Design and Hardware Implementation of Speed Control of Induction Motor using Z - Source Inverter

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Abstract
A hardware implementation of closed loop speed control of Z-source converter fed induction motor drive with peak dc link voltage control is projected in this paper. This paper aims to observe and manage of the induction motor speed with the help of high speed PIC controller. This control has been implemented using frequency and voltage control. The pulse width modulation logic control is implemented in PIC controller to implement the speed control of induction motor using frequency control. The single phase source voltage, current from the induction machine has been sensed using sensors. This signal is conditioned and then given to the PIC controller to achieve the set speed. This logic is implemented in hardware environment and the compatibility of the hardware system is verified from the results.

Key words - Z - Source inverter, closed loop, Speed Control, Induction Motor

INTRODUCTION
The use of induction motors has increased greatly since the day of its development. They are being used as actuators in various built-up processes, robotics, domestic and other applications. The reason for its day by day increasing reputation can be primarily attributed to its robust construction, simplicity in design and cost effectiveness. Speed control is one of the application imposed constraints for the choice of a motor. Out of all the speed control mechanisms, the Volts/Hertz (V/F)
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control scheme is very popular because it provides a wide range of speed control with good running and transient performance. This control mechanism is referred to as scalar control mode.

PROPOSED INDUCTION MOTOR DRIVE SYSTEM WITH Z – SOURCE INVERTER

The proposed impedance source inverter fed V/F control of induction motor block diagram is shown in Fig. 2. It consists of an ac voltage source, rectifier, Z-source inverter, speed sensing unit, signal conditioning unit, PIC controller, LCD and induction motor. The single phase ac supply is given to the rectifier the output of the rectifier is the dc voltage. The dc voltage is buck or boosted by the Z-source inverter according to the gate pulse provided to the inverter. The output of the inverter is the three phase ac which drives the induction motor. The speed of the induction motor is sensed by speed sensing unit and given to PIC controller. Accordingly PIC controller compares it with set speed and gives the gating signal to Z-source inverter.

![Fig. 2 Block diagram of proposed speed control system](image1)

![Fig. 4 Connection diagram of speed control of Z-source inverter fed v/f controlled induction motor drive](image2)

To overcome the problems of the traditional V-source and I-source converters, this project proposes an impedance-source (or impedance-fed) power converter (abbreviated as Z-source converter) and its control method for implementing dc-to-ac, ac-to-dc, ac-to-ac, and dc-to-dc power conversion. It employs a unique impedance network (or circuit) to couple the converter main circuit to the power source, load, or another converter, for providing unique features that cannot be observed in the traditional V-source and I-source converters where a capacitor and inductor are used, respectively. Figure 4 shows the Connection diagram of speed control of Z-source inverter fed v/f controlled induction motor drive. Since slip generated is proportional to the developed torque at constant flux, the scheme considered as open loop with
speed control loop. Fig. 4 shows connection diagram of speed control of Z-source inverter fed v/f controlled induction motor.

SIMULATION MODEL AND OUTPUTS

The proposed model is simulated in MATLAB 7.12.1.0 (R2011a). Various simulation parameters (Table 1) are given for simulation.

<table>
<thead>
<tr>
<th>Components</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS line voltage</td>
<td>325.22 V</td>
</tr>
<tr>
<td>Input frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>No. of poles</td>
<td>4</td>
</tr>
<tr>
<td>Stator resistance</td>
<td>0.01965 Ω</td>
</tr>
<tr>
<td>Rotor resistance</td>
<td>0.01909 Ω</td>
</tr>
<tr>
<td>Stator inductance</td>
<td>0.0397 Ω</td>
</tr>
<tr>
<td>Rotor inductance</td>
<td>0.0397 Ω</td>
</tr>
<tr>
<td>Mutual inductance</td>
<td>1.354 Ω</td>
</tr>
<tr>
<td>Capacitance</td>
<td>750mF</td>
</tr>
<tr>
<td>Inductance</td>
<td>40mH</td>
</tr>
</tbody>
</table>

Fig. 5. Simulation Model of speed control of Z-source inverter fed v/f controlled induction motor drive
Fig. 5 shows the Simulation Model of speed control of Z-source inverter fed v/f controlled induction motor drive. The simulation result (Figure 6) shows the V/F speed control operation of the Z-source inverter fed induction motor drive.

**Fig. 6a** DC Terminal voltage of ZSI fed Induction motor drive with Rated input voltage.

**Fig. 6b** Voltage Response of ZSI fed Induction motor drive with Rated input voltage.

**Fig. 6c.** Current Response of ZSI fed Induction motor drive with rated input voltage.

**Fig. 6d** Speed Response of ZSI fed Induction motor drive with Rated input voltage.

**Fig. 6e** DC Voltage Response of ZSI fed Induction motor drive with 20% Reduction in Input voltage.

**Fig. 6f** Current Response of ZSI fed Induction motor drive with 20% Reduction in Input voltage.
Fig. 6f Speed Response of ZSI fed Induction motor drive with 20% Reduction in Input voltage

Fig. 6 Simulation outputs of speed control of Z-source inverter fed v/f controlled induction motor drive

Hardware Model
The main objective of the proposed hardware model (Fig. 7) is to provide speed control of induction motor with Z-source inverter. The hardware circuit includes power supply, Voltage regulator, Power MOSFET, Diode, Resistor, Capacitor, Inductor, Driver circuit and Pic microcontroller.

Fig. 7 Proto type model of speed control of Z-source inverter fed v/f controlled induction motor drive

CONCLUSION
This paper presents a design and hardware implementation of speed control of induction motor using z-source inverter. The peak dc link voltage is controlled by a single loop controller. The simulation results verified the validity of the proposed closed loop speed control methods during start up and input voltage change.
REFERENCES


