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Advanced Optimal For Three Phase Rectifier in Power Electronic System

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Article Info	ABSTRACT
	Interest in the power electronic system which used in many applications is increasing day by day. So, many researchers have focused on the analyses, design and control of these systems. In this study, Optimal for Three Phase Rectifier in Power Electronic System control strategy has been proposed for PSO-PI fuzzy logic controller (FLC) based Three Phase Rectifier in Power Electronic System. Proposed Power Electronic System (PES) consists of input, isolation and output stages. In order to test dynamic performance of PSO-PI based PES, simulation study was carried out by MATLAB/Simulink. The results obtained from the PSO-PI based PES are not only superior in the rise time, settling time and overshoot but can prevent from voltage and has improved power quality.

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1. INTRODUCTION

Increasing orientation for the use of Power Electronic in industry and electrical appliances because Power Electronic is predictable to play a big role in future smart grids as distribution renewable source [1-2]. Power Electronic with electric system is investigated. The Power Electronic system application is prospected, source to an AC voltage source by rectifier has the ability for controlling a load [3]. A way controller (PI) in addition to the controller integral relative formulated and implemented, using speed control drive system and a pilot phase. While the new strategy promotes traditional PI control performance to a large extent, and proves to be a model-free approach completely, it also keeps the structure and features of a simple PI controller [4-5]. The use consoles mode instead of Fuzzy-PI control to improve the performance of engines of Three Phase PWM Rectifier. To control the speed of motor using fuzzy logic (FL) approach leads to a speed control to improve the dynamic behavior of the motor drive system and immune disorders to download and parameter variations [6-7]. In the drive systems, and gains from the traditional can't usually be set in proportion-integral (PI) controller three Phase PWM Rectifier because of mechanical resonance. As a result, performance degradation and three Phase PWM Rectifier control. In our work described in this paper, have been adopted and fuzzy logic controller (FLC) for use in drive systems in order to improve the performance of the three Phase PWM Rectifier control. The proposed FLC has been compared with traditional PI control with respect to the three Phase PWM Rectifier of response [8-9]. Simulation and experimental results have proved that FLC was proposed is superior to the traditional PI. This FLC can be a good solution for the high-performance three Phase PWM Rectifier systems. A modern approach to control the speed of load using particle swarm optimization (PSO) to improve the algorithm parameters observer PI-. Simulate the system under different operating year conditions is prepared and the experimental setup. Use PSO algorithm and optimization make a powerful engine, with faster response and higher resolution dynamic and sensitive to load variation [10].

2.   POWER ELECTRONIC

Power electronic converter includes four types, rectifier (AC-DC), inverter (DC-AC), and converter (DC-DC or AC-AC). The power electronic device is building by using diode, thyristor, insulated gate bipolar transistor IGBT, and …etc.

Where: DC: is a direct current

AC: is an alternate current

Grid side (three phase AC source), in this part the system get its power by many sources like diesel generators systems, wind turbines generators systems, photovoltaic generators systems and…etc. Figure 1 shows source connected machine by power electronic converter. Figure 2 shows (a)source connected with diode rectifier for AC-DC-AC conversion [2] (b)source connected with thyristor rectifier for AC-DC-AC conversion. Figure 3 shows source connected with IGBT rectifier for AC-DC-AC conversion.
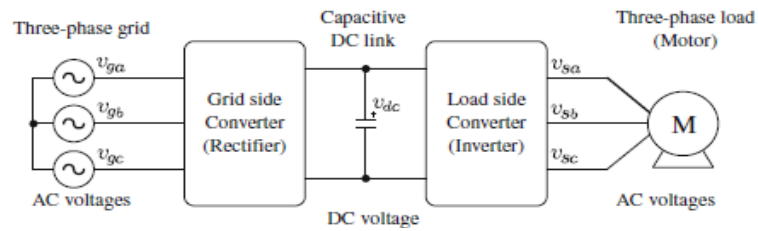

