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Design and Implementation of SHE PWM in a Single Phase A.C.Chopper Using Generalized Hopfield Neural Network

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Abstract— In this paper, an implementation of Selective Harmonic Elimination Pulse Width Modulation (SHEPWM) as applied to a single phase AC chopper using Generalized Hopfield Neural Network (GHNN) is designed and implemented. The objective of this paper is to eliminate 5, 7, 11, 13 th order harmonics in the output voltage waveform of the AC chopper while retaining fundamental component to the desired value. The switching angles corresponds to the above objective are obtained by solving a set of non-linear algebraic transcendental equations. The problem is redrafted as an optimization problem and it is solved by using GHNN. An energy function is formulated for the above problem and a set of differential equations describing the behavior of GHNN were formed by using the derived energy function. These set of differential equations are stiff in nature and it is numerically solved by the semi-implicit midpoint rule based extrapolation method with suitable initial conditions. The initial conditions are obtained from a look up table. A MATLAB simulation was carried out and the FFT analysis of the simulated output voltage waveform confirms the effectiveness of the proposed method. Hence, the proposed method proves that it is much applicable in the industrial applications.

Index Terms— GHNN- Generalized Hopfield Neural Network, ANN-Artificial Neural Network, SHEPWM-Selective harmonic elimination pulse width modulation, FFT-Fast Fourier Transform

I. INTRODUCTION

AC voltage controller converts fixed magnitude ac into variable magnitude ac without any change in the frequency. AC voltage controllers have been widely used in applications such as soft starting of induction motors and speed control of pumps, industrial heating, line conditioners, and lighting dimmers. For power transfer in AC voltage controller mainly two types of control are normally used. They are on-off control and Phase angle control. In on-off control, the source is connected to load for n integral cycles and disconnected from load for m integral cycles. As the source connected to the load at the zero crossing of the input voltage and turn-off occurs at zero current, hence supply harmonics and radio frequency interference are very low. So it is used for heating loads. However, sub harmonic frequency components may be generated that are undesirable as they may set up sub harmonic resonance in the power supply system, cause lamp flicker, and may interfere with the natural frequencies of motor loads causing shaft oscillations.

In phase angle control, switches connect the load to the ac source for a portion of each cycle of input voltage. However, the main disadvantage of ac voltage controllers with phase angle control is the introduction of objectionable harmonics in the load voltage waveforms, particularly at reduced output levels. Therefore, it suffers from poor power factor, high lower order harmonic content in both of load voltage and source current.

The problems introduced by phase angle control or on-off control method can be overcome by pulse width modulation techniques. In pulse width modulation (PWM) control, the harmonic distortion can be reduced and the power factor can be improved by controlling the switching instants. There are two methodologies by which pulse width modulation can be achieved. One method is by the use of an explicit carrier based and other the method is carrier less method. In carrier-based method, a high frequency triangular carrier signal is compared with a reference signal gives the required gating signal to trigger the switches in the ac voltage controller. The significant example for carrier based PWM is sinusoidal PWM. In carrier less method, the switching instants required for the pulse generation are determined by the solutions obtained by solving a set of equations using from numerical methods or any of the optimization techniques. The significant example for carrier less PWM is SHEPWM technique [1-2].

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The Selective Harmonic Elimination (SHE) PWM technique is a widely used PWM method for the elimination of lower order harmonics and to retain the fundamental component at the desired level in the output voltage of single-phase ac-ac chopper. The higher order harmonics are eliminated by using passive filters or by the inherent low pass nature of electrical machines. The switching instants on the time axis are obtained by solving a set of nonlinear algebraic transcendental equations by two popular approaches. In the first approach, numerical iterative techniques such as the Newton Raphson method are proposed. The second approach views the problem as an optimization problem rather than an analytical problem. This approach involves forming of an objective function using the analytical equations, and then the objective function is minimized to get the solutions. Various optimization techniques have been adopted for minimizing the objective function such as Genetic Algorithm, Particle Swarm Optimization and Ant Colony Algorithm etc [3-4]. Nevertheless, these optimization techniques are difficult to be implemented in hardware and hence their real time implementation is a tedious one.

Neural network based optimization approach is also used for solving the above problem, in which feed forward artificial neural network [Back Propagation Network] is used for selecting suitable switching instants for the elimination of low-order harmonics and to retain the fundamental at the desired level. A non-deterministic method is used to solve the system of nonlinear algebraic transcendental equations to obtain the data set for the ANN training. This method also provides a set of acceptable solutions in the space where solutions are not obtained by analytical methods.The advantage of neural network based approach is it can be realized in hardware and hence real time implementation is possible.

In this paper, an implementation of selective harmonic elimination (SHEPWM) using Generalized Hopfield Neural Network (GHNN) to minimize 5th, 7th, 11th and 13th order harmonics while retaining the desired fundamental in a single phase AC-AC chopper is discussed. Generalized Hopfield Neural Network (GHNN) is a continuous time single layer feedback network. Figure.1 shows the block diagram of the proposed method. For the given normalized fundamental output, voltage the GHNN block is used to calculate the switching instants. These switching instants are given to the PWM generator, which generates the required gating signals to the chopper.

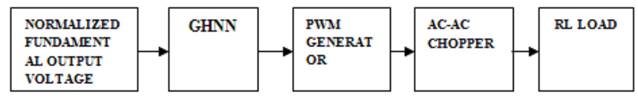

Fig.1 Block diagram of proposed method.

The paper has been organized as follows: Chapter II gives an overview of GHNN and its application to the solution of nonlinear algebraic transcendental equations. Chapter III describes the proposed method of application of GHNN to SHEPWM in AC Chopper. Chapter IV explains the MATLAB simulation. Chapter V Gives results of simulation. Finally, conclusions of this work are summarized in Chapter VI.

