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CURRENT SOURCE INVERTER FED INDUCTION MOTOR DRIVE USING MULTICELL CONVERTER WITH ANFIS CONTROL

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Efficient control strategies are used for reducing operation cost too. To maintain torque capability of the motor close to the rated torque at any frequency, the air gap flux is maintained constant. Multilevel converters offer good quality load waveforms. Among all the multilevel topologies, cascade multi-cell converters (CM), characterized by high modularity, allow for power to be easily increased. Moreover, this characteristic also allows any faulty module (cell) to be isolated, so the load can be fed by the remaining operational cells. Modifications to the motor control scheme are proposed based on the use of field weakening to achieve operation and on-line speed reference modifications. The simulation operations are carried out using MATLAB/Simulink.

Keywords: Induction motor drives, Current Source Inverter (CSI), Multicell Converter, ANFIS Control

INTRODUCTION

Recent work has focused on control strategies, PWM schemes topologies, and efficiency, for high-power current-source converters and drives, where significant improvements have been achieved such as harmonic distortion minimization, high input power factor, minimized dc-link current, and reduced switching frequencies. Zero-speed operation plays an important role in applications such as cranes, hoists, and traction drives, where maintaining the desired torque down to zero speed or starting the load with a high torque from zero speed is highly desirable [1]. The motor is controlled with rotor flux orientation, where the rotor flux is estimated using stator currents and motor speed. Due to the CSI-side filter capacitors, the stator currents are a portion of the inverter output currents. The influence of these capacitors on the motor control performance is systematically evaluated [4].

One winding is designed for higher voltage and is meant to handle the main (active) power. The second winding is designed for lower voltage and is meant to carry the excitation (reactive) power [5]. However, this method is not effective for the lagging power factor compensation or during SHE modulation of the CSI. In these situations, the flux adjustment method was proposed to improve the power factor when the power factor is lagging or

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when the drive is running at high speeds where SHE modulation is used for the CSI [6]. The mechanism of the SS-DPWM is also presented to develop its modulating characteristics, and it is shown that, comparing with the conventional SPWM, the SS-DPWM has lower switching frequency, higher dc current utilization ratio, and in-phase transfer between the line currents and their references [1]. Hybrid CSC (HCSCs) with both SCRs and force-commutated switches usually offer a compromise solution regarding cost and performance. This paper discusses the use of space vector modulation (SVM) techniques to enhance the performance of a bidirectional three-SCR four-switch HCSC.

**EXISTING MOTOR CONTROL SCHEME**

Recent work has focused on control strategies, PWM schemes topologies, and efficiency, for high-power current-source converters and drives, where significant improvements have been achieved such as harmonic distortion minimization, high input power factor, minimized dc-link current, and reduced switching frequencies. However, it seems that zero-speed operation of the high-power PWM CSI-fed induction motor drive (IMD) has seldom been reported. Zero-speed operation plays an important role in applications such as cranes, hoists, and traction drives, where maintaining the desired torque down to zero speed or starting the load with a high torque from zero speed is highly desirable.

Three phase electric motors are the largest prime mover in all of the industry. They are offered in ranges from 0.35 up to 4300 kW. A squirrel cage induction motors fill the large percentage of the total motor industry. Because of the presence of current loops, vector control is implemented and it is ensured that active power is always sourced by the CSI. The proposed drive scheme is implemented in an experimental prototype. The experimental results show the feasibility of the control strategy. Operation without capacitor is also demonstrated. This type of drive scheme is suitable for large power (multiples of megawatt) applications. For high-power induction motors, the full load power factor generally is above 0.9. Figure 1 shows the schematic model of existing system.

![Figure 1: Block Diagram Of CSI fed Induction Motor for Zero Speed Operation](image)

In existing system Current source inverter driven by PWM method is used so harmonics in the converter is high. Current control scheme is not efficient in faulty condition so speed control is not accurate. The CSI fed Induction Motor for Zero Speed Operation is the Single phase supply of 230Volts AC Voltage is given to the Diode Bridge Rectifier IC of main circuit. The Diode bridge rectifier IC which converts AC voltage to pulsating DC voltage. The pulsating DC voltage is given to Current source inverter as input. The Voltage source inverter converts pulsating DC voltage into AC voltage. Speed measurement is done by the speed sensor and it is given to the dsPIC microcontroller. It acts as the feedback loop and also generates the gate pulse depends on the
speed. Speed control is done by PWM technique which is fed as a program in the dsPIC microcontroller. The output of the controller generates the PWM signal which is given to the inverter as gate signal and whose control and modulation of frequency is extremely high to avoid the ripple caused by the small inductance windings modulation. Driver circuit which consists of Photo coupler needed to isolate the low voltage dsPIC Microcontroller unit from the high voltage main circuit.