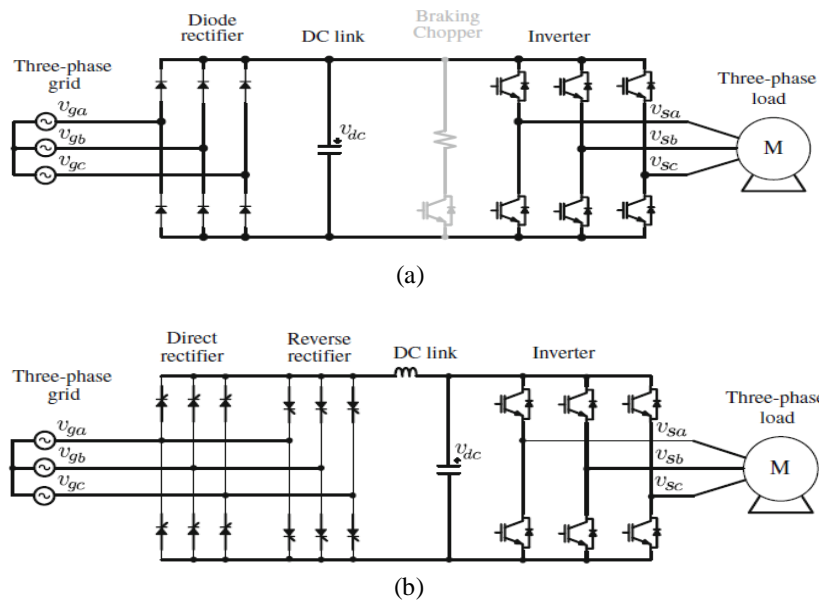Figure 1. Source connected machine by power electronic converter

(a)

(b)

Figure 2. (a)source connected with diode rectifier for AC-DC-AC conversion [2] (b)source connected with thyristor rectifier for AC-DC-AC conversion
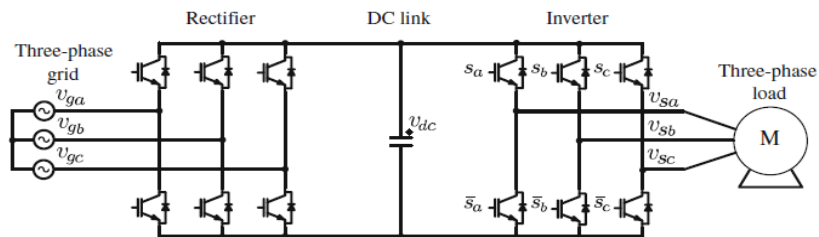

Figure 3. Source connected with IGBT rectifier for AC-DC-AC conversion

3. PULSE-WIDTH MODULATION (PWM)

PWM are vastly used, the comparing between a triangular carrier wave and error signal which comes from subtracting of the reference signal from the actual signal this is a voltage control signal. Voltage control signal, this is the input gates signal of the IGBT that use in the output. The response control is depending on the error signal (upper switch on or lower switch on). Figure 4 show generate a PWM signal.
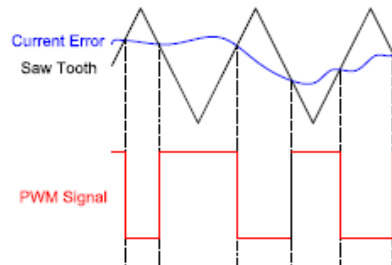

Figure 4. Generate a PWM signal

4. OPTIMIZATION AND CONTROLLER

Optimization and Controller (Classical controller type PI Controller, Expert System type FLC and Optimization type and PSO), Electric system driven is formulated by the motor. By using control to suppress harmonic noise to a level. Then, noise to a level below and vibration translates into a more comfortable ride for passengers. Source connected with IGBT rectifier for AC-DC conversion (IGBT, PWM rectifier) make the ride smoother with precisely adjusting speed control with frequency and voltage regulation. It has the latest low-noise power units to make the ride even quieter. Load system has directed high-speed motor. Energy reform in the application geared for small rise because travel extremely small and fast.

4.1. PI Controller Modeling

In the PI controller three Phase PWM Rectifier, the actual value is compared with the reference value and the error is the nth sampling interval as;

$$\omega e[n] = \omega r^*[n] - \omega r[n] \tag{1}$$

The output of the three Phase PWM Rectifier controller gives the reference. Hence the output of the three Phase PWM Rectifier controller at the nth sampling interval is;

$$T[n] = T[n-1] + Kp(\omega e[n] - \omega e[n-1]) + Ki.\omega e[n] \tag{2}$$

For constant air gap flux operation reference quadrature axis current is given as;

$$iq^* = T[n]/Kt \tag{3}$$

The limiter is used to limit the maximum value of output of speed controller. The maximum machine rated current and device current of the converter dictate the limit. Figure 5 shows block diagram of the PI controller.