II. GHNN AND ITS APPLICATION TO THE SOLUTION OF NON-LINEAR ALGEBRAIC TRANSCENDAL EQUATION

A.Overview of GHNN

The continuous time single layer feedback networks are called "gradient type networks" in which time is assumed a continuous variable. Gradient type neural networks are the Generalized Hopfield Neural Networks (GHNN) in which the computational energy decreases continuously with time. The evolution of the system is in the general direction of the negative gradient of the energy function. The transients of the GHNN converge to one of the stable minima in the state space. The generalized electrical architecture of the GHNN is shown as in Figure.2

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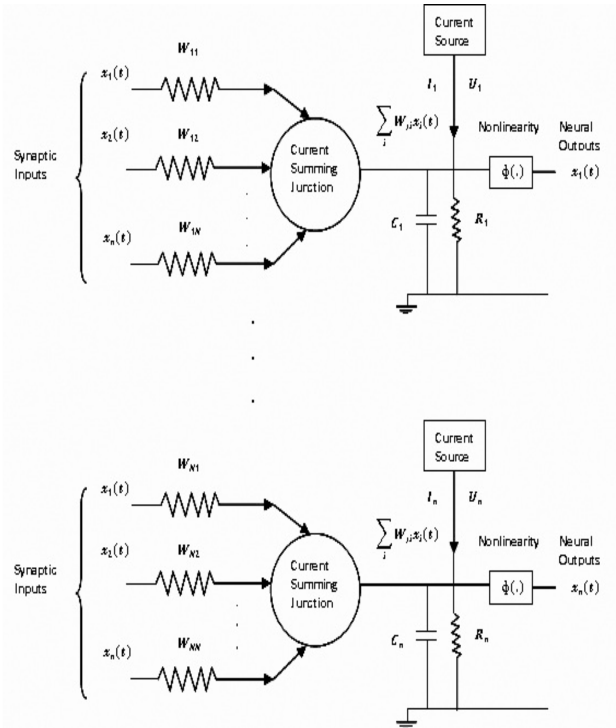

Fig.2. Generalized Architecture of GHNN.

It consisting of an interconnection of n' neurons, each one of which is assumed to have the same mathematical model described in equations (1) and (2). Where R_j represents leakage resistance, C_j represents leakage capacitance and φ (.) represents activation function. In physical terms, the synaptic weights W_{j1}, $W_{j2}, \ldots W_{jn}$ represent conductance's, and the respective inputs $x_1(t), x_2(t), \ldots, x_n(t)$ represent potentials; n is the number of inputs. These inputs are applied to a current summing junction characterized by low input resistance, unity current gain and high output resistance. It thus acts as a summing node for the input currents. The total current flowing toward the input node of the nonlinear element(activation function) in Figure.2 is therefore where the first(summation) term is due to the stimuli $x_1(t), x_2(t), \ldots, x_n(t)$ acting on the synaptic weights (conductances) W_{j1}, $W_{j2}, \ldots W_{jn}$ respectively, and the second term is due to the current source I_j representing an externally applied bias.

$$\sum_{i=1}^{N} w_{ji}\, x_i(t) + I_j \tag{1}$$

Let $u_j(t)$ denote the induced local field at the input of the nonlinear activation function. We may then express the total current flowing away from the input node of the nonlinear element as follows:

$$\frac{u_{j}(t)}{R_j} + C_j \frac{du_{j}(t)}{dt} \tag{2}$$

Where the first term is due to the leakage resistance R_j and the second term is due to leakage capacitance C_j. From Kirchoff's current law, we know that the total current flowing toward any node of an electrical circuit is zero. By applying Kirchoff's current law to the input node of the nonlinearity. We may define the dynamics of the network by the following system of coupled first-order differential equations by ignoring interneuron propagation time delays.

$$C_j \frac{du_{j}(t)}{dt} = -\frac{u_{j}(t)}{R_j} + \sum_{i=1}^{N} w_{ji}\, x_i(t) + I_j', \tag{3}$$

An assumption is made that the activation function relating the output $x_j(t)$ of neuron 'j' to its induced local field $u_j(t)$ is a continuous function and therefore differentiable. A commonly used activation function is the logistic function.

$$\varphi\,(u_j) = \frac{1}{1+exp(-u_j)} \quad , \qquad j=1,2,\ldots n \tag{4}$$

The energy function for the proposed model is given by

$$E = \left(\sum_i \int_0^{x_i} \frac{\varphi^{-1}(s)}{R_i} ds \sum_i \sum_j w_{ij} f_{ij}\,(x1, x2, \ldots, xN) x_i + \sum I_i x_i\right) \tag{5}$$

By using conventional methodology one can see that the derivative for the proposed energy function is always less than or equal to zero, i.e. $\frac{dE}{dt} < 0$ and energy of the system is thus bounded.

B. Application of GHNN to the solution of nonlinear equations

Let us consider a set of nonlinear algebraic equations given below:

$$\begin{aligned} f_1(x_1, x_2, \ldots, x_j \ldots x_n) &= P_1 \\ f_2(x_1, x_2, \ldots, x_j \ldots x_n) &= P_2 \\ &\vdots \\ f_j(x_1, x_2, \ldots, x_j \ldots x_n) &= P_j \\ f_N(x_1, x_2, \ldots, x_j \ldots x_n) &= P_N \end{aligned} \tag{6}$$

In the above equations $f_j(.)$ is a function of variables $x_1, x_2, \ldots, x_j \ldots x_n \in \Re$ and $P_j \in \Re$ is a real constant. Our objective is to find the values for variables $x_1, x_2, \ldots, x_j \ldots x_n$ such that it satisfies the equation (8).To obtain the solution using proposed approach an energy function has to be

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formulated. The energy function for the above set of equations is derived as follows:

$$E = \sum_j^n ((g_j(.))^2 \tag{7}$$

Where

$$g_j(.) = (f_j(x_1, x_2, \dots, x_j \dots x_n) - P_j) \tag{8}$$

Equations (9) and (10) have been used for designing the proposed network. The number of neurons in network is equal to the number of variables whose value is to be determined. In the given problem, we have 'n' number of variables and hence the network should have 'n' number of neurons. The network dynamics are governed by following differential equations:

$$\frac{du_j}{dt} = -\frac{\partial E}{\partial x_j} \tag{9}$$

$$x_j = \varphi(u_j), j = 1,2\dots n \tag{10}$$

Where u_j is the net input to the j^{th} neuron in the network and x_j is its output. In this application, the function $\varphi_j(.)$ is a linear input – output transfer function for the 'j' the neuron. Calculating the partial derivatives of Equation (10) with respect to unknown variables $x_1, x_2, \dots, x_j \dots x_n$ and colleting, the terms of identical order will results in Hopfield equations like form. The coefficients and constants in the available expression give the weights and bias values for the network respectively. A suitable numerical algorithm is used to solve the differential equations governing the network dynamics.

