Novel Approach for 3-Phase Induction Motor Speed Control using VVVF Control Method

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Abstract : An induction motor (generally called a non-simultaneous motor) is a for the most part used AC electric motor. In an induction motor, the electric flow in the rotor expected to deliver torque is overcome electromagnetic induction from the pivoting attractive field of the stator winding. The rotor of an induction motor can be a squirrel confine rotor or wound sort rotor. An induction motor or nonconcurring motor is an AC electric motor where the electric flow in the rotor expected to deliver torque is gained by electromagnetic induction from the attractive field of the stator winding. V/F control principle is to make a circuit called voltage-controller oscillator with oscillator frequency. It is a voltage-subordinate capacitance, when shown to an alteration in voltage, its capacity will change, and after that the modification in farthest point will cause changes in the vacillating frequency, achieving factor frequency. This controlled frequency is used to control the frequency of the yield voltage, in order to achieve speed changes of the controlled electric motors. This model circuits the improved V/F control framework for 3 stage induction motor. A balanced approach including the implantation of a low frequency reinforce voltage was made, which offers the opportunity to perceive most ridiculous torque from zero to evaluated speed..

***IndexTerms* – Three Phase Induction Motor , V/F Control.**

I. INTRODUCTION

An induction motor or non-simultaneous motor is an AC motor in which the electric stream in the rotor expected to make torque is gotten by electromagnetic induction from the drawing in field of the stator winding.[1]

There are basically two sorts of an induction motor:

1.1 Single Phase Induction Motor

Single phase induction motor: As the name suggests, this kind of motor is given single phase power supply. Cooling current is passed on in the standard turning of the motor. The kind of single phase induction motor used depends on the beginning system they use as a partner as they are not self-starting.[1] Single phase induction motors are regularly used in low control applications, a dash of those are referenced underneath:

• Small siphons

• Small versatile blowers

• Small fans

• Drilling machines

1.2 3 Phase Induction Motor:

These 3 phase motor is outfitted with 3 three-phase AC supply and is altogether used in vessels for heavier burdens. 3 phase induction motors are of two sorts, squirrel tie and slip ring motors. Squirrel point of confinement motors are generally used on vessels in perspective on their extraordinary improvement and fundamental arrangement, few for instance of their applications are:[1]

- Lifts
- Cranes
- Large limit vapor fans
- Motor Auxiliary siphons
- Motor blower fan motor
- Motor room overpowering weight siphons – Ballast, Fire, Freshwater, Sea Water, etc.
- Winch motor
- Windlass motor

1.3 3 Phase Induction Motor Construction

These three phase motors fuse a stator and a rotor and between which no electrical coalition exists. These stator and rotors are worked with the use of high-captivating focus materials to decrease hysteresis and whirlpool current losses.[2]

