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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

NEURAL NETWORK BASED OPTIMISATION OF HARMONICS ON AC-DC SIDES OF HVDC TRANSMISSION

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ABSTRACT

This paper investigates possibility of using Neural network for optimisation of AC-DC Harmonics of HVDC Transmission. Dependableness and potency of power transmission has been at the forefront of analysis for a few time and is presently being given essential thought owing to the inflated dependence on current. With the inflated demand for electricity, engineers area unit considering completely different strategies of provide arrangement to enhance the protection of electricity provide. speedy development within the field of power physical science devices particularly Insulated Gate Bipolar Transistors (IGBTs) has semiconductor diode to the High Voltage electrical energy (HVDC) transmission supported Voltage supply Converters (VSCs). This new innovative technology provides substantial technical and economical benefits for direct applications compared to standard HVDC transmission. The VSC primarily based HVDC transmission primarily consists of two convertor stations connected by a DC cable. This analysis work presents the performance analysis of VSC based HVDC Transmission . To reinforce the performance of the projected model, the management strategy is ruled by soft computing algorithmic rule i.e. Neural Network. Simulation and results show that the projected model is additional economical with the employment of Neural Network (NN).

KEYWORDS: Harmonic control, HVDC, Insulated-gate bipolar transistor (IGBT), Pulse-width modulation, Voltage Source Converters (VSCs), High Voltage Direct Current (HVDC), Radial Basis Network algorithm(RBN).

INTRODUCTION

HIGH Voltage Direct Current (HVDC) HIGH Voltage electricity (HVDC) technology has characteristics that makes it particularly attractive for certain transmission applications. transmission applications. HVDC transmission is well known as being advantageous for long-distance, bulk power delivery, asynchronous interconnections and long submarine cable crossings in [7] .HVDC has been utilized in power systems for fifty years. The interaction between HVDC convertor and alternative facility parts is of complicated nature and has been paid vital attention. The growing variety of HVDC links worldwide is making enhanced interest within the field of power quality and harmonic. HVDC converters introduce each AC and DC harmonics that area unit injected into the AC system and DC line severally in [1]. This model is often accustomed derive the system harmonic impedances at the purpose of common coupling as required in filter style. With the advances in semiconductor trade, DC cable system and control technology ,the Voltage supply device primarily based High Voltage electricity (VSC-HVDC) is receiving respectable interest in recent years for its helpful characteristics. Compared with typical HVDC with current supply converters, VSC-HVDC may be a comparatively innovative technology and has several benefits over the traditional one in several aspects. the event of power semiconductors devices, particularly IGBT's has led to the transmission of power based on Voltage source converters (VSCs). The VSC based mostly HVDC installation has many benefits compared to traditional HVDC like, independent control of active and reactive power, dynamic voltage support at the device bus for enhancing stability chance to feed to weak AC systems or maybe passive hundreds, reversal of power while not dynamical the polarity of dc voltage (advantageous in multi terminal dc system) and no necessities or quick communication between the two converter stations. HVDC lightweight is additionally known as voltage source converter HVDC or VSC HVDC. HVDC lightweight will management each active and reactive power severally while not commutation failure within the inverters, each device station consists of a VSC. The amplitude and phase angle of the converter AC output voltage will be controlled at the same time to realize speedy, freelance management of active and reactive power is bi-directional and continuous across the operative vary. For active power equalisation, one amongst the devices

operates on dc voltage control and different converter on active power control. Once dc line power is zero, the two converters, will operate as independent STATCOMs in [5]. Each VSC encompasses a minimum of three controllers for regulation active power outputs of individual VSC. It doesn't need reactive power compensator ensuing a lot of smaller equipment size. The VSC primarily based HVDC transmission principally consists of 2 convertor stations connected by a dc cable. Usually the magnitude of AC output voltage of convertor is controlled by Pulse Width Modulation (PWM) while not dynamical the magnitude of DC voltage.