Where: $\omega e[n]$ is speed error at nth instant, $\omega r^*[n]$ is the reference speed at nth instant

$\omega r[n]$ is the actual machine speed at nth instant, $\omega e[n-1]$ is the speed error at (n-1)th instant

$T[n]$ is the reference torque at nth instant, $T[n-1]$ is the reference torque at (n-1)th instant

Kp is proportional gain of the speed controller

Ki is integral gain of the speed controller is reference quadrature axis current
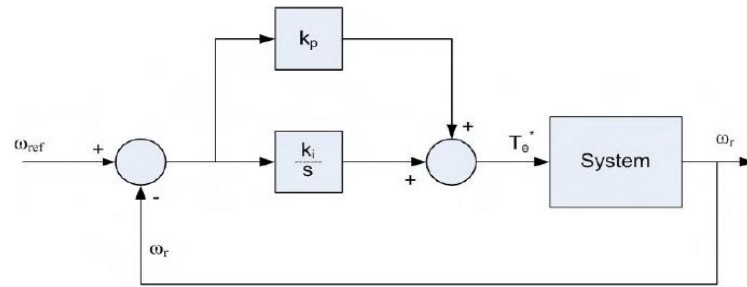
Kt is torque constant

Figure 5. Block diagram of the PI controller

4.2. Fuzzy Logic Controller

Fuzzy logic controllers have the following advantages over the conventional controllers that they are cheaper to develop, they cover a wide range of operating conditions, and they are more readily customizable in natural language terms. In Mamdani type FIS the crisp result is obtained by defuzzification, in the Mamdani FIS can be used for both multiple input and single output and multiple inputs multiple outputs system as shown in Figure 6.
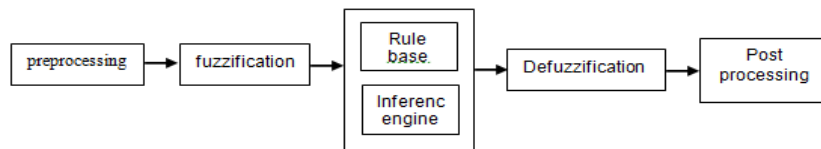

Figure 6. Arrangement of fuzzy logic controller

The usefulness of fuzzy logic controller is adopted especially in a complex and nonlinear system. The rules of conventional FLC are produced depend on the operator's experience or general knowledge of the system in a heuristic way. The thresholds of the fuzzy linguistic variables are usually chosen arbitrarily in the design process. An improper controller value leads to an adverse consequence, unstable mode, collapse and separation. This work propose PSO to design an Optimal Fuzzy Logic Controller OFLC, the optimized criteria is how to minimizing the transient state.

The motor in a nonlinear system, time-change and complex system. The PI control is difficult to realize, which needs the accurate mathematical model with synthesizes the fuzzy control and PI control, the parameters can be adjusted deceptively. The fuzzy PI controller has better performance and robustness than conventional PI controller in the servo motor system. Block diagram of fuzzy PI controller as shown in Figure 7.
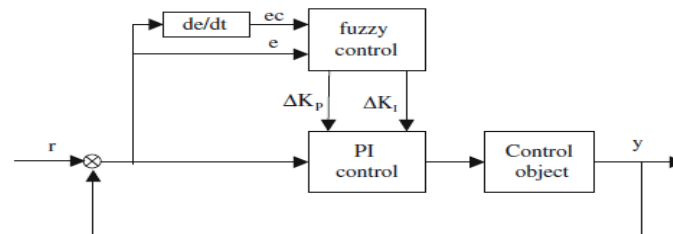

Figure 7. Block diagram of fuzzy PI controller

4.3. Particle Swarm Optimization (PSO)

The biggest characteristic of PSO is in its simple structure, fast convergence, and its ability to prevent falling into a local optimum solution. At the same time, PSO is a random algorithm with a parallel structure. A uniform distribution is used to randomly create a particle swarm. Each particle represents a

feasible solution to the problem, the particle swarm refers to the individual's best experience, and the group's best experience, and logically chooses the method it will move itself. After continuous iterations, the particle swarm will gravitate towards the optimum solution. For the ith particle and n-dimensional space can be represented as an Equation 6, the best previous position of its particle is recorded as Equation 7:

$$x_i = (x_{i,1}, x_{i,2}, \ldots x_{i,n})$$ (4)

$$p_{best_i} = (p_{best_i,1}, p_{best_i,2}, \ldots p_{best_i,n})$$ (5)

