JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Pid based induction motor using inverter concept

Venkatesh Sehgal, Chiranjeev rao***

** Research scholar, Department of Electrical & Engineering, Shri Shankaracharya Technical campus bhilai,490020*

Email:sehgalvenkatesh@gmail.com

***Assistant Professor, Department of Electrical & Engineering, Shri Shankaracharya Technical campus bhilai,490020*

Email: raochiranjeev81@gmail.com

Abstract* - *The PID controlled algorithm controls an induction motor with consistent pace response, consistent electromagnetic torque response, and consistent three section stator contemporary. It shows a way to use the SIMULINK tool in MATLAB to correctly simulate a (PID) controller with a targeted load. The operation's parameters had been cautiously chosen because the device changed into tuned for peak overall performance. The proposed approach has exceptional traits which includes ease of implementation, strong convergence traits, and accurate overall performance. The preliminary PID parameters below ordinary working situations and the most desirable parameters beneath targeted load conditions had been acquired the use of software PID. The proposed PID controlled model is tuned in keeping with the parameter levels. A three section asynchronous induction motor turned into modelled within the MATLAB surroundings to illustrate high-quality approach execution. The results display that the gadget has fast reference tracking, steady speed similar to the reference velocity below load condition with a moderate overshoot and occasional undershoot while using a PID controller. The simulated effects tested that the proposed PID controller has the ability to be very green.

Index Terms*— *PID controller, modeling of induction machine, speed control, v/f control technique

I. INTRODUCTION

Induction automobiles are extensively used in a variety of applications because of their several advantages inclusive of high efficiency, low upkeep expenses, sturdy production, performance and ease, and so on. Many packages, consisting of business and home, necessitate velocity control. The real velocity differs from the reference velocity whilst a load is applied. As a result, retaining the actual and reference speeds to the equal value after load version may be very appropriate for a selected application. Many manipulate techniques for induction motor speed control have been advanced. The maximum vital of these strategies are scalar and vector control. However, because of its benefits and simplicity, scalar manage is the most inexpensive and maximum without problems carried out approach. This manipulate method is used in a huge range of business applications. One of the scalar speed manipulate techniques of V/f control is completed here [1]-[4] the use of a traditional PID controller. Over the years, the industry's control approach has visible incredible advancement. As a result, numerous manipulate techniques were investigated, such as adaptive-control, neural-control, and fuzzy-manage. Among the severa techniques, the proportional-essential-derivative controller is extensively frequent as the excellent in the industry because of its easy shape and sturdy performance in the course of operation. Unfortunately, it has been hard to correctly tune the profits of proportional Integral spinoff (PID) controllers due to the fact many industrial plants are frequently plagued by using troubles which includes excessive order, time delays, and nonlinearities. [5]–[9]. The PID controller's influences on 3 phase induction automobiles, inclusive of modern, voltage, and electricity, can be seen inside the PQM II panel or the SCADA records show. It then simplifies the information collection process. [10] Another crucial method is Space-vector Pulse-width Modulation, which has tested to be powerful within the production of three phase sine-wave voltage-source inverters aligned to manipulate 3 phase induction cars with v/f manage over time. V.S.I. Fueled Because of the use of non-sinusoidal voltages, induction vehicles produce resonant torque. According to this technique, three segment V.S.I. Generates 8 switching states, zero states and six active states. The hybrid PWM approach and the awesome area vector based sequences used to provide the switching pulse for hybrid PWM reduce the torque ripples of induction automobiles. When using SVPWM with every other collection, most effective one zero vector is used in place of 0 vectors as in traditional SVPWM. The carried out voltage vector is simplest equivalent to the reference voltage vector in a median point over the specified sub cycle, now not in a fast way. The instant blunders voltage vector is the difference between the reference vector and the immediate applied voltage vector. The time imperative of the error voltage vector, also known as the "stator flux ripple vector," is a measure of the ripple within the converter's line current. In the open loop system, the frequency is seemed as an input to V/f manage for all voltage conversion and Pulse technology. "The open loop manipulate subsystems are coding for pulse era, inverter modelling, and induction motor modelling." The mistakes acquired from a VSI fed three phase induction motor force machine with a regular v/f manage technique become processed in a Proportional Integral (PI) controller, and its output set the inverter frequency and the modulation index. [11] – [14].

