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"Comparative analysis of V/F and Vector ControlMethods for Three Phase Induction Motor Fed SVPWM Technique"

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Abstract
This paper presents a comparison of V/F control and vector control methods for three-phase induction motors driven by voltage source inverters (VSI) based on space vector pulse width modulation (SVPWM). Three-phase induction motors are widely used in various industrial applications due to their simplicity, robustness, and low cost. V/F control is a simple and widely used method that provides stable performance over a wide speed range, while vector control is a more advanced method that provides precise control of the motor's speed and torque. The comparison between these two methods considers their advantages, disadvantages, and suitability for different applications. The use of SVPWM enhances the efficiency and performance of both control methods. The choice of control method depends on the specific application requirements, and this paper provides a base for further research and development in the area of motor control.

Introduction
Three-phase induction motors are commonly used in various industrial applications due to their simplicity, robustness, and low cost. In recent years, there has been a growing interest indeveloping efficient and high-performance motor drives to improve their energy efficiency and dynamic response[2]. Two commonly used motor control methods are V/F control and vectorcontrol[7]. This paper presents a comparison of V/F control and vector control of three-phase inductionmotors driven by voltage source inverters (VSI) based on space vector pulse width modulation (SVPWM).

V/F Control of Three-Phase InductionMotors
V/F control is a simple and widely used method of controlling the speed of three-phase induction motors. In this method, the frequency and voltage supplied to the motor are controlled in a linear relationship, with the ratio of voltage to frequency (V/F) being kept constant[6]. The V/F control method is suitable for constant speed and load applications such as fans, pumps, and conveyor belts[4]. The V/F control method provides stableperformance over a wide speed range, but it has limited torque control at low speeds and low efficiency.

Vector Control of Three-Phase Induction Motors
Vector control, also known as field-oriented control(FOC), is a more advanced method of controlling the speed and torque of three-phase induction motors. Vector control is based on the principle of separating the magnetizing and torque-producing components of the motor's stator current[8]. The motor is modeled as a set of two axes, a direct axis (d-axis) and a quadrature axis (q-axis), and axis is controlled independently. Vector control provides precise control of the motor's speed and torque, and it is suitable for dynamic and variable speed applications[10]. However, vector control iscomplex, requires advanced control algorithms, andis more difficult to implement compared to V/F control.

Comparison of V/F Control andVector Control
Both V/F control and vector control methods use VSIs based on SVPWM to drive three- phase induction motors[2]. SVPWM is a technique used to generate the control signals for the inverter. It provides better utilization ofthe DC link voltage and reduces the harmonic distortion in the output voltage. The use of SVPWM enhances the efficiency and performance of the motor drive. V/F control is asimple and cost-effective method, and it provides stable performance over a wide speed range. However, it has limited torque control at low speedsand low efficiency. Vector control, on the other hand, provides precise control of the motor's speed and torque, and it is more suitable for dynamic andvariable speed applications.

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Proposed models

This model is used as a V/f supply to the SVPWM part. A three-phase inverter is cascaded with SVPWM and used as a drive circuit to the three- phase induction motor as in the Fig.1.and the resulting control signals in for the open-loop control system Simulink model (open loop).

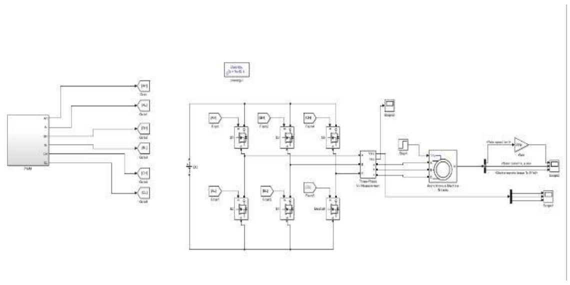

Fig-1: Open Loop Simulink Model

In order for the induction motor to return to thereference speed after the external torque is loaded on the shaft of the motor, a closed-loopsystem is initiated in Figure feedback rotor speed is compared with a reference speed of 1430 rpm and the difference is supplied to proportional and integral PI controller. The outputof the controller is supplied to the V/f three-phase supply to compensate for the error. This process isrepeated until the actual speed approximately matches the reference value. As shown in the Fig.2

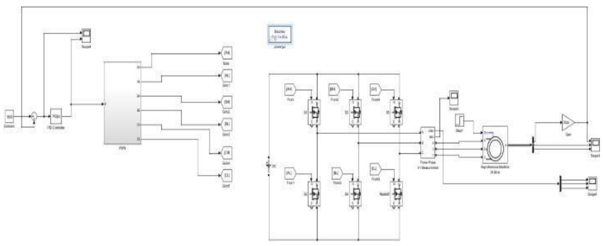

Fig-2: Closed Loop Simulink Model

Vector control Simulink Model

Vector control, also known as field-oriented control (FOC), is a more advanced and sophisticated method of controlling the speed and torque of induction motors. In vector control, the motor is modeled as shown in the Fig.3.a series of components, including the magnetizing component, the torque component, and the resistive component. Each component is controlled independently to achieve precise control of the motor's performance.

