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Comparative Analysis of PWM AC Choppers with Different Loads with and Without Neural Network Application

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ABSTRACT: In this paper, we focus on the "Artificial Neural Network (ANN) based PWM-AC chopper". This system is based on the PWM AC chopper-encouraged single-phase induction motor. The main purpose of this paper is to design and implement an ideal technique regarding speed control. Here analyzed PWM-based AC-AC converter with resistive load, R-L load and finally, the PWM AC chopper is fed to single phase induction for speed control. Using other soft computing and optimization techniques such as Artificial Neural Networks, Fuzzy Logic, Convolution algorithm, PSO, and Neuro Fuzzy can control the Speed. We used Artificial Neural Network to control the Speed of the PWM-AC Single phase induction motor drive. The Neural Network toolbox has been further used for getting desired responses. Neural system computer programs are executed in MATLAB. The performance of the proposed method of ANN system of PWM AC Chopper fed single phase induction motor drive is better than other traditional and base methods for controlling the Speed, based on the MOSFET.

Keywords: AC Chopper, PWM, Induction Motor, ANN

1. INTRODUCTION

Power electronics is the utilized electronics application, which is utilized for the conversion of power. A subsection of the power conversion is AC (Alternative Current) to the AC (Alternative Current) transformation. Changing over AC waveform to a different AC waveform enables one to control the period of the waveform connected to a load provided by the AC waveform, voltage, and frequency.

Two primary sources are commonly utilized to isolate the different types of converters, and they change the frequency of the waveform. Based on this concept, adjusting the frequency to be acknowledged as an Alternative Current Voltage Regulator or Controllers is impossible. Alternative Current converters allowing users to modify the frequency are indicated as frequency converters for Alternative Current to Alternative Current conversion.

The motivation behind an Alternative Current Voltage Controller, or Alternative Current Regulator, is to fluctuate the RMS voltage over the load while at a consistent frequency. The variety of RMS voltage over the load without any variation in frequency can be executed by conventional Alternative Current-voltage regulators.

An alternative Current-voltage controller is a kind of thyristor control converter utilized to change over a fixed voltage and frequency Alternative Current input supply to acquire a variable voltage Alternative Current outcome. The RMS value of the Alternative Current outcome voltage and the Alternative Current power stream to the load is controlled by shifting (altering) the trigger angle 'α'.

In phase control, the thyristor is utilized to switch the interface, the load circuit, to the input Alternative Current source for a portion of each input cycle. The Alternative Current source voltage is chopped utilizing a thyristor among a portion

of each input cycle.

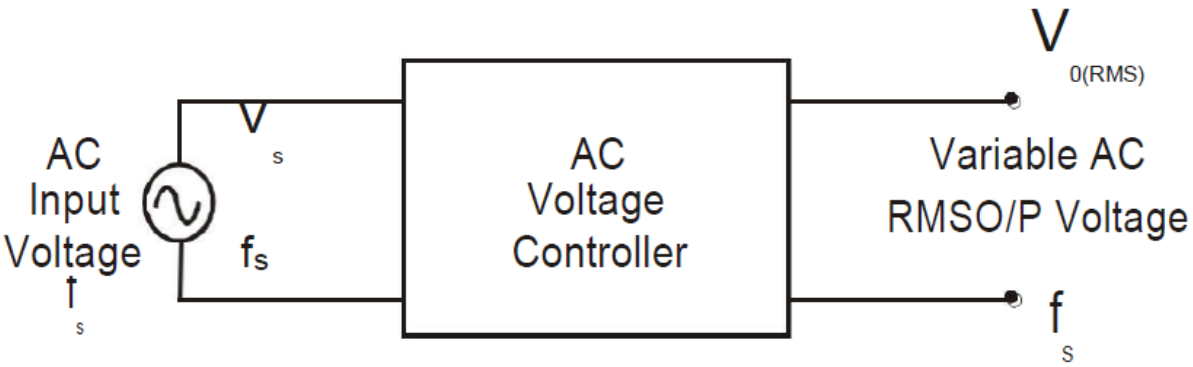

FIGURE 1. **AC Voltage Controller.**

Here the switch (thyristor) is activated (ON conditions) two times per cycle (Once for every half cycle) with the goal that input source voltage shows up over the load and, after that, is turned off among the rest of the portion of input half cycle to separate the Alternative Current source from the load. The regular Alternative Current-voltage controller appears in Figure 1.

