered by the method of CWT may end up being extremely big, which evaluates data and choice producing difficult. The above trouble is usually resolved with the discrete wavelet transform (DWT), which a digitalized form of CWT and may be acquired without Faults. The DWT of any transmission x(t) can be displayed by

$$DWT(m,k) = \frac{1}{\sqrt{a_0^m}} \sum_n x(t)\psi\,(\frac{k - nb_0a_0^m}{a_0^m})$$

Method of where ψ(T) is the parent wavelet, a0 is climbing parameter, w0 is translation parameter, both a0 and m0 are features of an integer meters such that a = and b =, k is an integer that indicates to a quantity of a selected test of an insight signal [12]. The useful implementation of DWT is certainly carried out with the help of level blocking, i.e., One filtration system is usually a high pass filtration system and second is normally filtration system low pass filtration system. The DWT harm the received present day time signal into varied frequency phases, and this is usually carried out using down sample path of technique. The obtained stage current transmission is usually going by via low pass filtration system and extreme bypass filtration system together, as a result, broken into by extreme regularity component and a low-frequency component. This technique is usually typically recognized as the multi decision evaluation (MDE), i.e., Analyzing the signal at several and remarkable regularity amounts. The evaluation affords the approximate and fine detail coefficients. The approximate and component coefficients achieved by using down sample path. Those information and approximate coefficients comprise useful information, centered totally upon which the types of fault may become classified. This paper has followed the Daubechies parent wavelet of level four (Db4) for analysis of three-phase current because Db4 affords most correct consequences for electricity system signals. The assessed three stage particular modern is usually examined up to the degree of four for obtaining component and approximate coefficients. The precision and overall performance is dependent upon the level of decomposition, the decomposition offers achieved as very much as level four, which gives needed precision. The MDV coefficients are is utilized for developing the insight figures arranged for each types of fault e.g. faults including one phase and ground (LG), faults concerning two stages and ground (LLG), faults related to handiest any dual levels (LL) and triple collection (LLL) errors additionally known to as symmetrical fault. The comprehensive and careful declaration of these coefficients illustrate that the charge of the details coefficients is definitely exclusive for a provided type of fault. Those ideals are unique for ten particular designs of three stage transmitting range flaws [14]. The fine detail coefficients of level 3 and stage four are amount up, to type the enter figures established. There are total three signals particular to the three-stage currents;

correspondingly there are six component coefficients three for level three and three for four levels respectively.

Overall twenty-one of kind mixtures ten for level three and ten for stage four are designed structured entirely upon the component coefficients of the three section cutting-edge sign. Those twenty combos of precise ratios of three stage currents are utilized to make the inputs details arranged. This information arranged is usually uses for developing the suggested protocol. The Figure-1 describes attained three stage currents for healthy system. The three currents are well balanced and symmetric. Figure-3 describes the received three stage currents for series to floor fault on stage A, the distortion might be discovered. Those three stage altered currents when examined by using DWT presents unique ideals of approximate and component coefficients.

B. Back propagation neural network algorithm

The produced data from the simulation of three-phase transmitting network contain populace of data approximately the fault and the Information cannot be analyzed with any suitable shrewd artificial approach. Back propagation neural network protocol can become used for Fault category properly because it's much a development technique relevant to the faults where the details to end up being experienced in big, vague, redundant, altered and cannot categorize out via any linear development strategy.

In the complications of fault category, they're efficaciously relevant because of:

- They may be educated by using offline Information and also can be utilized online.
- There are several components which affect the Fault category, e.g., fault impedance, fault beginning position, range from the relaying factors and many others.
- The results of back propagation neural network Protocol are hold off much less control, reliable and accurate if it's kilometers Informed correctly and may be retrained very easily.
- The weight may become transform quickly, actually in at some stage in the feature teaching process.

The first back propagation neural network algorithm network offers four basic equipment in carrying out its total fault:

- Choice of populace- strategy the enter figures arranged which may arrive to be better parent
- Proceed over from the particular populace- achieving close to better solution, i.e., from the parent of greatest stage creation of latest and better off suspension springs
- Mutations of off-springs- removal of comparable solutions, i.e., on related off-springs is utilized in further choice

The success of mightiest and fittest-the the last answer, i.e., the acceptable results are to maintain and used. The overall performance of any back propagation neural network protocol is dependent upon the education of the community. The suggested strategy provides used powerful weights technique to ensure that the Protocol can end up being conversed without faults and quick.