II. RELATED WORKS

Senthilkumar and S. Vijayan have presented Simulation of High Performance PID Controller for Induction Motor Speed Control with Mathematical Modeling in this article This examine presents the design of excessive overall performance PID controller for three phase induction motor V/f pace manipulate with induction motor mathematical modeling. V/f technique is a simple technique for pace manipulate of induction motor. The manage scheme is primarily based at the popular constant volts in step with hertz (V/f) technique using the high overall performance PID controller [3].

Martino O Ajangnay In this paper, we proposed strategies of computing Proportional, Integral and Derivative (PID) parameters controller for vector manipulate of induction motor. The optimal parameters for present day loop, flux loop, and velocity loop as function of required settling time and motor parameters could be computed by means of the proposed technique. The enormous of the proposed approach is that one thing (settling time) is the only parameter required to be given by using the consumer such that the technique calculated the PID parameter for each loop manage [4].

Nguyen Vinh Quan, Nguyen Minh Tam have offered Sliding Mode Control of a Three Phase Induction Motor Based on RBF Neural Network on this artivcle A statortlux-orientated vector controller of induction motor is often used in the controllers due to less depending on parameters of the motors, the parameters of the motors are nonlinear and time-various answer situations slip control might be implemented via the extremely good benefits of balance control is slipping sustainable and as soon as the device noise. On the alternative hand, whilst the parameters of nonlinear objects adjustments through the years, the troubles hold consistent speed while the load adjustments are tough toimplement, consequently the neural community is used to identify the speed of machines are needed to boom the stableness control system. This article provides a brand new technique of designing sliding mode controller based totally on radial simple feature network for three-section asynchronous vehicles based totally a stator-tlux-orientated vector controller [5].

Madhavi L. Mhaisgawali, Prof. Muley in this article the induction cars were characterized by complicated, tremendously non-linear and time-varying dynamics, and consequently their pace manage is a tough problem in the industry. The creation of vector control techniques has solved induction motor manipulate troubles. This paper based on the rate manipulate of induction motor the usage of proportional integral derivative controller with the usage of vector control technique [6].

Lavanya, has presented Performance of Indirect Matrix Converter with Improved Control Feeding Doubly Fed Induction Machine on this paper An Indirect Matrix Converter with modified control method feeding the rotor of Doubly fed induction device with stator linked to three section supply is mentioned on this paper. This Indirect Matrix Converter with proposed control is split into Rectifier stage and inverter degree. The output of the Rectifier level with the proposed advanced switching produces maximum dc voltage while compared to that of conventional IMC at the DC bus and guarantees that the fundamental input contemporary is stored at unity power aspect below all operating conditions. The inverter stage makes use of new vectors wherein with the aid of the switching losses and output voltage distortions are decreased.

III. SIMULATION OF INDUCTIONMOTOR

The three-phase voltages, their fundamental frequency, and the load torque are the inputs of a squirrel cage induction machine. The outputs, on the other hand, are the three phase currents, the electrical torque, and the rotor speed; the induction machine model will include blocks that convert three-phase voltages to the d-q frame and d-q currents back to three-phase[12]. The (vabc to vdq) block converts a three-phase voltage vabc into a two-phase stationary reference frame voltage vdq. Figure (2) The simulation of the IM mathematical model is represented by the following main blocks: abc to dq block, D-axis circuit block, Q-axis circuit block, dq to abc current block, speed determination block, and torque determination block.

