BFA Based Model Reference Adaptive PI Controller for 3 Phase Induction Motor

Mr.R.RaghuRaman

Assistant Professor

Department of Electronics & Instrumentation Engineering, Faculty of Engineering & Technology, Annamalai University, Chidambaram,Tamil Nadu, India

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 bacterial foraging algorithm (BFA) 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 bacterial foraging algorithm (BFA) 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).

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

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

$k_d = 21.8, \psi_{rd} = 87.5 \times 10^5$

Weber,

$B = 5.65 \times 10^{-3}\, kgm^2/s, J = 5 \times 10^{-4}, kp = 3797.56,$

$a_p = 11$ 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:

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

The adaptation error

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

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 . BFA Based Model Reference Adaptive PI Control

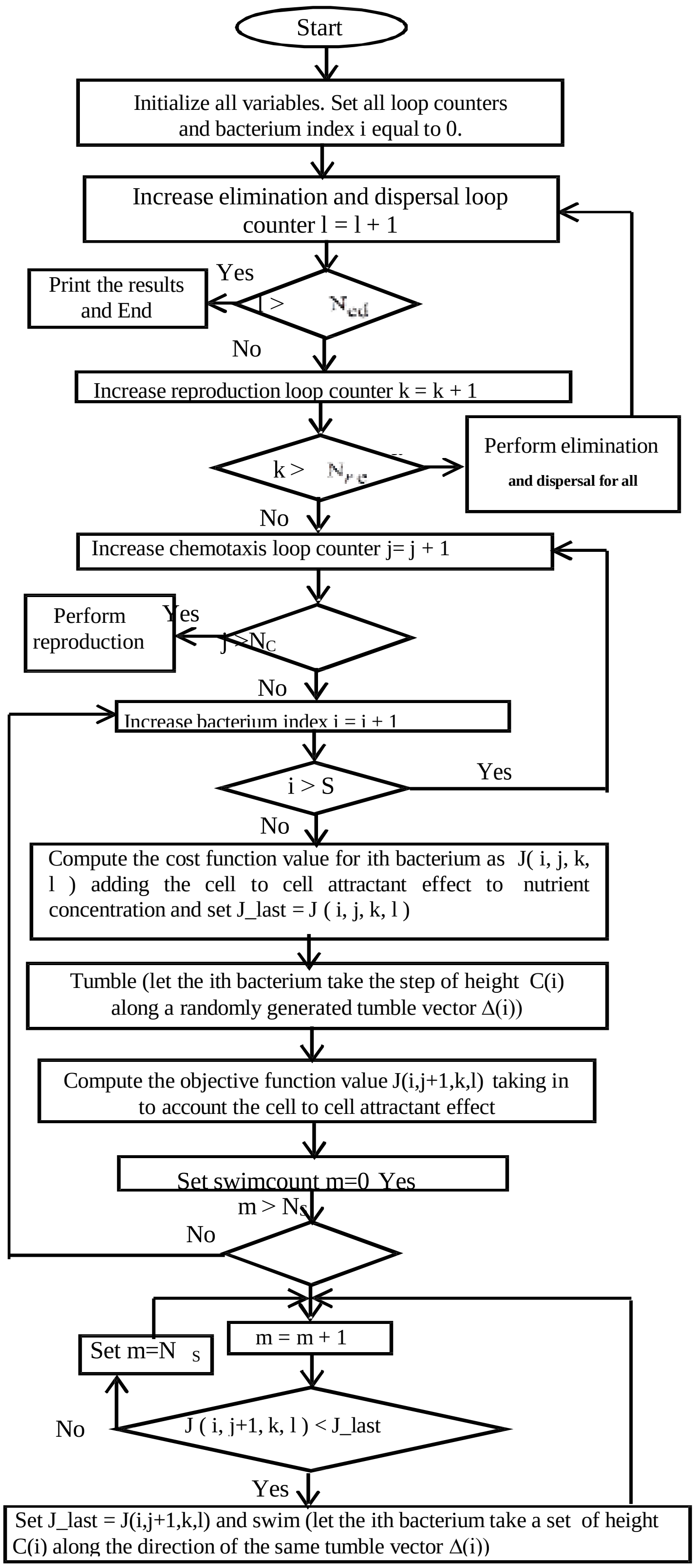

Fig. 1. Flow chart of BFOA

Bactarial Foraging Array Algorithm Flow Chart shown in Fig.1. In Model Reference Adaptive PI controller γ_p and γ_i values are set by trial and error method. Whereas in BFA based MRA-PI controller γ_p and γ_i values are obtained using BFA. Bacterial Foraging algorithm is a random search method that can be used to solve nonlinear system of equations and optimize complex problems.

