Review on PVA Fed Sensor Less Fuzzy Logic Speed Control Of Induction Motor For Water Pumping Application

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Abstract : The speed of the imported vehicle is measured in terms of speed by three-phase voltages and input currents. In this paper it is proposed that the sensor of the abstract structure of the small vector control of the induction motor be raised with PVA. The import vehicle is controlled by six switching machines where the pulses are generated by the hysteresis current loop control. Speed is measured by stator flux measurement. The proposed system includes a solar photovoltaic (PV) array, a threephase voltage source inverter (VSI) and a motor pump assembly. An advanced mounting algorithm (INC) based on MPPT (Maximum Power Point Tracking) is used to generate maximum power from the same PV components. The controller includes a speed controller and a PI control that is later replaced with a logic fuzzy control with 49 base. The import speed of the vehicle is more stable with a higher number of heights and settling times when driven by fuzzy logic.

***IndexTerms* - fuzzy logic, peed Sensorless Control, Stator FieldOriented Vector Control, Photovoltaic (PV), InC MPPTAlgorithm, Induction Motor Drive (IMD), Water Pump**

I. INTRODUCTION

In the cutting edge period of improvement, inexhaustible assets of energy, are being upheld by numerous nations to satisfy the expanding need of electrical energy because of quick consumption of non-sustainable assets [1]-[2]. Sun based PV based energy age, has come up as a significant option for some reasons [3]. The water system area is one of the significant areas where sun based PV power is widely utilized for water siphoning [4-5]. Sunlight based PV water siphoning has been at first acknowledged utilizing the DC engine. Notwithstanding, with all due ideals related with the enlistment engine as far as mechanical effortlessness, toughness, unwavering quality, minimal expense, higher effectiveness and lower upkeep than the DC engines, it has supplanted DC engines. Here, a sun based PV cluster took care of enlistment engine drive utilizing vector control is utilized [6]-[7]. As one realizes that sun oriented PV power relies upon sun based insolation and temperature. The trait of PV module displays a solitary force top. An extraction of greatest force is vital piece of the PV framework. Consequently, different MPPT (Maximum Power Point following) procedures have been created and clarified in the writing. These calculations differ in their speed, scope of viability and intricacies [8]. Here, a steady conductance (InC) based MPPT calculation is utilized to follow MPPT. This calculation is created to beat a few downsides of annoy and notice (P&O) calculation. InC calculation further develops the following time and to deliver expanded energy on a huge light changes. Besides, it enjoys upper hand over P&O strategy, which expands misfortunes in lethargic changing environmental condition as it sways around MPP [9]-[10].

A large portion of the current acceptance engine drives (IMDs) join one DC-DC converter and a VSI (Voltage Source Inverter) for accomplishing MPPT and most extreme proficiency of the engine [11]. In addition, the DC interface voltage guideline is accomplished by VSI itself. In any case, the framework needs something like seven force converter switches and consequently exchanging misfortunes are expanded. This further incorporates a DC-AC transformation with a VSI taking care of a vector-controlled three-stage IMD. In this manner, there is a need to utilize single stage controlled drive for water siphoning and consequently diminishing number of switches and misfortunes. In single stage framework, a VSI needs to keep up with the MPP just as DC connect voltage is additionally constrained by it. Subsequently, factor DC connect voltage can't be accomplished as clarified in [12]-[13].

The vector control procedure is better than scalar control as far as speed of reaction and precision as clarified in [14]-[16]. In the vector control method, an AC engine is worked in such a way to act progressively as a DC engine by utilizing input control [16]. This method empowers to change the speed over the wide reach. Consequently with the progression of force hardware and by utilizing incredible microcomputer and DSPs, the vector control removes scalar control [17]-[19]. In this vector control conspire, the stator motion is assessed in writing material αβ outline, which is utilized to gauge the slip speed (ω_{sl}), simultaneous speed (ω_e) and the engine speed as clarified in Fig.1 shows the design of a solitary stage sun oriented PV exhibit took care of speed sensorless acceptance engine drive consolidating vector control for water siphoning. This proposed framework comprises PV cluster followed by a VSI took care of three-stage acceptance engine drive worked siphon. The engine speed is assessed by stator transitions, which is assessed by DC interface voltage and engine flows. Three-stage VSI exchanging is constrained by hysteresis-band regulator. A steady conductance (InC) control calculation is utilized for MPPT to produce exchanging beats for the VSI.