2. RELATED WORKS

The enhanced circuit of Alternative Current choppers for single-phase is innovated and examined. These new circuits utilize Current Direct choppers modulated switch for a bridge diode rectifier and a couple of changes to give in the freewheeling way to the load current during the balanced turn is switched off. The impressive component of this enhanced circuit is that it utilizes just a single modulated switch. The enhanced electric circuit has numerous advantages contrasted and the regular AC choppers, for example, basic structure prerequisites, simple execution, higher power limit, quick unique response, high power and function, minimal effort, low exchanging loss and, like this, high proficiency. Advanced reproduction explores a few qualities [1]. UPS power supply has Alternative Current choppers and dynamic channel function [2]. This author presents another voltage stabilizer that uses an electronic item. This topology uses four Alternative Current switches in the frame called an "AC H-connect" association and dependent PWM Alternative Current choppers joined with a low-power compensating converter [3]. The investigation was conducted of the single-phase RL load created with the controller by the triac (triode) for the Alternative Current choppers [4].

The control procedure for the firing-angle frequencies in PWM Alternative Current-voltage controllers [5]. Here author presented asymmetrical pulse width modulated (APWM) controls as the strategy for the mono-phase Alternative Current choppers, enhancing the power input factor and removing the harmonics of the voltage outcome upto a predefined range. This system additionally empowers direct control of the major part of the outcome voltage. The Newton-Rapson technique acquired APWM exchanging designs at the predetermined phase angle [6, 7].

The FFT investigation for the voltage/current has been accomplished for the created scheme. Simulink finishes the simulation is executed utilizing the installed microcontroller. The exploratory outcomes analyses and examine the final result [8, 9]. The structure of the novel PWM Alternative Current choppers to the mono-phase and tri-phase systems are invented for the buck and boost types. An Alternative Current chopper with the critical points of interest contrasted with the phase-controlled ACs controller utilizing thyristor [10] . The joined feed-forward and PI criticism control should be connected to the settle the outcome voltage at the coveted dimension when it's liable to the unpredicted input voltage and load varieties. The innovative Alternative Current chopper has been the focal point in precise voltage control, low consonant contortion, quick reactions and ease [11] .

The author explains a couple of alternative circuit enhancing commutations: the primary circuit represents the capacitors, and the second circuit represents the voltages [12]. Author [13], presenting the study for the mono-phase induction motors. The study also explains that the DC chopper's diode is a connection identifier associated with the stator in a non-conventional form. The Speed of the mono-phase induction motors is navigated with the help of chopping modulation of the socket (Switches) choppers.

Here is a new strategy for the energy-efficient task of the voltage-controlled induction motor utilizing ANN [14] . The

back-propagation method of the neural system is prepared offline to distinguish the ideal proficiency purpose of the motor to the full extent which having any earlier input from the device spares [15] . PWM control methods for AC choppers are recommended for those having the upsides of empowering direct control of a key segment of the outcome [16].

3. DESIGN METHODOLOGY

A PWM AC Chopper circuit for a single phase is displayed in Figure 2. It comprises four kinds of switches. The series connection switches S1 & S4 are utilized to disconnect & connect the motor terminals to the supply. The proper series connection of switches S3 and S4 is utilized to provide freewheeling. Each switch has a parallel diode connection to complete the current path of the freewheeling path. Mostly, these gating switches, dependent on an equivalent PWM procedure or a steady pulse width technique, are effective and easy to simulate.

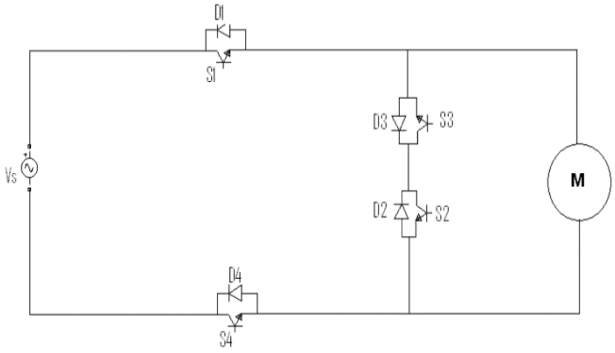

FIGURE 2. Circuit of PWM AC Chopper

Here are mentioned two following cases:

- When the source voltage is greater than zero, S3 & S4 switches are working, and S2 is organized by pulse width modulation. As switch S1 is on, then current flows through the load.
- When the source voltage is less than zero, S1 & S2 switches are working, and S3 & S4 switches are organized by pulse width modulation.