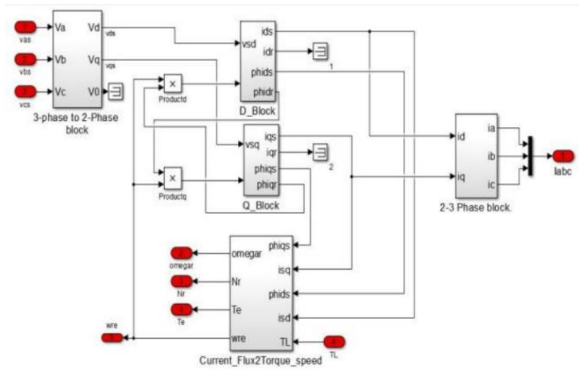

Figure (2) IM dynamic model Simulink circuit

Using inverse transformation equation (12), transfer the 2-axis stationary current frame (is) to the three-phase stationary current frame (iabc).

IV. SPEED CONTROLLER

The following controllers were used in this section to improve the FOC and scalar vector system for controlling the speed of IM:

1. The V/F constant

2. Traditional PI controller (trial and error tuning)

4.1 (V/F) Scalar Control

The most common induction motor speed control is V/F. An induction motor's torque is proportional to its V/F ratio. The torque produced by the induction motor remains constant throughout the speed range when the voltage and frequency are varied while keeping their ratio constant [14]. In addition, V/F is the most fundamental controller. The controller does not achieve good accuracy in both speed and torque responses because it assumes a constant relationship between voltage and frequency, owing primarily to the fact that the stator flux and torque are not directly controlled [4]. The scalar control method works by simultaneously varying two parameters. The speed can be changed by changing the supply frequency, but this results in an impedance change. The current changes due to the change in impedance increase or decrease. When the current is low, the torque of the motor decreases If the frequency or voltage decreases, the coils can burn or the iron of the coils can become saturated. To avoid these issues, the frequency and voltage must be varied simultaneously. The disadvantages of changing frequency and voltage can thus be compensated for. According to the induced voltage equation, the V/Hz constant control provides constant flux in the stator (Eq. 13).

$V_{rms} = 4.44\ K.N.\text{hs}.f$ (13)

The torque–speed equation of induction motors (Eq. 14) can be used to determine the voltage–torque

$$T_{air\,gap} = \frac{3}{2\omega_m} i^2 \frac{R_r}{s} \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

4.1.1 Closed Loop V/F Control

Application of a variable magnitude and variable frequency voltage to the motor is the cornerstone of induction motor constant V/F speed control (Fig. 3). Both voltage source and current source inverters are employed in variable speed ac drives. Using a VSI, the closed loop V/F control is shown in the block diagram below.

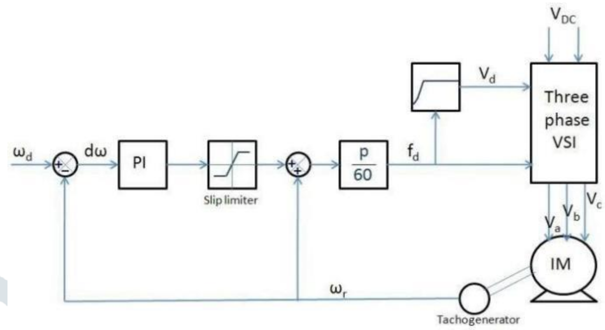

Fig. (3) Closed-loop V/Hz constant control

For controlling speed, the closed-loop approach is more accurate than the open-loop approach. Torque is controlled by the closed-loop method as well. Because torque is not controlled by the open-loop control method, the desired torque is only accessible at the nominal operating point. The motor speed changes as the load torque varies [7, 14].

