Motor Drived Design Based On Pso And Pid In Reducing Ripple Tors And Ripple Fluxs In

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Abstract. Direct torque control (DTC) of an induction motor tends to be a value determined from torque. The torque provided is the speed output regulator, therefore it must continue tuning to adjust the Kp, Ki parameters. In conventional proportional-integral (PI) speed controllers, motor performance may vary from time to time which may cause uncertain torque disturbances, causing a flux response sluggish so that the choice of PID parameters is important for DTC systems. In this paper we present control techniques using Particle Swarm Optimization (PSO) to improve parameters (Kp, Ki) of the speed controller to reduce torque ripple, flux stator distortion ripple and fast response of rotor speed. Unlike conventional designs, this method is able to achieve the desired control performance. The closed loop control speed in the DTC for induction motors uses PSO techniques so as to provide a practical level of accuracy. The results show good features and strong exemplary in dynamic system response and decreased motor and transient torque

Keywords. Particle swarm optimization, direct torque control (DTC), motor performance

1. Introduction

Today, in addition to growing in technology and direct improvement in electrical devices, the parameters are perfect and reliable that are significant for drawing and developing high-performance induction motor drive systems. However, practice demands the exact parameters of PI controllers speed in direct torque control to achieve outstanding performance with high quality truth and wide reasonableness (Jadot, Malrait, Moreno-Valenzuela, & Sepulchre, 2009). Various researchers have done a lot of investigating the parameters of PID controller optimization. PSO has been practically productive in different optimization problems. One of the initial PSO applications is in neural network feed-forward (FFNN) (solly Aryza, 2017). However, some research is still being completed to reduce electromagnetic torque ripple and this major problem causes an increase in current stator distortion noise (Wibowo P, 2017). Artificial neural networks (ANNs) can be used to design mathematical controllers in order to continue high dynamic performance and toughness in high and low speeds even when detuning occurs. This method is not ideal in real time line performance. DTC also presents several weaknesses, including large torque ripple, variable switching frequency, and acoustic sound, among others (Zulkarnain Lubis et al, 2016). It is possible to directly control the stator flux and electromagnetic torque by selecting the optimal switching inverter mode (S (S.Aryza, 2012) but this encounters technical problems such as variable switching frequencies when the sample is high. Active vectors are obtained from conventional switching tables, and liability ratios are determined according to various principles, including torque-ripple minimization (Kar, Mohanty, & Singh, 2011) fuzzy logic-adaptation (Lftisi, George, & Rahman, 2017), equating mean torque with reference values more than one cycles (Aryza et al., 2012). This method is complicated and requires many motor parameters.
Several methods are used to reduce harmonics at torque and flux levels. Fuzzy logic strategy has been planned for speed control in drive motor vector control induction and sharing with neural networks, an adaptive hybrid neuro-fuzzy controller has also been presented for speed control (Aryza, 2018) and genetic algorithm (Goyal & Palwalia, 2016) optimal voltage vector space is achieved using an algorithm neural network-based (GA) genetics. Nevertheless, all have some disadvantages such as GA requires large computational complexity, Fuzzy systems require many parameters for optimization, neural network structure and parameters do not have a common standard to confirm. This paper proposes a high performance direct torque control using swarm particle optimization for PID parameter optimization. The induction motor used in the proposed scheme is kw 2.2, 4 poles, 420 V. Finally, the simulation results are obtained to authenticate the possibilities and high performance of this method (Aryza et al., 2018).

2. Literature Review

- Model of an induction motor

The electrical circuit of a three-phase induction motor is shown in the figure. Stator voltage equation. In the terms of reference dq can be described as (Rabanal-Arabach, Schneider, & Cabrera, 2015)

\[
V_{sd} = R_s i_{sd} + \frac{\lambda_{sd}}{dt} - \frac{\lambda_{sq}}{dt} - \omega_d \lambda_{sd} \tag{1}
\]

\[
V_{sq} = R_s i_{sq} + \frac{\lambda_{sq}}{dt} - \frac{\lambda_{sd}}{dt} - \omega_d \lambda_{sq} \tag{2}
\]

The rotor voltage equation in the direct and quadrature terms of reference is displayed.

\[
V_{rd} = R_r i_{rd} + \frac{\lambda_{rd}}{dt} - \frac{\lambda_{rq}}{dt} - \omega_d \lambda_{rd} \tag{3}
\]

\[
V_{rq} = R_r i_{rq} + \frac{\lambda_{rq}}{dt} - \frac{\lambda_{rd}}{dt} - \omega_d \lambda_{rq} \tag{4}
\]

The electromagnetic torque of the induction motor is given by the equation:

\[
T_{em} = \frac{3P}{2} L_m (i_{sq} i_{rd} - i_{sd} i_{rq}) \tag{5}
\]