ANALYSIS OF MODULATION

A converter is interconnecting two electrical networks to transmit wattage from one network to alternative, every network being coupled to a individual power generator station. The converter, having an AC side and a DC side, includes a bridge of semiconductor switches with gate turn- off capability coupled to an control system to supply a bridge voltage wave shape having a basic Fourier component at the frequency of the electrical network coupled to the AC side of the converter. The control system includes three inputs for receiving reference signals permitting controlling the frequency the amplitude and the phase angle of the fundamental Fourier component and the alternating voltage of the network coupled to the DC side of the converter. The principle characteristic of VCS-HVDC transmission is its ability to independently control the reactive and real power flow at every of the AC systems to that it is connected, at the point of Common Coupling (PCC) in [3].In constant to line commutated HVDC transmission, the polarity of the DC link voltage remains identical with the DC current being reversed to alter the direction of power flow. There are many popular methods are used to reduce the harmonics in order to get an effective The popular methods for high switching frequency are Sinusoidal PWM and Space Vector PWM. For low switching frequency methods are space vector modulation and selective harmonic elimination The SPWM technique has disadvantage that it cannot fully eliminate the low order harmonics as a result of this it cause loss and high filter demand is required in [11]. In Space Vector Modulation technique cannot be applied for unbalanced DC voltages

SHE PWM technique uses several mathematical strategies to eliminate specific harmonics such as 5th, 7th, 11th, and 13th harmonics. The popular Selective Harmonic Elimination technique is additionally referred to as fundamental switching frequency supported harmonic elimination Theory. Selective harmonic elimination control has been a a widely researched alternative to traditional pulse-width modulation technique. The elimination of specific low-order harmonics from a given voltage/current wave form achieved by Selective Harmonic Elimination (SHE) technique in [1]. During this technique there is no ought to calculate the firing angles for putting notches. Here, the lower order harmonics are reduced by the dominant harmonics of same order generated in opposite section by sine PWM inverter. This is achieved by varying the phase angle of the carrier wave of the sinusoidal Pulse Width Modulation (PWM) inverter , that generates the dominant harmonics with sidebands terribly near the amplitude of distinguished voltage harmonics exist within the system however in opposite polarity. During this technique initial, calculate the Total Harmonic Distortion (THD) for 3rd, 5th, 7th and 9th order harmonics. Then calculate the amplitude of those order (3rd, 5th, 7th, and 9th) harmonics with facilitate of Total Harmonic Distortion (THD). After calculating amplitude, injecting a similar order of harmonics in opposite amplitude therefore the resultant disorder wave is compared with triangular wave form and leads to in pulse are produced and will give to the switches. This technique is straightforward and easy implementation technique for reducing the Total Harmonic Distortion (THD).

SIMULATION MODEL

The simulation model is as shown in Figure 1 . The VSC converters are three-level bridge blocks victimization near ideal switch device model of IGBT/diodes. The control capability of IGBTs and its suitableness for top frequency switch has created this device the higher alternative over GTO and thyristor . Like all power electronic converters, VSC generate harmonic voltages and currents within the AC and DC systems connected. In an exceedingly simplified manner, from the AC system a VSC may be thought-about a harmonic current supply connected in parallel to the storage condenser. This behaviour is simply opposite to those of standard line commutated converters. Harmonics generated depends on the station topology, switch frequency of IGBTs and pulse pattern applied. victimization twelve pulse configurations rather than six pulse can improve harmonic condition each on AC and DC aspect. All harmonics are off out under ideal conditions.