4.1.2 Open loop V/F control

Due to its simplicity, open loop V/F control of an induction motor is the most popular method of speed control, and these motors are frequently used in industry. This kind of motor control is simple, inexpensive, and resistant to feedback signal errors, among other benefits. Induction motors have historically been used with open loop 50Hz power supplies for constant speed applications. Frequency control makes sense for variable speed drive applications, but to keep the stator flux constant, voltage must be proportional to frequency [7]. A block diagram of an IM open loop V/F control is shown in Figure 1. (4)

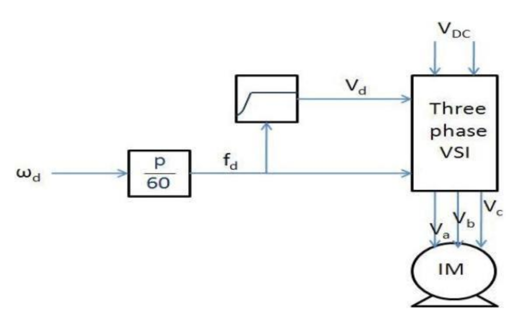

Fig (4) open loop constant V/F speed control [14]

Some issues encountered in the operation of this open loop strength ,those trouble are the velocity of the motor can't be managed , because of the truth the rotor pace is probably slightly much less than the synchronous pace and that during this scheme the stator frequency and as a end result the synchronous speed is the most effective manage variable. The effect of the above can make the stator currents exceed the rated cutting-edge by means of a big amount. Then the slip pace can't be maintained, because of the difference among the synchronous speed and the electrical rotor pace [7].

4.2 Vector Controllers

The FOC method is one of the most commonly used control methods to improve the dynamic performance of a three-phase induction motor because it involves making the induction motor behave similarly to a DC motor. Based on mathematical abstraction, the FOC is a good and robust transient control. A transformation to the d-q coordinate system, whose direct axis (d), is aligned with the rotor flux space vector, divides an induction machine's stator currents into flux- and torque-producing components. This means that the rotor flux space vector's q-axis component is always zero [14, 15].

$h_{qr} = 0$, $h_{dr} = h_r$

the velocity mistakes, with the help of a traditional PI controller, is converted into a torque controlling cutting-edge thing (iqs *), of the stator contemporary. This modern-day element is used to adjust the torque in conjunction with the slip pace. The manipulate equation which The PI controller includes is given as

$$i^*_{qs} = k_p \Delta w_r + k_i \int \Delta w_r \, dt \text{ ....(15)}$$

Similarly the flux generating contemporary component (ids *), is received from the stator flux linkage reference value and is given with the aid of the subsequent

$$h_r = L_m \, i^*_{ds} \text{ .... (16)}$$

In the indirect field oriented control, the stator reference flux linkage space vector position e is obtained by integrating the calculated slip angle with the feedback rotor speed based on motor parameters. calculated using

$$_e = \int w_e \, dt = \int (w_{sl} + w_r) dt \text{ .... (17)}$$

Because of its simplicity and the clear courting that exists between its parameters and the system reaction specs, the conventional PI controller is one of the maximum commonplace approaches for velocity control in industrial electric drives in widespread. It also improves the machine's dynamic reaction and decreases or eliminates regular-kingdom mistakes and errors sensibility. This is performed through combining an imperative element correction with a proportional benefit (Kp) for the mistake enter time period (Ki)

$$u(t) = K_p e(t) + K_i \int^t e(\tau)\, d\tau \text{ .... (18)}$$

in which, u (t) is the output of the PI controller and e (t) is the error sign

The conventional PI controller constant gain might also carry out properly underneath some working conditions however now not all. The traditional PI controller block version is given in Fig. (5) [3, 6].