The velocity is an essential part of how PSO work so as modified velocity and position of each particle can be calculated using the current velocity and distance from ($P_{best_{id}}$) to (g_{best_d}):

$$V^{(It+1)}_{i,m} = W * V^{(It)}_{i,m} + c_1 * r * (p_{best_i,m} - x^{(It)}_{i,m}) + c_2 * r * (g_{best_i,m} - x^{(It)}_{i,m})$$ (6)

$$x^{(It+1)}_{i,m} = x^{(It+1)}_{i,m} + V^{(It)}_{i,m})$$ (7)

Where n is the number of particles in a group; m is number of Dimension m=1, 2,…,. ; It is a pointer of iterations (generations); W is an inertia weight factor; c1, c2 are acceleration constants were often set to be 1.2 according to past experiences; r is random value in the range between [0,1]; $V^{(It)}_{i,m}$: Velocity of particle no. i at iteration It., $x^{(It)}_{i,m}$: Current position of particle i at iteration It. G_{best_m} : Global best particle among all the particles in the population. In the above procedures, the parameter determined the resolution, or fitness, with which regions are to be searched between the present position and the target position, the inertia weight is set according to the Equation 8.

$$W = w_{max} - \frac{w_{max} - w_{min}}{Iter_{max}}.Iter$$ (8)

Where: Itermax is the maximum number of iterations and Iter is the current number of iterations.

5. ADVANCED IMPLEMENTATION FOR THREE PHASE PWM RECTIFIER

To use different control systems, like Classical PI Controller, Expert System Fuzzy Logic Controller and Optimization PSO Controller. It used to control for Implementation for Three Phase PWM Rectifier. The simulation model as shown in Figures 8 to 11, by used all types to get the result and analysis it with compared to see the advanced implementation for three phase PWM rectifier:
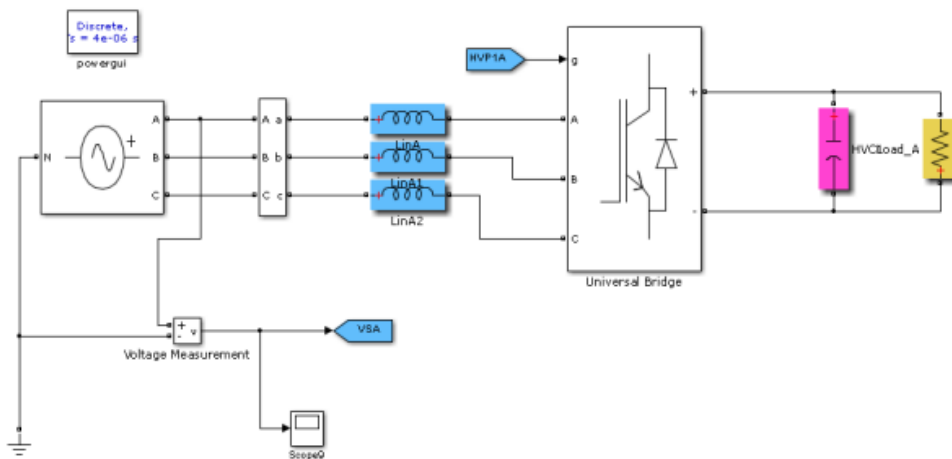

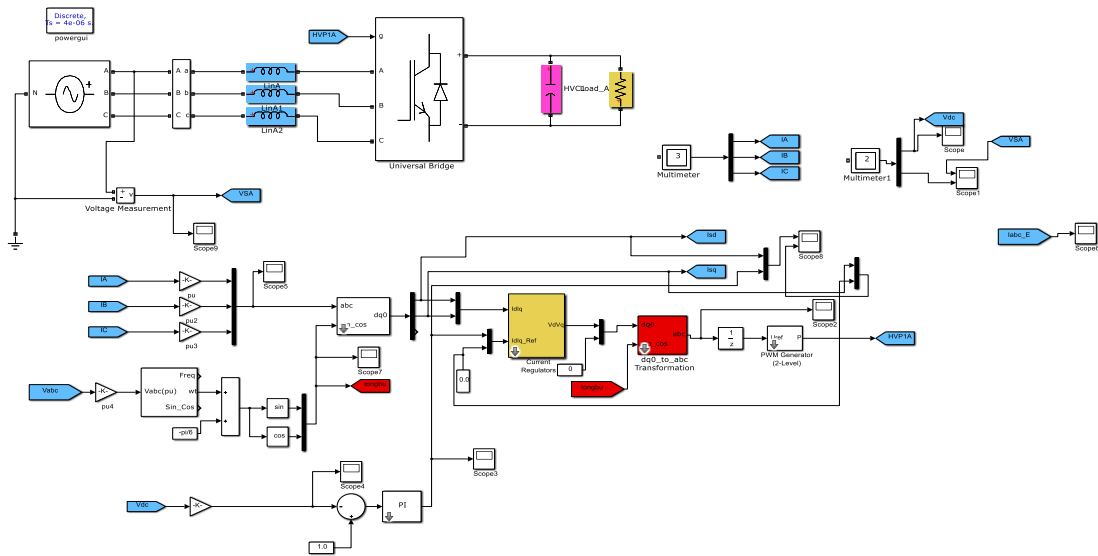Figure 8. The simulation model for three phase PWM rectifier