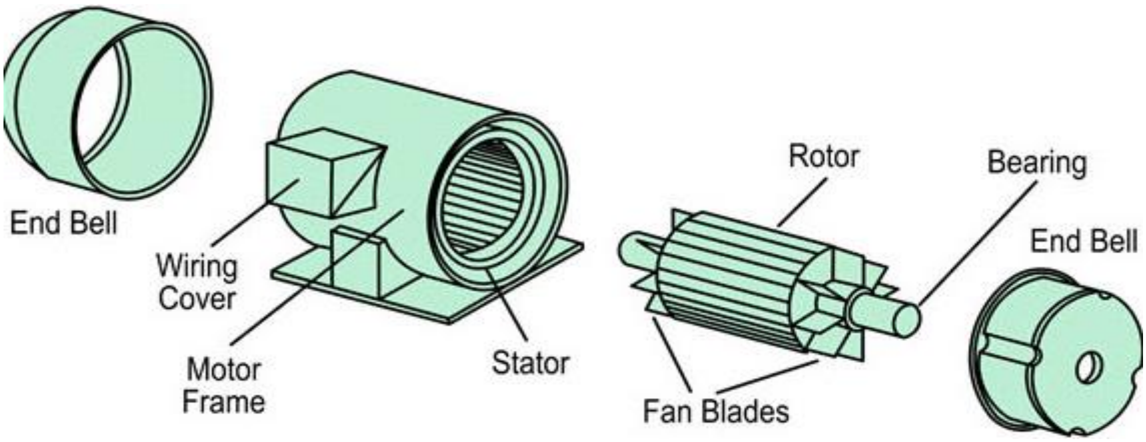


Fig 1.3 Phase Induction Motor

Stator packaging can be made using cast iron, aluminum or moved steel. Stator edge gives head mechanical security and sponsorship for stator verified focus, windings and different methodologies for ventilation. Stator is harmed with three-phase windings which are verified with one another at 120 degree phase move fitted into opened overlays. The six fruitions of the three windings are finished and connected with the terminal box so these windings are engaged by three-phase key supply.[2]

These windings are of copper wire ensured with varnish fitted into verified opened overlays. At all working temperatures, this impregnated varnish remains firm. These windings have high-security restriction and high affirmation from saline condition, dampness, essential fumes, oil and oil, etc. Whichever suits the voltage level, these windings are associated in either star or delta affiliations.

The rotor of three phase AC induction motor is specific for the slip-ring and squirrel-limit induction motors. Rotor in slip-ring type consolidates liberal aluminum or copper bars shorted on the two terminations of the barrel formed rotor. The shaft of the induction motor is maintained on two heading at each conclusion to ensure free turning inside the stator and to decrease the separating. It contains heap of steel overlays similarly spread openings that are punched around of its farthest point into which un-ensured overpowering aluminum or copper bars are put.

A slip-ring-type rotor contains three-phase windings are inside featured toward one side, and different fulfillments are conveyed outside and related with the slip rings mounted on the rotor shaft. Moreover, for structure up a high-beginning torque these windings are associated with rheostat with the help of carbon brushes. This external resistors or rheostat is used toward the beginning timeframe in a manner of speaking. Right when the motor achieves the typical speed, the brushes are shortcircuited, and the damage rotor fills in as squirrel limit rotor.[2]. [4]

II. Related Work

R. P. Vieira and H. A. Grundling[1] This paper investigates the issue of Single-Phase Induction Motor (SPIM) sensorless speed control. A discrete time PI controller and a sensorless strategy are realized on a PC-based stage using a standard three-phase inverter drive and vector control. A variant rotor change arranged control technique is made reliant on a sensorless framework. A MRAS with a Kalman channel count is created for a rotor speed estimation. Proliferation and test outcomes are shown to approve the sufficiency of the system.

A. Z. Latt and N. N. Win [2], Single-phase induction motors are commonly used in home contraptions and mechanical control. The multispeed activity and multipurpose assignment are given by controlling the speed of these motors. This assessment paper is variable speed drive of induction motor using frequency control system. It is to develop the solid state control framework to be strong and financially viable to use with fragmentary drive motors. The proposed variable speed drive fuses control transformation zone (AC to DC and DC to AC), used the trading part of IRF 840 N-channel MOSFET.

A. Hmidet and O. Hasnaoui[3] Induction motors of wound rotor or squirrel pen type are comprehensively used in industry application in light of their simplicity and vigor. Everything considered, for a long time, these sorts of motors were used especially in factor speed drives. During the two every decades prior, as a result of the amazing advancement in microelectronic control frameworks and power converters they ended up being in like manner a significant in controlled relentless speed drives. This paper shows a response for control an AC Induction Motor (IM) using WaijungBlockset and STM32F4 DISCOVRY that enable down to earth plan, decreasing the framework parts and addition productivity. The purpose of this work is to keep an unfaltering rate at variable mechanical torque. Therefore a shut circle speed control for an induction motor with scalar control strategy is shown. Confirmation of the proposed controller is given by test tests. The preliminary outcomes exhibit the viability of the speed controller with a wide extent of weight.

