# DESIGN AND IMPLEMENTATION OF INDUCTION MOTOR DRIVE BASED SLIDING MODE CONTROLLER

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**ABSTRACT:** Acceptance engines are being connected today to a more extensive scope of utilizations requiring variable speed. For the most part, factor speed drives for Induction Motor require both wide working scope of speed and quick torque reaction, paying little heed to any aggravations and vulnerabilities (like load variety, parameters variety and un- demonstrated flow). This prompts further developed control techniques to take care of the genuine demand. The ongoing advances in the territory of field-arranged control alongside the fast improvement and cost decrease of intensity hardware gadgets and microchips have made variable speed enlistment engine drives a practical option for some modern applications. One specific way to deal with powerful control controller configuration is the purported sliding mode control philosophy.

In this paper, a sliding mode controller is intended for an acceptance engine drive. The pick up and transfer speed of the controller are planned considering rotor obstruction variety, demonstrate mistakes, and load unsettling influence, to have a perfect speed following. The babbling impact is additionally considered. The controller is recreated under different conditions and a near investigation of the outcomes with that of PI controller has been introduced.

## 1.1 Introduction

The modern standard for superior movement control applications require, four quadrant task including field debilitating, least torque swell, quick speed recuperation under effect stack torque and quick unique torque and speed reactions. DC engines with thyristor converter and basic controller structure have been the customary decision for most mechanical and elite applications. Be that as it may, they are related to specific issues identified with substitution prerequisite and support. Low torque to weight proportion and lessened unit limit add some more negative focuses to DC machine drives. Then again AC engines, particularly acceptance engines are appropriate for mechanical drives, on account of there basic and hearty structure, high torque to weight proportion, higher dependability and capacity to work in dangerous situations. Anyway there control is a testing errand in light of the fact that the rotor amounts are not available which are in charge of torque generation. DC machines are decoupled regarding motion and torque.

Consequently, control is simple. In the event that it is conceivable in the event of acceptance engine to control the sufficiency and space edge (between turning stator and rotor fields), as such to supply control from a controlled source so the motion creating and torque delivering parts of stator current can be controlled autonomously, the engine progression can be contrasted with that of DC engine with quick transient reaction. By and by a presentation of smaller scale controllers and high exchanging recurrence semiconductor gadgets, and VLSI innovation has prompted practical complex control procedures.

## 1.2 Scalar control

The name scalar control demonstrates the extent variety of control factors as it were. The control of an acceptance engine requires a variable voltage variable recurrence control source. With coming of the voltage source inverter (VSI), steady voltage/hertz (V/f) control has turned into the most straightforward, least expensive and thus one of the well-known strategies for speed control of enlistment engine. This goes for keeping up a similar terminal voltage to recurrence proportion in order to give an almost consistent transition over an extensive variety of speed variety. Since transition is kept consistent the full load torque capacity are kept up steady under relentless state condition aside from low speed(when an extra voltage support is expected to make up for stator winding voltage drop ).In this control conspire, the execution of machine enhances in the enduring state just, however, the transient reaction is poor.

### 2.1 Sliding Mode Controller

Sliding mode controller is appropriate for a particular class of nonlinear frameworks. This is connected within the sight of displaying errors, parameter variety, and unsettling influences, given that the upper limits of their supreme qualities are known. Demonstrating errors may originate from certain vulnerability about the plant (e.g. obscure plant parameters), or from the decision of a rearranged portrayal of the framework dynamic. Sliding mode controller configuration gives a methodical way to deal with the issue of keeping up soundness and agreeable execution in the nearness of displaying defects. The sliding mode control is particularly proper for the following control of engines, robot controllers whose mechanical load change over a wide range.

Acceptance engines are utilized as actuators which need to take after complex directions determined for controller developments. Points of interest of sliding mode controllers are that it is computationally straightforward contrasted versatile controllers and parameter estimation and furthermore powerful to parameter varieties. The disservice of sliding mode control is the sudden and vast difference in control factors amid the procedure which prompts high worry for the framework to be controlled. It additionally prompts the prattling of the framework states.

