SVPWM based Induction Motor Speed Control

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Abstract— Induction machines play a crucial role in certain industries, such as manufacture, transportation, etc. They offer the core capabilities for industrial success and the maintenance of them is essential and profitable to most electrical industrial processes. A lack of coherent maintenance strategy may lead to the loss of individual items of a plant, and a heavy capitalized losses burden. In this research space vector pulse width modulation based induction motor with proportional integral control model is designed through MATLAB software and also tested successfully by evaluating the parameters like stator current, stator current, torque and speed. . It is due to its characteristics like good power factor, extremely rugged and high efficiency. This scheme leads to be able to adjust the speed of the motor by control the frequency and amplitude of the stator voltage, the ratio of stator voltage to frequency should be kept constant. In addition to that the design and implementation of an induction in simulink is uncomplicated and trouble free. These types of induction motors can be used in lathes, drilling machines, lifts, cranes, conveyors, industrial drives, agricultural and industrial pumps.

Keywords: SVPWM, Speed control, MATLAB, Induction motor

I. INTRODUCTION

In industry today, induction motors are preferred due to some superior properties such as their having a cheap and simple structure compared to other motors, their capability to operate under all and every harsh ambient conditions including explosions, and their being maintenance-free and they are usually used in variable-speed drive systems. The variable-speed control of induction motors can be performed in two different manner scalar and vector. In the scalar speed control method, the steady state model of the motor is used and the speed control is carried out with the ratio of the voltage to the frequency (V/f) kept fixed. This speed control method is used because of its easy implementation. The fundamental property of this method is to keep ratio of the voltage, which is supplied to the stator at speed between zero and the rated value, to the frequency (V/f), and therefore the air gap flux and the induced torque as fixed. Speed control may be carried out keeping the voltage fixed and increasing the frequency at speeds greater than the rated speed, therefore weakening the air gap flux. The greatest disadvantage of scalar control is that the rated torque is reduced as a result of the relative effect of the voltage, which decreases with the stator resistance at low voltages of 3-5 Hz, on the phase voltage. Thanks to the developments in the microprocessor technology, vector control systems became applicable for the pulse width modulation (PWM) control of three-phase inverters. In many operations and machinery in industry, sensitive revolution and torque adjustments have to be performed with high accuracy. Field-oriented control of the alternative current motor adjusts the component that constitute the flux and the torque independently in closed loop and enables obtaining high torque even in low speed in addition to many other advantageous that cannot be achieved in scalar mode.

Multilevel inverters generate sinusoidal voltages from discrete voltage levels, and pulse width modulation (PWM) strategies accomplish this task of generating sinusoids of variable voltage and frequency. Modulation methods for Hybrid Multilevel Inverter can be classified according to the switching frequency methods. Many different PWM methods have been developed to achieve the following: Wide linear modulation range, less switching loss, reduced Total Harmonic Distortion (THD) in the spectrum of switching waveform: and easy implementation and less computation time. The most widely used techniques for implementing the pulse with modulation (PWM) strategy for multilevel inverters are Sinusoidal PWM (SPWM) and space vector PWM (SPWM). The SVPWM is considered as a better technique of PWM implementation as it has advantages over SPWM in terms of good utilization of dc bus voltage, reduced switching frequency and low current ripple.

II. PROBLEM IDENTIFICATION

1) Studies have been mainly confined for condition monitoring and fault analysis of induction motor.
2) The study on speed control of the induction motor has not been done much.
3) The support vector machine along with pulse width modulation is beyond the scope of studies.
4) The study for speed controlling is mainly done using fuzzy logic and PI controller.
5) The use of variable frequency control is beyond the scope of studies.
6) The use of three level inverter for speed control is not done.
7) The studies are mainly done using direct torque control (DTC) based support vector machine (SVM).

A. Motivation and Aim:

These problems identified gives us the motivation for making a study on the speed control of the induction motor by using support vector pulse width modulation (SVPWM) with variable frequency V/F control based three level inverter.

III. METHODOLOGY

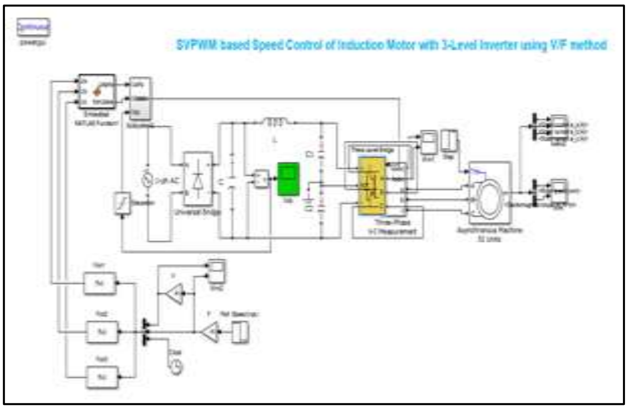

Fig. 3.1: Simulink model

A power supply unit of AC source is made. A voltage divider circuit is made through the universal bridge. This power is boosted using the inductor. This single phase power is converted to three phase using the variable frequency drive. A three phase asynchronous machine with a step input and defined stator current and voltage. The power and torque are calculated. The gain input is given to the sine wave generator function block. The variation in the speed generates the pulse and these pulses are fed to the subsystem alpha, beta, delta function. The output of these will be given to pulse width modulation block which will control the speed of the motor.