C. Primary concepts of back propagation neural network algorithm and modeling of the back propagation neural network algorithm

The supplied paper has adopted two foundation features for growing the back propagation neural network algorithm. The first one is the Sigmoid feature and the second one is the Gaussian function. The combination of each provides the potential to deal with the nonlinearity worried within the hassle of fault detection and type. The typical advanced back propagation neural network algorithm version techniques the output by taking the sum of the output of Sigmoid characteristic and Gaussian characteristic. Subsequently, the proposed model is known as for as summation kind version. The very last output of the back propagation neural network algorithm is a feature of two outputs OΣ and Oπ, where Σ is summation characteristic, and π is aggregation characteristic. The output of summation component is given via

$$o_\varepsilon = {}^{1}/_{e^{-\lambda s * s\_net}} \quad (1)$$

Where $\boldsymbol{s_{net}} = \Sigma W_i X_i + X_{O\Sigma}$

The overall results of the product aggregation part can be denoted as

$$O_\pi = e^{-\lambda p * pi\_net^2} \quad (2)$$

Where,p _ net =$\pi W_i X_i * X_{O\pi}$and the final output of the MNN is given by (5).

$$MNN_{output} = O_\Sigma * W + O_\pi * (1 - \mathrm{W}) \quad (3)$$

D. Error minimization in MNN

The output of the back propagation neural network set of rules truly will include error, and this Fault is calculated and minimized with the aid of evaluating it with the favored output. Essentially the sum squared errors for convergence of version is used. The sum squared error Ep is given using

$$\mathrm{Ep} = \sum \mathrm{Ei} \quad (4)$$

where, Ei is error i.e. 2 Ei = (Yi –Oi) between input Yi and output Oi There are handiest ten forms of fault that could arise on a transmission line. The output matrix may be formed easily because of this, as most useful ten elements are sufficient for representing the all viable faults on a 3 phase transmission line. The Back propagation neural network set of rules model is educated and examined again and again that allows you to decrease the education time with an increase in accuracy and overall performance. The coding of Back propagation neural network algorithm is accomplished in MATLAB.

2. INTRODUCTION OF THE SIMULATED MODEL

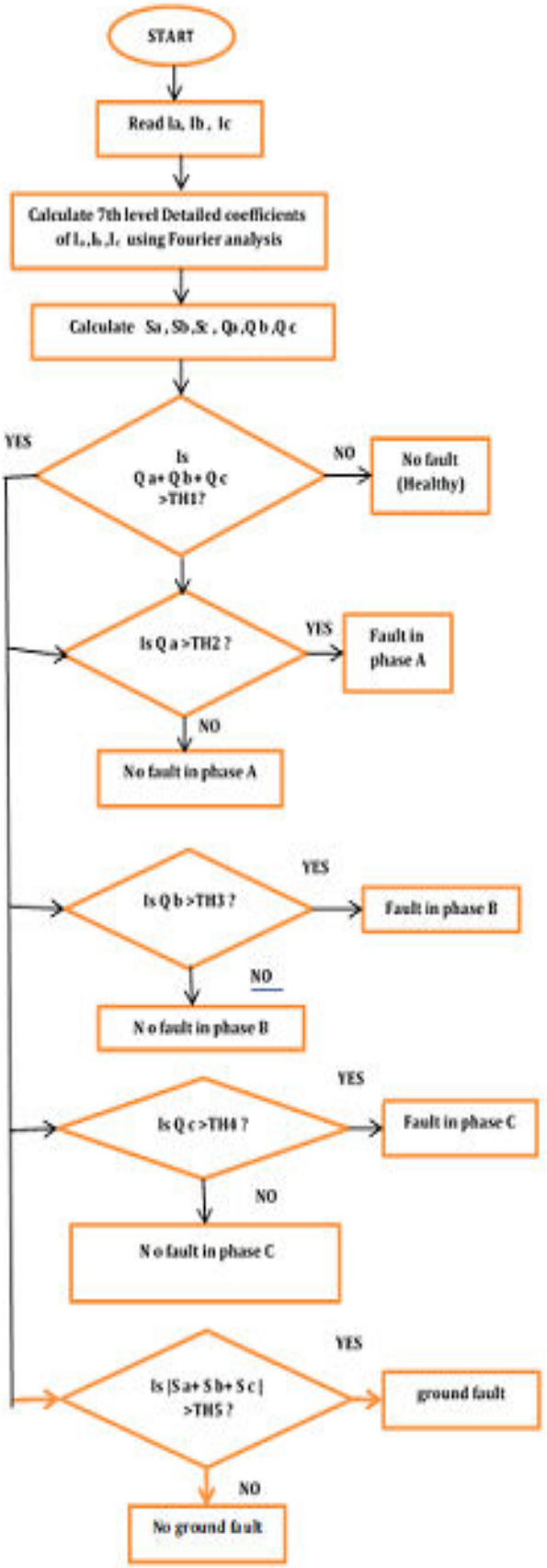

Figure-1. Flow chart for proposed fault classification algorithm.