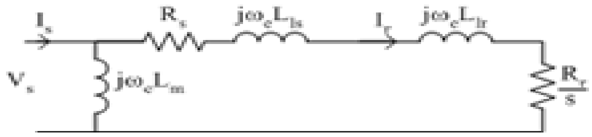
M. Chen and W. Zhang[4] This paper contemplates the usage of H2 perfect control to speed controller for vector controlled induction motor drives. A mechanical development model gained from vector power is used in the structure. A descriptive perfect speed controller is obtained which has a sort of PI controller. Generation subject to MATLAB/Simulink is finished to check the control plot, and the results exhibit that the arranged controller has incredible speed following limit with regards to different speed headings and is solid against weight torque varieties.

A. H. M. Yatim and W. M. Utomo[5], Development of an effectiveness improvement control for variable speed drive framework is significant from the perspectives of vitality saving just as from the expansive perspective of nursery release. In this paper the plans of a Back Engendering Based Productivity Advancement Control (BPEOC) for variable speed blower induction motor drive is depicted. The controller is proposed to make signal voltage and frequency references simultaneously. This technique mulls over control of both the speed and proficiency. To achieve a powerful BPEOC from variety of motor parameters, an electronic learning count is used. Propagation of the BPEOC and research facility test set up has been made using TMS320C60 advanced sign processor. The result demonstrated a significant augmentation in productivity and an improvement in speed execution.

Ping Liu and LanyingHao[6] In solicitation to discard the effect of parameter vulnerabilities on field-orchestrated control for induction motor drive, a sliding-mode speed controller with fundamental sliding surface is proposed. In this proposed control plot the sliding-mode control system is worked identified with the field-arranged control method to improve the controller execution. The surveyed rotor speed used in speed analysis circle is dictated by a versatile computation subject to evaluated terminal sums. Security assessment subject to Lyapunov speculation is acquainted with demonstrate that the rotor speed is exponential focalized. Reenactment results are furthermore displayed to affirm the characteristics of the proposed as a rule control plot.

III. PROPOSED WORK

With variable voltage, variable recurrence activity, any mix of voltage and recurrence can be utilized to supply the motor, with the condition that activity ought to stay inside the breaking points of evaluated voltage a frequency.AS was shown with the fixed recurrence notes, if the voltage drop over the stator is irrelevant in respect to the voltage drop over the charging reactance, it is sensible to re-draw the identical circuit with the polarizing branch at the terminals of the circuit.



Analysis of the circuit leads to the following torque equation

$$\tau = 3\frac{p}{2}\frac{R_r}{\omega_{sl}}\frac{V_s^2}{\left(R_r + \frac{R_r}{s}\right)^2 + j\omega_e^2\left(L_{lr} + L_{ls}\right)^2}$$

Presently, going above and beyond, in the event that the charging voltage is near the stator supply voltage, at that point the stator opposition can be ignored from the torque conditions:

$$\tau \approx 3\frac{p}{2}\frac{R_r}{\omega_{sl}}\frac{V_s^2}{\left(\frac{R_r}{s}\right)^2 + \omega_e^2\left(L_{ls} + L_{lr}\right)^2}$$

$$\tau \approx 3\frac{p}{2}\frac{R_r}{s\omega_e}\frac{s^2\omega_e V_s^2}{R_r^2 + s^2\omega_e^2\left(L_{ls} + L_{lr}\right)^2}$$

$$\tau \approx 3\frac{p}{2}\left(\frac{V_s}{\omega_e}\right)^2\frac{\omega_{sl}R_r}{R_r^2 + \omega_{sl}^2\left(L_{ls} + L_{lr}\right)^2}$$

Examining the torque condition over two can be made:

- Supply voltage over supply recurrence is around equivalent to motion. In this manner, if the apportion V/f is held steady, transition will be around consistent
- If slip is little, the torque condition lessens to