III. APPLICATION OF GHNN TO SHEPWM

A standard single phase AC-AC Chopper is shown as in Fig. 3 is used to generate the waveform shown as Fig.4.

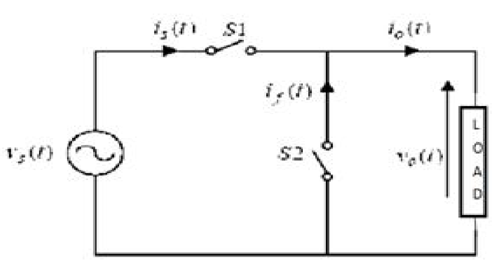

Fig. 3. Single Phase AC-AC Chopper

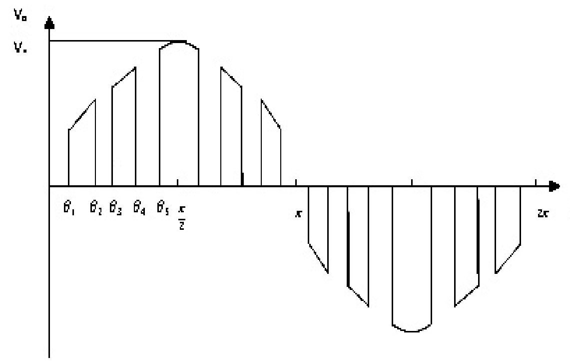

Fig. 4.Output Voltage Waveform

A.Formulation of the Transcendental Equations

The Fourier series expression for the output voltage waveform shown as in Figure. Is given dy the following equation

$$v_0 = \sum_{n=1}^{\infty} A_n \sin(n\omega t) + B_n \cos(n\omega t) \tag{11}$$

Where B_n=0 for n=1,2,3…and thus the above equation reduces to:

$$v_0 = \sum_{n=1,3,5..}^{\infty} A_n \sin(n\omega t) \tag{12}$$

The value of A_n is computed as

$$A_n = \frac{2Vm}{\pi}\sum_{i=1}^{M}(-1)^i\left(\sin\frac{(n-1)\theta_i}{(n-1)} - \sin\frac{(n+1)\theta_i}{(n+1)}\right) \tag{13}$$

Where n=1,5,7,11,13 ;
i=1,2,3,4,5;

The fundamental component is given by

$$A_1 = \frac{2Vm}{\pi}\sum_{i=1}^{5}(-1)^i\left(\theta_i - \sin\frac{2\theta_i}{2}\right) \tag{14}$$

Given a desired fundamental voltage V_1 and for the elimination 5,7,11 and 13th harmonics, the problem here is to determine the switching angles $\theta_1, \theta_2, \theta_3, \theta_4$ and θ_5 such that

$$-\theta_1 + \sin\frac{2\theta_1}{2} + \theta_2 - \sin\frac{2\theta_2}{2} - \theta_3 + \sin\frac{2\theta_3}{2} + \theta_4 - \sin\frac{2\theta_4}{2} - \theta_5 + \sin\frac{2\theta_5}{2} + \frac{\pi}{2} = M$$

$$-\sin\frac{4\theta_1}{4} + \sin\frac{6\theta_1}{6} + \sin\frac{4\theta_2}{4} - \sin\frac{6\theta_2}{6} - \sin\frac{4\theta_3}{4} + \sin\frac{6\theta_3}{6} + \sin\frac{4\theta_4}{4} - \sin\frac{6\theta_4}{6} - \sin\frac{4\theta_5}{4} + \sin\frac{6\theta_5}{6} = 0$$

$$-\sin\frac{6\theta_1}{6} + \sin\frac{8\theta_1}{8} + \sin\frac{6\theta_2}{6} - \sin\frac{8\theta_2}{8} - \sin\frac{6\theta_3}{6} + \sin\frac{8\theta_3}{8} + \sin\frac{6\theta_4}{6} - \sin\frac{8\theta_4}{8} - \sin\frac{6\theta_5}{6} + \sin\frac{8\theta_5}{8} = 0$$

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$$-\sin\frac{10\theta_1}{10}+\sin\frac{12\theta_1}{12}+\sin\frac{10\theta_2}{10}-\sin\frac{12\theta_2}{12}-\sin\frac{10\theta_3}{10}+\sin\frac{12\theta_3}{12}+\sin\frac{10\theta_4}{10}-\sin\frac{12\theta_4}{12}-\sin\frac{10\theta_5}{10}+\sin\frac{12\theta_5}{12}=0$$

$$\sin\frac{12\theta_1}{12}+\sin\frac{14\theta_1}{14}+\sin\frac{12\theta_2}{12}-\sin\frac{14\theta_2}{14}-\sin\frac{12\theta_3}{12}+\sin\frac{14\theta_3}{14}+\sin\frac{12\theta_4}{12}-\sin\frac{14\theta_4}{14}-\sin\frac{12\theta_5}{12}+\sin\frac{14\theta_5}{14}=0$$

(15)

Where $M=\frac{V_m^*}{\frac{2V_m}{\pi}}$

V_m^* - Maximum value of fundamental output voltage
V_m – maximum value of the supply voltage
M-Normalized fundamental output voltage

This is a system of five nonlinear algebraic transcendental equations in the unknown's θ_1, θ_2, θ_3, θ_4 and θ_5.