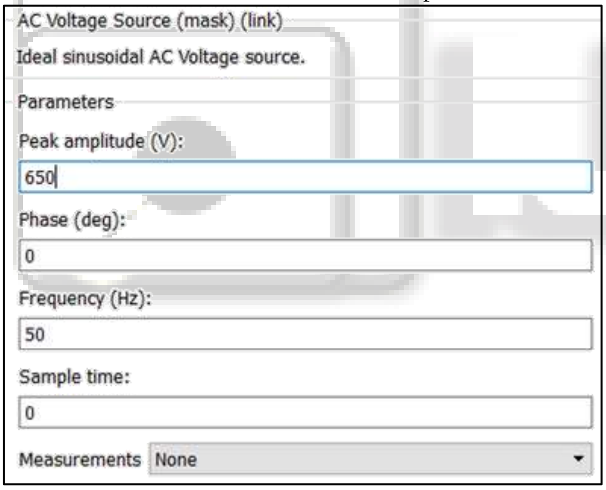

Fig. 3.2: Parameters of input AC voltage

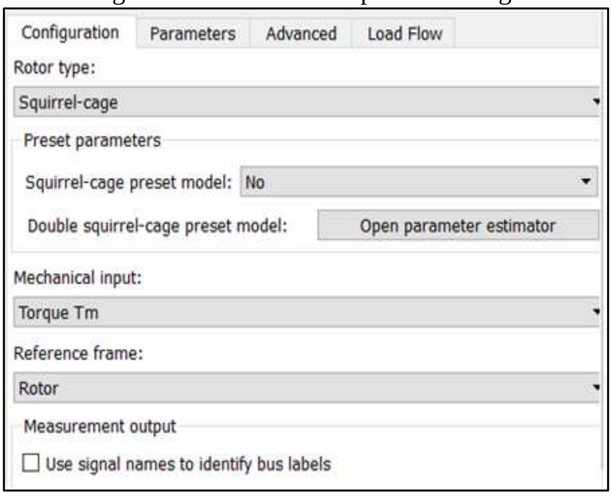

Fig. 3.3: Parameters of asynchronous motor

This block implements a three-phase asynchronous machine (wound rotor, squirrel cage or double squirrel cage) modeled in a selectable dq reference frame (rotor, stator, or synchronous). Stator and rotor windings are connected in wye to an internal neutral point.

An induction motor or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding.[1] An induction motor can therefore be made without electrical connections to the rotor.[a] An induction motor's rotor can be either wound type or squirrel-cage type.

Three-phase squirrel-cage induction motors are widely used as industrial drives because they are self-starting, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service. VFDs offer especially important energy savings opportunities for existing and prospective induction motors in variable-torque centrifugal fan, pump and compressor load applications. Squirrel cage induction motors are very widely used in both fixed-speed and variable-frequency drive (VFD) applications.

In both induction and synchronous motors, the AC power supplied to the motor's stator creates a magnetic field that rotates in synchronism with the AC oscillations. Whereas a synchronous motor's rotor turns at the same rate as the stator field, an induction motor's rotor rotates at a somewhat slower speed than the stator field. The induction motor stator's magnetic field is therefore changing or rotating relative to the rotor. This induces an opposing current in the induction motor's rotor, in effect the motor's secondary winding, when the latter is short-circuited or closed through an external impedance.[28] The rotating magnetic flux induces currents in the windings of the rotor, [29] in a manner similar to currents induced in a transformer's secondary winding(s).

The induced currents in the rotor windings in turn create magnetic fields in the rotor that react against the stator field. Due to Lenz's Law, the direction of the magnetic field created will be such as to oppose the change in current through the rotor windings. The cause of induced current in the rotor windings is the rotating stator magnetic field, so to oppose the change in rotor-winding currents the rotor will start to rotate in the direction of the rotating stator magnetic field. The rotor accelerates until the magnitude of induced rotor current and torque balances the applied mechanical load on the rotation of the rotor. Since rotation at synchronous speed would result in no induced rotor current, an induction motor always operates slightly slower than synchronous speed. The difference, or "slip," between actual and synchronous speed varies from about 0.5% to 5.0% for standard Design B torque curve induction motors. The induction motor's essential character is that it is created solely by induction instead of being separately excited as in synchronous or DC machines or being self-magnetized as in permanent magnet motors.

