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A MODELING DESIGN BASED ON PSO AND PID IN REDUCTION RIPPLE TORQUE AND RIPPLE FLUX IN MOTOR

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ABSTRACT

Direct torque control(DTC) of the induction motor is inclined to a specified value of torque. The torque provided is a speed output regulator, therefore it is mandatory to continue tuning to adjust the Kp, Ki parameters. In conventional proportional-integral (PI) speed controllers, motor performance may differ over time which may lead to torque disturbance uncertainty, causing sluggishness of the flux response so the choice of PID parameters is important for DTC systems. In this paper we present a control technique using Particle Swarm Optimization (PSO) to improve the parameters (Kp, Ki) of the speed controller to reduce torque ripple, stator flux distortion ripple and fast response of rotor speed. Unlike conventional designs, this method is capable of achieving the desired control performance. The closed-loop speed control in DTC for induction motors uses the PSO technique thus providing a practical level of accuracy. The results show good features and strong exemplary in dynamic system response and reduction in motor torque and transients.

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 perfect and reliable parameters are significant for the drawing and development of high-performance induction motor drive systems. However, practice demands precise parameters from the PI-controller speed in direct torque control to achieve outstanding performance with high quality correctness and wide reasonableness. Various researchers have investigated the optimization parameters of the PID controller.PSO has been practically productive in different optimization problems. One of the early applications of PSO was in the preparation of feed-forward neural networks (FFNN) [1], [2]. However, some research is still being completed to reduce electromagnetic torque ripple and this main problem causes an increase in stator current distortion noise [3]. Artificial neural networks (ANN) can be used to design mathematical controllers in order to maintain high dynamic performance and toughness in high and low speeds even when detuning occurs [4].

This method is not ideal in real time line performance. DTC also presents several disadvantages, including large torque ripple, variable switching frequency, and acoustic noise, among others [5]. It is possible to directly control the stator flux and electromagnetic torque by selecting the optimal inverter switching mode [6] but this encounters engineering problems such as variable switching frequency at high sample times. The active vectors are obtained from conventional switching tables, and the liability ratios are determined according to various principles, including torque-ripple minimization [7], [8], [9], fuzzy logic-adaptation [10], equating the mean torque with a reference value over one cycle [11], [12]. This method is complicated and requires many motor parameters. Several methods are used to reduce harmonics at the torque and flux levels. Fuzzy logic strategies have been planned for speed control in motor control and shared induction vector drives with neural networks, an adaptive hybrid neuro-fuzzy controller has also been presented for speed control [13] and a genetic algorithm [14] for optimal voltage vector space achieved using the algorithm. genetics (GA) based on neural networks. However, all have some disadvantages such as GA requires large computational complexity, Fuzzy system requires a lot of parameters for optimization, the structure and parameters of the neural network does not have a common standard to confirm. PaperIt proposes a high performance direct torque control using particle swarm optimization for PID parameter optimization. The induction motor used in the proposed scheme is 2.2, kw, 4 pole, 420 V. Lastly, simulation results are obtained to authenticate the possibility and high performance of this method.

2. LITERATURE REVIEW.

SuiteThe electrical power of a three-phase induction motor is shown in the figure. Stator voltage equation .In the reference frame dq can be described as [15].

$Vsd = Rs\ isd + \frac{d}{dt}sd - wd\ sq$(1)

$Vsq = Rs\ isq + \frac{d}{dt}sq - wd\ sd$(2

Equalityrotor voltages in direct and quadrature reference frames are shown.

$Vrd = Rr\ ird + \frac{d}{dt}rd - wdA\ sq$(3)

$Vrq = Rr\ irq + \frac{d}{dt}rq - wdA\ sd$(4)

TorqueThe electromagnetic field of an induction motor is given by the equation:

$tem = \frac{3P}{2}Lm(isq\ ird - isd\ irq\ )$(5)

WhereThe flux relationship variable is defined in the equation below.

$sd = Ls\ isd + Lm\ ird$(6)
$sq = Ls\ isq + Lm\ irq$(7)
$rd = Lm\ isd + Lr\ ird$(8)
$rq = Lm\ isq + Lr\ irq$(9)
where:
Rs, Rr are the stator and rotor resistances.
Ls, Lr, Lm are the inductance of the stator, rotor
sd, sq is the stator flux in dq
rd, rq is the rotor flux in dq
ISD, isq, ird, irq are the stator and rotor currents in the dq frame. is the number of poles.

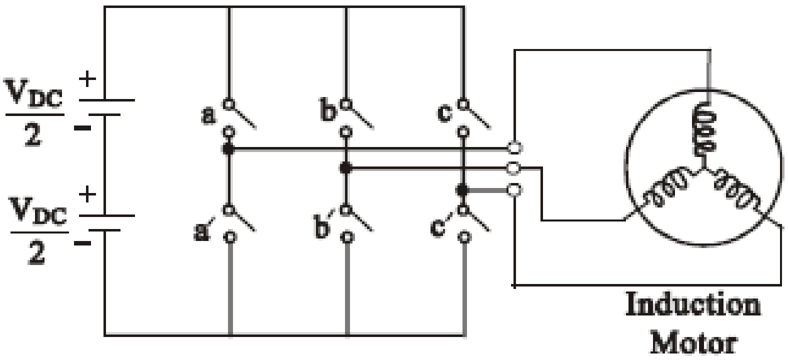

Figure 1. Circuit diagram of induction motor with interface

The direct induction motor equivalent circuit and the quadrature reference frame are shown in Figure 2 .