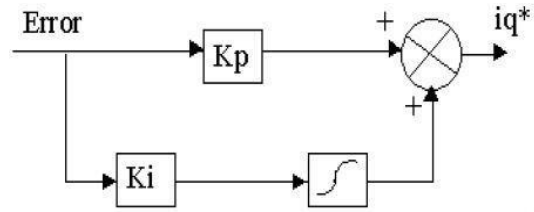

Figure (5) Conventional PI controller

V. SIMULATION AND RESULT

In closed-loop V/f control, a sensor is used to measure the rotor's speed and contrast it with the reference speed. The difference is considered the error, and a proportional controller receives the error. The inverter's frequency is set by the P controller. To maintain a steady V/f ratio, the Voltage Source Inverter takes the frequency as input and alters the terminal voltage accordingly.

A detailed SIMULINK diagram of the suggested control strategy for a squirrel cage induction motor is shown in Figure 5.11. The characteristics of the 50 HP, 460 V, 60 Hz, squirrel-cage induction motor used in this simulation are listed in table 5.11.A three-phase inverter bridge with current control supplies power to the induction motor stator. The hysteresis regulator controls the stator currents, producing inverter drive signals for the inverter switches to operate the induction motor.

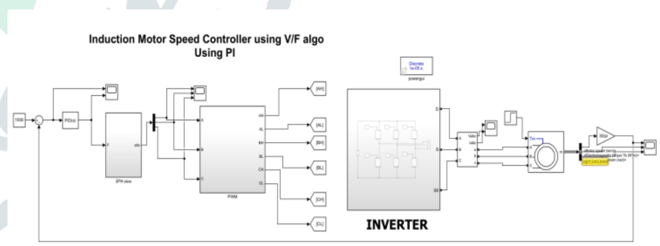

Figure 5.11: A three-phase squirrel cage induction motor speed controller system is fully modelled in SIMULINK.

In the proposed model the following are the step taken;

- First we take a reference RPM then.
- A PI controller is used for error and correction .
- The pi signal sent to 3- Phase Sine detector logic.
- Then this 3 phase signal send to PWM generator. This generated signal is used to switch the IGBT of inverter block.
- This signal is feed to asynchrous machine which controller the speed of the machine.
- Then the final torque, speed and current can be seen in

last scope of the model.

Figure 5.12 shows the PI generated signal .

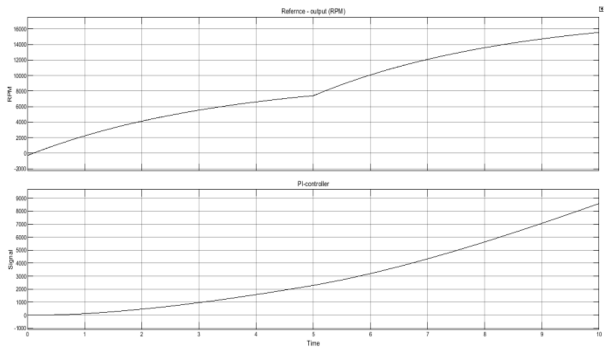

Figure 5.12 Error RPM And Pi-Controller Signal .

Figure 5.13 shows the 3phase sine Block

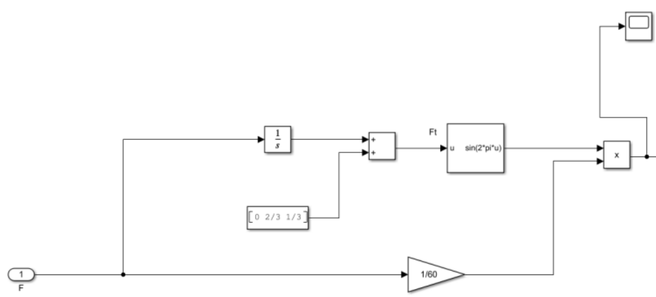

Figure 5.13 3-phase sine

Figure 5.14 depicts the Voltage. of R,Y,B phase

Figure 5.14 shows the R,Y,B phase voltage

Figure 5.15 show the PWM generator Circuit. For Generate PWM signal a repeating signal logic is used