The control scheme for a greater and lesser value than the zero period of the voltage source is mentioned in Table 1.

Table 1. Sequence of switching

	S1	S2	S3	S4
Vs > 0	PWM	PWM	ON	ON
Vs < 0	ON	ON	PWM	PWM

3.1 PERSPECTIVE OF USING MOSFET

1. Usually, the MOSFETs are in little contrast with BJTs, so it created the equivalent space plan on the circuit effortlessly.
2. If the MOSFET's input impedance is too large, it does not load the circuit. Its loading impact did not emerge.
3. The MOSFET operating frequency is higher than BJT, so a higher operating frequency is utilized.
4. It is utilized in digital circuits for its dependability purposes.
5. It may ensure an electrical (circuit-based) system. It passes significantly less present through the contacts by the triggers.

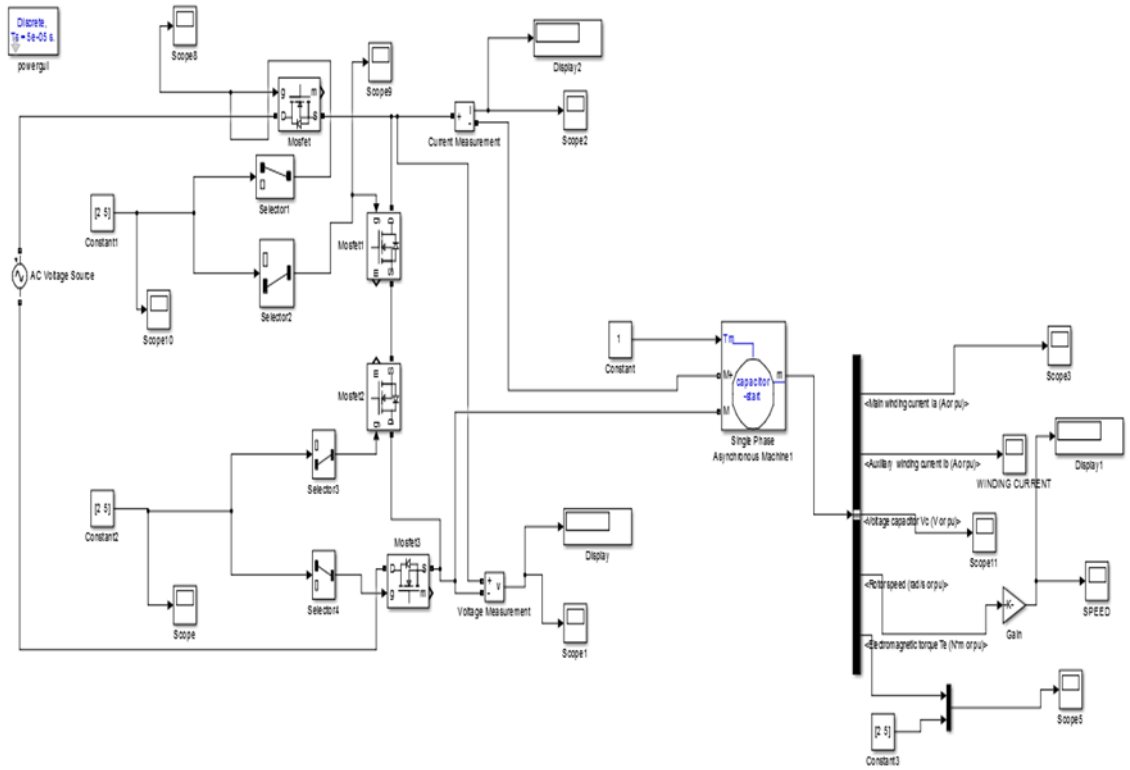

FIGURE 3. The Simulink model of PWM Alternative Current chopper-driven single-phase induction motor

4. SIMULINK MODEL OF THE SYSTEM

This paper aims to control the perspective of the Speed regarding single-phase induction motors. PWM alternative current choppers accomplish it. The idea of a neural system is added to accomplish desired speed control.