Fig.1 shows a fundamental schematic of a three-stage acceptance engine of a 7.5 kW (10 HP), 415V, used to drive the siphon controlled by a 8.7 kW most extreme force sunlight based PV exhibit. The different phases of framework, have been planned here and the exhibition of by and large framework is displayed in ensuing segments under different conditions. The definite information are given in Appendices.[20]. The paper is coordinated as given: framework arrangement is given in area II followed by the plan of framework, control system including vector control and results and conversation in the ensuing segments. The exhibition of the given framework is accomplished through reenactment utilizing MATLAB/Simulink. In future work we recreation results are approved by experimentation completed in the research center on the created model.

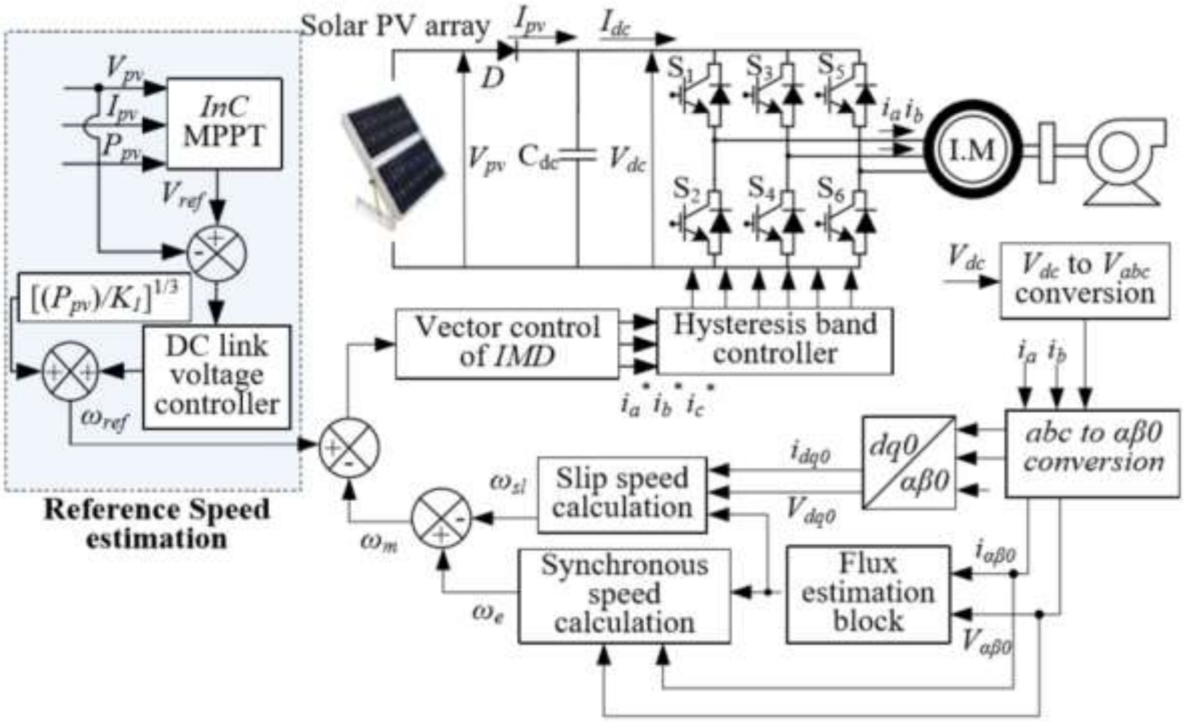

Fig. 1. PV fed induction motor drive configuration

II. System Configuration

Figure 1 shows the suspension of one phase of solar PV array fed speed sensor induction motor drive insert controlling the water pump vector. This is the proposed program creates a PV list followed by a VSI fed into three phases induction motor drive with pump. The speed of the car is measured by stator fluxes, measured by a DC connector electrical and motor power. Three VSI phase shifts controlled by a hysteresis-band controller. Rising the conductance (InC) control algorithm used for MPPT to generate VSI pulse switch.

