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Speed Control of Induction Motor Drive Based on SPWM Using PI Controller

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ABSTRACT

The induction motors were characterized by complex, highly non-linear and time-varying dynamics, and hence their speed control is a challenging problem in the industry. The advent of vector control techniques has solved induction motor control problems. The vector control analysis of an induction motor allows the decoupled analysis where the torque and the flux components can be independently controlled (just as in dc motor). This makes the analysis easier than the per phase equivalent circuit.. In recent years, the field oriented control of induction motor drive is widely used in high performance drive system. It is due to its unique characteristics like high efficiency, good power factor and extremely rugged. This paper presents simulation of SPWM based speed control of induction motor drive by means of PI controller using MATLAB/SIMULINK.
Keywords: Induction motor, SPWM Based control, MATLAB, speed control, modeling, field oriented control and PI controller.

I. INTRODUCTION

Rotational industrial loads require operation at any one of a wide range of operating speeds. Such loads are generally termed as variable speed drives or adjustable speed drives. The variable speed drive systems are also an integral part of automation. There are three basic types of variable speed drive systems: electrical drives, hydraulic drives and finally mechanical drives [1]. AC motors exhibit highly coupled, nonlinear and multi variable structures as opposed to much simpler decoupled structures of separately excited DC motors [2]. Variable speed drive systems are essential in many industrial applications [3]. The AC motors have a number of advantages: light weight, inexpensive and have low maintenance compared with DC motors. The torque of the DC motors can be controlled by two independent orthogonal variables, stator current and rotor flux, where such a decoupling does not exist in induction motors [4]. Recent years have seen the evolution of a new control strategy for AC motors, called “vector control”, which has made a fundamental change in this picture of AC motor drives in regard to dynamic performance. Vector control makes it possible to control an AC motor in a manner similar to the control of a separately excited DC motor, and achieve the same quality of dynamic performance [5]. As for DC machines, torque control in AC machines is achieved by controlling the motor currents. However, in contrast to a DC machine, in AC machine, both the phase angle and the modulus of the current has to be controlled, or in other words, the current vector has to be controlled. This is the reason for the terminology “vector control” [6]. The indirect vector control uses an induction motor model to predict the voltage required to achieve a desired output torque [7]. The electromagnetic forces or torques developed in the driving motor tend to propagate motion of the drive system. This motion may be uniform if the linear velocity or the angular velocity is constant. Therefore the electrical drives good dynamic performance is mandatory so as to respond the changes in command speed and torques. The most commonly used controller for the speed control of Induction motor is Proportional plus Integral (PI) controller [8]. In this paper application of PI controller for intelligent speed control of SPWM based Induction Motor drive is investigated and implemented in MATLAB/SIMULINK environment. The simulation results obtained from Matlab/Simulink are analyzed and presented.

II. METHODS AND MATERIAL

Matlab/Simulink Models

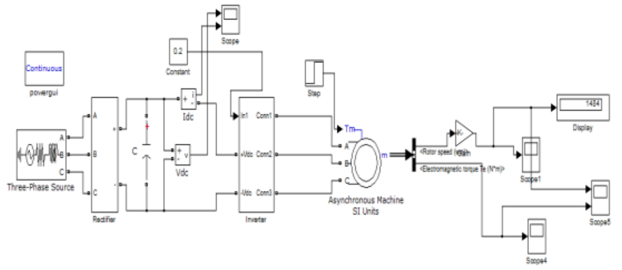

Figure 1. Open Loop with Readymade module

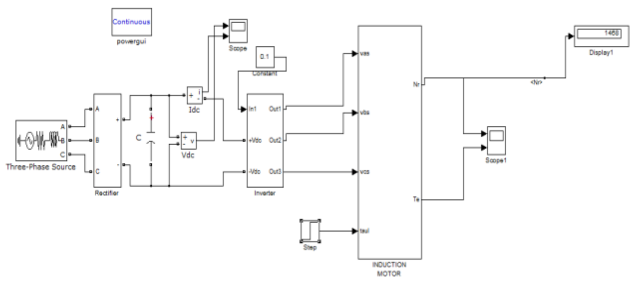

Figure 2. Open loop with module model of I.M

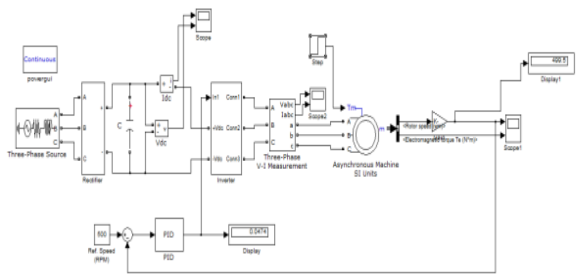

Figure 3. Closed loop control with PI controller (Readymade module)