Generally, the neural system is trained regarding the provided arrangement of input sources and targets. The input is considered Speed, and the output is phase delay according to the rpm. The following program would be executed.

The neural system program flowchart is simulated in the Simulink model, and comparing results is demonstrated as follows, and the representation of the flowchart is mentioned below.

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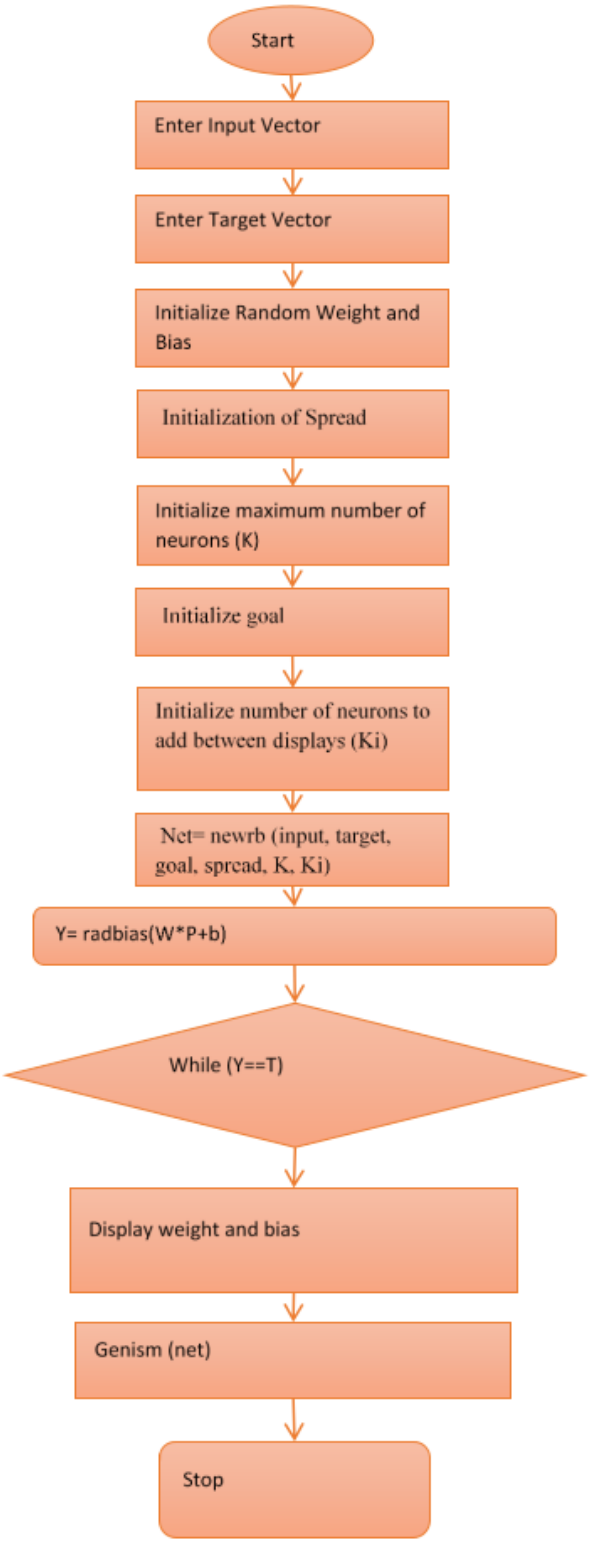

The structure of the architecture appears below regarding the neural network.

