Investigation of of Three Phase Induction Speed Control Strategies using NO controller and PID Controller

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Abstract - *This paper based on the speed control of induction motor using Without control, proportional control, proportional integral controller and smart proportional integral derivative controller with the use of vector control technique. The induction motors were characterized by complex, highly non-linear and time-varying dynamics, and hence their speed control is a challenging problem in the industry. The advent of vector control techniques has solved induction motor control problems; this paper presents a discrete PI and PID control based speed controller and its design for vector controlled induction motor drive. MATLAB simulation is carried out and results are investigated for speed control of Induction Motor without any controller, P- controller, with PI controller and with PID controller on full load condition. The proposed method, are very efficient and could easily be extended for other global Techniques.*

Key Words: *induction motors, Speed Control of induction motors, P- Controller, PI Controller, PID Controller,*

1. INTRODUCTION

The demand for control of electric power for electric motor drive system and industrial control existed for many years. Power electronics have revolutionized the concept of power control for power conversion and for control of electrical motor drives. Variable-speed drives are created when a motor is combined with a power electronics converter. Variable speed AC motor drives have been continuously developed during the last decades owing to the advances in power electronics, control theory and microprocessors technology. By introducing variable speed to the driven load, it is possible to optimize the efficiency of the entire system and it is in this area that the greatest efficiency gains are possible. AC motor drives are widely used to control the speed of conveyor systems, blower speeds, pump [1].Along with industrial progress high performance drives are essential. Recent advances in semiconductors, converters and new control techniques have great role in this progress. Usually classical control requires accurate mathematical model of the system and also its performance decreases for nonlinear system such as drives. Recently by adapting non linear speed control techniques the dynamic performance of electric drives can be improved. Speeds, machine tool speeds, and other applications that require variable speed. Control deals with the steady state and dynamic characteristics of closed loop system. The development in microprocessor and microcontroller technology has a great impact on the control and synthesizing the control strategy for power semiconductor devices [2].

In this paper we will discuss the conventional all tuning controller. Finally we will present the simulation result for speed control of induction motor using without control, proportional control, proportional integral controller and smart proportional integral derivative controller with the use of vector control technique and a brief discussion.

2 Related works

S. Senthilkumar and S. Vijayan have presented Simulation of High Performance PID Controller for Induction Motor Speed Control with Mathematical Modeling in this article This study presents the design of high performance PID controller for three phase induction motor V/f speed control with induction motor mathematical modeling. V/f method is a simple method for speed control of induction motor. The control scheme is based on the popular constant volts per hertz (V/f) method using the high performance PID controller [3].

Martino O Ajangnay

In this paper, we proposed methods of computing Proportional, Integral and Derivative (PID) parameters controller for vector control of induction motor. The optimal parameters for current loop, flux loop, and speed loop as function of required settling time and motor parameters will be computed by the proposed method. The significant of the proposed method is that one factor (settling time) is the only parameter required to be given by the user such that the method calculated the PID parameter for each loop control [4].

Nguyen Vinh Quan, Nguyen Minh Tam have presented Sliding Mode Control of a Three Phase Induction Motor Based on RBF Neural Network in this artivcle A stator-tlux-oriented 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-varying solution conditions slip control will be applied by the brilliant advantages of stability control is slipping sustainable and as soon as the system noise. On the other hand, when the parameters of nonlinear objects changes over time, the problems keep constant speed when the load changes are difficult to implement, therefore the neural network is used to identify the speed of machines are needed to increase the stability control system. This article presents a new method of designing sliding mode controller based on radial basic function network for three-phase asynchronous motors based a stator-tlux-oriented vector controller [5].

Madhavi L. Mhaisgawali, Prof.Mrs. S. P. Muley in this article the induction motors were characterized by complex, highly non-linear and time-varying dynamics, and hence their speed control is a challenging problem in the industry. The advent of vector control techniques has solved induction motor control problems. This paper based on the speed control of induction motor using proportional integral derivative controller with the use of vector control technique [6].