Due to its inherent harmonic elimination capability the harmonic interface of VSC device is very tiny compared to the standard line commutated converters in [8]. But harmonics filters could be necessary on the AC and DC sides looking on the harmonics performance necessities each for AC and DC sides. AC system harmonic electrical phenomenon , DC line/cable electrical phenomenon and loss analysis.
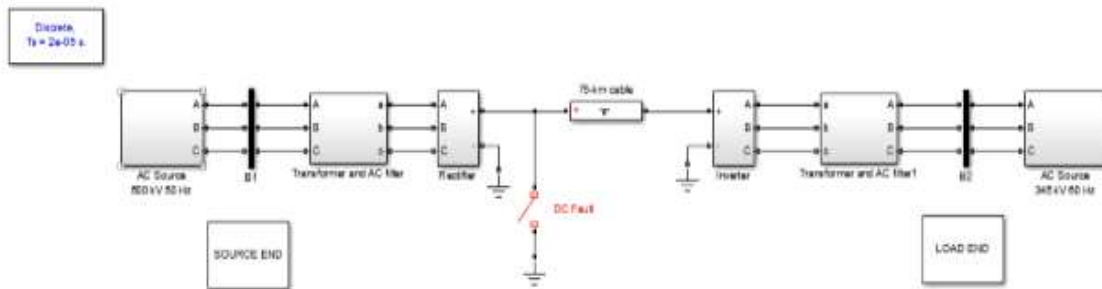
Fig1: HVDC Transmission model

In this simulation figure AC source 500 kv 50 Hz consisting of Three phase zero impedance voltage source connected to RLC circuit then fed to transformer comprise of AC filter through voltage-current measurement and rectifier to convert AC to pulsating DC and this same process for HVDC transmission is performed in inverter side. Like all power electronic converters, VSC generate harmonic voltages and currents in the AC and DC systems connected. In a simplified manner, from the AC system a VSC can be considered a harmonic current source connected in parallel to the storage capacitor. This behaviour is just opposite to those of conventional line commutated converters. To reduce the complex computing of PWM controlling, we have used soft computing and hence used Neural Networks which is explained in the following section.

ARTIFICIAL NEURAL NETWORKS

ANNs simulate the natural systems behaviour by means of the interconnection of process basic units referred to as neurons . Neurons area unit extremely connected with one another by means that of links. The neurons will receive external signals or signals coming back from different neurons tormented by an element referred to as weight. The output of the nerve cell is that the results of applying a selected operate, called a transfer operate, to the sum of its inputs, plus a threshold value called bias.With these general characteristics, it is able to develop different network structures. There are

ANNs simulate the natural systems behaviour by means of the interconnection of processing basic units called neurons . Neurons are highly related with each other by means of links.
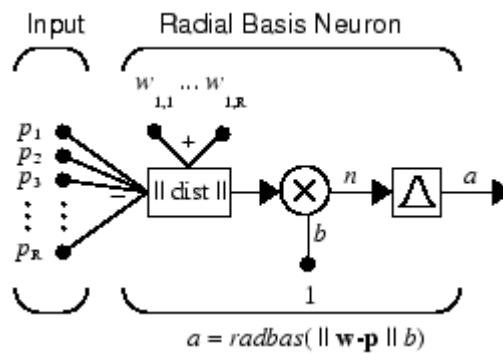

$$a = radbas(\| \mathbf{w}\text{-}\mathbf{p} \| \, b)$$

Fig .2. Radial basis model

The neurons can receive external signals or signals coming from other neurons affected by a factor called weight. The output of the neuron is the result of applying a specific function, known as a transfer function, to the sum of its inputs, plus a threshold value called bias. With these general characteristics, it is able to develop different network structures. There are

various obtainable neural network structures at intervals the developed system. during this paper ,Radial basis network is employed. The user will select the characteristic parameters. the training method ends once all conditions established by the user (maximum error, most coaching time, etc.) are consummated in [13].

A radial basis perform network is a synthetic neural network that uses radial basis functions as activation functions. The output of the network could be a linear combination of radial basis functions of the inputs and somatic cell parameters. Radial basis perform networks have several uses, as well as perform approximation, statistic prediction, classification, and system management .Radial basis networks encompass 2 layers: a hidden radial basis layer of S1 neurons, associate degree an output linear layer of S2 neurons. during this paper radial basis network primarily based neural network is enforced on electrical converter aspect as a result of harmonics is optimised in receiving aspect of HVDC Transmission. It reduces Total Harmonic Distortion as little as potential as compared to model while not neural network.