B. Formulation of the Energy Function:

The energy function for the above system of equations is given by

$$E=-0.5(-\theta_1+\sin\frac{2\theta_1}{2}+\theta_2-\sin\frac{2\theta_2}{2}-\theta_3+\sin\frac{2\theta_3}{2}+\theta_4-\sin\frac{2\theta_4}{2}-\theta_5+\sin\frac{2\theta_5}{2})^2+(-\sin\frac{4\theta_1}{4}+\sin\frac{6\theta_1}{6}+\sin\frac{4\theta_2}{4}-\sin\frac{6\theta_2}{6}-\sin\frac{4\theta_3}{4}+\sin\frac{6\theta_3}{6}+\sin\frac{4\theta_4}{4}-\sin\frac{6\theta_4}{6}-\sin\frac{4\theta_5}{4}+\sin\frac{6\theta_5}{6})^2+(-\sin\frac{6\theta_1}{6}+\sin\frac{8\theta_1}{8}+\sin\frac{6\theta_2}{6}-\sin\frac{8\theta_2}{8}-\sin\frac{6\theta_3}{6}+\sin\frac{8\theta_3}{8}+\sin\frac{6\theta_4}{6}-\sin\frac{8\theta_4}{8}-\sin\frac{6\theta_5}{6}+\sin\frac{8\theta_5}{8})^2+(-\sin\frac{10\theta_1}{10}+\sin\frac{12\theta_1}{12}+\sin\frac{10\theta_2}{10}-\sin\frac{12\theta_2}{12}-\sin\frac{10\theta_3}{10}+\sin\frac{12\theta_3}{12}+\sin\frac{10\theta_4}{10}-\sin\frac{12\theta_4}{12}-\sin\frac{10\theta_5}{10}+\sin\frac{12\theta_5}{12})^2+(-\sin\frac{12\theta_1}{12}+\sin\frac{14\theta_1}{14}+\sin\frac{12\theta_2}{12}-\sin\frac{14\theta_2}{14}-\sin\frac{12\theta_3}{12}+\sin\frac{14\theta_3}{14}+\sin\frac{12\theta_4}{12}-\sin\frac{14\theta_4}{14}-\sin\frac{12\theta_5}{12}+\sin\frac{14\theta_5}{14})^2$$

(16)

The differential equation governing the behavior of the network dynamics is calculated using energy function and is given as follows:

$$\frac{d\theta_1}{dt}=-\frac{\partial E}{\partial\theta_1}$$
$$\frac{d\theta_2}{dt}=-\frac{\partial E}{\partial\theta_2}$$
$$\frac{d\theta_3}{dt}=-\frac{\partial E}{\partial\theta_3}$$
$$\frac{d\theta_4}{dt}=-\frac{\partial E}{\partial\theta_4}$$
$$\frac{d\theta_5}{dt}=-\frac{\partial E}{\partial\theta_5} \qquad (17)$$

C. Solution of Non-Linear Algebraic Transcendental Equations

The flow chart of the semi-implicit mi point rule based extrapolation method to solve a set of five non-linear algebraic transcendental equations[6] is shown as in Fig.5.

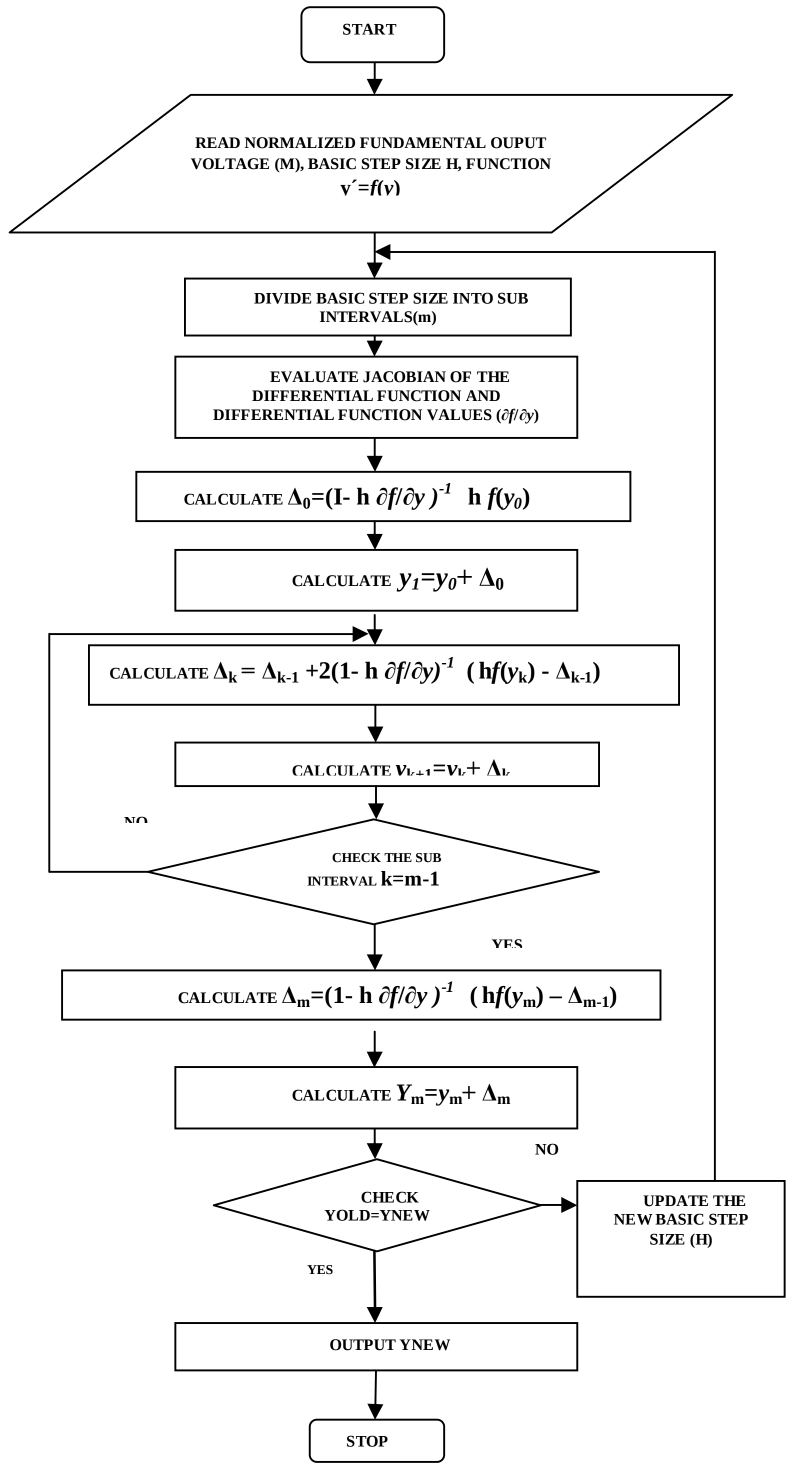

Fig. 5 Flowchart for semi explicit extrapolation method to solve non-linear equations

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IV. SIMULATION

In this section the matlab simulation and implementation using the derived mathematical model is explained.