Where the flux relationship variable is defined in the equation below.

\[
\lambda_{sd} = L_s i_{sd} + L_m i_{rd} \tag{6}
\]

\[
\lambda_{sq} = L_s i_{sq} + L_m i_{rq} \tag{7}
\]

\[
\lambda_{rd} = L_m i_{sd} + L_r i_{rd} \tag{8}
\]

\[
\lambda_{rq} = L_m i_{sq} + L_r i_{rq} \tag{9}
\]

Where:

Rs, Rr is the stator and rotor resistance.
Ls, Lr, Lm are the stator, rotor inductance
\(\lambda_{sd}, \lambda_{sq}\) is the stator flux at d-q
\(\lambda_{rd}, \lambda_{rq}\) is the rotor flux at d-q
ISD, ISQ, IRD, IRQ are stator and rotor currents in dq frame. is the number of poles.

Figure 1. Circuit diagram of an induction motor with an interface
The equivalent circuit of direct and quadrature induction motors is shown in Figure 2.

![Figure 2. Equivalen wire induksi d-q](image)

3. Method Of Research

An optimization of the PID controller procedure parameters becomes more important especially for speed control in DTC. In this case, it is not possible to get high performance for speed control on DTC drives without optimizing Kp, Ki, Kd parameters using intelligent techniques. This can be noted there the difference between conventional parameters and optimized direct torque control parameters that will find the right PID parameter which minimizes errors between estimated torque and reference torque. The speed and flux that is used as a reference signal in optimization contains two PID controller and PSO processes. The procedure used to execute this method can be summarized as follows:

1) Initialization speed, position, number of iterations, particle groups, weight inertia and constants.
2) Calculate the fitness function of each particle to measure system performance.
3) Set the Kp parameter, Ki controls the speed of random DTCs.
4) Compare the fitness value during each iteration for each particle with the location position. Is it better, then replace it as the current position.
5) Compare the fitness value for each particle in each generation with a global position.
6) Update speed and position for each particle that can be calculated by the equation.
7) If the number of iterations is not reached then return to step 2.
8) Best location by groups to get PID controller parameters based on particle swarm optimization

![Figure 3. Direct torque control based on PSO-PID controller](image)

The particle optimization flock adjusts the PID controller parameters to minimize the error between the reference and the actual speed to obtain reference torque as shown in equations (13) and (14). Where \( e(t) \) is the speed that is lost.
\[ e(t) = (W_{\text{ref}} - W_{\text{rot}}) \] .................................................... (13)

\[ T_e^* = PSO[(K_p e(t) + \frac{1}{T_i} \int e(t) \, dt)] \] ..................... (14)

\( W_{\text{ref}} \), \( W_{\text{rot}} \) are references and rotor speeds respectively. \( T_e \) is the reference torque.

4. Result And Analysis

In order to verify the accuracy and optimization of parameters (Kp, Ki) for speed control in DTC using particle swarm optimization (PSO-PID controller). The proposed method is tested by simulation. Besides this, the reference speed is taken as 1500 rpm, reference flux is 0.9Wb. The simulation results show that the optimization algorithm using particle swarm for tuning the PID parameters in the DTC speed controller is much better than the conventional method. To validate the accuracy of the proposed method, the stator when DTC with the PSO-PID controller is distortion-free compared to the classic DTC at low speeds (500RPM) as shown in Fig. 4 and Fig. 5 respectively.

![Figure 4. Graph of Stator Flow Results Using Pso-Pid in Dtc Control](image1)

![Figure 5. Graph the results of the stator current without using pso-pid in controlling DTC](image2)

![Figure 6. Estimated speed of the induction motor with pso-pid](image3)
Figure 7. Induction motor speed estimation with the old method

here it is clear that the difference in torque in the proposed method is almost negligible as shown in Fig. 8. different from the classic torque DTC in Fig.9. Or at the same time the stator flux and the stator flux angle as shown below shows the DTC performance based on the PSO-PID controller has a faster response, higher accuracy and overall improved system performance.

5. Conclusion

The proposed method describes direct torque control behavior based on particle swarm optimization (PSO) by adjusting the speed control parameters (Kp, Ki) to overcome the weaknesses of the DTC and to improve overall system performance, especially in low speed. The simulation results of the proposed surly method can improve the performance of a three-phase induction motor by minimizing torque and flux ripples and improving speed response with good stabilization. Therefore, the PSO is productive to optimize the PID controller parameters in controlling DTC speed. Finally, the response of this method is proposed to gather faster than traditional PID control systems. In addition, the PSO-PID controller increases the dynamic response of the entire system.

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