SIMUILATION RESULT

The simulation result for the simultaneous AC-DC power transmission the overall result for sending end voltages, receiving end voltages that shows the combined supply graph for AC with DC supply. Simulation results represent the waveform of Voltage ,Current, Magnitude of Vabc, Active and Reactive Power .
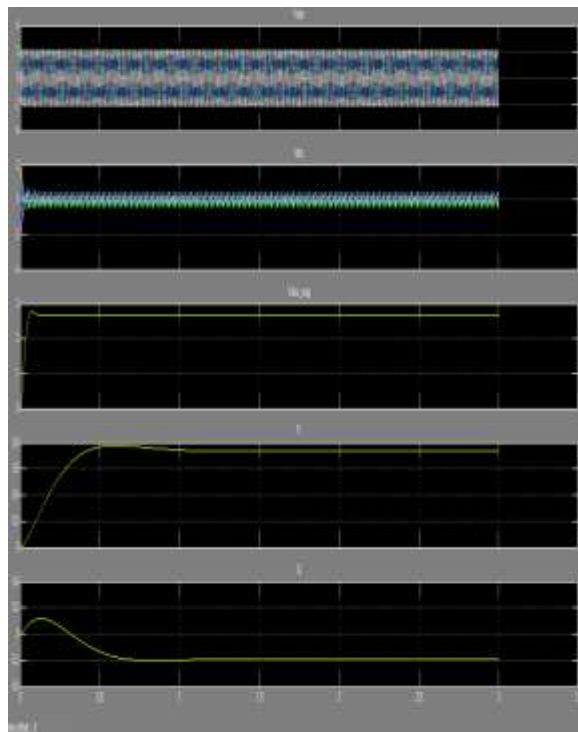

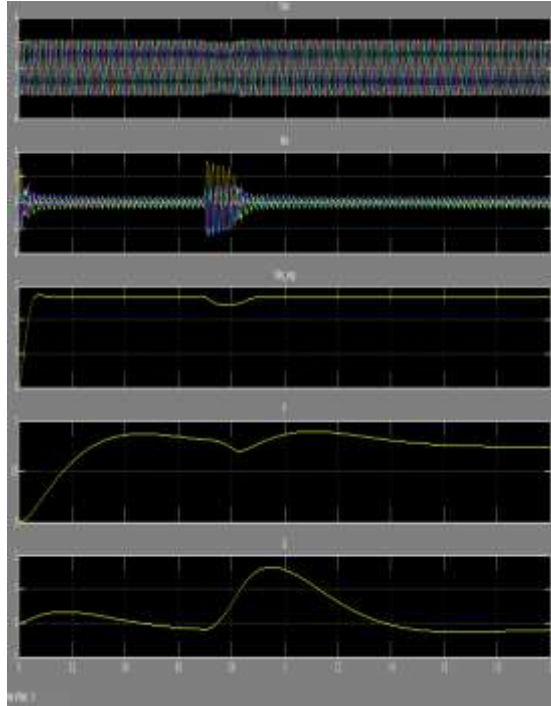*Fig.3.Dynamic response of system at sending side of HVDC before applying Neural Network*

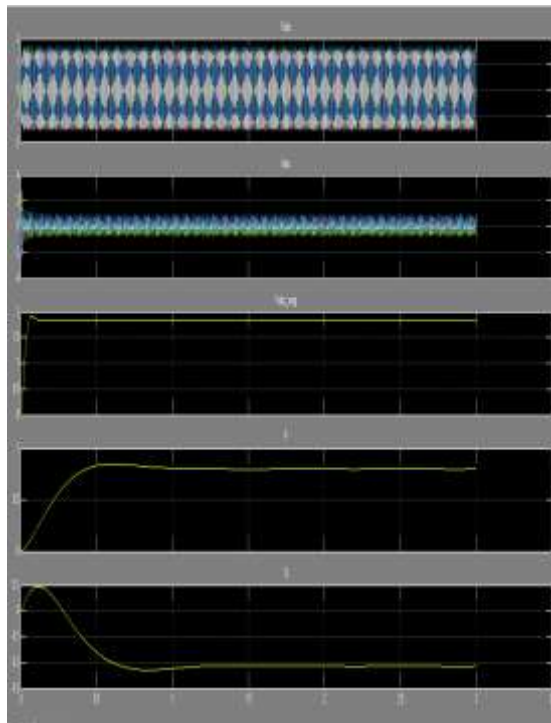*Fig.5. Dynamic response of system at sending side of HVDC after applying Neural Network*