A.MATLAB/SIMULINK SIMULATION

The MATLAB/SIMULINK simulation diagram of the proposed system is shown as in Fig.6. It consist of three main sections of main power circuit, switching section and load . The power circuit of single phase AC-AC Chopper simulation model is formed by using main power module and freewheeling module, both consists of four diodes and one IGBT. The switching section generates switching angles for the various normalized fundamental output voltages that lies in between 0.02 and 1.16.

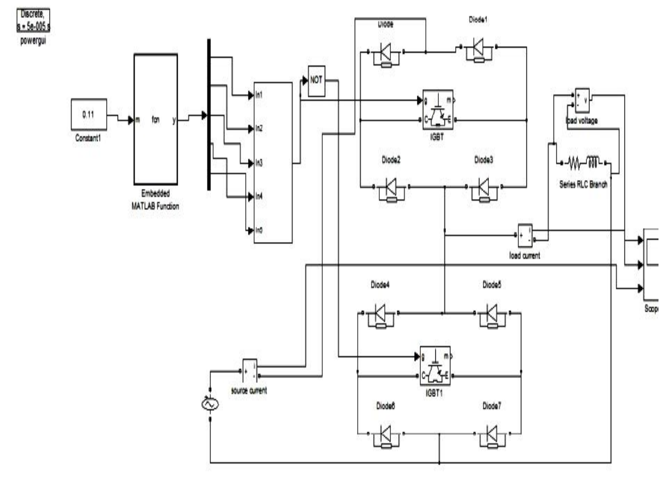

Fig. 6 MATLAB SIMULINK Simulation diagram of the proposed method

The switching section consists of two sub systems. One of these two subsystems is a MATLAB embedded functionblock1 contained the m file of the GHNN, which accepts different normalized fundamental output voltages and thus provides the required switching instants $\theta_1, \theta_2, \theta_3, \theta_4$ and θ_5. The switching instants derived are in radians. The second subsystem consists of a triangular wave generator and a gating system. The triangular wave is synchronized with the supply voltage. The synchronization is achieved by detecting the zero crossing point of the supply voltage. The main line derived AC sample is first attenuated and then fed to the zero cross detector. At the front end there are two diodes connected anti parallel for limiting the voltage to be applied across the input terminals of the comparator. At the output of the comparator, a train of positive and negative half cycles of square wave is obtained. The positive half cycles of square pulses are separated by rectification process. The rectified positive half cycles is used as timing references for the switching instants of the positive half cycle of the AC chopper. The positive square wave is then phase shifted by 180 degree, by a transistorized phase inverter to be used for timing reference for the switching instants of the positive half cycle of the AC chopper. The triangular wave generator generates a triangular wave that rises linearly in 5 ms from 0 to 1.57 radians and falls to zero at the same rate at a frequency of same as that of the chopper output frequency. A comparison of this triangular wave against the switching instants produced the embedded MATLAB function block gives the 'on and off' pulses required to drive the IGBT switches as shown in Fig.7. The train of 'on and off' pulses thus produced are used to drive main power module of chopper The same train of pulses just delayed by 10 milliseconds drives freewheeling module of chopper.

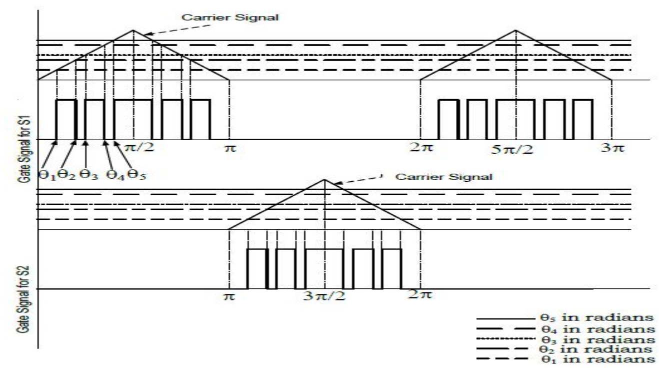

Fig. 7 The triangular wave, switching instants and the generated gate signals.

V. SIMULATION RESULTS AND DISCUSSIONS

The AC Chopper was studied with a AC supply of 110V rms and checked with a RL load of R=50Ω and L=150mH.The simulated results for Chopper output voltage waveform and source current for different normalized fundamental output voltages and the corresponding FFTs are shown from Fig.8 to Fig.16

A. MATLAB/SIMULINK SIMULATION RESULTS

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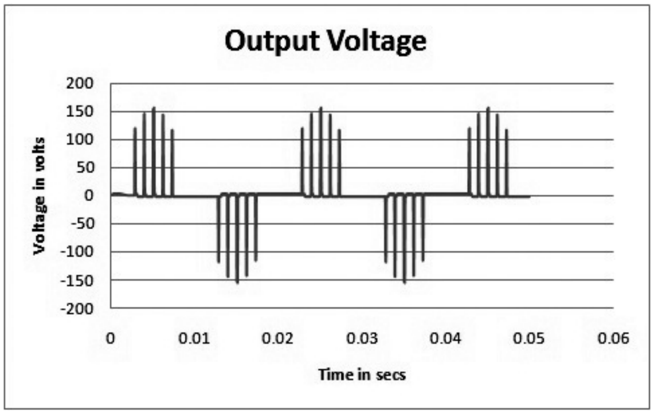


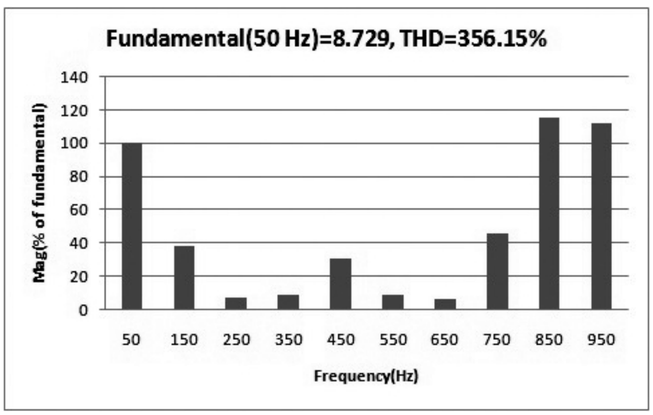
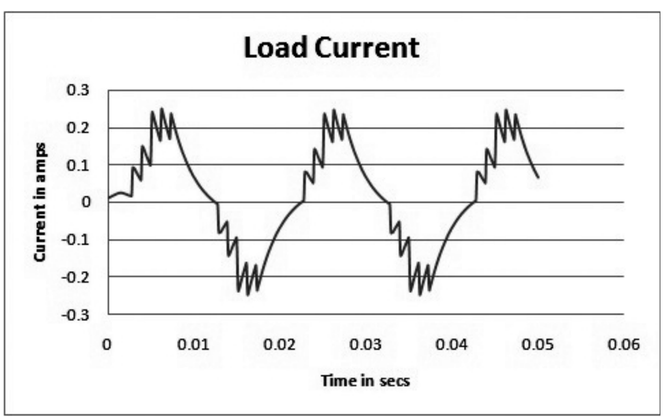


