Genetic Algorithm Based Model Reference Adaptive PI Controller for 3 Phase Induction Motor

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Abstract:

Induction motors are highly nonlinear in nature. Vectorial analysis with rotor flux orientation is used to formation of mathematical model of the motor for speed control. A model reference adaptive PI controller is used for speed control. Adaptation mechanism uses MIT rule. Simulation results show that Genetic Algorithm Based Model reference Adaptive PI Controller fast response when it compares with other PI controller.

I .Introduction

Principal of three phase induction motors is the creation of rotating and sinusoidally distributing magnetic field in the air gap. Synchronously rotating magnetic field created by Sinusoidal three phase power supply in the three stator windings. Induction motor can runs at its rated speed. External load changes interferes the stable operation.

This paper deals with the speed control of three phase induction motor through GA based model reference adaptive control approach .

II MATHEMATICAL MODEL OF THE MOTOR

In vector control direct axis stator current is analogous to field current in a dc motor and quadrature axis stator current is analogous to armature current in a DC motor[1]. Electromagnetic torque produced by the motor can be expressed as

$$T_e(t) = k_d \psi_{rd}(t) i_{sq}(t)$$

k_d is a positive constant, ψ_{rd} is the direct axis rotor flux linkage. Induction motor dynamics can be expressed by equation(2).

$$J d\omega(t)/dt = T_e(t) - B\omega(t) - T_l(t)$$

Here J is rotational speed's the moment of inertia, $T_e(t)$ is the electromagnetic torque. B is the damping constant. $T_l(t)$ is the load torque, w is the rotor angular.

$$JS\omega(S) = (k_d \psi_{rd} i_{sq}(s))/J \; - B/J \;\; w(s)$$

$\omega(s) = k_{p/} s + a_p$

$k_d \psi_{rd\,/\,J} = k_p$

B/J = a_p

$k_d = 21.8, \psi_{rd} = 87.5\times10^5$

Weber,

$B = 5.65\times10^{-3} kgm^2 / s, J = 5\times10^{-4}, kp = 3797.56,$

$a_p = 11$ for a .25 HP motor. The reference model chosen here is

21 / (S+21)

III. MODEL REFERENCE ADAPTIVE PI CONTROL

MIT Rule is that the time rate of change of θ is proportional to negative gradient of the cost function (J), that is:

$$\frac{d\theta}{dt} = -\gamma \frac{\partial J}{\partial \theta} \qquad = -\gamma \epsilon \frac{\partial \epsilon}{\partial \theta}$$

The adaptation error

$\varepsilon = y_p(t) - y_M(t). J(\theta) \quad = \frac{1}{2}\varepsilon^2(t)$

Standard 2nd order differentials equation was chosen as the reference model given by

$$H_M(s) = \frac{b_M}{s^2 + a_{M1} + a_{M0}}$$

Then the approximate parameter adaptation laws are as follows

$$K_p^* = \left(\frac{-\gamma_p}{s}\right)\epsilon\left(\frac{s}{a_0 s^2 + a_{M1}s + a_{M2}}\right)e$$

$$K_i^* = \left(\frac{-\gamma_i}{s}\right)\epsilon\left(\frac{1}{a_0 s^2 + a_{M1}s + a_{M2}}\right)e$$

In Model Reference Adaptive PI controller and γ_i values are set by trial and error method. Whereas in GA based MRA-PI controller and γ_i values are obtained using GA.

To optimize Complex problems and to solve system of non linear equations Genetic Algorithm is used by random search method. Instead of deterministic rules .It handles population of potential solution like individuals or chromosomes to evolve iteratively. Each iteration is a generation. Evolution solution is simulated by Genetic operators and fitness function like mutation and crossover.

IV Genetic Algorithm Procedure

Step 1. Parameter with a population of random solutions, such as crossover rate, mutation rate, number of clusters, and number of generations were Initialized. The coding mode were Determined.
Step 2. Compute and evaluate the value of the fitness function.
Step 3. Proceed with crossover and mutation operation and make up the new cluster. Step 4. Repeat Step 2, till the best value is obtained.

