Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(4):31-35**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Fuzzy-PI Control for Speed of PMSM Drive System

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Abstract Many PECs and MDs are connect together in ES like RES, Electric and Vehicle Elevator. In simulations to present, apply drive system by PMSM. Applications due to their high efficiency, low inertia and high torque – to – volume ratio. In this work, the control system for PMSM by PID control, Fuzzy in positioning controller. The simulation circuits for drive system with the control system and makes a powerful engine, with faster response and higher resolution dynamic and sensitive to load variation.

Keywords PMSM, FLC, PID control

1. Introduction

Electricity Technology (E.T.), in industry applications there are many of E.T. like the Power Electronic Converters (PECs),Renewable Energy (RE), Motor Drives (MDs) [1,2]. The Permanent magnet synchronous machine (PMSM) is one of MDs [3]. It has advantages PMSM include Low-inertia, high efficiency, high energy density, a torque multiplier is small, low noise, large torque coefficient, high performance in a wide variety and robustness .Nowadays; it is the first choice because of inherent advantages [4-6]. PMSM uses permanent magnets to produce the air gap magnetic field rather than using electromagnets [7]. Many industrial applications require new control techniques, the techniques used, applied in all regulation loops, speed regulation of permanent magnet synchronous machine (PMSM) [8]. The controller is using in order to overcome the nonlinearity problem of PMSM and to achieve faster response [9]. A way control (PI) in addition to the controller's integral relative formulated and implemented, using speed control magnet synchronous motor drive system and a permanent pilot phase. While the new strategy promotes traditional PI control performance largely, and proves to be a model-free approach completely [10-13], it also keeps the structure and features of a simple PI control [14]. The using console mode instead of FLC control is to improve the performance of engines PMSM [15-17]. To control the speed of PMSM motor using FLC approach leads to a speed control to improve the dynamic behavior of the motor drive system and immune disorders to download and parameter variations [18]. In this work, the simulation by using PMSM Simulink model with different control system PIC&FLC to design and implementation of control system for PMSM. The PMSM 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 adaptively. The fuzzy PI controller has better performance and robustness than conventional PI controller does in the PMSM servo system. The fuzzy logic controllers can overcome it. PI control has good robustness, simple in structure, and high reliability which suitable for a deterministic system which has accurate mathematical model. The control system performance rely on PI controller parameters.

2. PMSM and Control System

PMSM, it has Math. Model, T.F that can use to simulation with control system in matlab:

2.1. Math. of drive system for PMSM [19]

In figures (1-6) the equations of electric and machine system for PMSM:

Where: vd and vq are the d,q axis voltages, id and iq are the d,q axis stator currents, Ld and Lq are the d,q axis inductances, R and ω_s are the stator resistance and inverter frequency respectively. λ_{af} is the flux linkage due to the rotor magnets linking the stator.

$$v_q = Ri_q + pL_q i_q + \omega_s(L_d i_d + \lambda_{af}) \quad (1)$$

$$v_d = Ri_d + p\lambda_d - \omega_s L_q i_q \quad (2)$$

$$T_e = 3P(\lambda_{af} i_q + (L_d - L_q) i_d i_q)/2 \quad (3)$$

$$T_e - T_L + B\omega_r + Jp\omega_r \quad (4)$$

$$\omega_s = p\omega_r \quad (5)$$

$$T_e = 3P\lambda_{af} i_q /2 = K_t i_q \quad (6)$$

2.2. Math. of Drive System for PID Controller

In figures (7-9) the equations of error, reference and actual for PID controller:

Where: ωe[n] is speed error at nth instant, ωr*[n] is the reference speed at nth instant, ωr[n] is the actual motor speed at nth instant, ωe[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

$$\omega_e[n] = \omega_r{}^*[n] - \omega_r[n] \quad (7)$$

$$T[n] = T[n-1] + Kp(\omega_e[n] - \omega_e[n-1]) + Ki\omega_e[n] \quad (8)$$

$$i_q{}^* = T[n]/Kt \quad (9)$$

2.3. PMSM with Control system [20]

There are two state in this work by using FLC and PI control with PMSM. The fig.1 as shown the block diagram of PMSM:

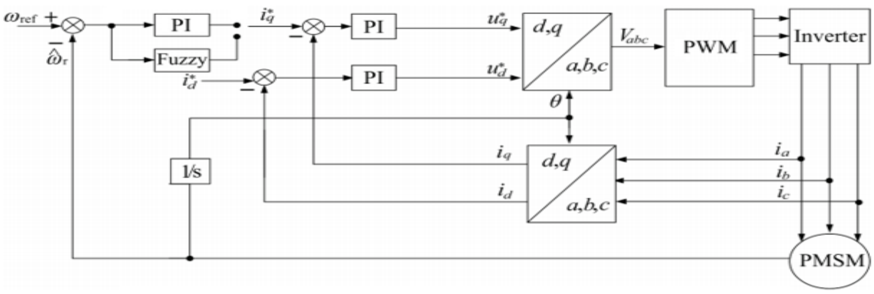

Figure 1: Block diagram of PMSM

The fig. 2 as shown the Block diagram of fuzzy PI controller:

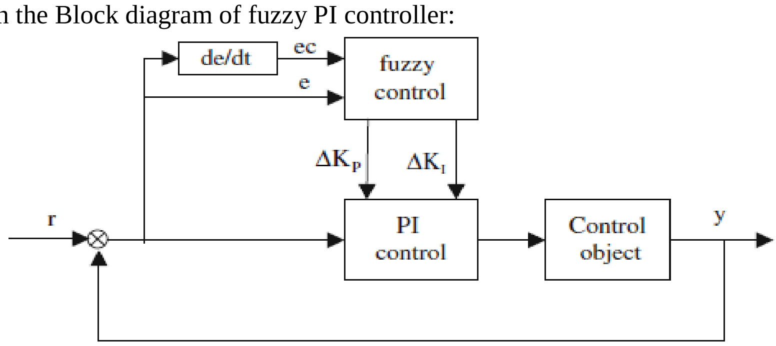

Figure 2: Block diagram of fuzzy PI controller

3. Simulation Models

There are two part, the Simulation Model of T.F for PMSM by PIC and FLC with PMSM.

3.1. Simulation Model of PI Controller for PMSM

The Simulation Model of PI control for PMSM as shown in fig. 3:

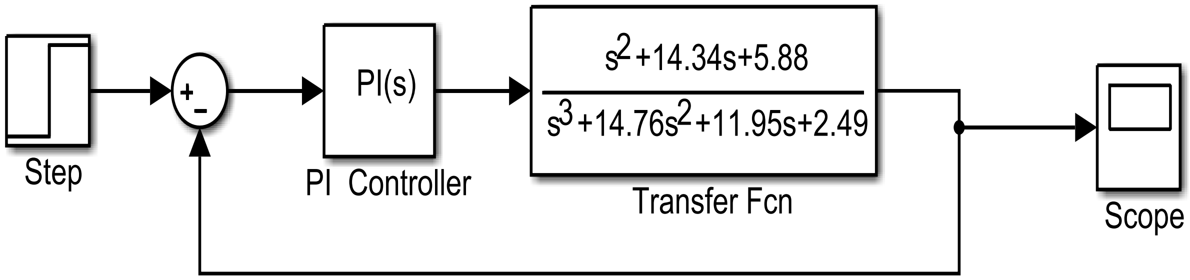

Figure 3: Simulation Model of PI control for PMSM

3.2. Simulation Model of FLC for PMSM

The Simulation Model of FLC for PMSM as shown in fig. 4:

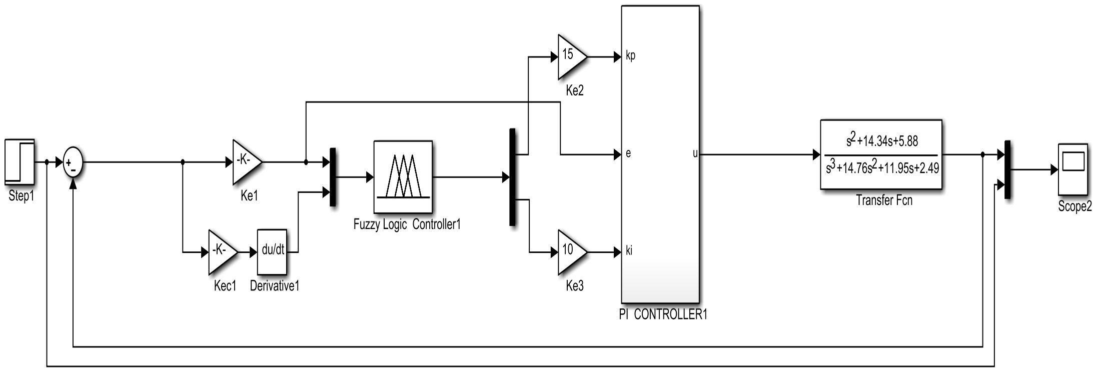

Figure 4: Simulation Model of FLC for PMSM

4. Simulation Results

There are two part, the Simulation Response of T.F for PMSM by PIC and FLC with PMSM

4.1. Simulation Response of PI Control

The simulation Response of PIC for PMSM as shown in fig. 5:

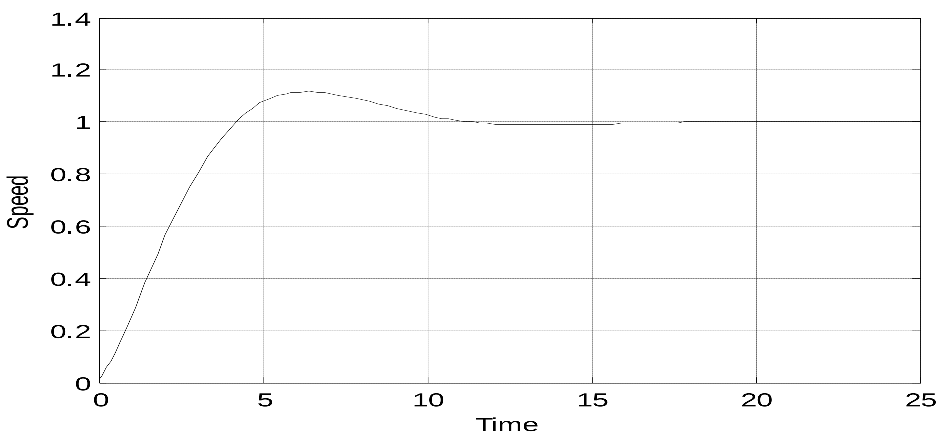

Figure 5: Simulation Response of PIC for PMSM

4.2. Simulation Response of FLC for PMSM

The simulation Response of FLCfor PMSM as shown in fig.6:

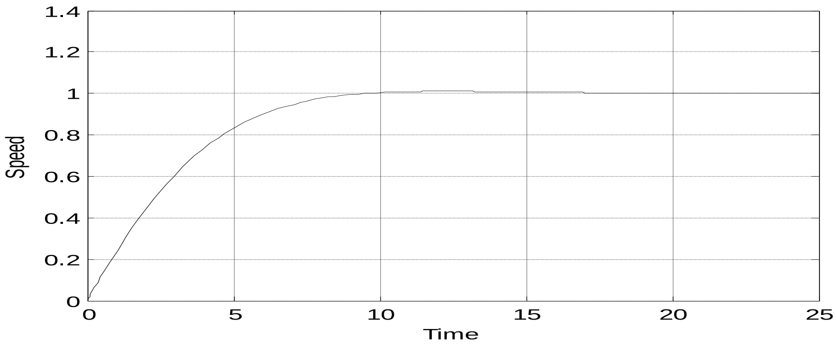

Figure 6: Simulation Response of FLC for PMSM

The Simulation Response of PIC&FLC for PMSM as shown in fig. 7:

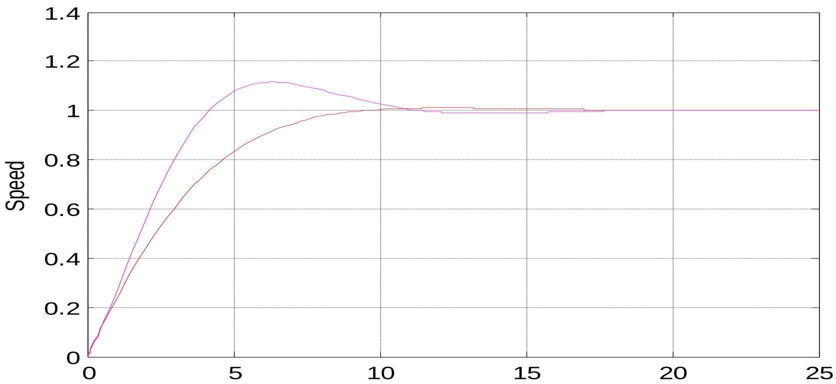

Figure 7: Simulation Response of PIC & FLC for PMSM

5. Conclusion

Improving a PI Controller Using Fuzzy Logic controller, PI controller unable to compensate for disturbances. To solve this problem by use Fuzzy Logic controller to improve the PI controllers ability to handle disturbances. First, try to test a system, which could control using a PI controller as well as be able to introduce a disturbance with chose to model a basic PMSM motor. The controller is used as the speed control in PMSM control system, which can adjust the controller parameters online according to the speed error and the speed error change rate. The simulation results show that the fuzzy PI controller has faster response, and is stronger and robust compared to the traditional PI controller.

References

[1]. Lei Jin-li, “Adaptive Control for Brushless DC Motor Based on Fuzzy Inference”. TELKOMNIKA Indonesian Journal of Electrical Engineering, 12(5): 3392-3398, 2014.

[2]. Shneen, Salam Waley, Chengxiong Mao, and Dan Wang. "Advanced Optimal PSO, Fuzzy and PI Controller with PMSM and WTGS at 5Hz Side of Generation and 50Hz Side of Grid." International Journal of Power Electronics and Drive Systems 7.1 (2016): 173.