Figure 9. The simulation model for three phases PWM Rectifier with PI control
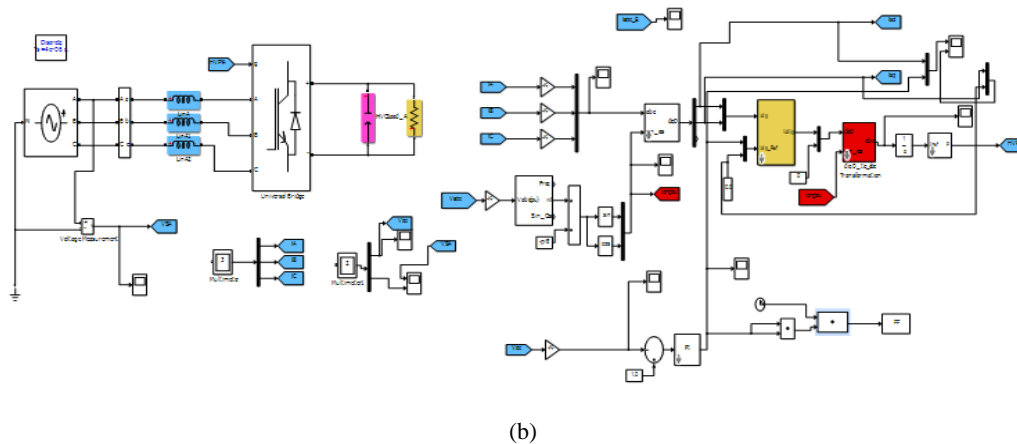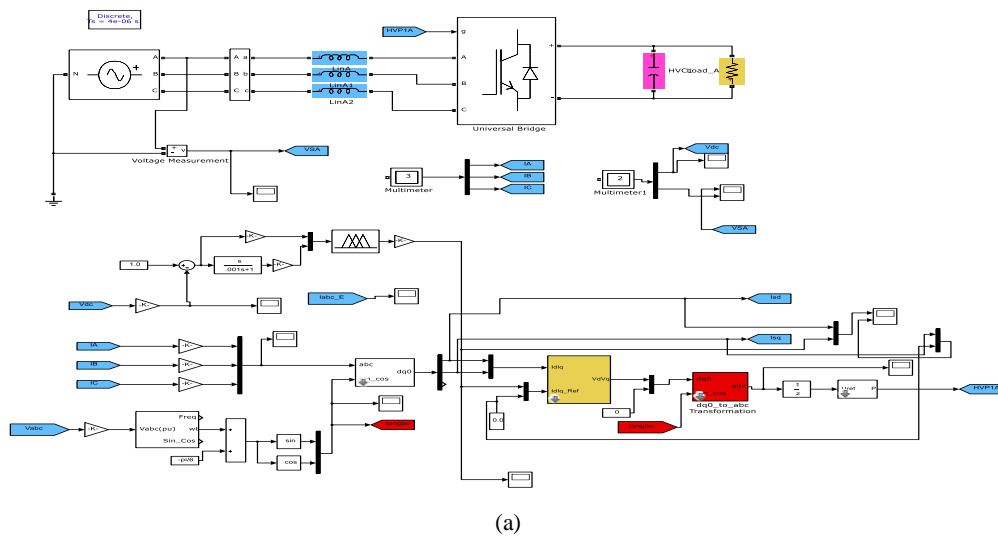

(a)

(b)

Figure 10. (a) The simulation model for three phase PWM rectifier with fuzzy control (b) The simulation model For Three Phase PWM Rectifier with PSO-PI control

6.   SIMULATION ANALYSIS AND RESULTS
6.1. The Simulation Results
6.1.1. The Simulation Results for Three Phase PWM Rectifier with Controller