V. Results & Discussion

Simulation run of speed control of 3 Phase Induction motor system is carried out with GA based MRAC-PI values. Similar test runs of MRAC -PI and ZN based PI are carried out and the responses of all the cases are recorded in Figure 1 & 2. From the results, the performances are analyzed in terms of Settling Time & Peak Overshoot are tabulated in Table 1. The results prove that GA based MRAC-PI controller gives better performance than the others . The responses are presented in the same (Figure 1 & 2) .From the table, it is observed that GA based MRAC- PI gives superior performance than the other control strategies

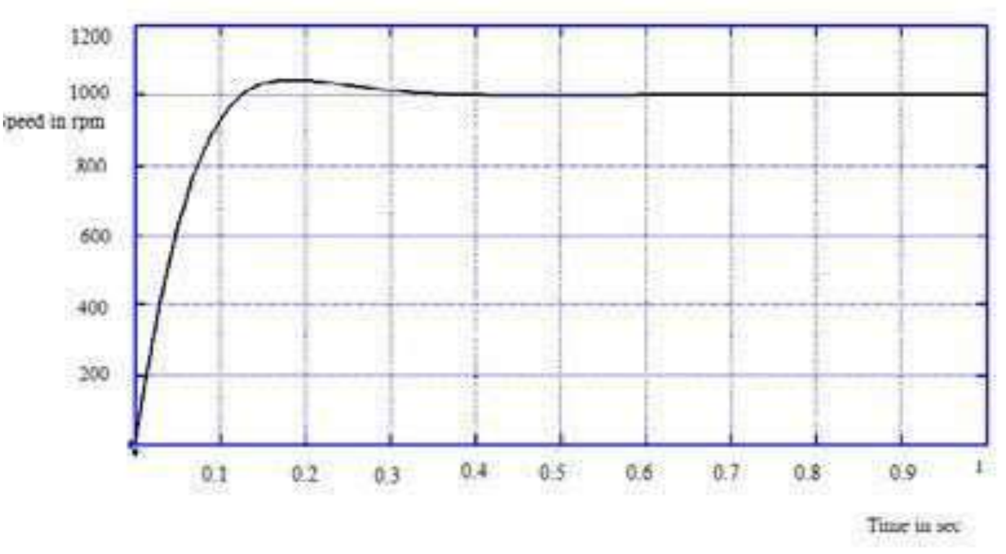

Fig 1 : Responses with conventional PI controller

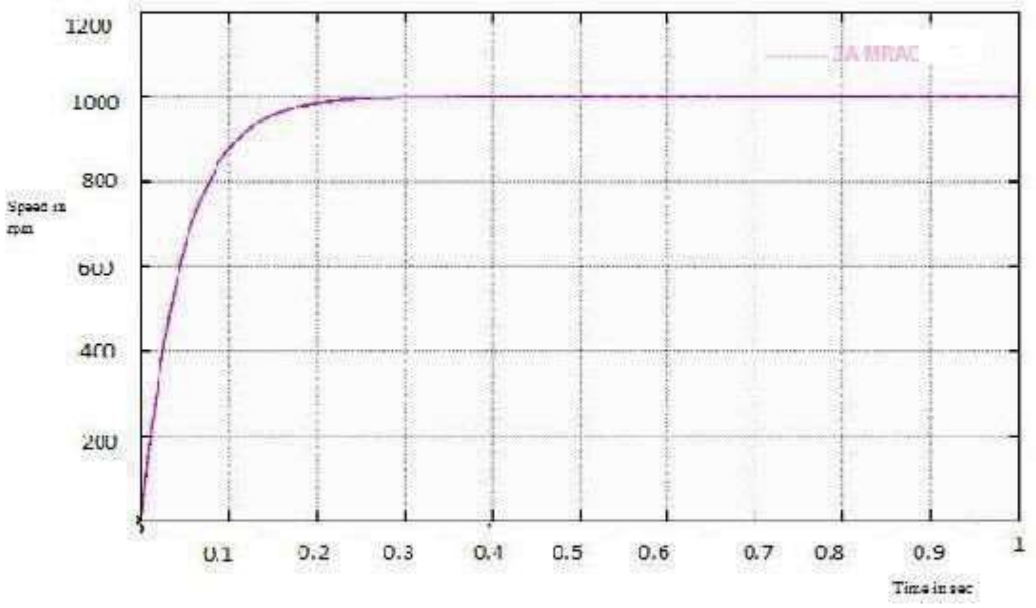

Fig 2: Responses with GA Model reference adaptive PI Controller

TABLE 1 COMPARISON BETWEEN MRAC AND CONVENTIONAL CONTROL STRATEGY

Controller	Settle time(in sec)	Overshoot Peak
PI	0.4	1050
GA Model reference adaptive PI controller	0.25	0

VI.CONCLUSION

This paper briefs GA based MRAPI based the speed control of three phase induction motor. Simulation results confirmed GA based MRAPI controller has better control performance than other methods. GA based MRAPI control algorithm reduced overshoot peak and it minimize the settle time of the process.

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