$$\tau \approx \frac{p}{2}\frac{3}{R_r}\psi^2\omega_{sl}$$

IV. Implementation and Result Analysis

The implementation of the proposed approach is done in Matlab

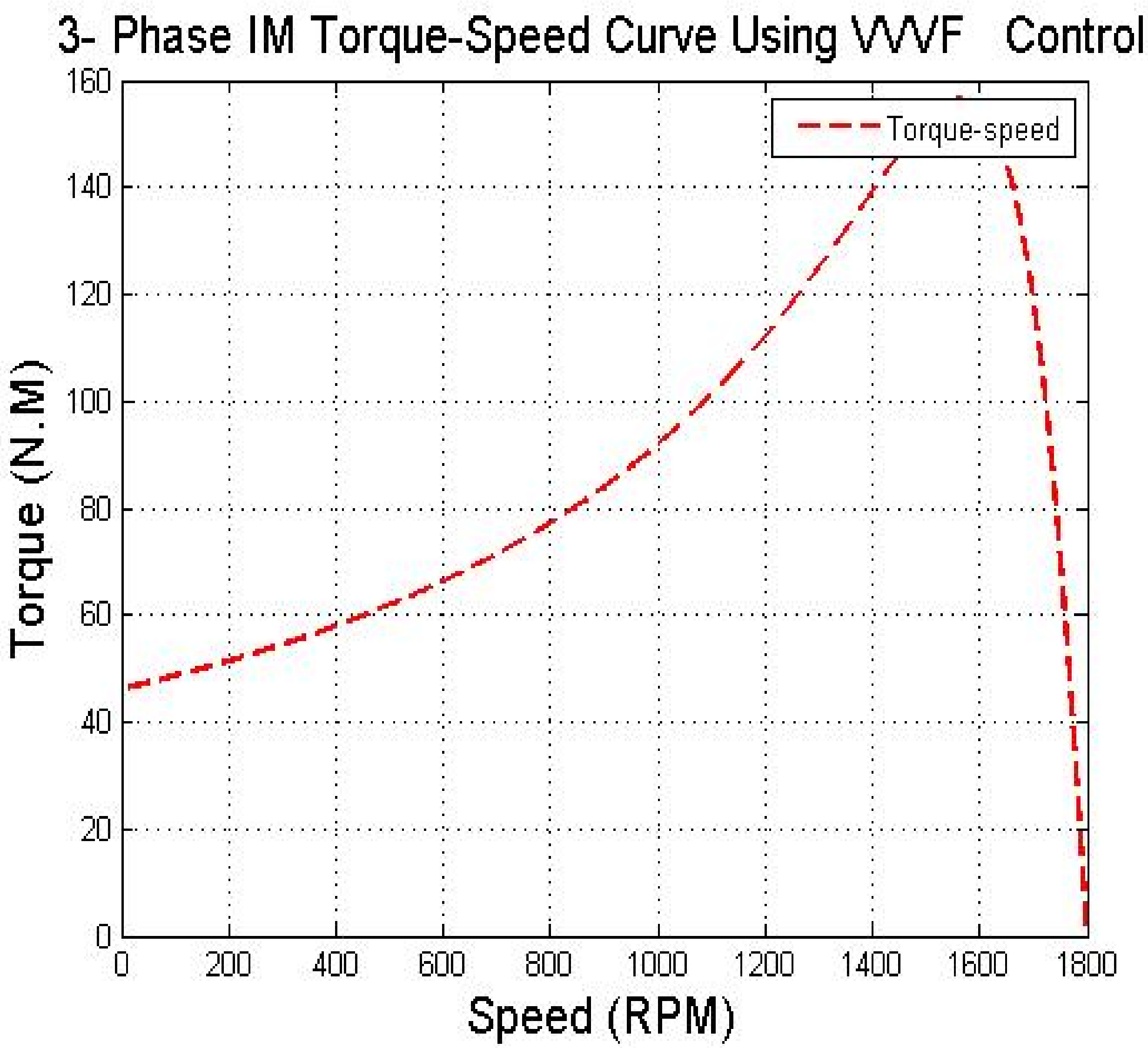


Fig 2. Result Case I

The result obtained with the case of f=60, the resultant torque and slip values are as follows,