By used the simulation model for three phase PWM rectifier with PI control to get the simulation results for three phase PWM rectifier with controller in Figures 12 to 14.
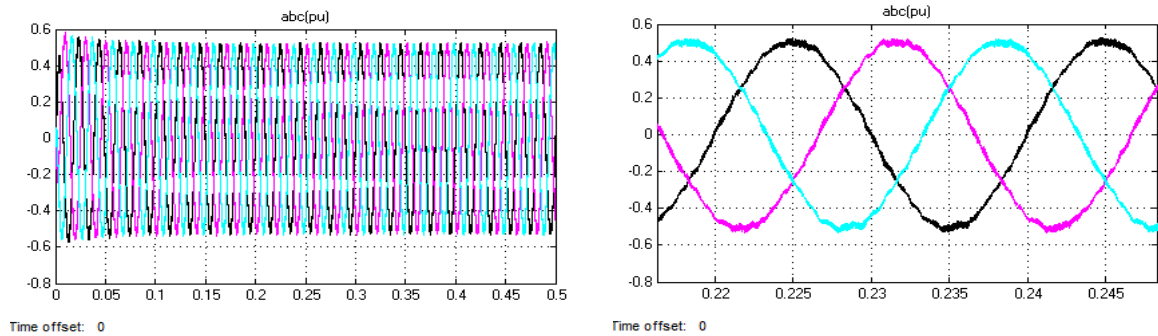
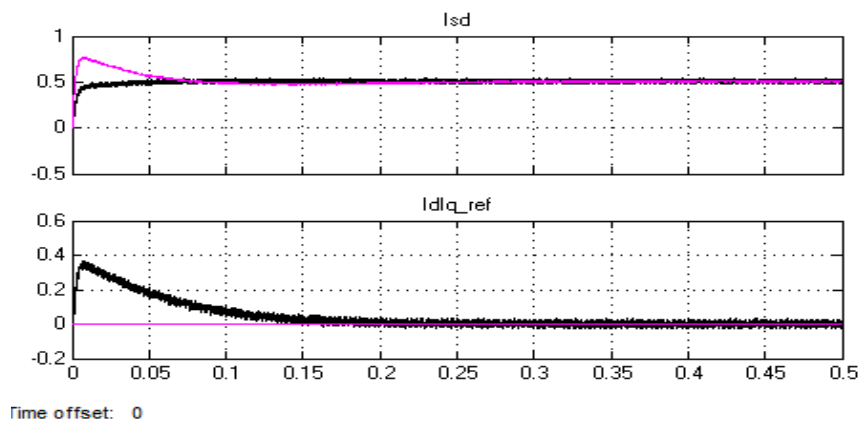Figure 12. The abc(pu) wave form for three phase PWM rectifier with controller

Figure 13. The Isd & IdIq_ref wave form for three phase PWM rectifier
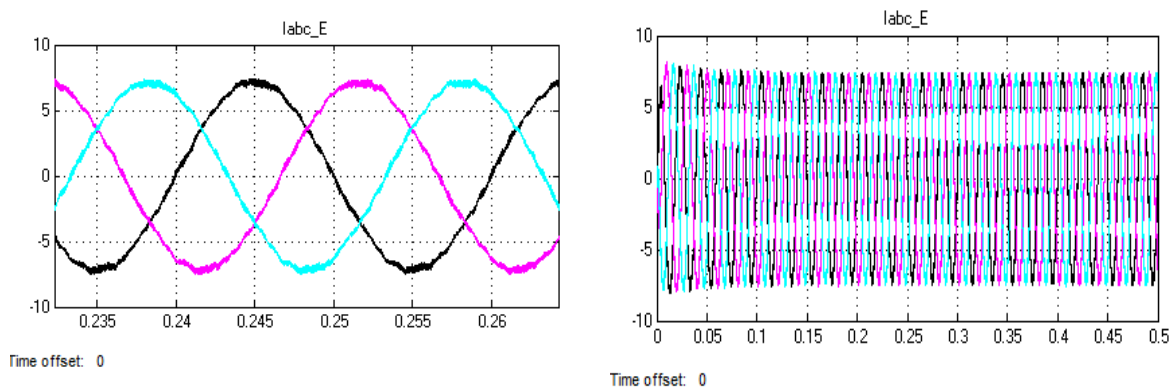
Figure 14. The Iabc_E wave form for three phase PWM rectifier