A three-phase transmission line is developed within the sim power system toolbox of MATLAB for reading the unique varieties of faults. The single line diagram of developed model is shown in the Figure-4. Two generators are linked at both the ends of the transmission line. The respective 3 phase currents are measured at the relay location as shown in the Figure 4. The price of fault resistance for all three phases is numerous from 15 Ω to 60 Ω for ground faults and 0.10 Ω to 0.75 Ω for the line to line faults for generating the education patters respectively. The fault starting attitude plays very vital role in the importance of fault present day, which impacts the fault contemporary styles. The cost of fault starting perspective is likewise various from 00 to 900 so that all the feasible conditions can be taken into consideration. The sampling time is 80e-6 s, which cover all of the signals of pursuits. The fault resistance and fault starting attitude are numerous for this reason, and the model is simulated over and over for sizable observe of the fault patterns. The accuracy of the Back propagation neural network set of rules relies upon the scale of the training patterns; more is the size of education styles extra is the accuracy. The model is simulated for all possible ten varieties of fault for exceptional parameters to generate the information set.

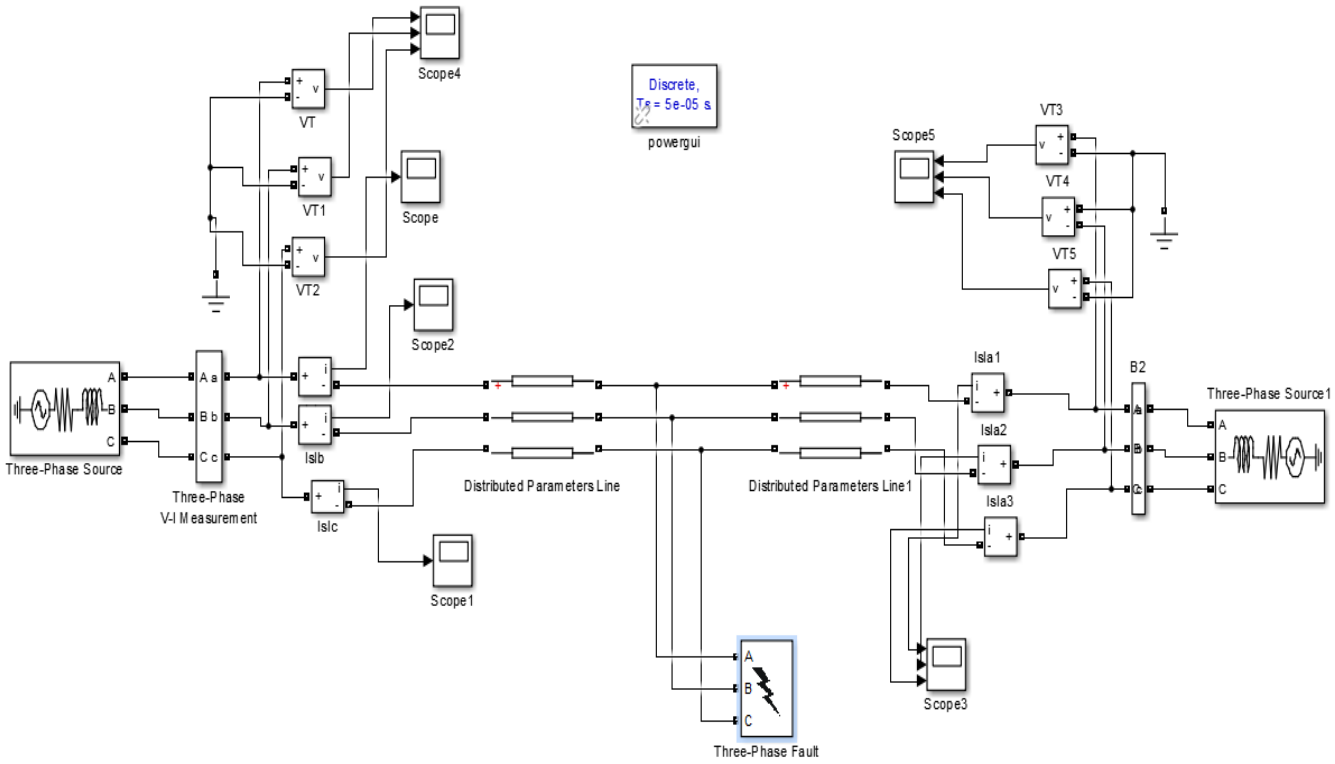

Figure-2. Proposed system Simulink model.