III. System Design

A three stage acceptance engine is fundamentally a steady speed engine so it's to some degree hard to control its speed. The speed control of enlistment engine is done at the expense of diminishing in effectiveness and low electrical force factor. Prior to talking about the techniques to control the speed of three stage acceptance engine one should know the essential recipes of speed and force of three stage enlistment engine as the strategies for speed control relies on these equations.

The Speed of Induction Motor is changed from Both Stator and Rotor Side. The speed control of three phase induction motor from stator side are further classified as :

- V / f control or frequency control.
- Changing the number of stator poles.
- Controlling supply voltage.
- Adding rheostat in the stator circuit.

The speed controls of three phase induction motor from rotor side are further classified as:

- Adding external resistance on rotor side.
- Cascade control method.
- Injecting slip frequency emf into rotor side.

Fig.1 shows a basic schematic of a three-phase induction motor of a 7.5 kW (10 HP), 415V, used to drive the pump powered by a 8.7 kW maximum power solar PV array. The various stages of system, have been designed here and the performance of overall system is shown in subsequent sections under various conditions.

3.1 Solar PV Array Design

The 8700 W PV range is designed for driving 7.5kW input driving a car. Rate of similar PV members selected overvehicle rating for vehicle performance to remain stable It is not affected by the losses incurred in the vehicle and converter. A The PV array is built by connecting 34 PV modules to a series of the voltage of the open circuit (Voc) equals 734V modules and 25 in the current parallel circuit (Isc) equal to 15.5 A, respectively. The voltage and current reach their MPP approximately 81% Voc and 90% Isc respectively as given in Table 3.1 Specification of the PV module used, is provided in Table 3.2 and Appendices.

Table 3.1: PV Array Design (Simulation Data)

MPP voltage, V_{mp}	600V
MPP power, P_{mp}	8700W
MPP current, $I_{mp}= P_{mp}/V_{mp}$	14.5A
Number of module in series, $N_{ser}= V_{mp}/V_{mpp}$	34
Number of module in parallel, $N_{par}=I_{mp}/I_{mpp}$	25

Table 3.2: PV Module (Simulation Data)

V_{oca} of one module	21.6V
I_{sca} of one module	0.64A
MPP Voltage, V_{mpp}	0.81*21.6=17.6V
MPP Current, I_{mpp}	0.9*0.64=0.58A

3.2 Calculation of DC Link Voltage

To control the yield current of VSI, the voltage of the DC connection ought to be more than when contrasted with the pinnacle sufficiency of line voltage given to the engine [13].

$$V_{dc} = \sqrt{2} \times V_L = \sqrt{2} \times 415 = 587V \qquad (1)$$

Hence the value of DC link voltage is kept as 600V.

3.3 Design of DC Link Capacitor

The value of DC link capacitor is estimated by using fundamental frequency component as [13],

$$\omega_{rated} = 2 \times \pi \times f_{rated} = 2 \times \pi \times 50 = 314 rad/s \qquad (2)$$

$$\frac{1}{2} \times C_{dc} \times \left(V_{dc}^2 - V_{dc1}^2\right) = 3aV_p It = 3 \times 1.2 \times 239.6 \times 13.5 \times .005 \qquad (3)$$

Therefore, Cdc = 2509µF

where Vdc is the DC connector and Vdc1 is the minimum The permissible DC for power connectivity in the short term, I the time required for the voltage to return to the permissible minimum DC-link voltage, is now the phase of the motor phase and Vp is electric field. Therefore, the value of the capacitor is chosen as 2500 µF.

3.4 Design of Water Pump

Water pumps have non-linear relationship between load torque and motor speed i.e. load torque (TL) is directly in proportion to the square of the rated rotor speed.

Hence,

$$T_L = K_1 \omega_m^2 \qquad (4)$$

where K1 is the proportionality constant of the pump.

Figure 2 shows Proposed system with PVA fed to induction motor and Figure 3 shows Speed regulator with PI controller.

