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BLDC MOTOR SPEED CONTROL BY OPTIMIZING PI CONTROLLER USING PSO TECHNIQUE

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ABSTRACT

This paper presents speed control of BLDC motor by PI controlling parameters and optimizing the PI controlling parameters by PSO technique. In many industrial sector BLDC motor is used as it has got many advantages such as high efficiency, high speed ranges, long operating life and compactness and less maintenance. The PI controller refines the characteristics performance of BLDC motor. Tuning of PI controller parameter is done by PSO technique. To implement the task of speed control of BLDC motor, brushless dc motor is modeled in MATLAB SIMULINK and PSO algorithm is designed in MATLAB PROGRAMMING. The project put forwarded has superior features such as good computational efficiency, stable convergence characteristics.

Keywords: BLDC motor, PI controller, PSO technique.

I. INTRODUCTON

The main advantage of BLDC motor is that it's ability to provide the necessary power at a low weight. So they are in demand for use in model aircraft, automotive, aerospace, medical, automated industrial equipment and instrumentation.

Also Brushless dc motor has many advantages over brushed dc motor counterparts. The most obvious advantage of a brushless motor is its lack of brushes and physical commutator. This difference means that there are many fewer parts that can wear out or break and need to be replaced than in brushed motor. It is also capable of operating in less noise and electromagnetic interference than a brushed motor because its internal parts are completely enclosed. Another advantage of this motor is that it can operate at a high speed in both loaded and unloaded conditions. Applications such as fans and pumps often have varying output and thus to meet this requirement speed control of motor is needed. In addition, BLDC motors useHall Effect sensors in place of mechanicalcommutations and brushes [1].

In industrial sector various controlling techniques are been implemented and are still making progress. Numerous control technique such as adaptive control, neural control and fuzzy control are been studied. Among all other the well-known controller is the PI controller. It is widely used in industrial as it has got simple

structure and robust performance in a wide range of operating condition[2]. Tuning of PI controller parameters are been well been carried out by Ziegler-Nichols method and Fuller's scheme. In the recent technology Particle Swarm Optimizing Technique is been widely used. PSO has reliable and well-balanced mechanism to enhance the local and global optimum solution [3].

II BRUSHLESS DC MOTOR

Characteristics equation for BLDC motor is given as.

$$V = \frac{LdIa}{dt} + IaRa + Eb \qquad (1)$$

$$Eb = Kb\ \Phi\ \omega \quad (2)$$

$$T = \frac{Jdw}{dt} + B\ \omega \quad (3)$$

$$T = Kt\ \Phi\ Ia \qquad (4)$$

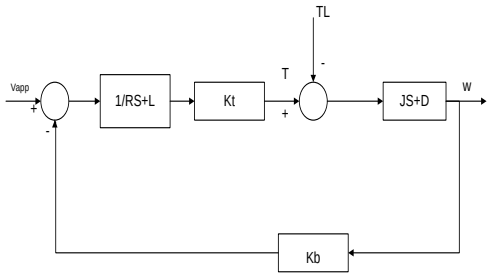

Fig 1. BLDC motor block diagram

III. PARTICLE SWARM OPTIMIZING TECHNIQUE

PSO is an optimizing technique which by iteratively trying to improve a candidate solution. It is a population based stochastic optimization technique which is inspired by social behaviour of bird flocking or fish schooling.

ALGORITHM:

1. Create a population of agents (particles) uniformly distributed over X dimensions.
2. Evaluate each particles position according to the objective function.
3. If each particles current position is better than its previous best position, update it.
4. Determine the best particle (according to the particles previous best positions)
5. Update particles" velocities: Vi
   $$V_i^{t+1} = V_i^t + C_1 U_1^t (Pb_i^t - P_i^t) + C_2 U_2^t (Gb_i^t - P_i^t)$$
6. Move particles to their new position
   $$P_i^{t+1} = P_i^t + V_i^{t+1}$$
7. Go to step 2 until stopping criteria has occurred.

IV IMPLEMENTATION OF PSO

The fundamental parameter on which the PSO technique is carried are given as follows,

(i) Particle (individual, agent): each individual in the

Swarm.

(ii) Position/location: A particle's n-dimensional coordinates. which represents a solution to the problem.

(iii) Swarm: The entire collection (population) of particles.

(iv) Fitness: The fitness function provides the interface between the physical problem and the optimization problem. The fitness function is a number representing the goodness of a given solution given by a position in solution space.

(v) Generation: Each iteration of optimization procedure using the PSO.

(v) Pbest (personal best): The position in parameter space of the best fitness returned for a specific particle.

(vi) Gbest (global best): The position in parameter space of the best fitness returned for the entire swarm.

(vii) Vmax: the maximum velocity value allowed in a given direction.

In this work of PSO

Number of particles =4;

And we require to optimize the parameters that is Kp and Ki for position as well as for speed for BLDC motor, so in this proposed method there are four dimension search space. Therefore each particle is required to obtain its best position in this four dimensions search space.

The next is the fitness function which is given as the performance criteria for the PI controller design are integrated absolute error(IAE), integrated of time weight square error (ITSE) and integrated of squared error (ISE).

The following PSOparameters are used to verify the performance of the PSO-PID controller parameters:

Population size: 30;

Wmax = 0.6, Wmin = 0.1;

Iteration= 50;

Correction factor = 2.05

V. SIMULATION RESULTS

The speed results are given as follows.

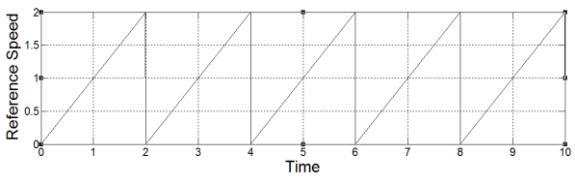

Fig 2:Output speed by optimizing the PI parameters by PSO technique

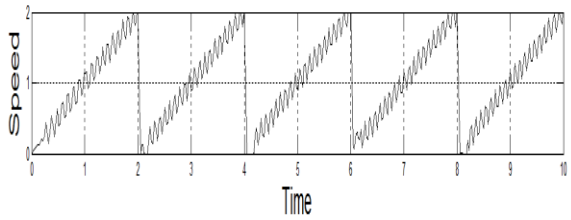

Fig 3: Speed obtained by manually controlling technique of PI parameters.

VI. CONCLUSION

In this paper BLDC motor speed controlling technique by optimizing the PI controlling parameters is presented. Thus from the simulation results obtained it shows that the proposed optimizing technique can perform an efficient search for the PI controller parameter. And thus the required speed is obtained perfectly.

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