

Speed Control of a Doubly Fed Induction Motor using Fuzzy Logic Techniques

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Abstract: This paper presents a comparison between a fuzzy logic controller and a conventional IP controller used for speed control with a direct stator flux orientation control of a doubly fed induction motor. The effectiveness of the proposed control strategy is evaluated under different operating conditions such as of reference speed and for load torque step changes at nominal parameters and in the presence of parameter variation. Simulation results show that the fuzzy logic controller is more robust than a conventional IP controller against parameter variation and uncertainty, and is less sensitive to external load torque disturbance with a fast dynamic response.

Keywords: direct stator flux orientation control, doubly fed induction motor, fuzzy logic controller, Fuzzy PI controller, conventional IP controller.

1. Introduction

Due to many freedom degrees, the Doubly Fed Induction Machine (DFIM) presents several advantages as well as motor application in high power applications such as traction, marine propulsion or as generator in wind energy conversion systems like wind turbine, or pumped storage systems [1].

The DFIM has some distinct advantages compared to the conventional squirrel-cage machine. The DFIM can be fed and controlled stator or rotor by various possible combinations. Indeed, the input-commands are done by means of four precise degrees of control freedom relatively to the squirrel cage induction machine where its control appears quite simpler. The flux orientation strategy can transform the non linear and coupled DFIM-mathematical model to a linear model conducting to one attractive solution as well as under generating or motoring operations [2], [3].

Several methods of control are used to control the induction motor among which the vector control or field orientation control that allows a decoupling between the torque and the flux, in order to obtain an independent control of torque and the flux like DC motors [4].

Therefore, decoupling the control scheme is required by compensation of the coupling effect between q-axis and d-axis current dynamics [4].

With the field orientation control (FOC) method, induction machine drives are becoming a major candidate in high-performance motion control applications, where servo quality operation is required. Fast transient response is made possible by decoupled torque and flux control. The most widely used control method is perhaps the proportional integral control (PI). It is easy to design and implement, but it has difficulty in dealing with parameter variations, and load disturbances [5]. Recent literature has paid much attention to the potential of fuzzy control in machine drive applications.

In the area of the control of the electric machines, the research works are oriented more and more towards the application of the modern control techniques. These techniques involve in a vertiginous way with the evolution of the computers and power electronics. This allows to lead to the industrial processes of high performances. These techniques are the fuzzy control, the adaptive control, the sliding mode control etc [6].