**PROPOSED MOTOR CONTROL SCHEME**

In this proposed system instead of PWM converter SHPWM is used and it is used to reduce the harmonics. As same as instead of current control scheme here ANFIS control is used. It is used to give the constant speed. In this method the motor equation are transformed in a coordinate system that rotates with the rotor flux vector. In such way created new field coordinates, when the rotor flux amplitude is constant, there is a linear relationship between control variables and speed.

The method allows control Voltage source inverter fed induction motor drive not only amplitude and frequency, like in Voltage/Frequency control, but also the phase of the voltage, current and flux vectors, what further significantly improve dynamic behavior of the system. The Fig.2. shows the proposed motor model.

CSI-fed motor drives have filter capacitors connected at the output of the inverter. This means that a portion of the inverter currents go through the capacitors. The influence of the filter capacitors on the system control is investigated in this section.

**DESIGN CONSIDERATION**

The existing conventional methods can perform well except in very low speeds, near zero stator frequency. At zero stator frequency the stator quantities are not affected by the rotor speed and, therefore, the speed cannot be observed from measured stator voltages and currents. Further, the stator voltage provided by the inverter is difficult to measure and sometimes is assumed to be equal to the reference voltage or calculated from the DC link voltage and inverter switches conditions. The errors caused by these assumptions are often negligible in high speeds. However, they can be relatively high in low speeds, since the voltages are reduced to maintain the reference flux and the errors due to the voltage...
drops and dead times in the switching devices become more prominent in lower output voltage range. However, they need a high computational effort to be implemented and a kind of intervention in the machine is necessary (e.g., high frequency signal injection and modifications on the rotor slots).

Despite the many attempts to obtain accurate flux and speed estimation for wide speed range induction motor drives proposed recently, it seems that the solutions do not meet simultaneously the simplicity, accuracy and reliability requisites to be largely accepted and used in the industries. Referring to Fig. 3 CSI modulation index is fixed at 1 and the stator current amplitude is regulated by varying the dc-link current. With a considerably large dc-link current, the CSI modulation index control may improve the speed dynamic performance; however, the losses will increase. Therefore, the load torque feed forward control is employed as a compromise.

**SIMULATION AND RESULTS**

Simulation has played a vital role in all research areas over the years. Simulation is necessary in order to evaluate some aspects of complex ideas. In this project MATLAB simulation tool is used to simulate the proposed system. MATLAB is an environment for scientific computing that is ideal for computations that require extensive use of arrays and graphical analysis of data. SIMULINK is a program with graphical programming facilities for simulating dynamic systems. As an extension to MATLAB, SIMULINK adds many features specific to dynamic systems while retaining of MATLAB’s general purpose functionality. For example complex systems containing also nonlinearities can be built and analyzed easily. SIMULINK has two phases of use, model definition and model analysis. First a model has to be defined or a previously defined model is recalled. Then that model is analyzed.

The Fig. 5 shows the resultant input waveform of d-axis. With 1 p.u. step torque variation, the system performance without and with the load torque observer are show in Figure 5. Without the load torque observer, the DC link current and stator d-axis currents exhibit almost no transient

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oscillations due to comparatively slow speed response. The speed drop is up to 28 r/min. With the help of load torque observer, the speed drop is reduced to 14 r/min, while the DC link current and stator d-axis currents suffer about two cycles of transient resonant.

The Figure 6 shows the resultant output waveform of the simulation diagram under CSI fed Induction Motor for zero speed operation. By employing the load torque feed forward control, the system performance under 0.5 p.u. Step load torque is shown Figure 5. Due to the faster speed response, the dc-link current and stator q-axis current exhibit more transient resonances, while the motor speed drop is reduced to 8 r/min. The speed recovery overshoot is increased as well, from 0 to 2.5 r/min. In the meantime, the q-axis current exhibits a small amount of LF ripples after the implementation of the feed forward control, which is not presented in the simulation results. This is mainly introduced by the speed derivative, which highly depends on the encoder resolution and measurement noises. A comparatively large time constant $\delta$ is adopted for the low-pass filter to suppress such effect, which contributes to larger speed recovery overshoot.

**CONCLUSION**

Some of the strategies for sensor less induction motor drives were reviewed and the effects of including a flux observer were analyzed. When a speed sensor is available, the use of a flux observer showed to be an effective means to enable fast and precise flux estimation without any voltage-measuring scheme. The observer uses both voltage and current models. The motor is controlled with rotor flux orientation, where the rotor flux is estimated using stator currents and motor speed. The influence of these capacitors on the motor control performance is systematically evaluated. A load torque observer with feed forward control is also utilized to improve the speed Dynamic response. Simulation and experiments show that the CSI-fed IMD works well at zero speed with promising speed dynamic performance.

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