6.1.2. The Simulation Results for Three Phase PWM Rectifier with Optimization

By used the simulation model for three phase PWM rectifier with Optimization to get the simulation results for three phase PWM rectifier with optimization in Figures 15 to 18.
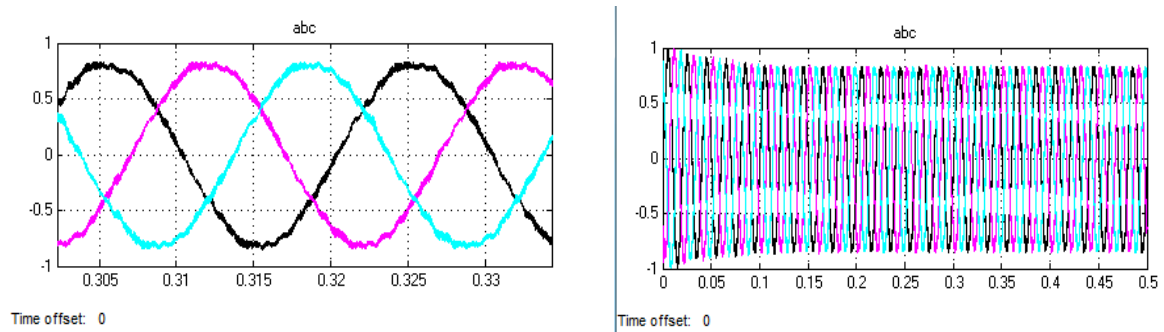

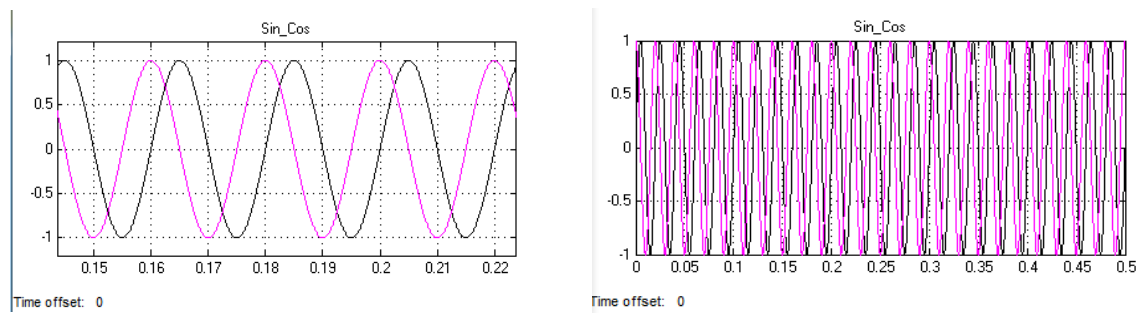Figure 15. The abc(pu) wave form for three phase PWM rectifier with optimization

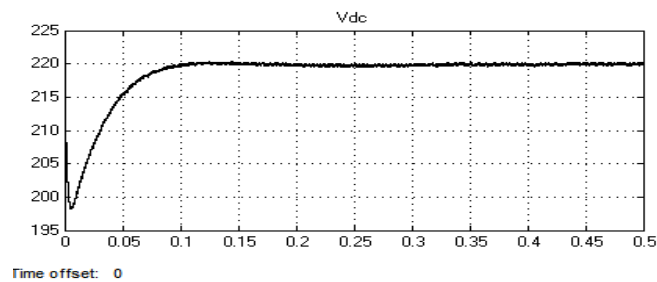Figure 16. The sin_cos wave form for three phase PWM rectifier

Figure 17. The Vdc(volt) wave form for three phase PWM rectifier
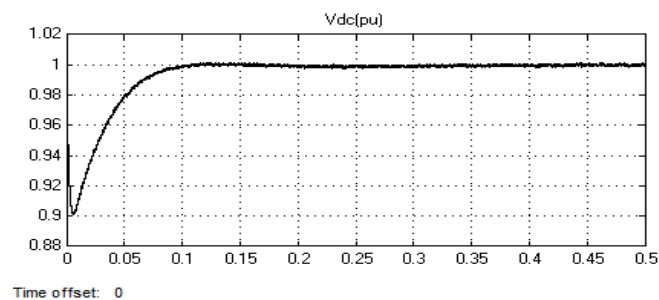