V. Results & Discussion

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

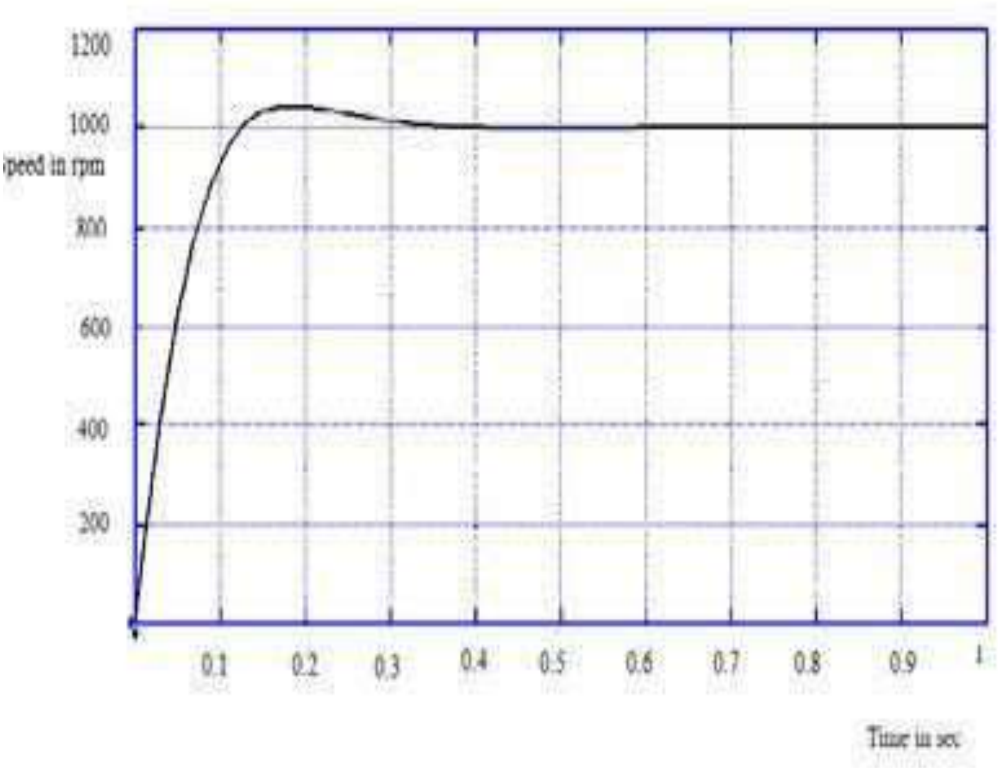

Fig 2 : Responses with conventional PI controller

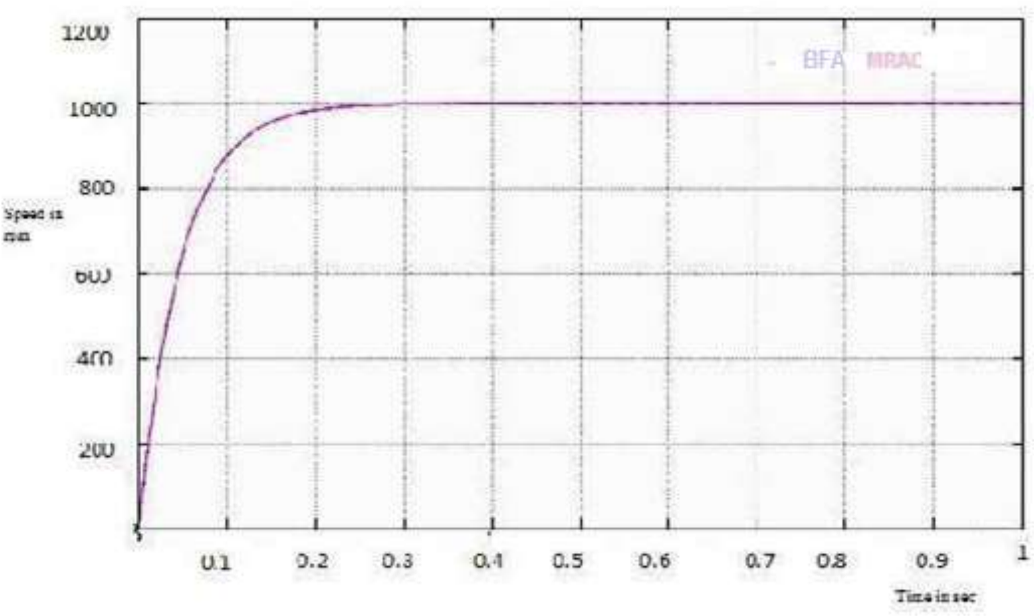

Fig 3: Responses with BFA Model reference adaptive PI Controller

TABLE 1 COMPARISON BETWEEN MRAC AND CONVENTIONAL CONTROL STRATEGY

Controller	Settling time(in sec)	Peak overshoot
PI	0.4	1050
BFA Model reference adaptive controller PI	0.23	0

VI.CONCLUSION

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

REFERENCES

[1] Bimal K Bose ”Modern Power Electronics and AC drives”Pearson Education Asia

[2] H. C. Cho, K. S. Lee, and S. M. FadaliREAL-, “Time adaptive speed control of dc motors with bounded periodic random disturbance,” in Proc. ICIC International Confernece, 2009, pp.1349-4198

[3] J. S. R. Jang, “Adaptive network based fuzzy inference systems,” IEEE Transactions onsystems man and cybernetics 1993, p. 665-685.

[4] B. Allaoua, A. Laoufi, B. Gasbaoui, and A. Abderrahmani, “neuro-Fuzzy DC Motor Speed Control Using Particle Swarm Optimization,” Issue 15, July-December 2009

[5] Astrom, K.J. and Hagglund, 1984. Automatic tuning of simple regulatorswith specifications on phase and amplitude margins, Automatica, 20: 645651.

[6] Swati Mohore and Shailja Shukla, 2013. Comparative Analysis of MRAFC Controller MRAC Controller, International Journal of Engineering Sciences & Research Technology, 2(9): 2264-2268.

[7] NCTU Department of Electrical and Computer Engineering 2015 Spring Course <Dynamic System Simulation and Implementationon> by Prof. Yon-Ping Chen

[8] Maheswary Mohan & Prof. Priyanka CP A Model Reference Adaptive PI Controller for the Speed Control of Three Phase Induction Motor Vol. 5 Issue 07, 2016,p 184-187