The SPWM Fuzzy Controller for speed control of Induction Motor

Kamsri T.*, Riewruja V.*, Ukakimaparn P.**, Pongswatd S.** and Kummool S.**

* Dept. of control Eng.
** Dept. of Instrumentation Eng.
Fac. of Engineering,King Mongkut 's Inst. of Tech. Ladkrabang
Ladkrabang, Bangkok ,10520 Thailand
(Tel : 66-2-326-7346; Fax : 66-2-326-7347 ; E-mail: klsawai@kmitl.ac.th)

Abstract

The paper presents the fuzzy control technique to adjust the gain schedule in the fuzzy controller. The micro computer is designed to the fuzzy controller to execute the proportional gain with the data of the error and speed command. The gain schedule is the fuzzy set which execute based on the fuzzy rule. The gain schedule from the fuzzy controller is fed to the sinusoidal pulse width modulation (SPWM) inverter for control the response and speed of the induction motor. The induction motor coupling to the DC motor and tachogenerator which DC motor as a load. The test result of the fuzzy control technique in the open loop control, it provides a good response and in the closed loop control it can control speed in the any condition of load design

1. Introduction

The ac motors have a number of advantages. They are light weight, inexpensive and easy to maintenance compared to the dc motor. They require control of frequency, voltage and current for variable speed applications. The power converters, inverters and ac voltage controllers can control the frequency , voltage ,and/or current to meet the drive requirements. These power controllers, which are relatively complex and more expensive, require advanced feed back control technique. The closed loop control system , the gain schedule is important for the response of the system. The paper presents the fuzzy control technique to control the gain schedule in the closed loop control .The micro controller is designed to execute the gain in the loop control and interface to the driver. The gain is fed to the inverter to control the speed of the motor when the loads apply.

2. Principle and Theory

A fuzzy set is a set containing elements which have vary degree of membership in the set.This idea is contrasted with classical,or crisp,sets because member of a crisp set would not be member unless their membership was full or complete in that set.Element in a fuzzy set,because their membership can be a value other than complete, can also be members of other fuzzy sets on the same universe. Element of fuzzy set are mapped to a universe of "membership value" using a function-theoretic form. Fuzzy sets are denoted by a set symbol with a tilde understrike This function maps elements of a fuzzy set $\underset{\sim}{A}$ to a real numbered value on the interval 0 to 1.If an element in the universe, say x is a member of fuzzy set $\underset{\sim}{A}$ then this mapping is given as

$$\mu_A(x) \in [0,1] \tag{1}$$

$$A = \left(x, \mu_A(x) \middle| x \in X\right) \tag{2}$$

These mapping are shown in the Fig. 1 and 2 respectively.

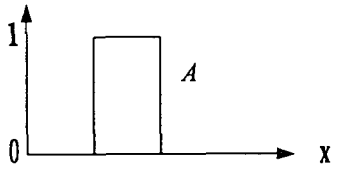

Fig. 1 Membership function for crisp set A

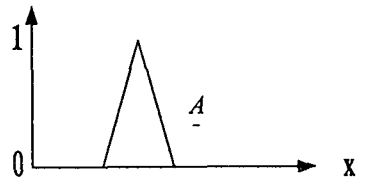

Fig. 2 Membership function for fuzzy set $\underset{\sim}{A}$

The fuzzy logic systems with fuzzifier and defuzzifier is shown in the Fig. 3 .The fuzzifier maps crisp points in U to fuzzy set in U, and the defuzzifier maps fuzzy sets in V to crisp points in V. The fuzzy rule base consists of a collection of fuzzy IF-THEN rules, and the fuzzy inference engine uses these fuzzy IF-THEN rules to determine a mapping from fuzzy sets in the input universe of discourse $U \subset R^n$ to fuzzy sets in the output universe of discourse $V \subset R$ based on fuzzy logic principles.

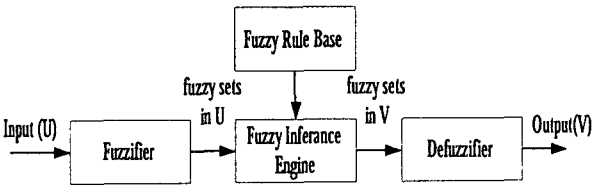

Fig.3 Basic configuration of fuzzy logic system with fuzzifier and defuzzifier

Three-phase induction motors are commonly used in adjustable-speed drives and they have three-phase stator and rotor windings. The stator windings are supplied with balanced three-phase ac voltages, which produce induced voltages in the rotor windings due to transformer action. It is an effect of multiple poles, producing several cycles of