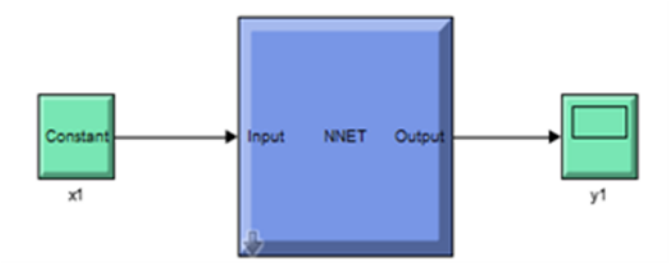

FIGURE 4. **Neural network**

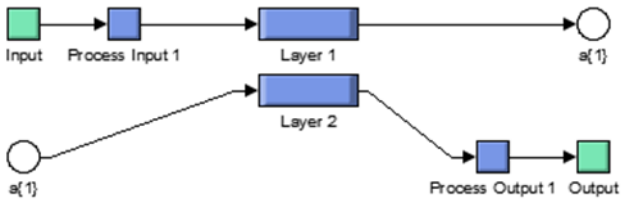

FIGURE 5. **Internal architecture of the neural network.**

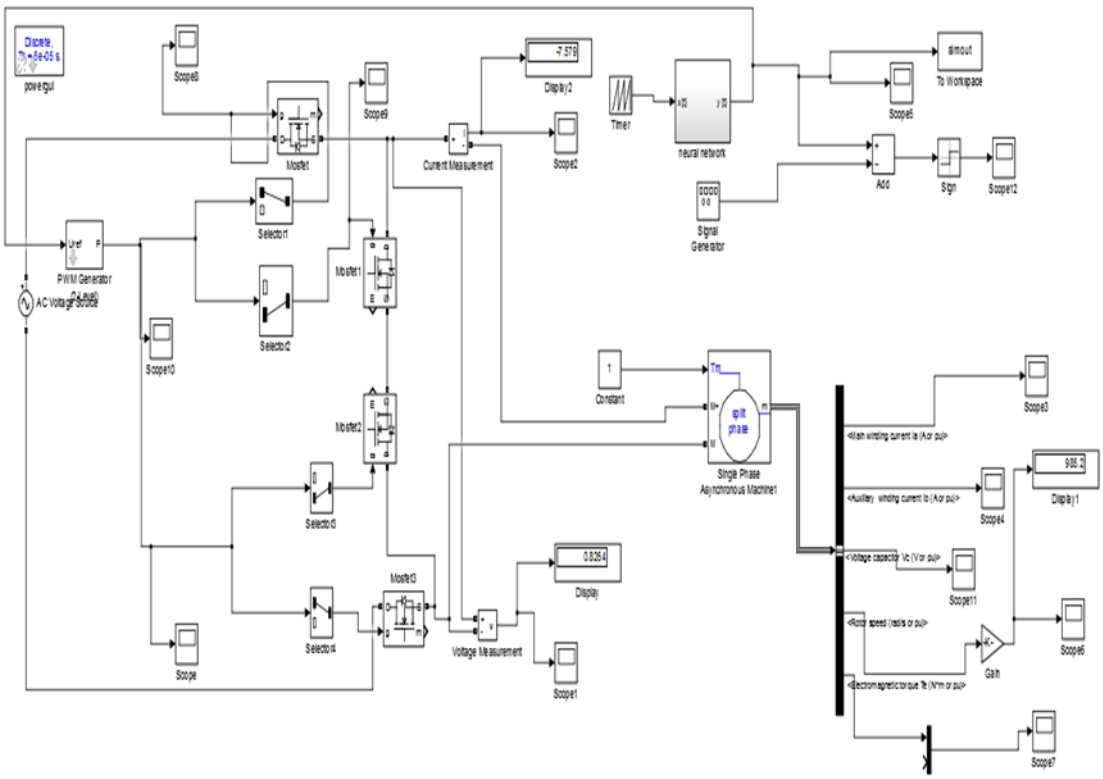

FIGURE 6. **Neural Network-based PWM current alternative Chopper fed single-phase induction motor using Simulink model.**

5. RESULTS AND DISCUSSIONS

The pulse width modulated AC Chopper circuit is exhibited, and outcomes are acquired through implementation and simulation. The investigations demonstrate that PWM AC Chopper indicates acceptable outcomes regarding the single-phase induction motors speed control.