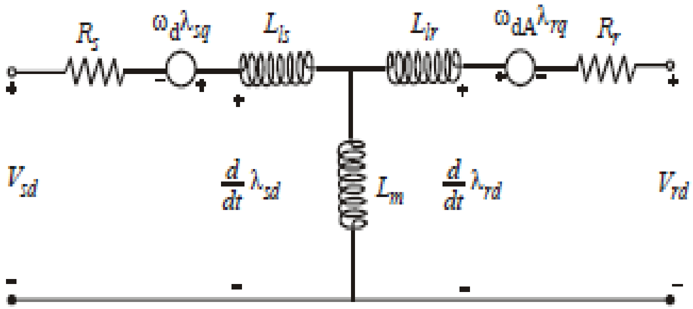

Figure 2. Equivalent induction circuit dq

3. METHODS

A parameter optimization procedure of PID controller becomes more important especially for speed control in DTC. In this case, it is not possible to get high performance for speed control in DTC drive without optimizing Kp, Ki, Kd parameters by using intelligent technique. It can be noted there the difference between conventional parameters and optimized parameters direct torque control which will find the right PID parameter which minimizes the error between the estimated torque and the reference torque. The speed and flux are used as reference signals in the optimization containing the two processes PID controller and PSO. The procedure used to carry out this proposed method can be summarized as follows.

1-initialization speed, position, number of iterations, particle group, inertial weight and constant.
2-calculate the fitness function of each particle to measure the system performance.
3 - set the parameter Kp, Ki control the random DTC speed.
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 - compares the fitness value for each particle in each generation with the global position.
6 - updated velocity and position for each particle which can be calculated by equation.
7 - if the number of iterations is not reached then go back to step 2.
8 - best location by groups to get PID controller parameters based on particle swarm optimization.

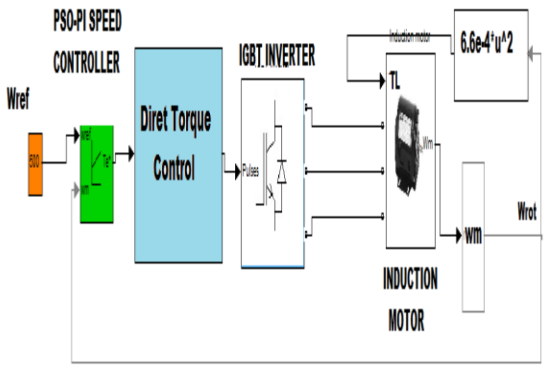

Figure 3.direct torque control based on PSO-PID controller

The particle swarm optimization adjusts the PID controller parameters to minimize the error between the reference and the actual velocity to obtain the reference torque as shown in equations (13) and (14). Where e(t) is the velocity lost

e(t)=(Wref - Wrot) (13)

$$Te^* = PSO[(Kp\ e(t) + \frac{1}{Ti}\int e(t)\,dt)] \quad (14)$$

Wref, Wrot are reference and rotor speed respectively. Te is the reference torque.

4. RESULTS AND DISCUSSION

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

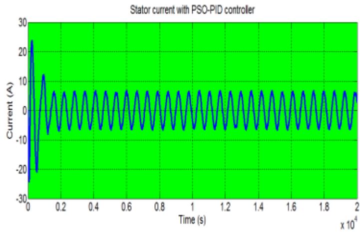

Figure 4. Graph of stator current results using pso-pid in DTC control

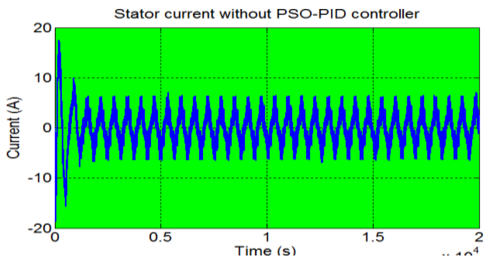

Figure 5. Graph of stator current results without using pso-pid in DTC control

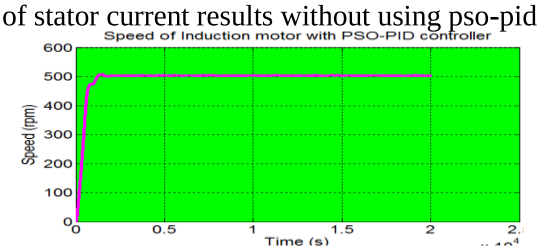

Figure 6. Induction motor speed estimation with pso-pid

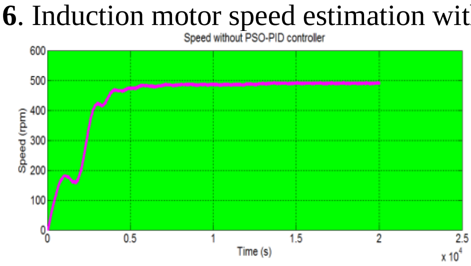

Figure7. Estimation of the speed of an induction motor with the old method

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

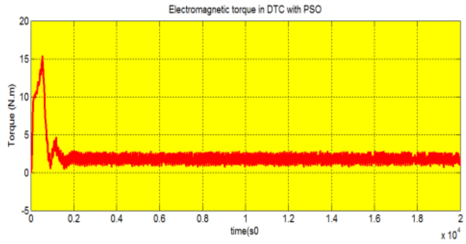

Figure 8. Electromagnetic torque using PSO

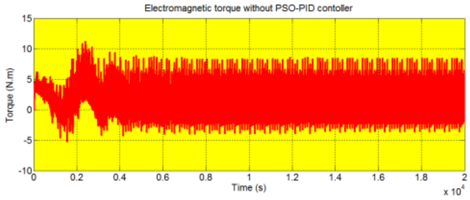

Figure 9. Electromagnetic torque using only old DTC

5. CONCLUSION

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

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