3. RESULTS AND DISCUSSIONS

After training, the proposed Back propagation neural network set of rules based method of fault category is tested with ninety new fault conditions for every kind of fault. Those situations blanketed exclusive fault locations, extraordinary inception angles from zero levels to 90 levels and special fault resistances zero Ω to 100 Ω. The graph in Figure-6 depicts fitness of the advanced Back propagation neural network algorithm, which is quite excellent.

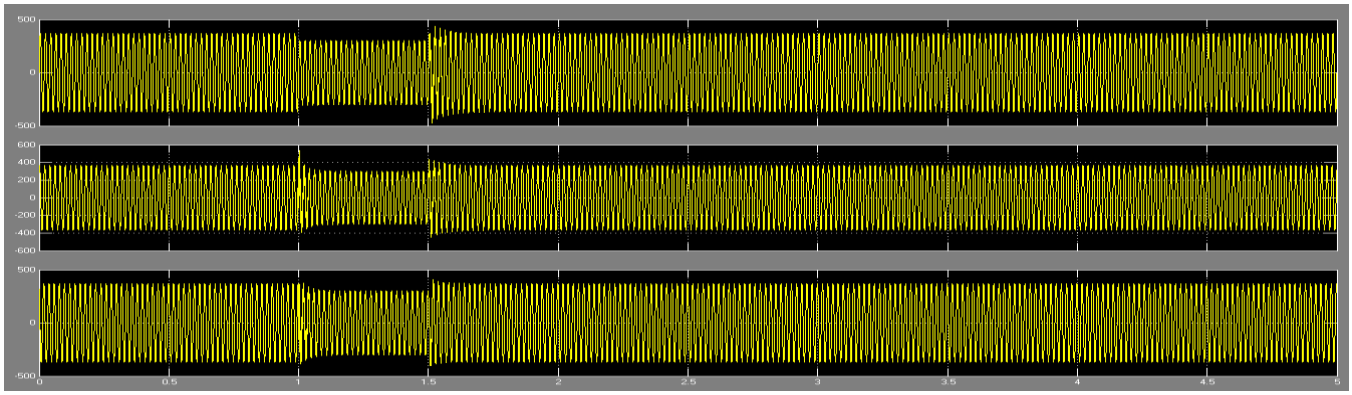

Figure-3. Generationof3 phase transmission lines with MNN controller at load perturbations.

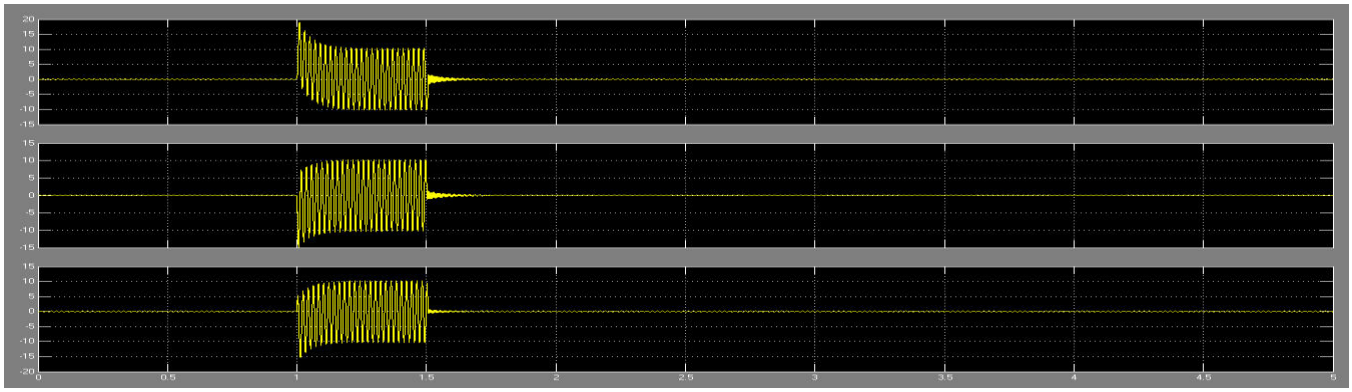

Figure-4. Performance 3 phase transmission lines with MNN controller at load perturbations.

