Fuzzy-Neuro Controller for Speed of Slip Energy Recovery and Active Power Filter Compensator

S. Tunyasrirut*, J. Ngamwiwit*, T. Furuya ** and Y. Yamamoto***

*Faculty of Engineering and Research Center for Communications and Information Technology
King Mongkut's Institute of Technology LadkrabangChalongkrung Road, Ladkrabang, Bangkok 10520, Thailand
(Tel: 66-2-3269989; E-mail: satean@ptwit.ac.th)
*Kitakyushu National College of Technology 5-20-1, Shii, Kokura-minami-ku, Kitakyushu 803-0985, Japan
(Tel:+81-93-964-7284; E-mail: furuya@kct.ac.jp)
***Kumamoto National College of Technology 2659-2 Suya Nishigoshi-Machi Kikuchi-Gun Kumamoto Japan
(E-mail: yamamoto@cesrv.knct.ac.jp)

Abstract

In this paper, we proposed a fuzzy-neuro controller to control the speed of wound rotor induction motor with slip energy recovery. The speed is limited at some range of sub-synchronous speed of the rotating magnetic field. Control speed by adjusting resistance value in the rotor circuit that occurs the efficiency of power are reduced, because of the slip energy is lost when it passes through the rotor resistance. The control system is designed to maintain efficiency of motor. Recently, the emergence of artificial neural networks has made it conductive to integrate fuzzy controllers and neural models for the development of fuzzy control systems. Fuzzy-neuro controller has been designed by integrating two neural network models with a basic fuzzy logic controller. Using the back propagation algorithm, the first neural network is trained as a plant emulator and the second neural network is used as a compensator for the basic fuzzy controller to improve its performance on-line. The function of the neural network plant emulator is to provide the correct error signal at the output of the neural fuzzy compensator without the need for any mathematical modeling of the plant. The difficulty of fine-tuning the scale factors and formulating the correct control rules in a basic fuzzy controller may be reduced using the proposed scheme. The scheme is applied to the control speed of a wound rotor induction motor process. The control system is designed to maintain efficiency of motor and compensate power factor of system. That is: the proposed controller gives the controlled system by keeping the speed constant and the good transient response without overshoot can be obtained.

1. Introduction

Several types of electric motors have been proposed for high performance drive applications[1]. This paper introduces the slip-energy recovery induction motor to the field of high performance drives. The slip-energy recovery induction motor is well known for its low cost, simple control circuitry and high efficiency even at low speeds. A schematic diagram of the slip-energy recovery induction motor drive is show in fig.1. In this drive the slip-frequency voltage is rectified through a diode bridge. The resulting dc voltage is inverted through a line-commutated inverter and fed back to the supply. Speed control is achieved by varying the firing angle (α) of the inverter. The output voltage of the rectifier must equal the input voltage of the inverter. A change in the rotor's voltage is obtained by changing the slip. Thus, the speed control of the induction motor can be accomplished by varying the firing angle of the inverter. In general, conventional controllers are not suitable for high performance drive systems. These controllers are not capable of capturing the unknown load characteristics over a wide range of operating points. There are many tracking control techniques that are evolving to serve high performance drives such as the sliding mode and the adaptive control [1,2]. The sliding mode control scheme requires a good model of the drive system and/or a comprehensive knowledge of its dynamics. Due to the structured uncertainty of the drive system, these two schemes are not sensitive to large parameter variations and noise. In adaptive control, the overall behavior of the drive system is identified using a linear parametric model at perspective time intervals. This model could be very complicated especially for the slip-energy recovery system. Also, the load torque is usually a nonlinear function of a combination of variables such as the speed and the rotor position. Hence, representing the overall system using a linearized model around a wide range of operating points and/or under fast switching frequencies may not guarantee the stability of the system. In addition, adaptive controllers need excessive computations for real time applications. Recently, the emergence of the artificial neural networks has made it conductive to integrate fuzzy logic controllers and neural models for the development of adaptive fuzzy control systems. Neural networks are trainable dynamical systems that estimate input-output functions. Their key advantage is their ability to learn and generalize. The integration of fuzzy logic and neural models is currently one of the most concentrated research efforts in the development of intelligent control systems. The objective of this paper is to design another approach of integrating neural networks into a fuzzy logic control system. The difficulty of fine-tuning the scale factors and formulating the correct control rules in a basic fuzzy controller may be reduced using the proposed scheme. In this approach the leaning and generalization capability of the neural networks is used to compensate on-line for any