Fig. 8 Chopper output voltage waveform and FFT for Normalized Fundamental output voltage M=0.11



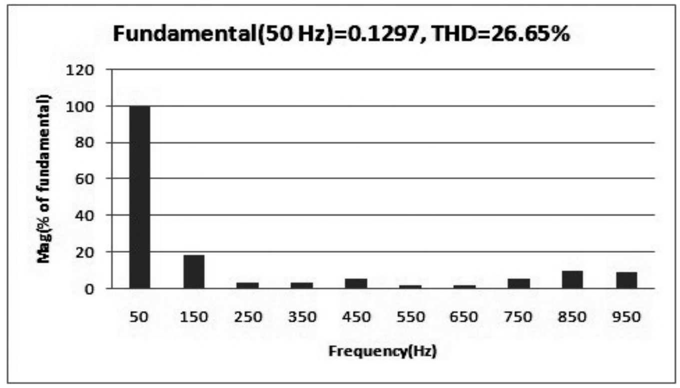
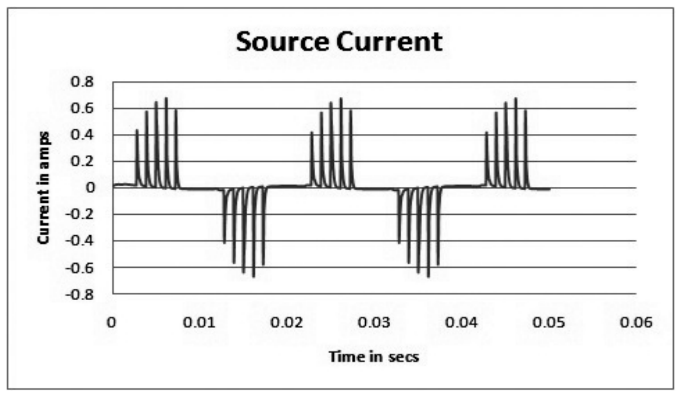


Fig. 9 Chopper Load current waveform and FFT for Normalized Fundamental output voltage M=0.11



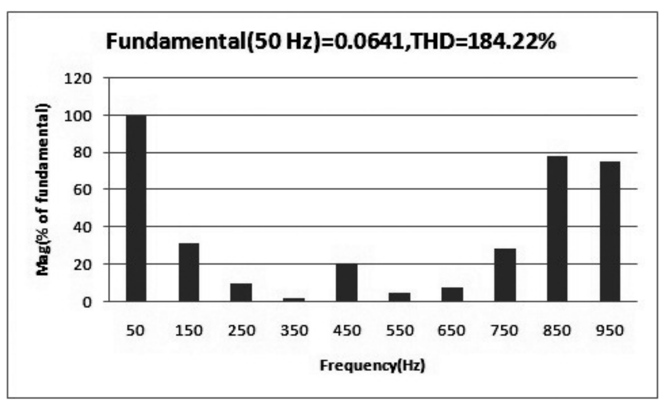


Fig. 10 Chopper source current waveform and FFT for Normalized fundamental output voltage M =0.11

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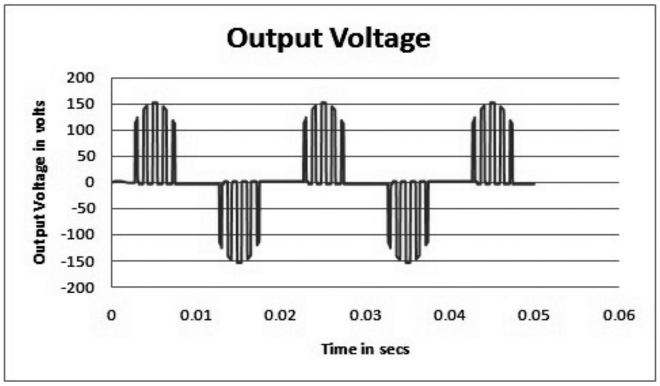


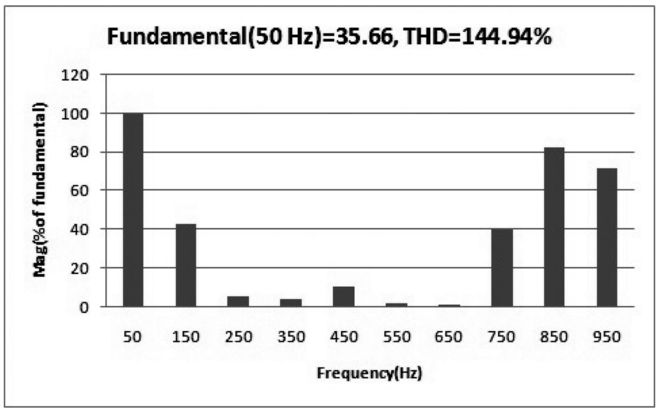
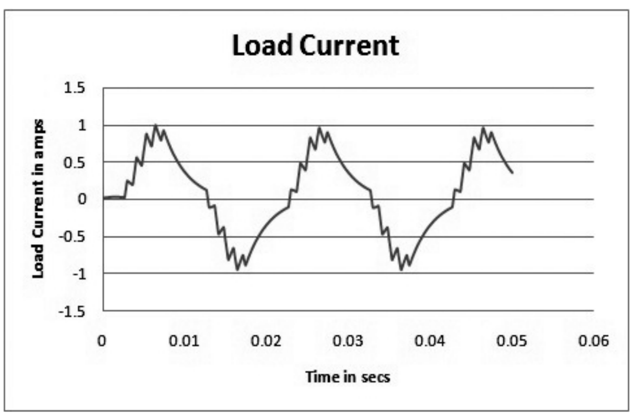


Fig.11 Chopper output voltage waveform and FFT for Normalized fundamental output voltage M=0.575