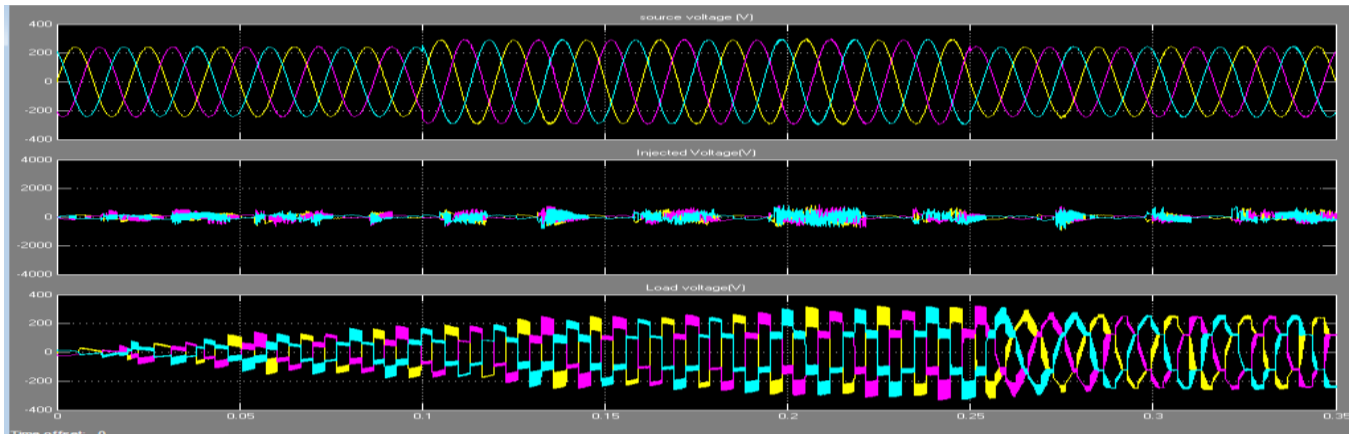

Figure-5. Performance 3 phase transmission lines Swell compensation results.

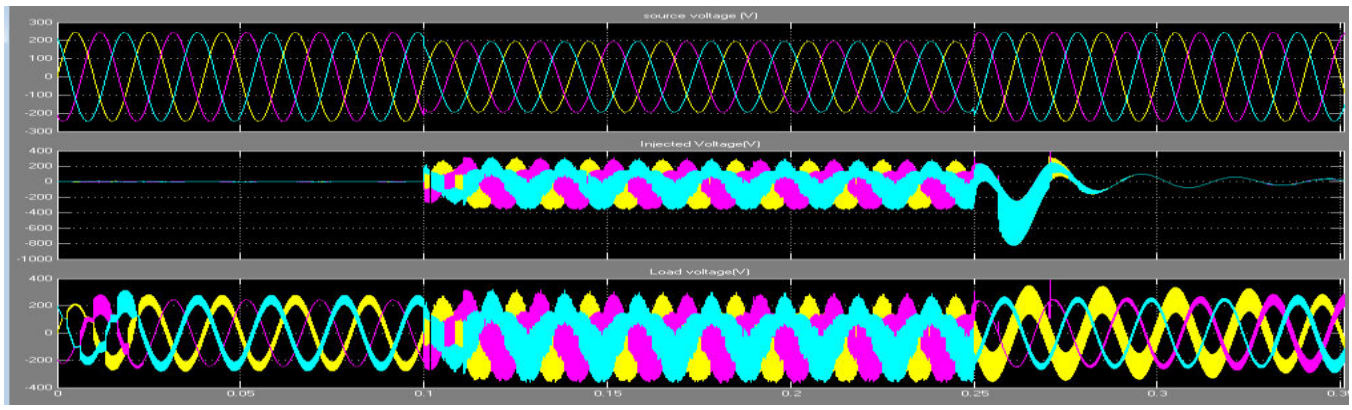

Figure-6. Performance 3 phase transmission lines SAG compensation result.

4. CONCLUSIONS

This paper has proposed a brand new simplified method for fault category on a 3 section transmission line community. The paper has applied the DWT and Back propagation neural network set of rules successfully for category and detection of faults on a three-phase transmission network. The paper has used the contemporary samples at one end of the transmission line for fault classification; it makes the sensible implementation of the scheme clean. The accuracy of the offered technique has been extended via increasing the training facts set of Back propagation neural network set of rules for extraordinary running situations, e.g., Fault inception attitude, fault resistance and ten one of a kind forms of faults. The scheme is tested time and again by using testing the set of rules for unique records set. The time taken toeducating the MNN is very much less and occupies less reminiscence space of the system. The consequences proven in the given figure helps that the supplied technique may be very effective and strong in the category of the fault kind. All efforts had been made in the modeling of the three-segment transmission line to fit with the actual existence transmission line. The mean of all errors of fault type is less than 7% of the system below examine.

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