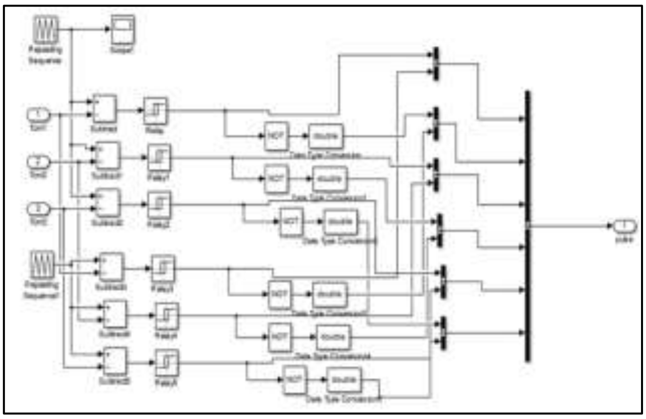

Fig. 3.5: PWM generator

Pulse width modulation (PWM), or pulse-duration modulation (PDM), is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer the switch is on compared to the off periods, the higher the total power supplied to the load.

IV. RESULT

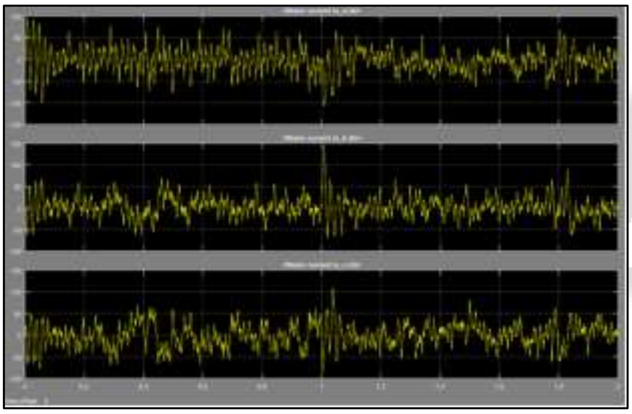

Fig. 4.1: Stator Current vs time plot

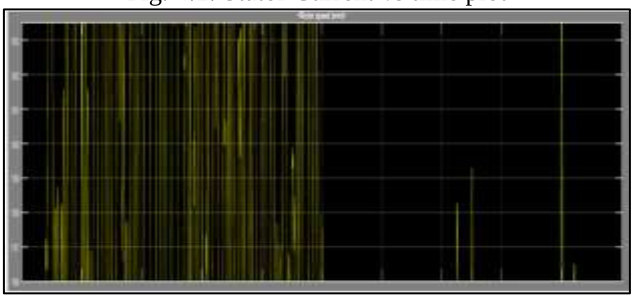

Fig. 4.2: Rotor Speed vs time plot

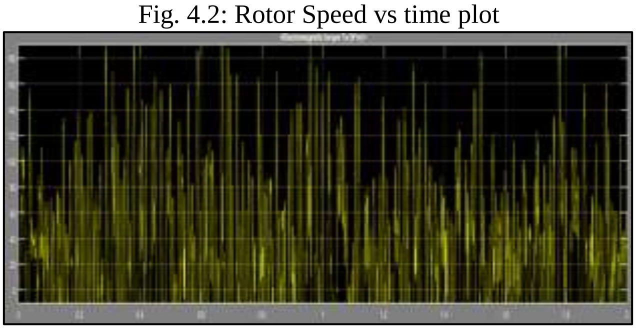

Fig. 4.3: Electromagnetic torque vs time plot

V. CONCLUSION

SVMs can produce accurate and robust classification results on a sound theoretical basis, even when input data are non-monotone and non-linearly separable. So they can help to evaluate more relevant information in a convenient way. Since they linearize data on an implicit basis by means of kernel transformation, the accuracy of results does not rely on the quality of human expertise judgement for the optimal choice of the linearization function of non-linear input data. SVMs operate locally, so they are able to reflect in their score the features of single companies, comparing their input variables with the ones of companies in the training sample showing similar constellations of financial ratios. Although SVMs do not deliver a parametric score function, its local linear approximation can offer an important support for recognising the mechanisms linking different financial ratios with the final score of a company. For these reasons SVMs are regarded as a useful tool for effectively complementing the information gained from classical linear classification techniques.

In this research space vector pulse width modulation based induction motor with proportional integral control model is designed through MATLAB software and also tested successfully by evaluating the parameters like stator current, stator current, torque and speed. . It is due to its characteristics like good power factor, extremely rugged and high efficiency. This scheme leads to be able to adjust the speed of the motor by control the frequency and amplitude of the stator voltage, the ratio of stator voltage to frequency should be kept constant. In addition to that the design and implementation of an induction in simulink is uncomplicated and trouble free. These types of induction motors can be used in lathes, drilling machines, lifts, cranes, conveyors, industrial drives, agricultural and industrial pumps.

VI. FUTURE SCOPE:

- These PWM techniques can also be extended to dual inverter fed open-end winding induction motor drives in order to meet the medium and high power applications.
- The experimental implementation of vector controlled induction motor drive can be carried out.
- The proposed scalar PWM techniques can be implemented using artificial intelligent techniques such as neural networks, ANFIS, etc.
- The switching loss analysis can be carried out for different PWM techniques based 2-level and multilevel fed induction motor drives.
- These PWM techniques can also be extended to sensorless speed control of vector controlled induction motor drive.
- The power quality at supply end can also be analysed with these PWM techniques.

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