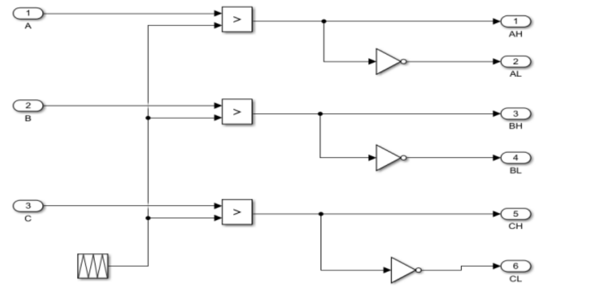

Figure 5.15 PWM generator Circuit

Then this signal is fed to Inverter block. Where 6 IGBT used in cascaded block for generate 3 phase supply to induction motor. The inverter connection in shown in figure 5.16

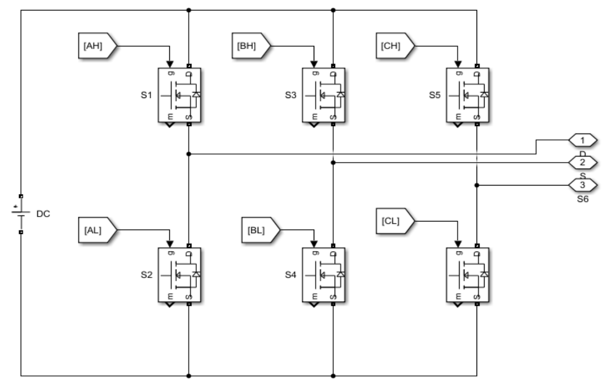

Figure 5.16 Inverter Block using cascade block

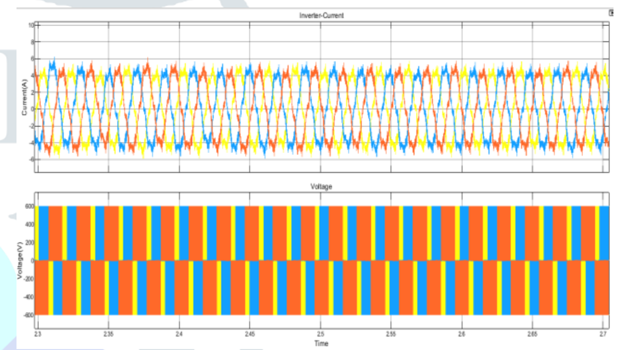

Figure 5.17 Shows inverter Voltage and current

Figure 5.18 show the speed, torque and Angle graph of Im motor and its behavior graph during the run model.