### 2.2 Induction Motor Modeling

An appropriate model for the three-stage acceptance engine is fundamental to reenact and think about the entire drive framework. The model of enlistment engine in a self- assertive reference outline is inferred in [16- 17].

Following are the presumptions made for the model:

1. Every stator winding is dispersed in order to deliver a sinusoidal mmf along the air gap, i.e. space sounds are insignificant.

2. The opening in stator and rotor produces insignificant variety in separate inductances.

3. Shared inductances are equivalent.

4. The music in voltages and streams are dismissed.

5. Immersion of the attractive circuit is ignored.

6. Hysteresis and vortex current misfortunes and skin impacts are dismissed.

### 2.3 Estimation of Speed

It is attractive to maintain a strategic distance from the utilization of speed sensors from the points of view of cost, size of the drive, commotion invulnerability and unwavering quality.

So the improvement of shaft sensorless movable speed drive has turned into a vital research theme. Numerous speed estimation calculations and sensorless control plans [22] have been produced amid a previous couple of years. The speed data required in the proposed control strategy is evaluated by the calculation portrayed in this segment. The speed of the engine is assessed by evaluating the synchronous speed and subtracting the charge slip speed. The synchronous speed is evaluated utilizing the stator transition parts, due to its higher exactness contrasted with estimation in view of rotor motion segments.

The square graph of the portrayed speed estimation calculation with the sensorless speed control plot appears in fig 2.1

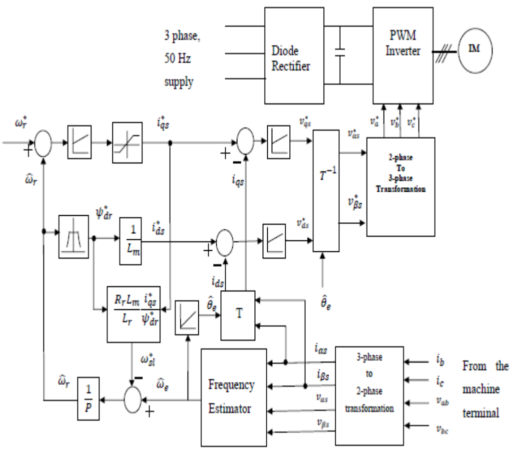



Fig 2.1 Induction motor drive system with sensorless speed control scheme

## 3.1 SIMULATION RESULTS AND DISCUSSIONS

The induction motor drive system is simulated with (*i*) P-I controller and

(*ii*) sliding mode controller in the mechanical

subsystem. Both the controllers are tested

for speed tracking and load torque variation conditions. Results are compared among both types of controllers. The drive is subjected to load disturbance to test the robustness of the sliding mode controller. Different cases under which the simulation tests are carried out are:

(a) Step change in reference speed.

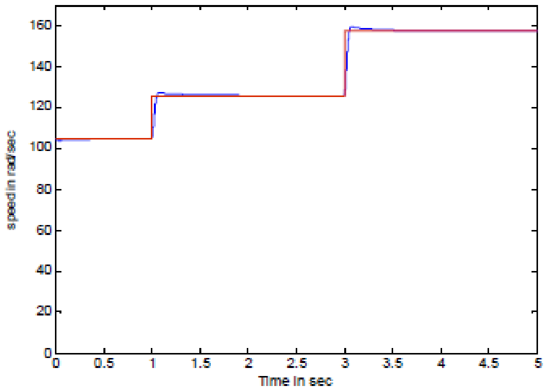
(b) Tracking of reference speed in trapezoidal form.

(c) Robustness test against load torque variation.

