

Vector Control of a Drive with Several Motors

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Abstract

Industrial electrical drives now use three-phase induction devices as a norm. These machines are replacing dc drive systems for a variety of reasons, including cost, dependability, robustness, and maintenance-free operation. One of the most significant problems of such ac systems, control, has been overcome thanks to the development of power electronics and signal processing systems. The problem of variable speed control of induction machines is no longer a disadvantage thanks to recent field oriented vector control techniques. The use of a phase number other than three is motivated by the desire to improve system performance, particularly when power supply and semiconductor power ratings are limited. A unique technique for connecting two three-phase induction motors in parallel fed by two inverters, namely, VSI and CSI, and vector control is provided in this study.

Keywords: *VSI, CSI, Multiphase induction motor, Field oriented control, Power electronics converter*

INTRODUCTION

The use of induction motors in continuous duty variable speed drives necessitates the use of powerful static inverters that generate three phase voltages with varying amplitude and frequency. Methods of indirect frequency conversion are

applicable in this scenario. Rectification and inversion make up the indirect frequency changer. The inverter and control problem has a wide range of solutions. They are divided into two categories based on the source of power they receive: voltage and current.

Induction motors with voltage source inverter fed and current source inverter fed.

Both the magnitude and phase alignment of vector variables are controlled in vector or field oriented control. The advent of vector control in the early 1970s, and the proof that an induction motor can be controlled like a separately excited dc motor, ushered in a new era in ac drive control performance. Vector control is sometimes known as "decoupling"

orthogonal or trans vector control because of its dc-like performance.

Field orientation is a means of isolating the two components of stator current: the one that produces air-gap flux and the other that produces torque. Blaschke and Hasse's work in the former West Germany gave birth to the concept of field orientation (Blaschke 1972; Hasse 1969). Although a number of implementation approaches have been created, they may be divided into two categories: direct control and indirect control.

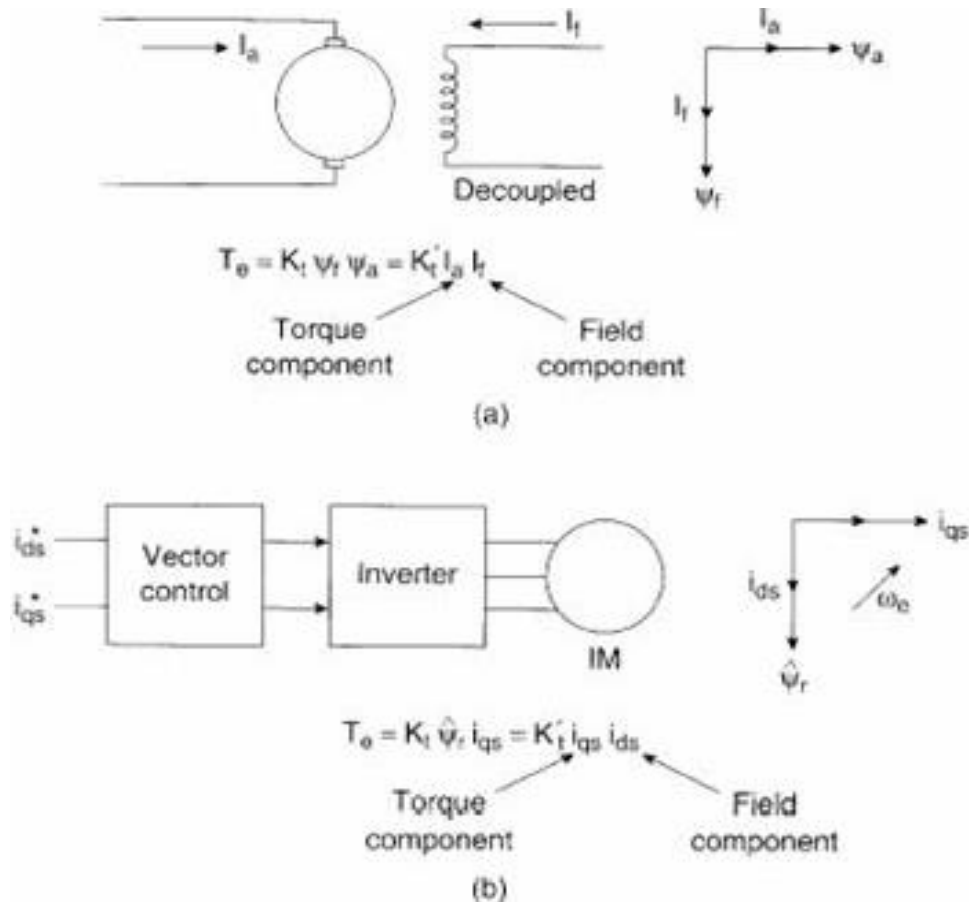


Fig. 1 Principal of field oriented control

The principle of vector control is illustrated in Figure 1. A three-phase induction motor is compared to an independently stimulated dc motor in this diagram. A three phase induction motor is operated as an independently excited dc motor for field oriented control. A d-q axis induction motor model is required.