N. Lavanya, has presented Performance of Indirect Matrix Converter with Improved Control Feeding Doubly Fed Induction Machine in this paper An Indirect Matrix Converter with modified control technique feeding the rotor of Doubly fed induction machine with stator connected to three phase supply is discussed in this paper. This Indirect Matrix Converter with proposed control is divided into Rectifier stage and inverter stage. The output of the Rectifier stage with the proposed improved switching produces maximum dc voltage when compared to that of conventional IMC at the DC bus and ensures that the fundamental input current is kept at unity power factor under all operating conditions. The inverter stage uses new vectors where by the switching losses and output voltage distortions are reduced. [7].

3. ELECTRICAL INDUCTION MACHINE

Electrical motor is an electromechanical energy converter that translates its input electrical energy into output mechanical energy. They are available for more than a century and are playing a very vital role in the development of modern technology. Better understanding of the energy conversion principles coupled with the evolution of new and improved materials have contributed to advanced machine design. The theory of finite element analysis which is introduced recently has helped in further development and design optimization of electrical motors. The advent of modern digital processors and massive development of power electronics and semiconductor devices have made revolutionary contribution in the control and application of these devices. The direct current (dc) motor, induction motor and synchronous motor are the most commonly used in industrial applications [7-8].

Fig 1 Squirrel cage induction motor

Most of the induction motors upto 90%) are of squirrel cage type. Squirrel cage type rotor has very simple and almost indestructible construction. This type of rotor consists of a cylindrical laminated core, having parallel slots on it. These parallel slots carry rotor conductors. In this type of rotor, heavy bars of copper, aluminum or alloys are used as rotor conductors instead of wires.fig 1 is induction motor Rotor slots are slightly skewed to achieve following advantages - it reduces locking tendency of the rotor, i.e. the tendency of rotor teeth to remain under stator teeth due to magnetic attraction. Increases the effective transformation ratio between stator and rotor and Increases rotor resistance due to increased length of the rotor conductor.

4. Synchronous Speed of induction motor

$Ns = \frac{120f}{P}$

Where, f = frequency and P is the number of poles

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The speed of induction motor is given by,

Nr = (1-s) Ns

Where, Nr is the speed of the rotor of an induction motor, N_s is the synchronous speed, S is the slip. The torque produced by three phase induction motor is given by,

$$T = \frac{3}{2\pi N_s} X \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$$

When the rotor is at standstill slip, s is one. So the equation of torque is,

$$T = \frac{3}{2\pi N_s} X \frac{E_2^2 R_2}{R_2^2 + X_2^2}$$

Where, E2 is the rotor emf Ns is the synchronous speed R2 is the rotor resistance X2 is the rotor inductive reactance.

5. PROPORTIONAL INTEGRATIVE DERIVATIVE CONTROLLER

PID controllers use a 3 basic behavior types or modes: P - proportional, I - integrative and D -derivative. While proportional and integrative modes are also used as single control modes, a derivative mode is rarely used on its own in control systems, such as PI and PD control are very often in practical systems.fig 2 is PID controller with speed control of induction motor [9-10].

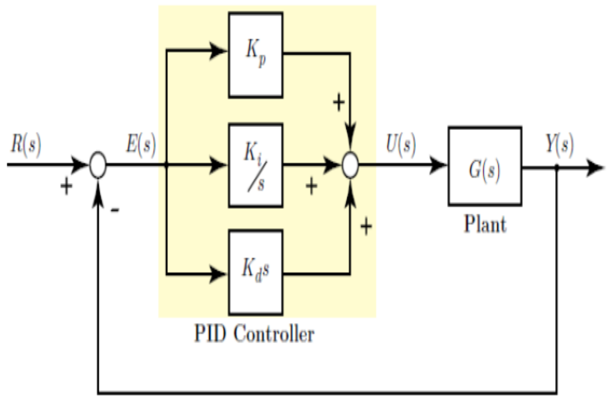

Fig 2 PID controller

This is the most popular method for controlling the speed of an induction motor. As in above method, if the supply frequency is reduced keeping the rated supply voltage, the air gap flux will tend to saturate. The magnitude of the stator flux is proportional to the ratio of the stator voltage and the frequency. Hence, if the ratio of voltage to frequency is kept constant, the flux remains constant. Also, by keeping V/F constant, the developed torque remains approximately constant. This method gives higher run-time efficiency. Therefore, majority of AC speed drives employ constant V/F method for the speed control. Along with wide range of speed control, this method also offers 'soft start' capability.

The speed performance of induction motor is checked first without any controller and then with without controller and Using PID controller. The simulink model is developed in the MATLAB which is shown in following Figures 3.