Fig.4. Dynamic response of system at recieving side of HVDC before applying Neural Network
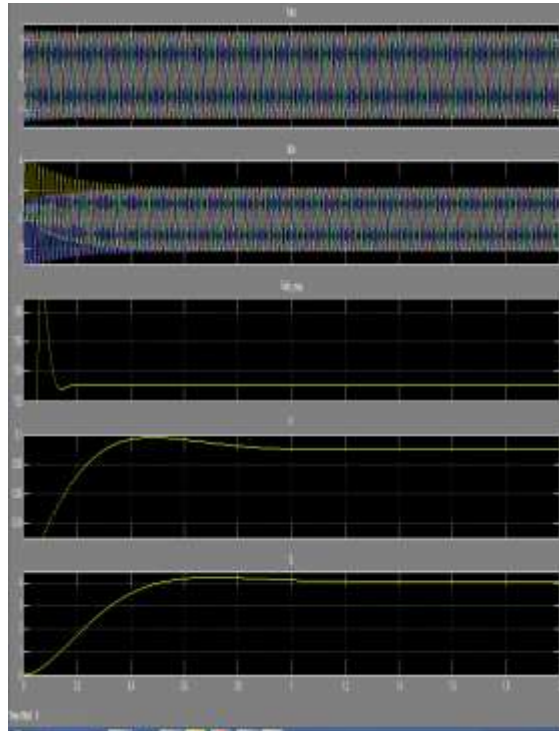
Fig.6. Dynamic response of system at receiving side of HVDC after applying Neural Network
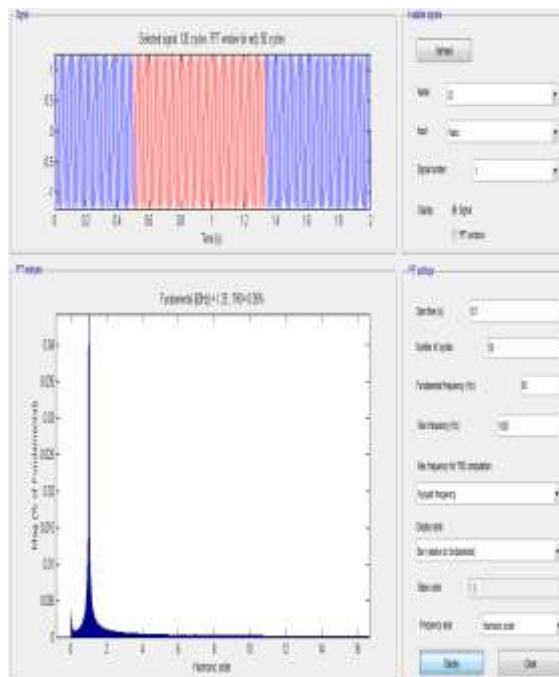

Fig.7. FFT Analysis

CONCLUSION

Increasing demand of wattage and need for bulk economical wattage gear result in the event of HVDC Transmission. HVDC Transmission nowadays become one in all the simplest different for transmittal bulk power over long distance with terribly less losses. controlled ways supported selective harmonic elimination pulse-width modulation (SHE-PWM) techniques provide all-time low attainable range of switch transitions. This feature conjointly ends up in all-

time low attainable level of convertor switch losses. Although, such kind of system offers complicated computing and having lesser potency than the soft computing. thus we've got used the Neural networks system to scale back the complexness thus on the planned algorithmic rule give a coffee loss, high performance system for interconnection of the HVDC system and expected to be providing prime quality HVDC system. There exist a lot of ways of soppy computing, formal logic is one in all them that offers higher ends up in computations. the long run analysis are going to be supported some hybrid technique Fuzzy logic and Neural Networks.

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