COMPARISON OF VSI AND CSI

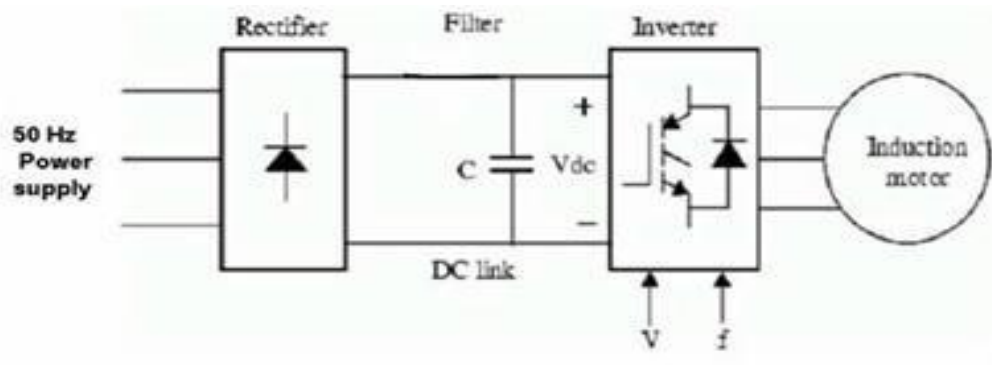


Fig. 2 VSI fed Induction motor

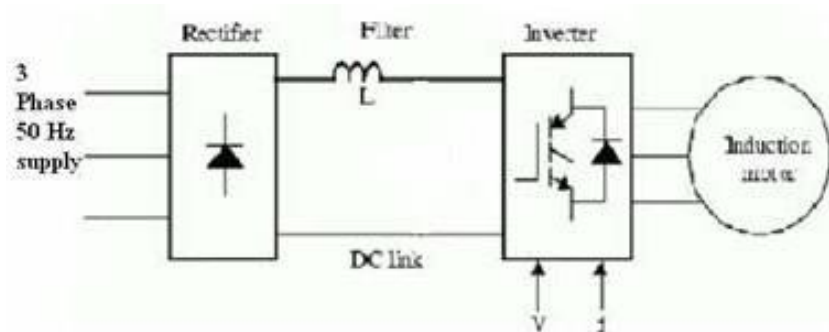


Fig. 3 CSI fed Induction motor

VSI

- a) Runs smoothly even when not in use.
- b) Multimachine capabilities are typically required.
- c) Less interactive with load
- d) Regenerative converter is required on the line.
- e) CSI is outperformed in terms of efficiency, total cost, and transient responsiveness.
- f) In comparison to CSI, it is less tough and trustworthy.
- g) Open loop volt/hertz is prevalent;
- h) PWM VSI control is difficult.

CSI

- a) Runs smoothly even when not loaded.
- b) Usually utilized when many machines are necessary.

- c) Asymmetric blocking devices are possible;
- d) Load interaction is reduced.
- e) Regenerative converter is required on the line side.
- f) Outperforms CSI in terms of efficiency, total cost, and transient responsiveness.
- g) Less durable and trustworthy
- h) Better dynamic responsiveness than CSI
- i) Open loop volt/hertz is prevalent;
- j) PWM VSI control is difficult.

PROPOSED SCHEME

The torque and flux control loops are used in the standard vector-control scheme, and motor 1 is powered by a voltage source inverter, while motor 2 is powered by a current source inverter. Although the CSI provides the majority of the power consumed by the motor, the VSI serves as the actuator in terms of control, and the motor can thus be classified as voltage-controlled. In terms of the construction of a vector-control scheme, the voltage source characteristic of the tandem converter is critical. The rotor-field orientation has the advantage of allowing the torque and flux controls to be decoupled easily for vector control of induction motors. Tandem converter is

used to regulate the two motors, one of which is fed by VSI and the other by CSI.

The present research in vector controlled induction motor drives is focused on the creation and testing of parameter compensation techniques. Modern adjustable speed ac drives use voltage source inverters, which are not without problems. Losses, electromagnetic interference, and other difficulties result from the high switching rate necessary for proper current quality in the motor. The amount of these unwanted occurrences is determined on the number of currents switched in VSI. Although they do not work in an open loop fashion, CSI fed drives are also used. In vector controlled induction motor drives, the current research is focused on the design and experimental testing of parameter compensation methods. The voltage source inverters that dominate current adjustable speed ac drives are not without flaws. The high switching rate required for adequate current quality in the motor creates losses, electromagnetic interference, and other issues. The quantity of currents switched in VSI determines the degree of these undesired events. CSI fed drives are also utilized, although they do not operate in an open loop mode.