[3]. M. A. Shamseldin, and A. M. A. Ghany, M. A. A. Ghany, “Performance Study of Enhanced Non-Linear PID Control Applied on Brushless DC Motor,” International Journal of Power Electronics and Drive System (IJPEDS), vol. 9, no. 2, pp. 536–545, 2018

[4]. Attiya, Adnan Jabbar, Yang Wenyu, and Salam Waley Shneen. "Fuzzy-PID Controller of robotic grinding force servo system." Indonesian Journal of Electrical Engineering and Computer Science 15.1 (2015): 87-99.

[5]. Madadi, Ali, and Mahmood Mohseni Motlagh. "Optimal control of DC motor using grey wolf optimizer algorithm." Technical Journal of Engineering and Applied Science 4.4 (2014): 373-379.
[6]. Attiya, Adnan Jabbar, et al. "Variable Speed Control Using Fuzzy-PID Controller for Two-phase Hybrid Stepping Motor in Robotic Grinding." Indonesian Journal of Electrical Engineering and Computer Science 3.1 (2016): 102-118.
[7]. Allaoua, Boumediene, Brahim Gasbaoui, and Brahim Mebarki. "Setting up PID DC motor speed control alteration parameters using particle swarm optimization strategy." Leonardo Electronic Journal of Practices and Technologies 14 (2009): 19-32.
[8]. Kanojiya, Rohit G., and P. M. Meshram. "Optimal tuning of PI controller for speed control of DC motor drive using particle swarm optimization." Advances in Power Conversion and Energy Technologies (APCET), 2012 International Conference on. IEEE, 2012.
[9]. Shneen, Jaafar Ali Kadhum Salam Waley, and Mahdi Ali Abdul Hussein. "Utilization of DC motor-AC generator system to convert the solar direct current into 220v alternating current."
[10]. M. A. A. Ghany, M. A. Shamseldin, and A. M. A. Ghany, “A Novel Fuzzy Self Tuning Technique of Single Neuron PID Controller for Brushless DC Motor,” International Journal of Power Electronics and Drive System (IJPEDS), vol. 8, no. 4, pp. 1705–1713, 2017.
[11]. Waley, A. Salam, Chengxiong Mao, and C. Dan Wang. "Artificial Optimal Fuzzy Control Strategy for Electric Vehicle Drive System by Using Permanent Magnet Synchronous Motor." International Journal of Engineering and Technology 9.1 (2017): 50.
[12]. Ghany, MA Abdel, Mohamed A. Shamseldin, and AM Abdel Ghany. "A novel fuzzy self tuning technique of single neuron PID controller for brushless DC motor." Power Systems Conference (MEPCON), 2017 Nineteenth International Middle East. IEEE, 2017.
[13]. Attiya, Adnan Jabbar, Yang Wenyu, and Salam Waley Shneen. "PSO_PI Controller of Robotic Grinding Force Servo System." Indonesian Journal of Electrical Engineering and Computer Science 15.3 (2015): 515-525.
[14]. Nasri, Mehdi, Hossein Nezamabadi-Pour, and Malihe Maghfoori. "A PSO-based optimum design of PID controller for a linear brushless DC motor." World Academy of Science, Engineering and Technology 26.40 (2007): 211-215.
[15]. Shneen S W, Mao C. Artificial Optimal Fuzzy Control Strategy for Elevator Drive System by Using Permanent Magnet Synchronous Motor[J]. TELKOMNIKA Indonesian Journal of Electrical Engineering, 2015, 14(3).
[16]. El-Gammal, Adel AA, and Adel A. El-Samahy. "A modified design of PID controller for DC motor drives using Particle Swarm Optimization PSO." Power Engineering, Energy and Electrical Drives, 2009. POWERENG'09. International Conference on. IEEE, 2009.
[17]. Attiya, Adnan Jabbar, Yang Wenyu, and Salam WaleyShneen. "Compared with PI, Fuzzy-PI and PSO-PI Controllers of Robotic Grinding Force Servo System." Indonesian Journal of Electrical Engineering and Computer Science 16.1 (2015): 65-74.
[18]. Montiel, Oscar, et al. "Performance of a simple tuned fuzzy controller and a PID controller on a DC motor." Foundations of Computational Intelligence, 2007. FOCI 2007. IEEE Symposium on. IEEE, 2007.
[19]. Waley, Salam, Chengxiong Mao, and Nasseer K. Bachache. "Biogeography Based Optimization Tuned Fuzzy Logic Controller to Adjust Speed of Electric Vehicle." Indonesian Journal of Electrical Engineering and Computer Science 16.3 (2015): 509-519.
[20]. Shneen, Salam Waley. "Advanced optimal for power-electronic systems for the grid integration of energy sources." Indonesian Journal of Electrical Engineering and Computer Science 1.3 (2016): 543-555.