Figure 18. The Vdc(pu) wave form for three phase PWM rectifier

6.2. Simulation Analysis

Final step, use different control systems, Like Classical PI Controller, Expert System Fuzzy Logic Controller and Optimization PSO Controller to analysis all result. Simulation models (Classical PI Controller, Expert System Fuzzy Logic Controller and Optimization PSO Controller of this step as shown in Figures 12 to 18 and simulation results as shown in Figure 19. Simulation Response (pu) Of PI Control, Fuzzy_ PI Control & PSO_PI Control. The results obtained from the PSO-PI based PES are not only superior in the rise time, settling time and overshoot but can prevent from voltage and has improved power quality.
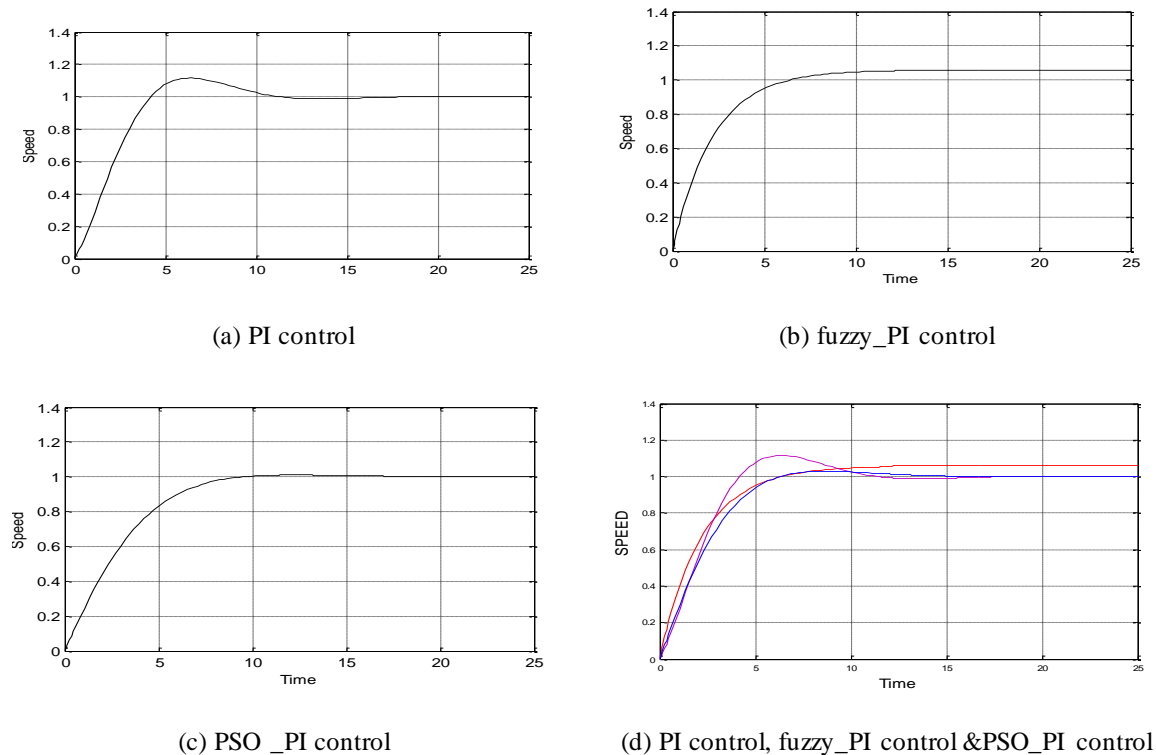

(a) PI control

(b) fuzzy_PI control

(c) PSO _PI control

(d) PI control, fuzzy_PI control &PSO_PI control

Figure 19. Simulation response (pu) of PI control, fuzzy_ PI control & PSO_PI control

7.   CONCLUSIONS

To use different control systems as a case studies. To achieve this objective which characterizes each part of a system such as a three phase PWM rectifier module, controller and Optimization. After that to investigate the design connection topology for all components of a three phase PWM rectifier system in order to study the operation of the system for different environmental conditions.

The simulation circuits for three phase PWM rectifier controllers include all realistic components of the system. These results also confirmed that the maximum permissible value. Modeling, analysis, testing and simulation a three phase PWM rectifier under different conditions using MATLAB. Three phase PWM rectifier is a material source of renewable energy and is likely for model a main source of future energy.

The performance of the three phase PWM rectifier system are controlled and Optimization by PI, fuzzy and PSO.

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       Controllers of Robotic Grinding Force Servo System." *Indonesian Journal of Electrical Engineering and Computer
       Science (IJEECS),* 16.1 (2015): 65-74.

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