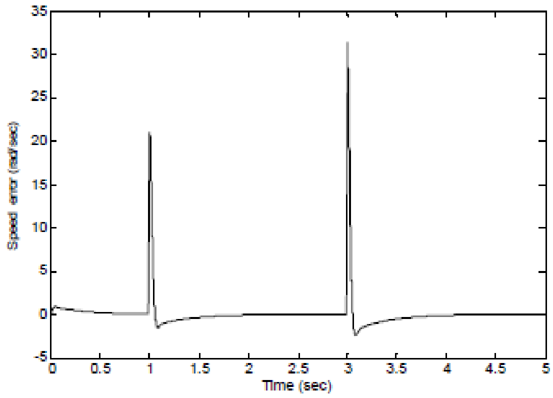
### (a) Step change in reference speed

The reference speed is changed from 1000 rpm to 1200 rpm at time, t = 1 sec, and again 1200 rpm to 1500rpm at time, t = 3 sec. The reference d-axis rotor flux linkage is kept at 0.45 V.sec and load torque is kept at zero. From the figures it is clear that in case of sliding mode controller, the speed error of the system comes to zero faster than fixed gain controller. The q- axis input voltage at the time of transition from one level to anther is nearly 20times larger in case of sliding mode controller.

Fig. 3.1 shows the responses of the controllers during variation of load torque. It is clear that the P-I controller speed response is affected by the load disturbance, where as the sliding mode controller has proved its robustness against load variations




(a)




(b)

Fig. 3.1 Step change in reference speed with P-I controller

(a) q- axis stator input voltage

(b) d- and q-axis stator current

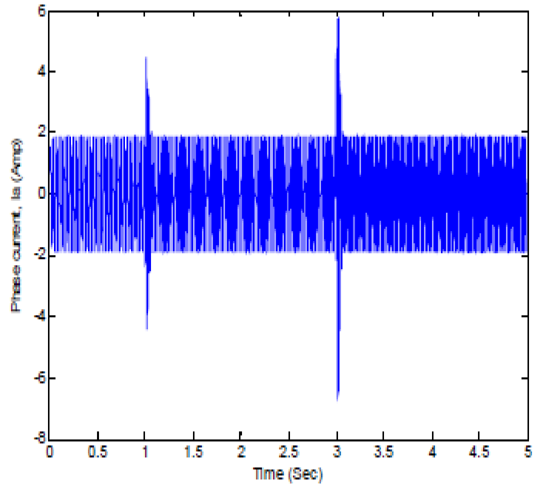
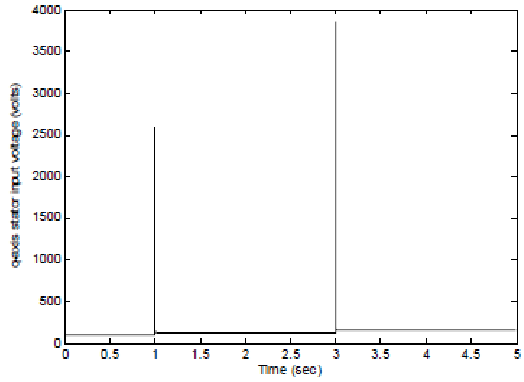



Fig. 3.2 stator phase current (Ia) for step change in reference speed with P-I controller



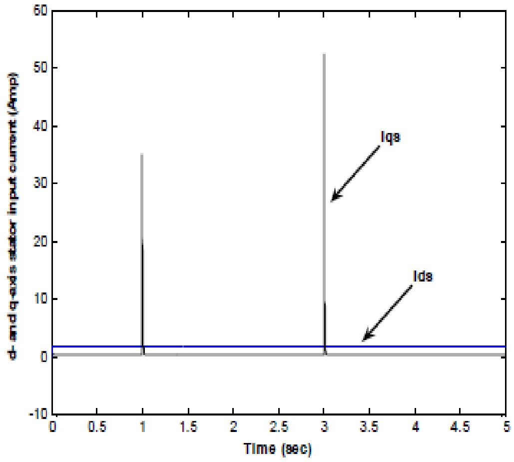
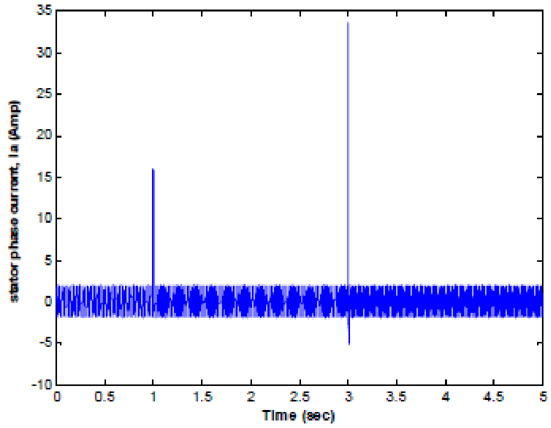