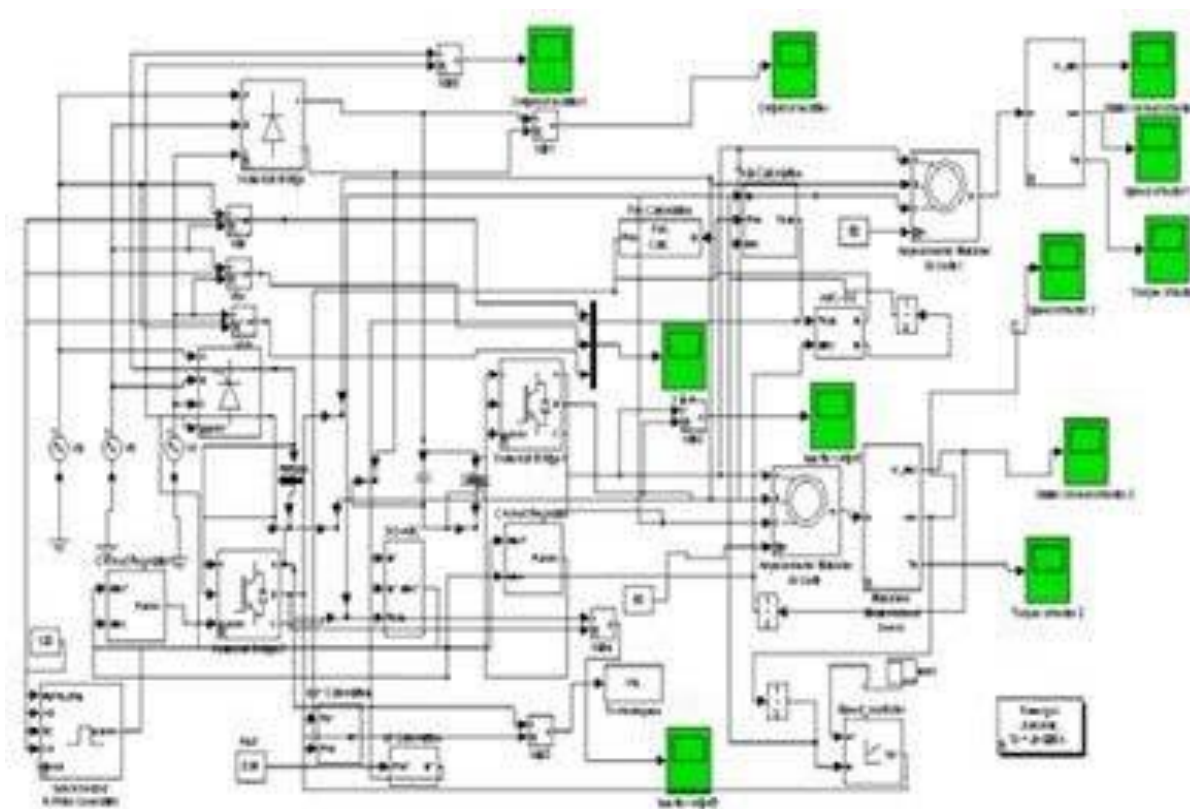


Fig. 4 Vector Control of Two, Three phase Induction motor

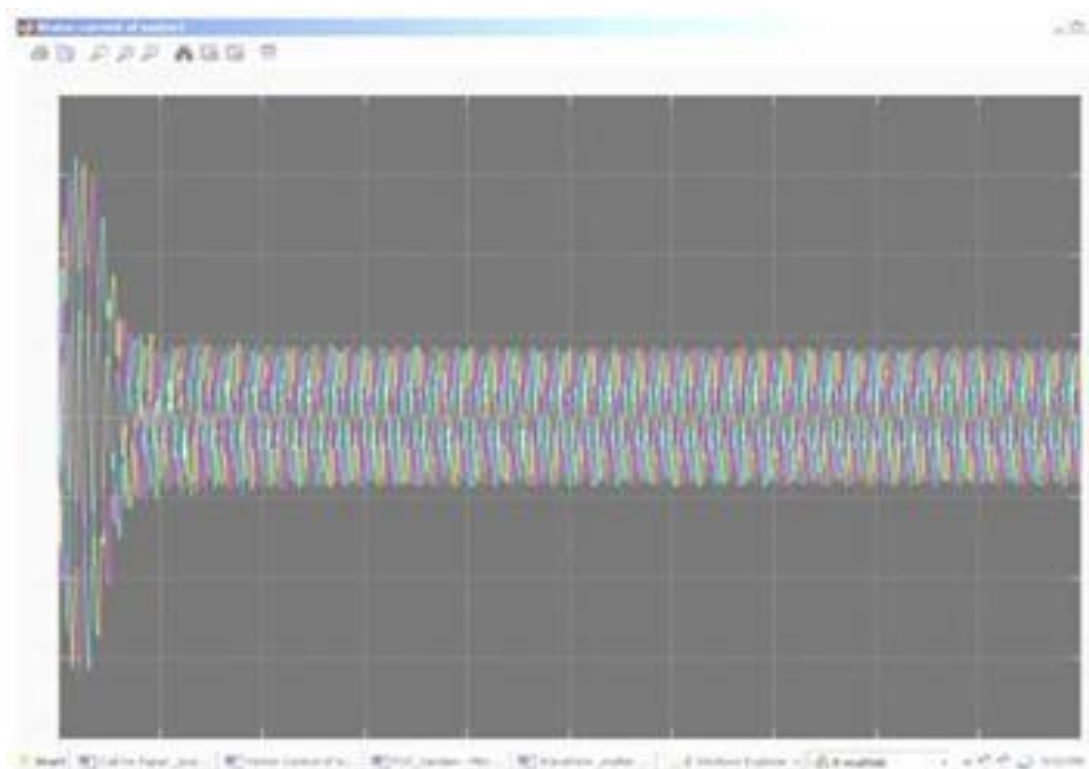


Fig. 5 (a) Waveform of Stator current of Motor 1

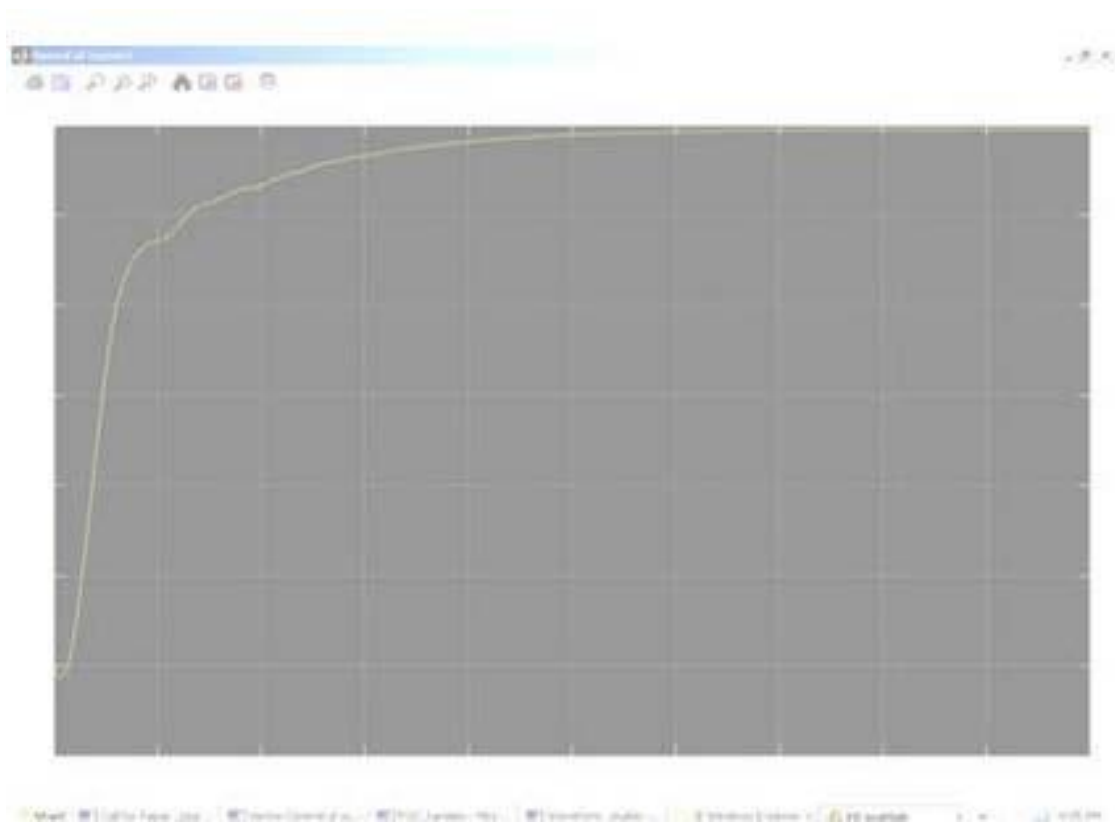


Fig. 5 (b) Waveform of speed of Motor 1

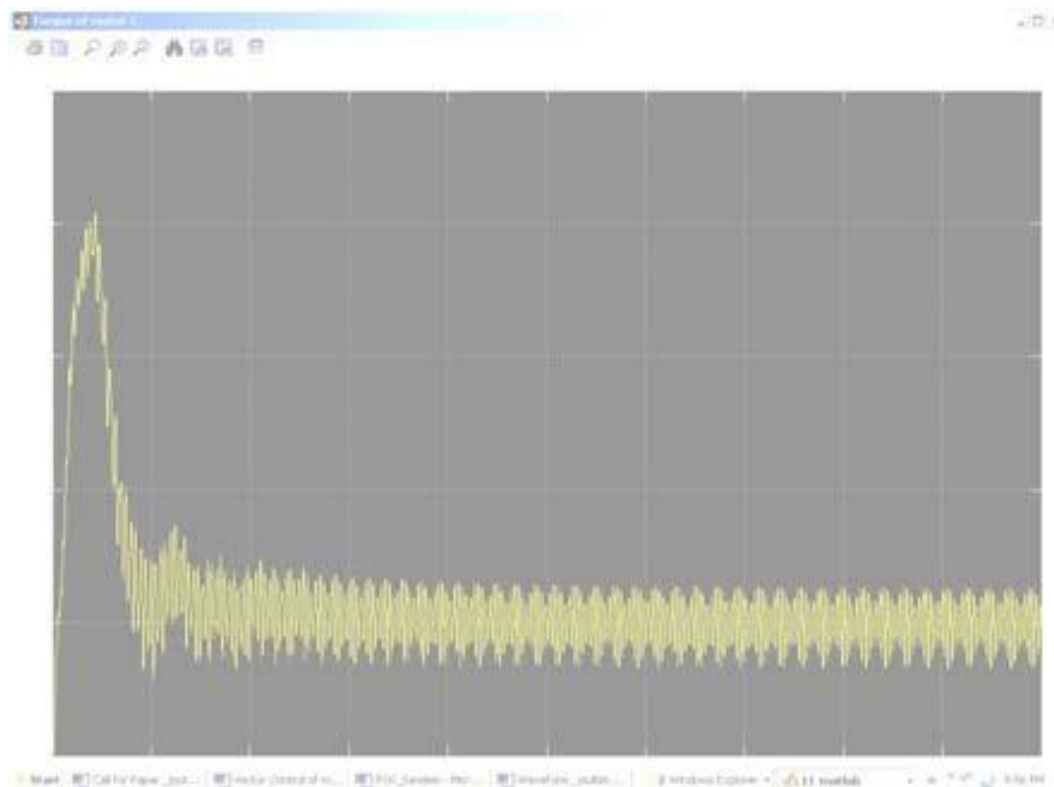


Fig. 5 (c) Waveform of torque of motor 1

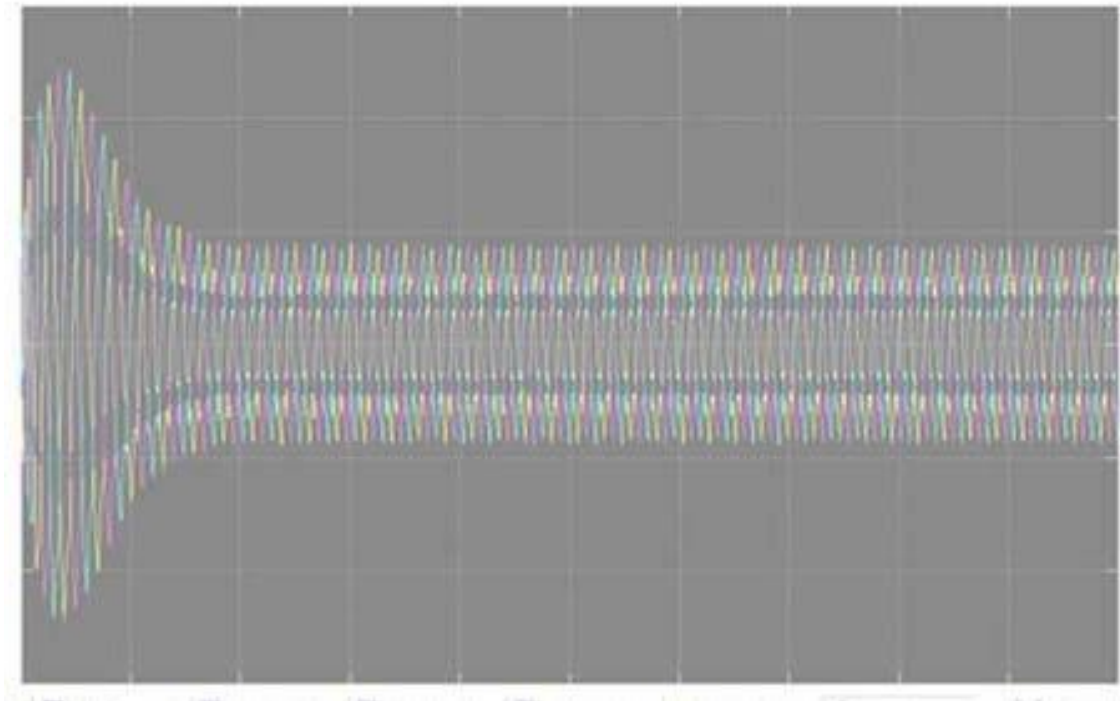


Fig. 6 (a) Waveform of Stator current of motor 2

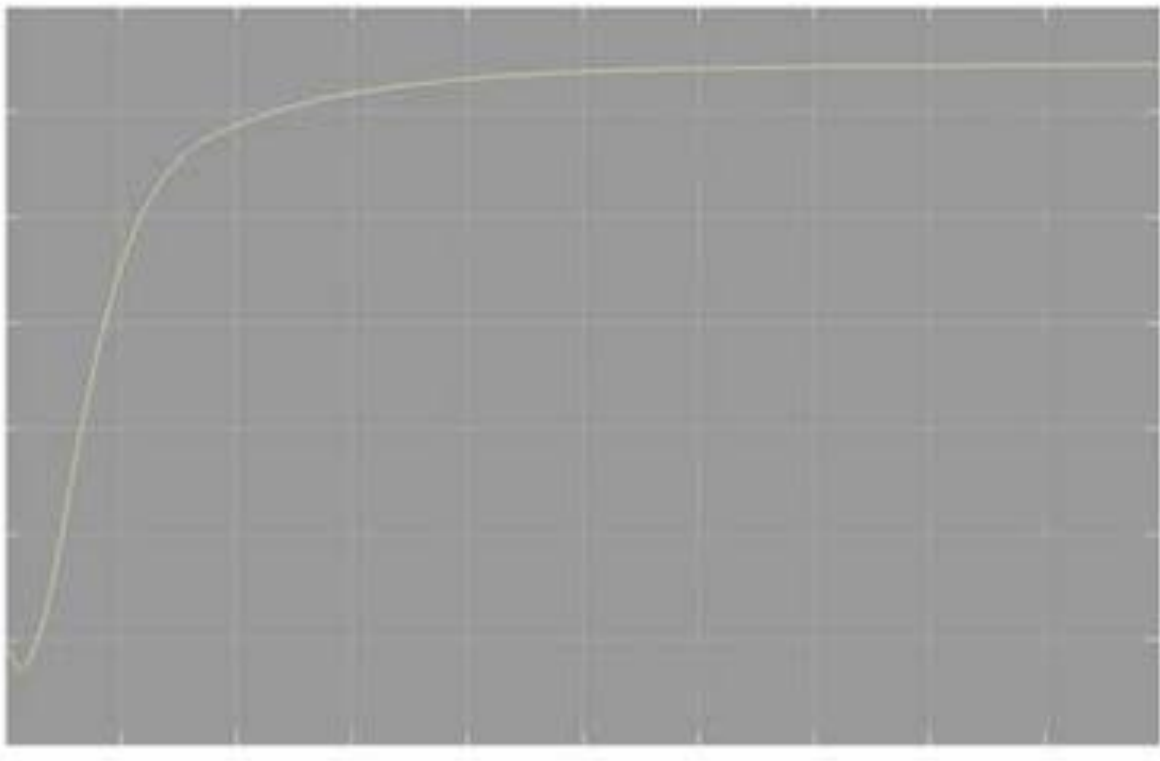


Fig. 6 (b) Waveform of Speed of motor 2

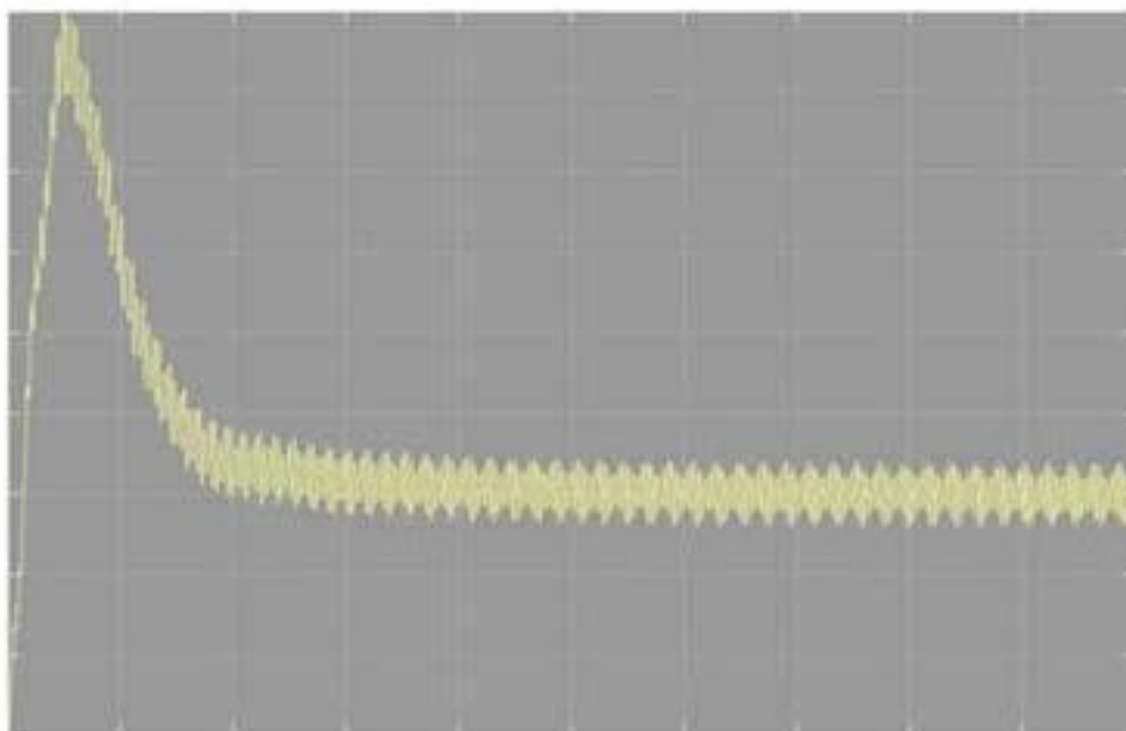


Fig. 6 (c) Waveform of torque of motor 2

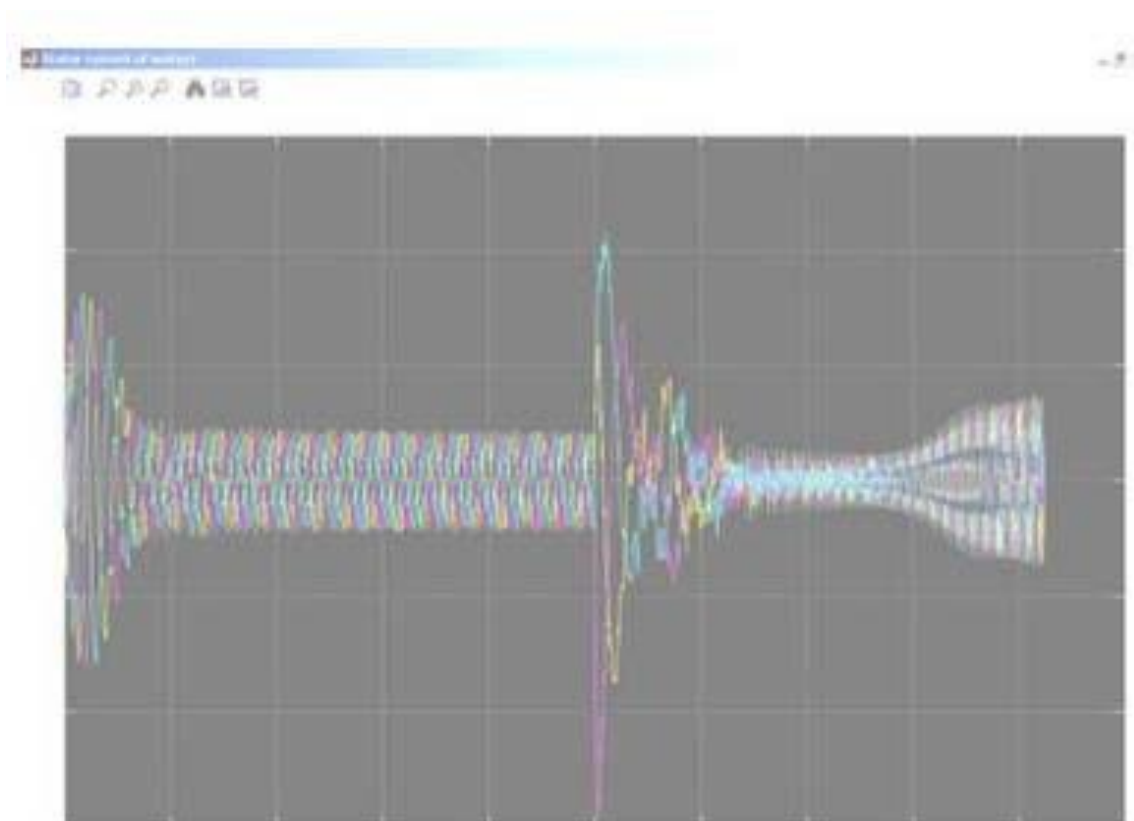


Fig. 7 (a) Waveform for Stator current of motor 1 for change in ref speed