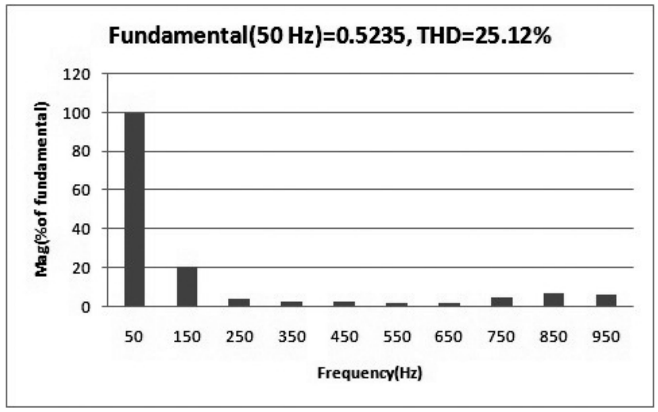
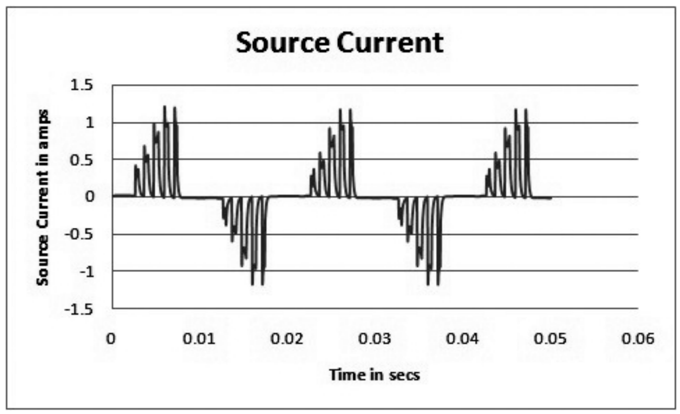


Fig.12 Chopper Load current waveform and FFT for Normalized fundamental output voltage M=0.575



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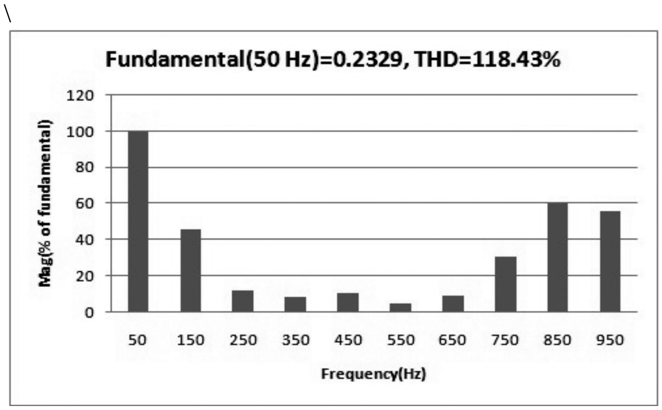

Fig. 13 Chopper source current waveform and FFT for Normalized fundamental output voltage M =0.575

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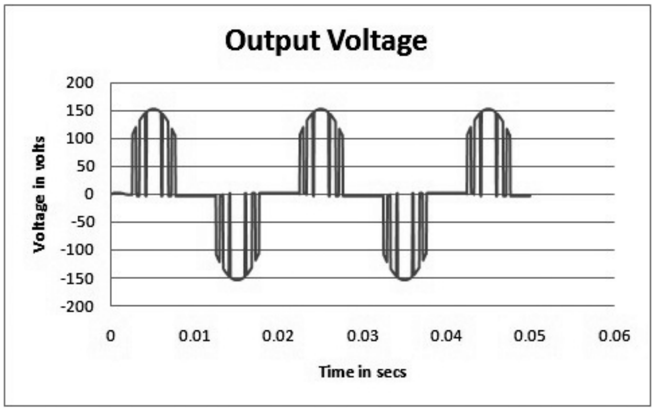


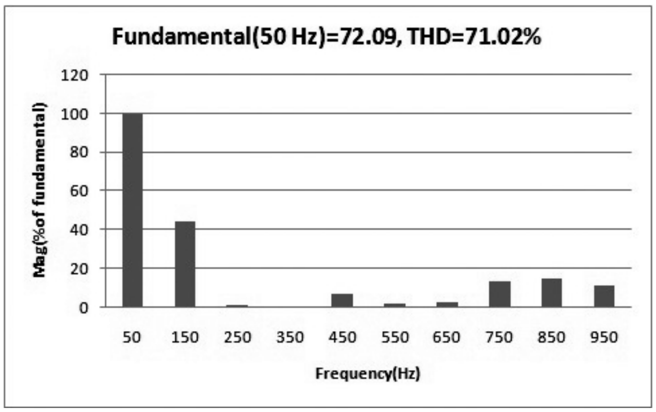
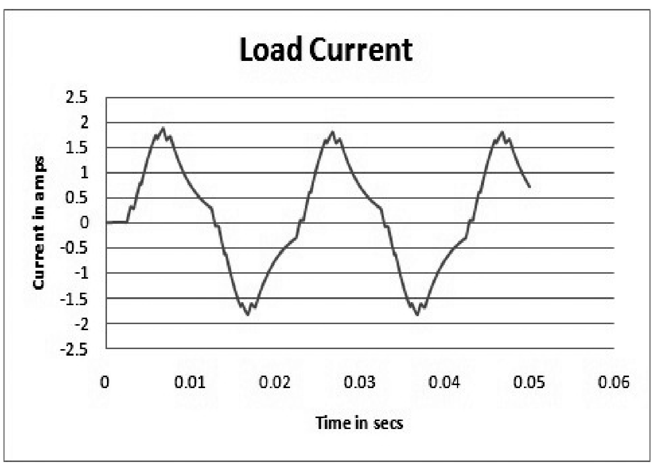


Fig. 14 Chopper output voltage waveform and FFT for Normalized fundamental output voltage M=1.15