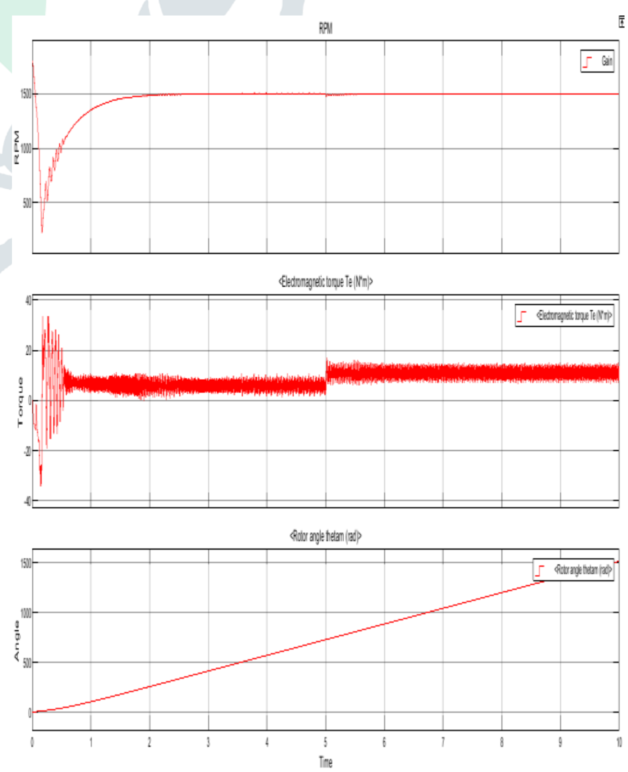

Figure 5.18 Show RPM ,Torque And Angle

VI. CONCLUSION

The P.I.D. velocity controlled version of a three section induction motor the usage of SIMULINK has tested to be very successful in phrases of power conservation and inspiring the usage of excessive overall performance applications consisting of robotics, hybrid automobiles, wind technology structures in paper and fabric generators, excessive electricity laboratory equipment including x-ray imaging systems, pump and compressor load programs. This paper honestly demonstrates the overall performance of a controlled system with a PID controller. consistent with the results, the PID controller quick catches the reference pace and settles the gadget. As a end result, for powerful velocity manage of induction vehicles, a PID controller is required.

VII REFERENCES

[1] Jay R. Patel and S.R. Vyas "Simulation and Analysis of Constant V/F Induction Motor Drive", International Journal of Engineering and Technical Research (IJETR), Volume -2, Issue 4, pp. 151-156, April 2014.

[2] Majida Khaleel Ahmed," Induction Motor Speed Drive Controller Using Indirect Field oriented and fuzzy logic techniques", University of Technology, Iraq, MSc. thesis, 2007

[3] Wiam Ismael Jabbar," Direct Torque Control of Induction Motor Based on Intelligent Techniques", University of Technology, Iraq, MSc. thesis, 2013

[4] Kanaan A. Jalal, "Direct Torque Control of Induction Motor Based on Intelligent Systems", PhD Thesis, University of Technology, Iraq, April 2007.

[5] Fadhil Abbas Hassan, "Modeling and Implementation of Space Vector PWM Driver of 3-Phase Induction Motor",
University of Technology, Iraq, MSc. thesis, 2008

[6] R. Arulmozhiyal, K.Baskaran, R. Manikandan ", A Fuzzy Based PI Speed Controller For Indirect Vector Controlled Induction Motor Drive "IEEE, 2011 Sona College of Technology, Salem, Tamilnadu 636005, and India.

[7] Pabitra Kumar Behera, Manoj Kumar Behera, Amit Kumar Sahoo," Speed Control of Induction Motor using Scalar Control Technique", International Conference on Emergent Trends in Computing and Communication,(0975 – 8887), ETCC-2014.

[8] Devraj Jee, Nikhar Patel," V/F Control of Induction Motor Drive" , MSc Thesis ,National institute of Technology, May-2013, Odisha, India.

[9] Riya Elizabeth Jose, Maheswaran K.," V/F Speed Control of an Induction Motor Drive Fed by Switched Boost Inverter", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 8, August 2015.

[10] P. M. Menghal, Dr. A. Jaya Laxmi, "Dynamic Modeling, Simulation & Analysis of Induction Motor Drives", International Conference on Science, Engineering and Management Research, 2014.

[11] Bose. K.B., "Modern Power Electronics and AC Drives",Book, Prentice Hall, 2002.

[12] Burak Ozpineci, Leon M. Tolbert," Simulink Implementation of Induction Machine Model– a Modular Approach", 2003 IEEE, pp 728-734.

[13] M.S.Aspalli., Asha.R, P.V. Hunagund ,"Three Phase Induction Motor Drive Using IGBTs And Constant V/F Method", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 1, Issue 5, November 2012.

[14] G. Kohlrusz, D. Fodor," Comparison of Scalar and Vector Control Strategies of Induction Motors", Hungarian Journal of Industrial Chemistry Veszprém Vol. 39(2) pp. 265-270 (2011).

[15] Anhar Azeez Sagger," Field Oriented Control of an Induction Motor Based on a Single –Phase to Three – Phase Indirect Matrix Converter", University of Technology, Iraq, MSc. thesis, June 2016.