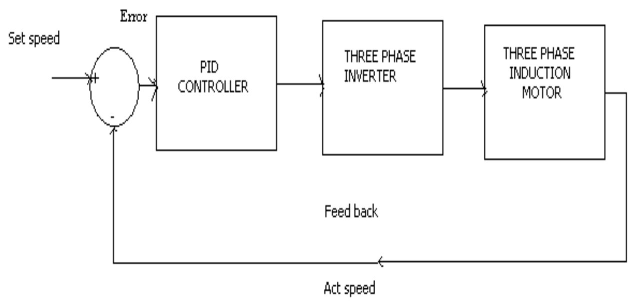

FIG 3 MATLAB Simulink Model of Asynchronous Moto

6. ASYNCHRONOUS MOTOR PARAMETERS

The IM motor under study has the following specification and parameters of induction motor. parameters of induction motor is given in table 1and MATLAB Model of induction motor show in the fig 4 fig 5, without controller and smart PID.

TABLE 1 -Asynchronous Induction Motor

S. No.	Parameter	Value
1.	Nominal power	7500
2.	Voltage Line to line	400 V
3.	Supply Frequency	50 Hz
4.	Stator Resistance	0.7384 ohm
5.	Stator Inductance	0.003045 H
6.	Rotor Resistance	0.7402 ohm
7.	Rotor Inductance	0.003045 H
8.	Mutual Inductance	0.1241 H
9.	Inertia	0.0343 Kg.m2
10.	Magnetizing Inductance	0.1722 H
11.	Friction Factor	0.000503 N.m.s
12.	No.of pole pair	2

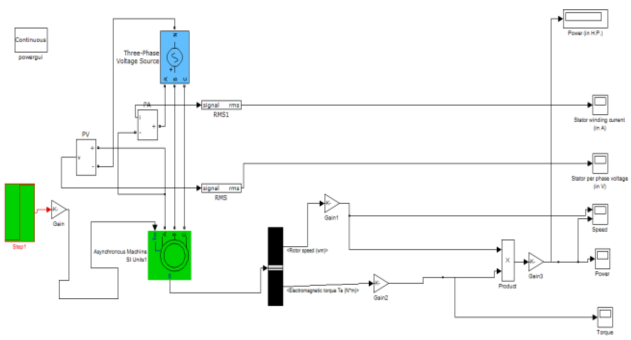

Fig 4 without controller induction motor

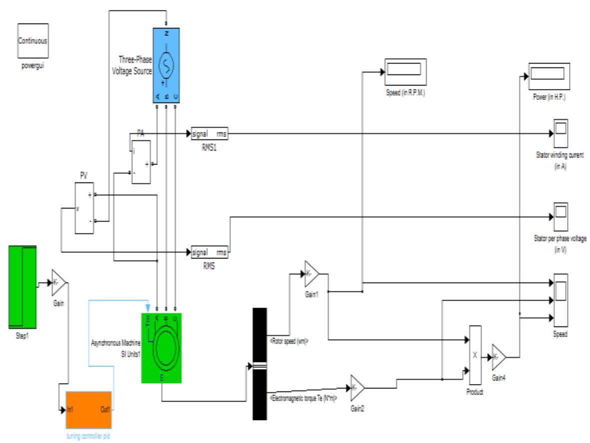

Fig 5 without controller induction motor

7. SIMULATION RESULTS

In this paper, two case studies of Induction Motor Speed Control induction motor has been designed and implemented in MATLAB along with the without controller response and smart PID controller. The speed or Stator per phase voltage Asynchronous Motor is checked NO controller is show in fig 6 and fig 7 ,its response is 1570 rpm or Stator per phase voltage *231.5* but smart PID controller is show in fig 8 or fig 9.