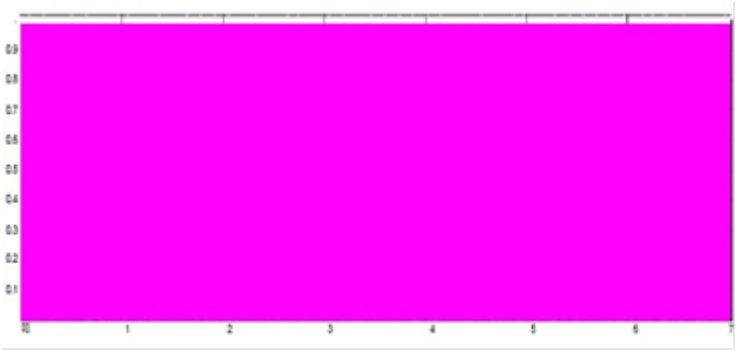

FIGURE 7. Pulse Width Modulation signal generator for pulse width.

The Speed is accomplished and controlled by shifting the phase angle of the PWM motion with the input source. Figures 8 to 11 are specified below to clarify the equivalent.

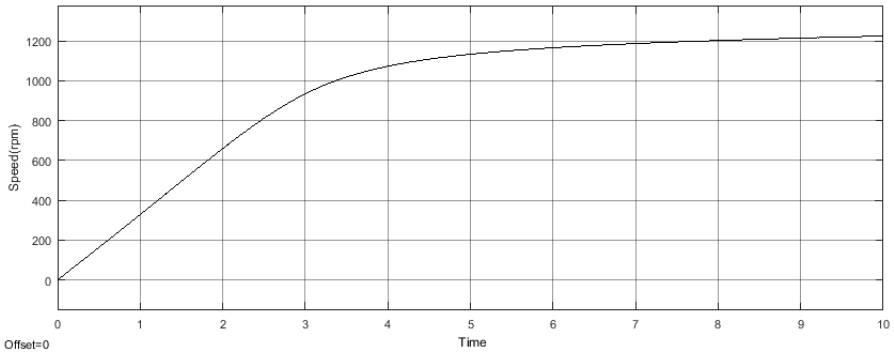

FIGURE 8. Speed when phase delay is 0 degrees.

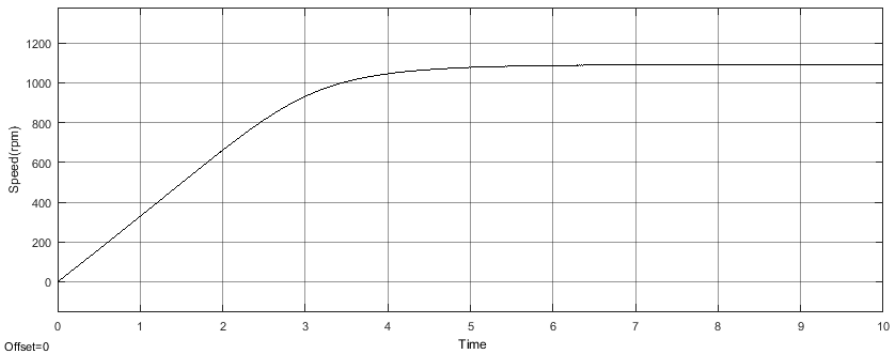

FIGURE 9. Speed when phase delay is 30 degree

The neural network outcome is illustrated by network speed control. According to that, the neural network provides the needed outcomes based on the phase angle variation. The speed control output on the different phase angle value using ANN is mentioned below (figure 12 to 15).

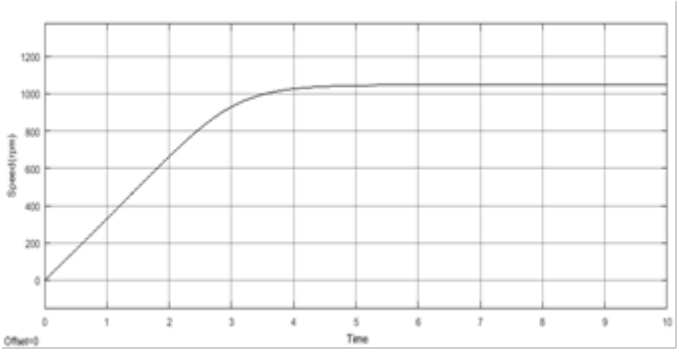

FIGURE 10. Speed when phase delay is 60 degrees.