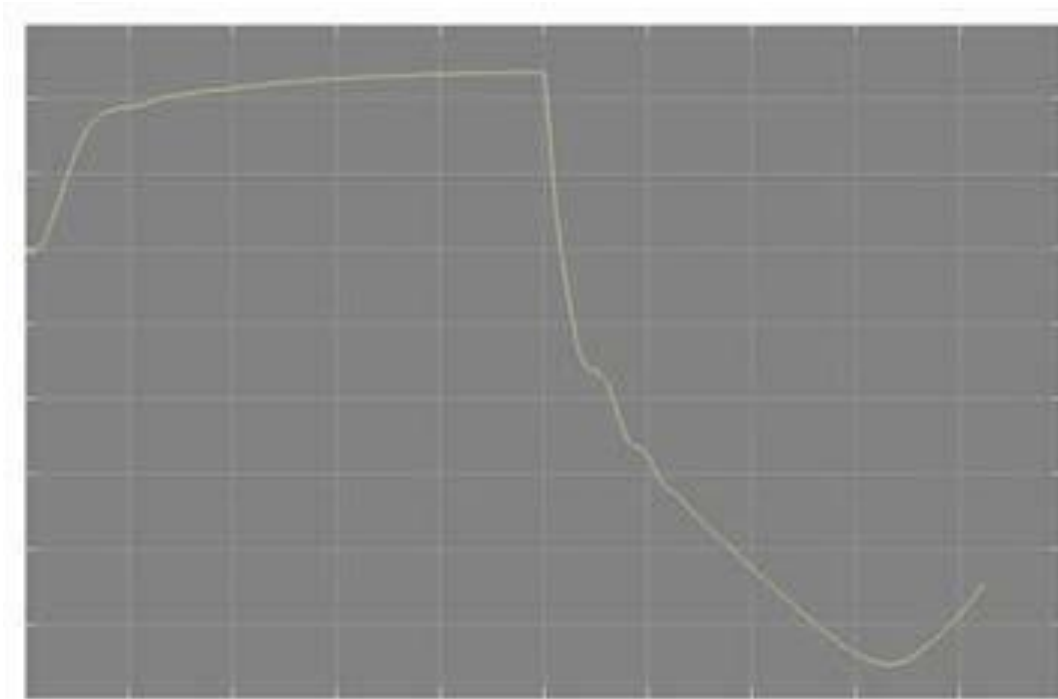


Fig. 7 (b) Waveform of speed of motor 1 for change in reference speed

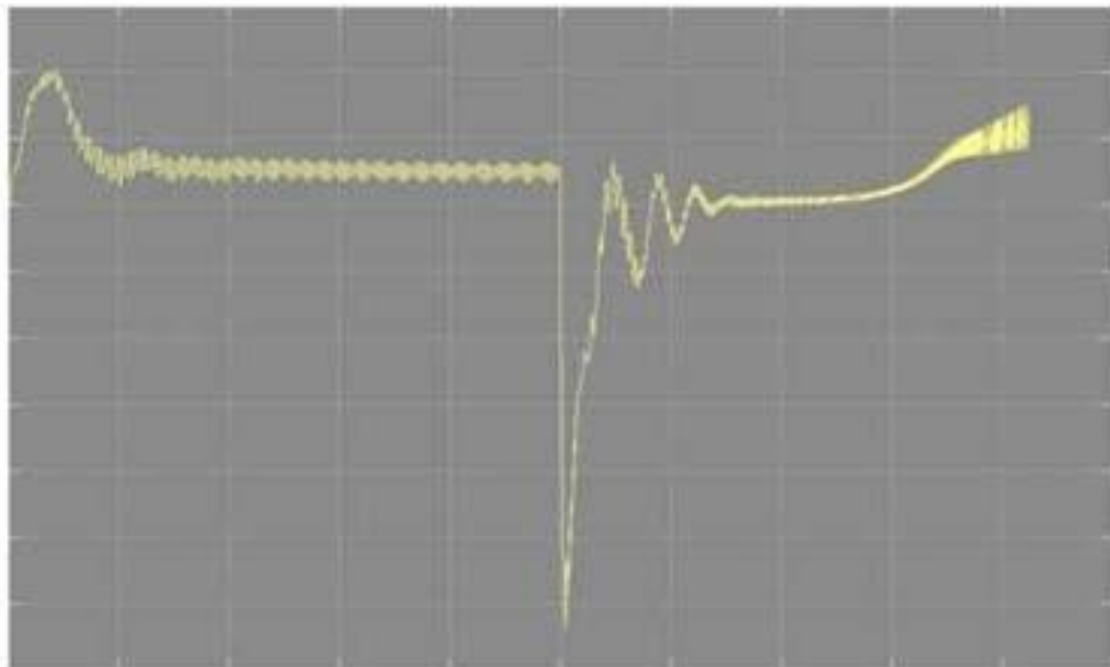


Fig. 7 (c) Waveform for torque of motor 1 for change in ref. speed

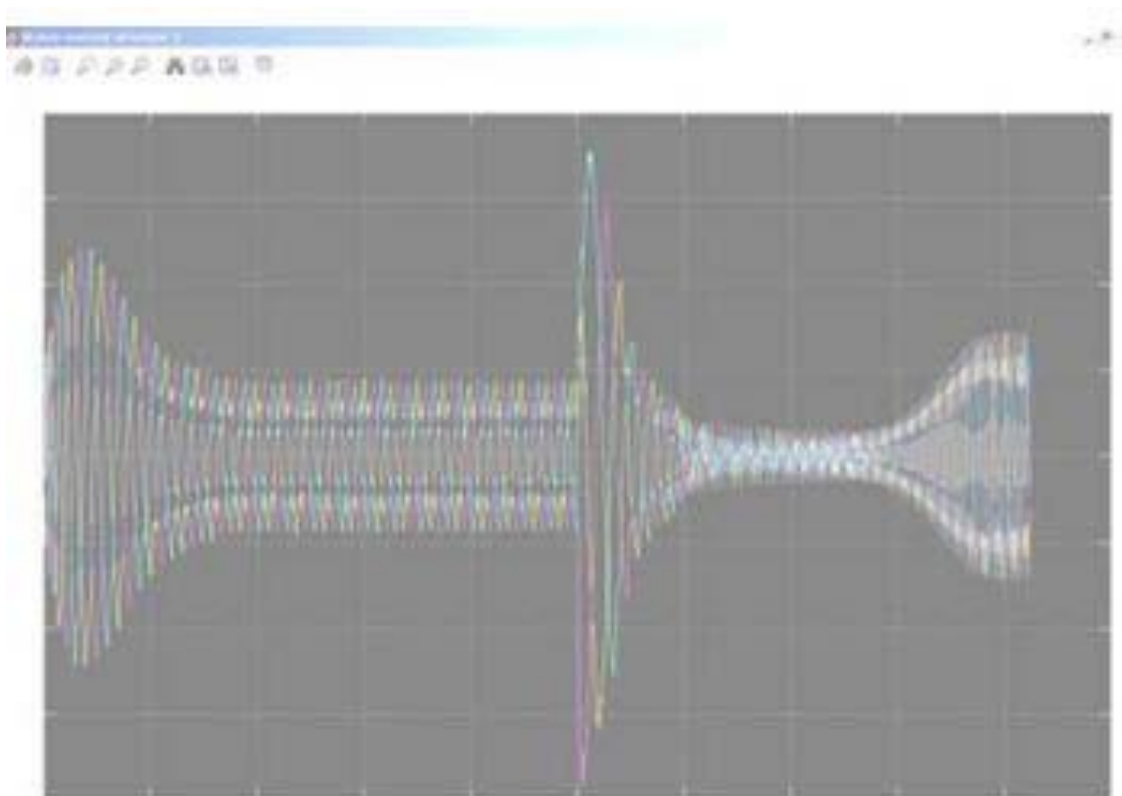


Fig. 8 (a) Waveform for Stator current of motor 2 for change in ref speed

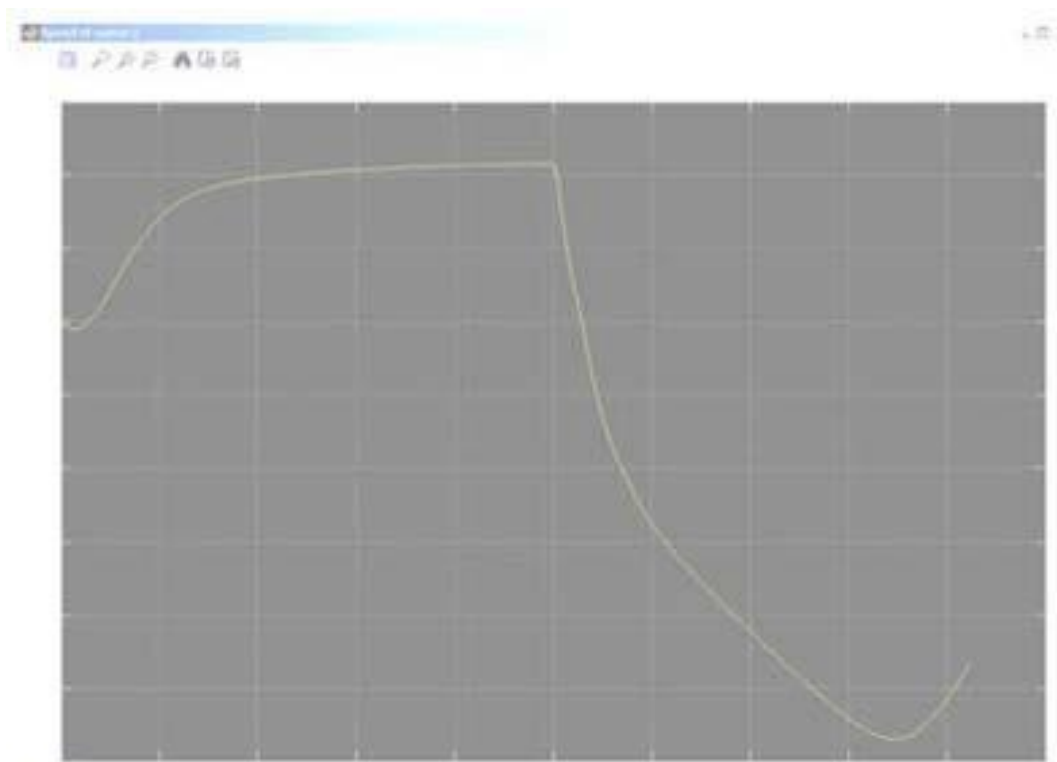


Fig. 8 (b) Waveform of speed of motor 2 for change in reference speed

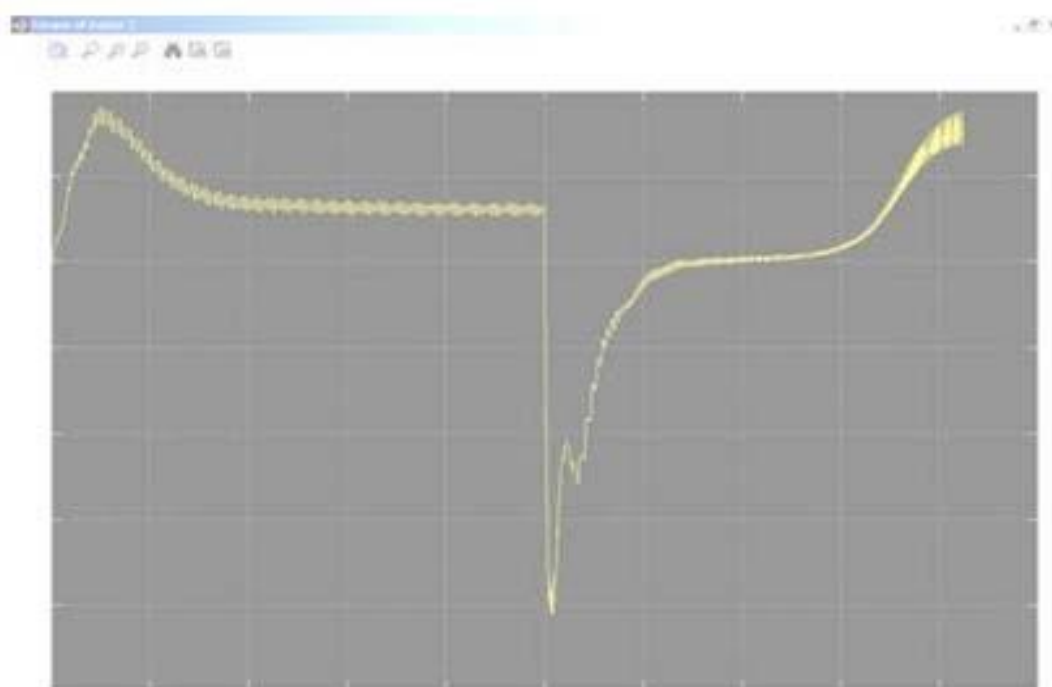


Fig. 8 (c) Waveform for torque of motor 2 for change in ref. speed

ADVANTAGES OF PROPOSED SCHEME