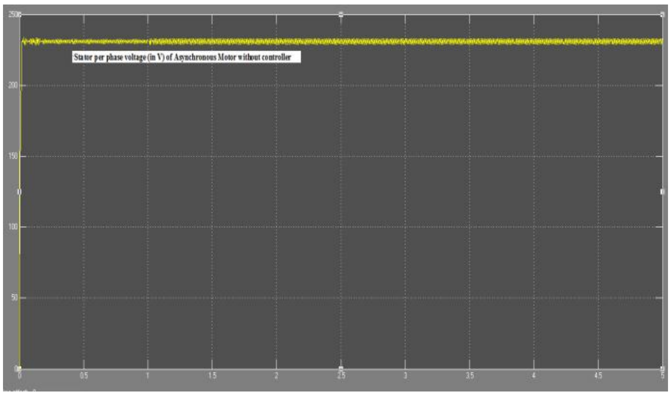

FIG 6 **Stator per phase voltage** (no controller)

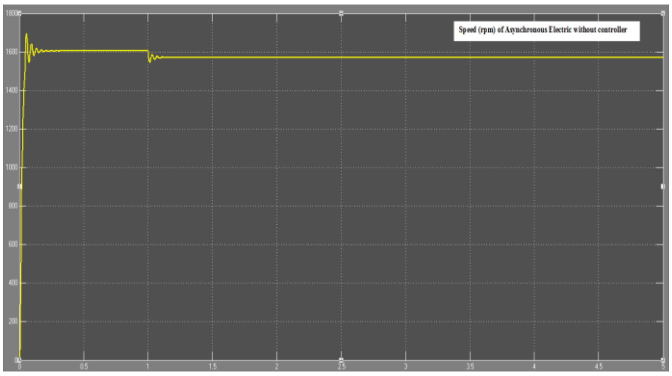

Fig 7 speed of Asynchronous Motor (no controller)

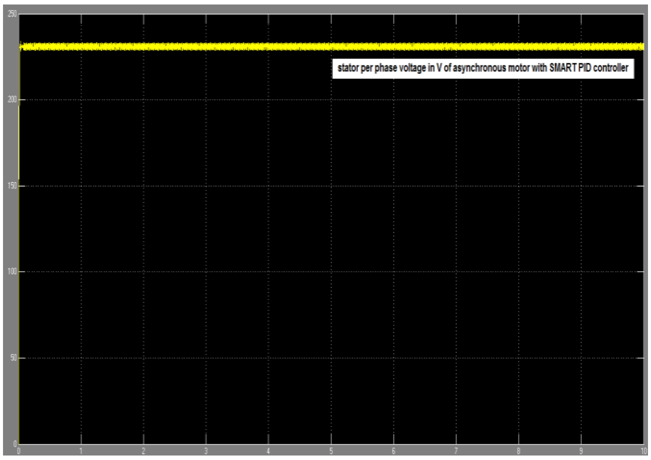

FIG 8 **Stator per phase voltage** (PID controller)

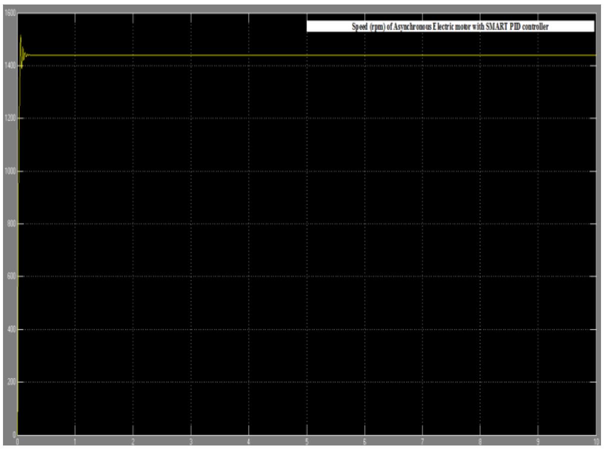

Fig 9 speed of Asynchronous Motor (PID -controller)

According to Smart PID controller speed is calculated 1440 R.P.M from display of speed or **Stator per phase voltage** 230.05, Speed is no fluctuated and more stable in PID case and settling time is 0.9940.

TABLE 2 Comparative tables of **Speed and Stator per phase voltage**

Parameters	No Controller used	Smart PID controller used
Stator per phase voltage	231.5 V	230.05 V
Speed	1570 rpm	1440 R.P.M.
Settling time	No settle	0.25 sec

8. CONSOLATION

In this paper Simulation results it is concluded that, compared with the NO controller and PID controller. The PID controller has better dynamic response, minimum response time, and small steady state error then NO controller, the paper proposes a PID controller for three-phase induction motor by using MATLAB SIMULINK simulation. The proposed design is able to enhance the performance and efficiency of the three-phase induction motor.PID based results is optimum and dynamic response.

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