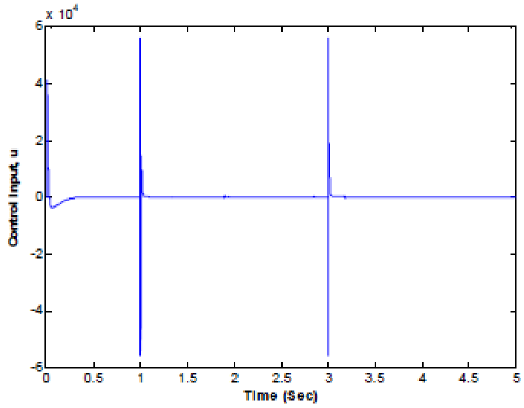

Fig. 3.3 Step change in reference speed with sliding mode controller

(a) q- axis stator input voltage

(b) d- and q-axis stator current




(a)

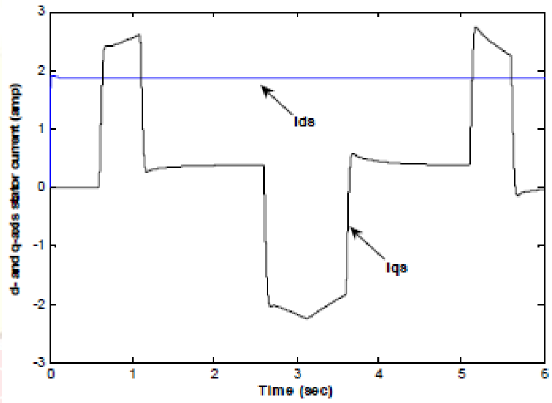



(b)

Fig. 3.4 Step change in reference speed with sliding Mode controller

(a) Stator phase current in Amp

(b) Control input, u in rad/s$^3$




(a)

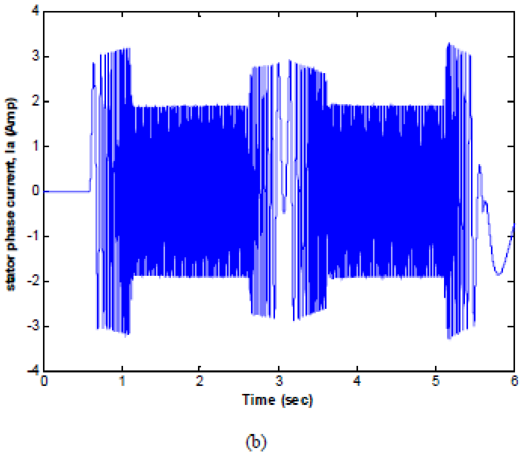



Fig. 3.5 Trapezoidal speed tracking with P-I controller
(a) d- and q-axis stator current
(b) stator phase current

**CONCLUSION**

In this postulation, the hypothesis of the sliding mode controller is considered in detail. The conditions of the acceptance engine display are rearranged in order to apply the control method. The controller picks up and data transmission is composed, considering different factors, for example, rotor opposition variety, the model mistakes, stack torque unsettling influence and furthermore to have a perfect speed following. Considering the case, for example, stack unsettling influence, the reaction of the outlined sliding mode controller is agreeable. It additionally gives great direction following execution. The speed control trademark is additionally tasteful. Just load aggravation is the issue considered for this situation and the power of the controller is checked. Since the machine rating is little, the opposition variety impact is little. Thus has the irrelevant impact.

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