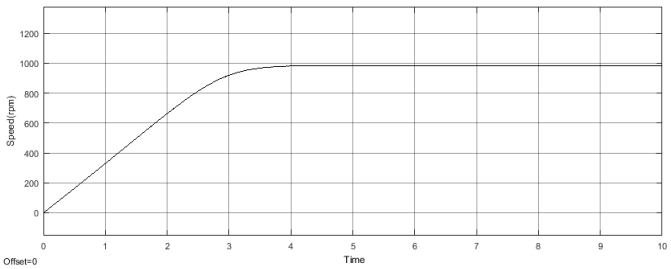

FIGURE 11. Speed when phase delay is 90 degrees.

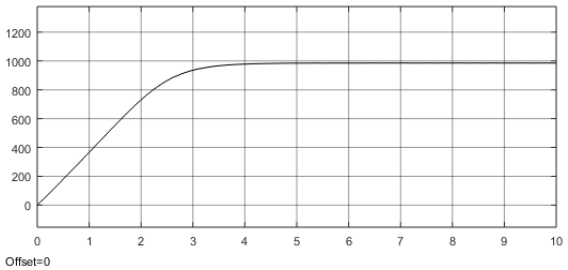

FIGURE 12. Speed when phase delay is 0 degrees.

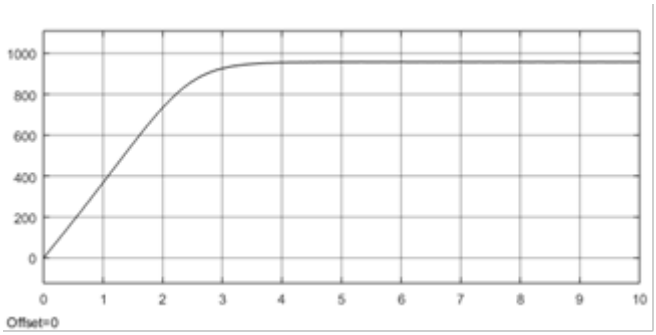

FIGURE 13. Speed when phase delay is 30 degrees.

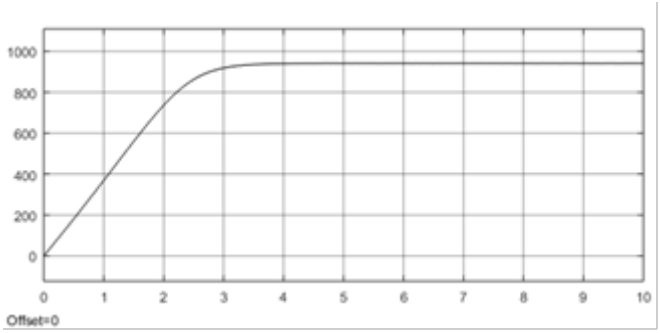

FIGURE 14. Speed when phase delay is 60 degrees.

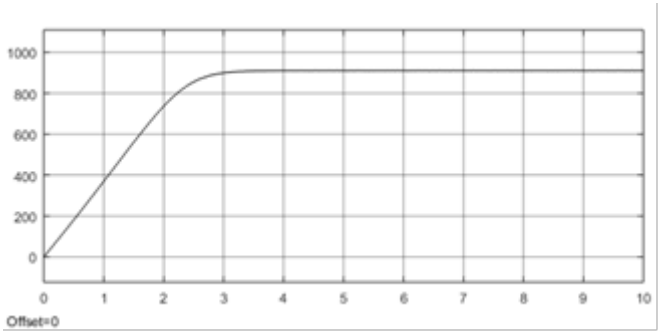

FIGURE 15. Speed when phase delay is 90 degrees.

The Speed is controlled through the neural network very well, and the neural system modifies itself to the parameter and produces the response for the variable Speed. It could be done at various phase angles. It has appeared separately in the figures as mentioned above.

6. CONCLUSION

This paper describes and shows the implementation of the ANN-based PWM alternative current Chopper. This system is based on the PWM alternative current chopper encouraged single-phase induction motor. The paper's main purpose is to build up an ideal technique regarding speed control. This technique can be utilized for the single-phase induction motor drive. Neural system computer programs are executed in MATLAB. The performance of the proposed ANN system of the PWM AC Chopper fed single-phase induction motor drive is better than other traditional and base methods for controlling the Speed, which is based on the MOSFET. This idea can be executed on other soft computing and optimization techniques such as Fuzzy Logic, Convolution algorithm, PSO and Neuro Fuzzy.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

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