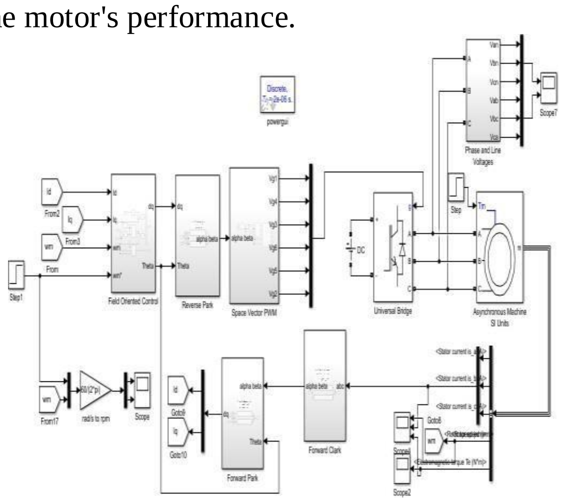

Fig-3: Vector Control Simulink Model

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Simulation Results

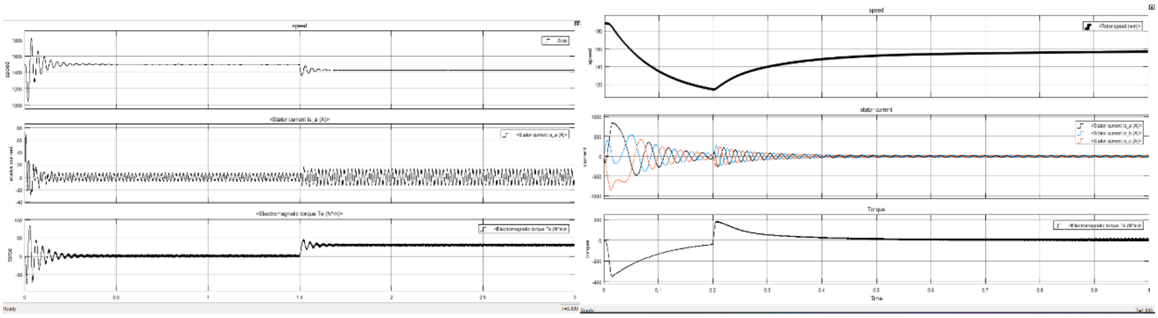

Fig-4. Response of Open Loop

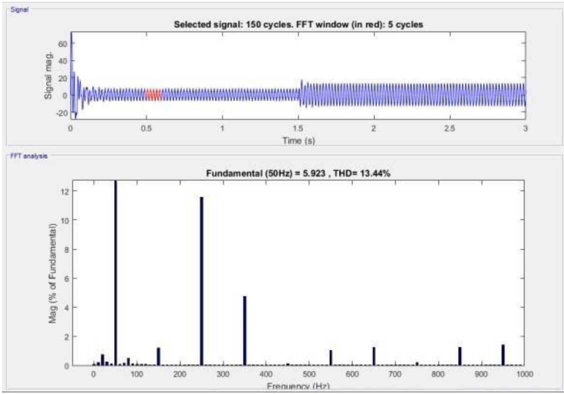

Fig-5. THD for Open Loop

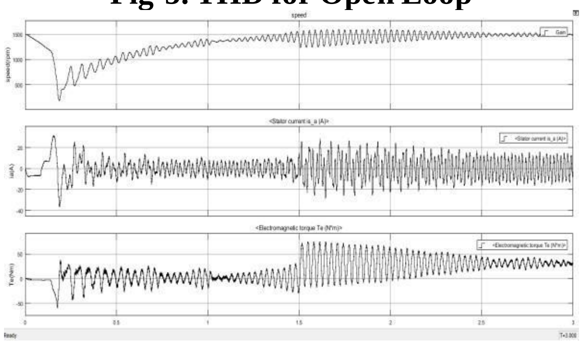

Fig-6. Response of Closed Loop

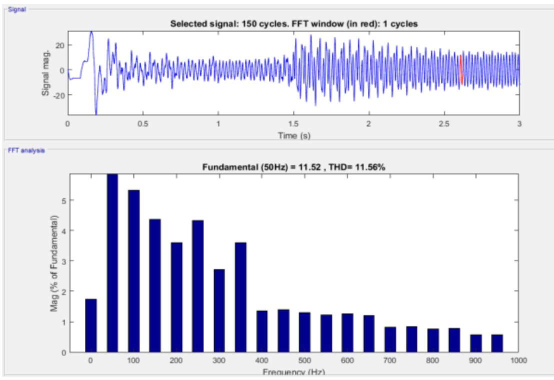

Fig.7. THD of Closed Loop

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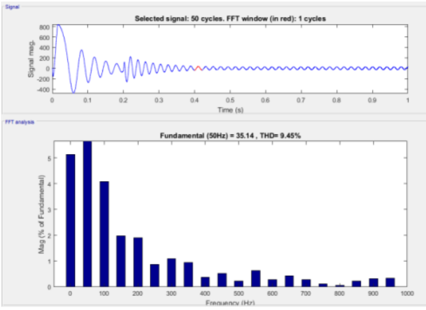

Fig-8: THD of Vector Control

Conclusion

V/F control and vector control methods are commonly used to drive three-phase induction motors. The choice of control method depends onthe specific application requirements. For constantspeed and load applications, V/F control is a simple and cost-effective method that providesstable performance over a wide speed range. For dynamic and variable speed applications that require high performance and precise control. Vector control has less THD value compare to V/F control method. Hence vector control is a more efficient method than V/F control method.

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