Because the CSI supplies the majority of the stator current, a PWM procedure is not required for total energy control of the motor. As a result, as compared to an equivalent standard VSI, the tandem inverter delivers a significant, over 60%, reduction in switching losses. Other benefits include quick response to current control commands, reduced vulnerability to short circuits, reversible power flow due to the CSI being supplied by an adhoc thyristor rectifier, and a degree of redundancy: if one of the constituent converters fails, the other can still keep the drive operational, albeit with a reduced

quantity or quality of power fed to the motor.

CONCLUSION

The universal diode bridge rectifier converts three phase sinusoidal electricity to direct current voltage. The rectified voltage is delivered into the voltage source and current source inverters. Bang-Bang current controller regulates inverter pulses. In a synchronously rotating reference frame, two three-phase induction motors are represented. Figure 5 depicts the stator currents, speed, and torque of the induction motor 1. (a, b, c). Figure 6 depicts the stator currents, speed, and torque of the induction motor 2. (a, b, c).

The speed controller in use is a PI controller. Flux is estimated in a flux calculator, and theta is derived from there. The current controller is a Bang-Bang. Figure 7 depicts the stator current, speed, and torque characteristics of motor 1 as the reference speed changes (a, b, c). Figure 8 depicts the stator current, speed, and torque characteristics of motor 2 as the reference speed changes (a, b, c).