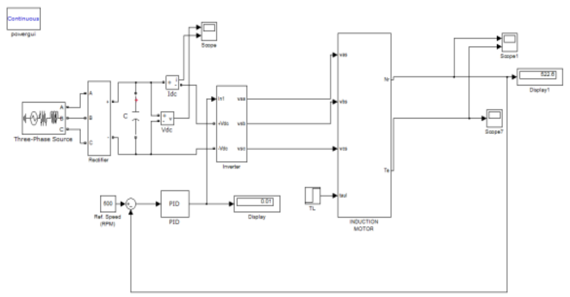

Figure 4. Closed loop control with PI controller (module model)

III. RESULTS AND DISCUSSION

A. Matlab/Simulink Results

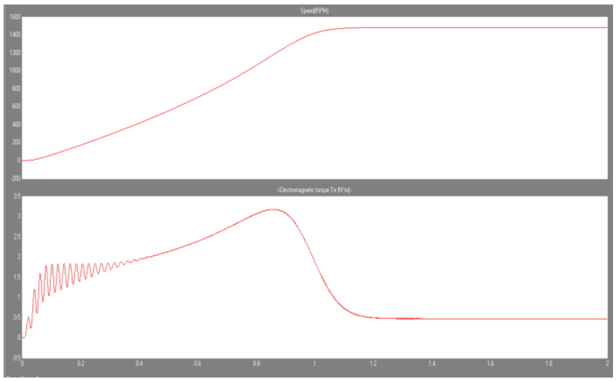

Figure 5. Speed and Torque of I.M with Readymade Model

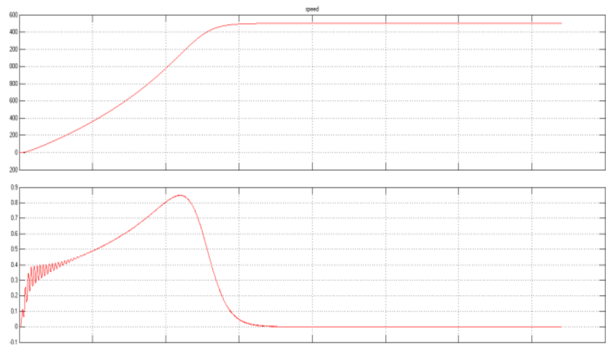

Figure 6. Speed and Torque of I.M with Module Model

Figure 7. Speed and Torque of I.M with PI controller With Readymade Model (Base speed 500 RPM)

Figure 8. Speed and Torque of I.M with PI controller with Module Model (Base speed 500 RPM)

B. Results With Variation in load torque (Tl):

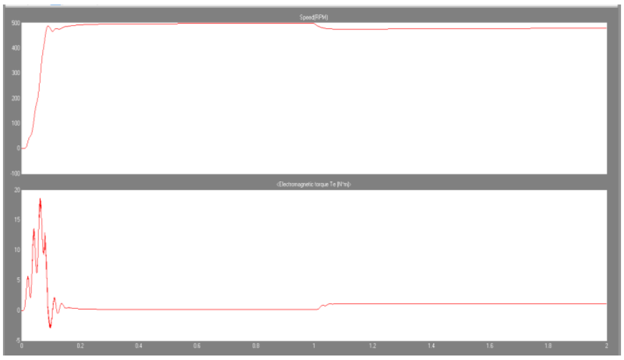

Figure 9. closed loop output when Tl Applied at t=1 with readymade model

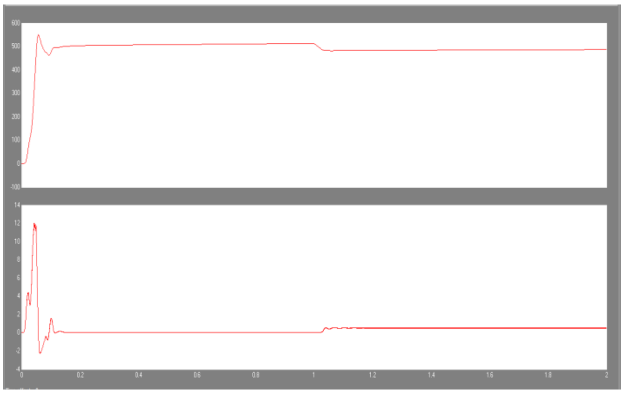

Figure 10. closed loop output when Tl Applied at t=1 with module model

IV. CONCLUSION

In this paper, the simulation model of indirect vector controlled Induction motor drive using PI controller has been developed. Various essential aspects of an Induction motor and indirect vector control were explored. The validity of the proposed method has been verified by the simulation by using MATLAB. Obtained results using developed simulation model are presented in the form of the waveforms for speed, torque and stator current using PI controller. From the simulation results we can conclude that the PI controller is better to improve the speed performance of induction motor.

V. REFERENCES

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