Maximum Torque: 156.5468

Slip for Maximum Torque: 0.1299

The other settings are,

Stator Resistance= 0.66 Ohm

Stator Reactance=1.14 Ohm

Rotor Resistance=0.38 Ohm

Rotor Reactance= 1.71 Ohm

Magnetizing Reactance=33.2

Base Synchronous Speed= 1800 rpm

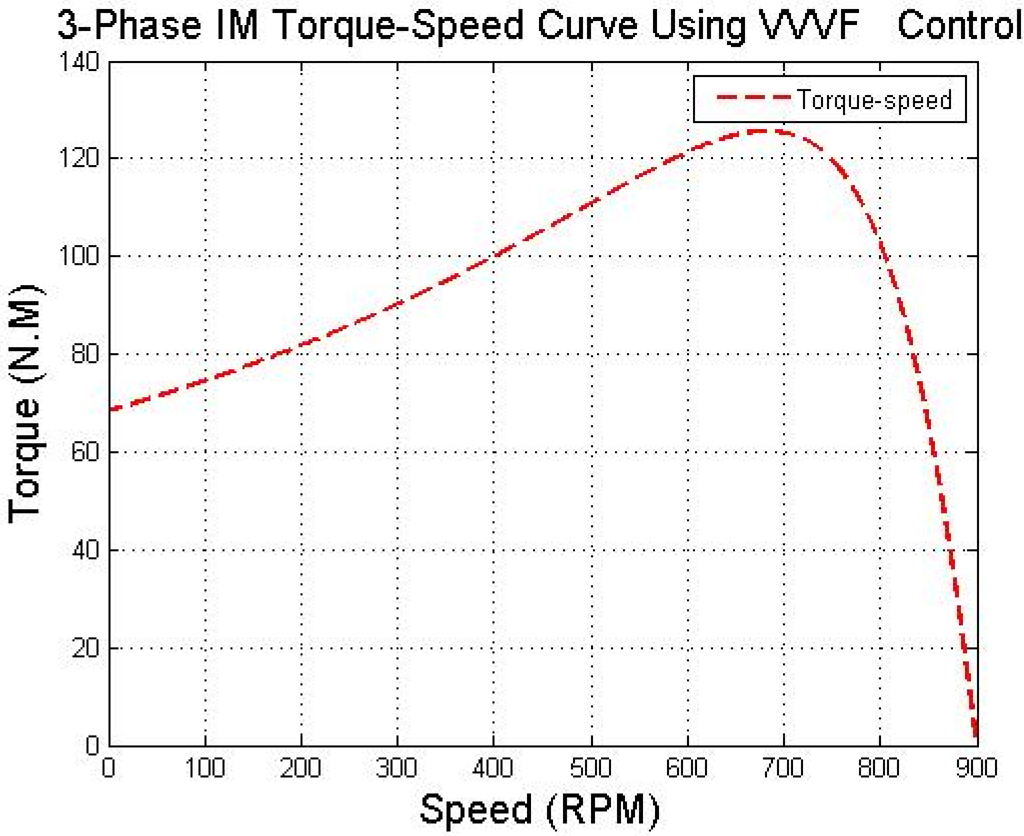


Fig 3 Result Case II

The result obtained with the case of f=60, the resultant torque and slip values are as follows,

Maximum Torque: 156.5468

Slip for Maximum Torque: 0.1299

The other settings are,

Stator Resistance= 0.66 Ohm

Stator Reactance=1.14 Ohm

Rotor Resistance=0.38 Ohm

Rotor Reactance= 1.71 Ohm

Magnetizing Reactance=33.2

Base Synchronous Speed= 1800 rpm

V. Conclusion

A three phase induction motor is fundamentally an even speed motor thusly it's to a point testing to coordinate its speed. The speed the leading body of induction motor is finished to the disservice of reducing in ability and low wattage issue. V/F the executives common is to make a circuit implied as voltage-controller generator with generator frequency. it's a voltage-subordinate capacitance, when given to A modification in voltage, its capacity can adjustment, and around then the alteration in limit can cause changes inside the faltering frequency, move as for issue frequency. This controlled frequency is used to coordinate the frequency of the yield voltage, to achieve speed changes of the controlled electrical motors. This model wires the improved V/F control methodology for three segment induction motor. A reasonable philosophy similarly as the imbuement of a coffee frequency reinforce voltage was made, that offers the chance to perceive most insane power from zero to surveyed speed. For prevailing the speed of 3 segment induction motor by V/f strategy we have to give variable voltage and frequency that is successfully noninheritable by utilizing convertor and electrical converter set.

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