COMPUTER SIMULATION

Matlab/Simulink computer simulations were used to evaluate the operational aspects of the suggested method. The simulation began with the start-up of an unloaded 5.5-kW, 380-V, 50-Hz motor and 4.5 Kw, 380-V, 50-Hz motor, followed by a step torque command at the rated torque level and drive reversal with the same rated torque. All relevant mathematical models were created independently, utilising Simulink's S-function blocks for the power electronic converters and motor (the "Power System" block set may also be utilised).

REFERENCES

1. Maria Imecs, Andrzej M. Trzynadlowski, Fellow, IEEE, Ioan I. Incze, and Csaba Szabo "Vector control schemes for Tandem converter fed induction motor drives" IEEE transactions on power electronics, vol. 20, no. 2, march 2005.
2. Bimal Bose, "Modern Power Electronics and AC Drives", Prentice Hall
3. R. H. Nelson and P. C. Krause, "Induction machine analysis for arbitrary displacement between multiple windings," IEEE Transactions on Power Apparatus and Systems, vol. 93, pp. 841-848, May 1974.
4. T. A. Lipo, "Flux sensing and control of staticac drives by use of fluxcoils," IEEE Transactions on Magnetics, vol. MAG-13, Sept 1997.
5. O. Ojo and I. E. Davidson, "PWM-VSI inverter-assisted stand-alone dual stator winding induction generator," IEEE Transactions on Industry Applications, vol. 36, pp. 1604-1611, Nov 2000.