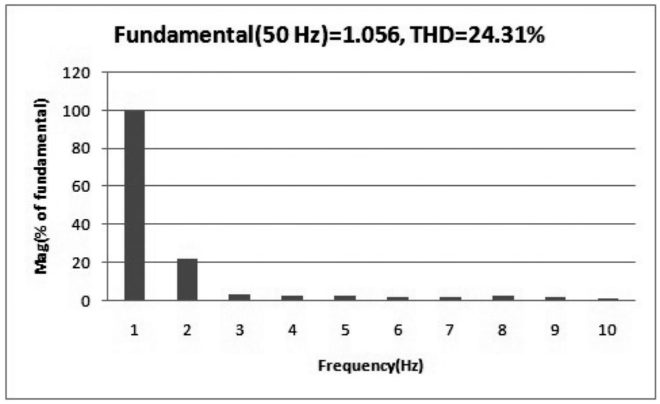
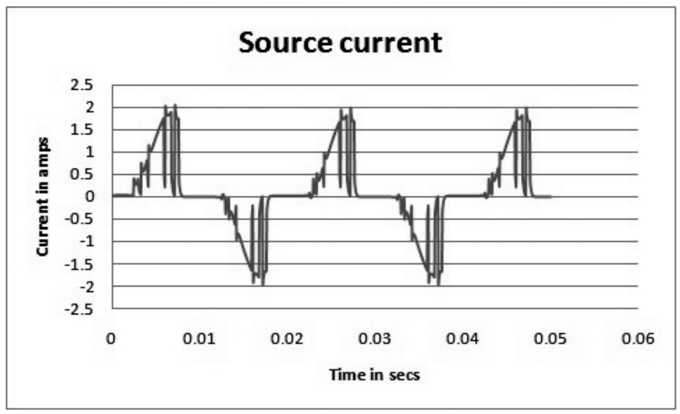


Fig. 15 Chopper Load current waveform and FFT for Normalized fundamental output voltage M =1.15



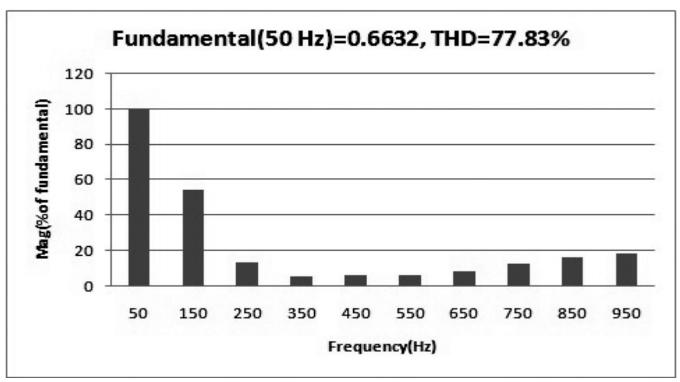


Fig. 16 Chopper source current waveform and FFT for Normalized fundamental output voltage M =1.15

It can be noted that the MATLAB simulation results reveals that the 5th, 7th,11th and the 13th order harmonics are minimized and the desired fundamental is retained for

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randomly selected modulation indices of 0.11, 0.575 and 1.15.The results of MATLAB simulation is shown in Table-I.

TABLE I
COMPARATIVE TABLE OF RESULTS OBTAINED FROM THE SIMULATION

Normalized Fundamental Output Voltage M=0.11

Harmonic order	Simulated Value of voltage in RMS	Percentage of amplitude relative to fundamental
Fundamental	8.729	100
5th harmonic	0.597	6.84
7th harmonic	0.768	8.80
11th harmonic	0.7576	8.68
13th harmonic	0.529	6.07

Normalized Fundamental Output Voltage M =0.575

Harmonic order	Simulated Value of voltage in RMS	Percentage of amplitude relative to fundamental
Fundamental	35.66	100
5th harmonic	0.514	1.29
7th harmonic	0.434	1.09
11th harmonic	0.374	0.94
13th harmonic	0.793	1.99

Normalized Fundamental Output Voltage M =1.15

Harmonic order	Simulated Value of voltage in RMS	Percentage of amplitude relative to fundamental
Fundamental	71.09	100
5th harmonic	0.319	3.24
7th harmonic	0.127	2.33
11th harmonic	0.247	1.49
13th harmonic	1.005	1.22

From table-I, it can be noted that the MATLAB simulation results confirms that the 5th, 7th,11th and the 13th order harmonics are minimized and the desired fundamental is retained for randomly selected Normalized fundamental output voltage of 0.11, 0.575 and 1.15.

VI.CONCLUSION

In this paper an implementation of SHE PWM to minimize the 5th, 7th, 11th and 13th order harmonics in the output voltage waveform of single phase AC-AC Chopper while retaining the desired fundamental is discussed. In this paper, the initial conditions for solving the differential equations governing the behavior of GHNN are obtained from a look up table. More over this paper uses semi-implicit midpoint rule based extrapolation method for solving the differential equations, which is faster than any other implicit algorithm. Therefore, the dynamic response of the system is faster. The efficiency of the proposed technique has been validated using simulation The potential application or use of the proposed algorithm implementation is in a very wide range of low, medium, and high power applications including residential applications, renewable energy systems, distributed generation, and automotive. The proposed method produces consistent results and highly reliable, hence it has potential to solve varieties of optimization problems

REFERENCES

[1]. Muhammed H. Rashid, "Power Electronics Circuits, Devices and Applications", *Third Edition, Dorling Kindersley of India, New Delhi-*17,2011,pp-265-280

[2].Flores-Arias.J.-M. ; Moreno-Muñoz.A. ; Domingo-Perez.F. ; Pallares-Lopez, V. ; Gutierrez, D."Voltage regulator system based on PWM ACchopper converter" *IEEE International Symposium on Industrial Electronics (ISIE*), 2011, Page(s): 468 – 473

[3].Sundareswaran.K. ; Kumar.A.P. " Voltage harmonic elimination in PWM AC chopper using genetic algorithm" *Electric Power Applications, IEE Proceedings* Volume.151 , Issue.1, Jan. 2004, Pages:26 – 31

[4].Sadr, S.M. , Monfared, M. , Mashhadi.H.R. "Application of PSO for selective harmonic eliminationin a PWM AC/AC voltage regulator" , *International eConference on Computer and Knowledge Engineering (ICCKE)*,2012 Page(s): 62 – 65

[5]. James A. Anderson, "An Introduction to Neural Networks" *Prentice Hall of India, New Delhi-1*, 1998, pp. 401-416.

[6].H.Rosenbrock; "Some general implicit processes for the numerical solution of differential equations", : *Indian Institute of Technology,Guwahati.* On 1st June 2013