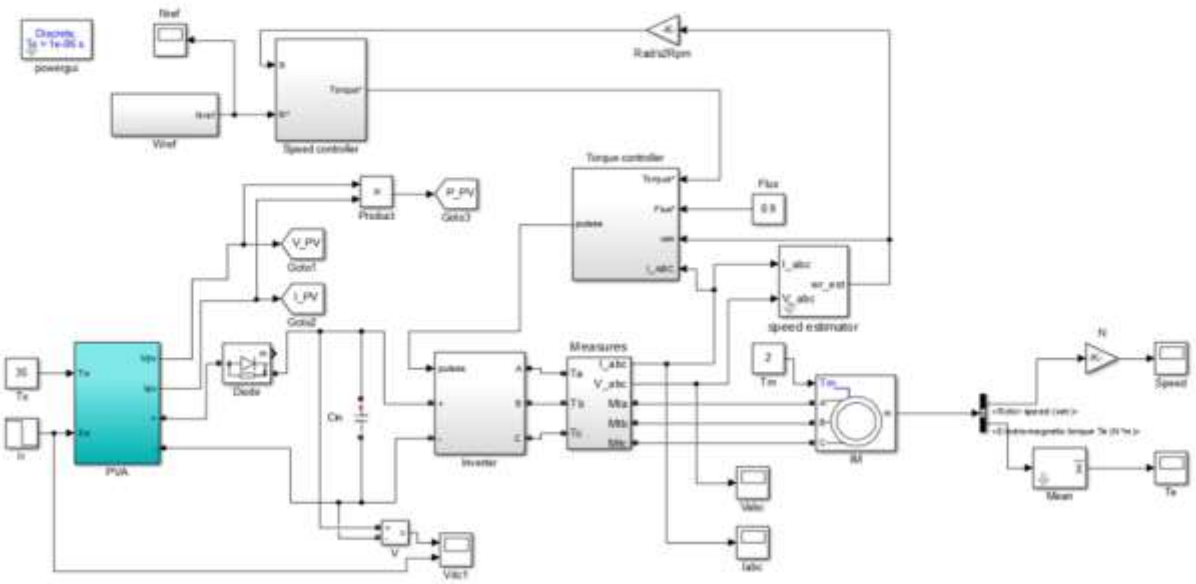

Fig. 2 Proposed system with PVA fed to induction motor

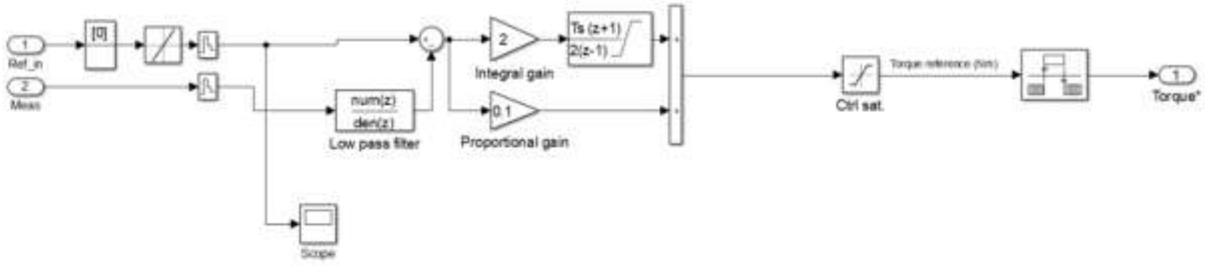

Fig. 3 Speed regulator with PI controller

IV. CONTROL SRUCTURE

4.1 Induction motor speed control from stator side

A. By changing the applied voltage:

From the torque equation of induction motor,

$$T = \frac{k_1 s E_2^{\,2} R_2}{\sqrt{(R_2^{\,2} + (s X_2)^2)}} = \frac{3}{2\pi N_s} \frac{s E_2^{\,2} R_2}{\sqrt{(R_2^{\,2} + (s X_2)^2)}} \qquad (5)$$

Resistance to the Rotor R2 is permanent and if the slips s are small (sX2) 2 they are too small to be maintained. Therefore, the T-sE22 where the E2 is a rotor made of emf and E2-V.

Therefore, the T-sV2, which means, when the power supply is reduced, the improved torque decreases. Therefore, by providing the same loading torque, the slip increases with increasing force, and as a result, the speed decreases. This method is the simplest and cheapest, most widely used, because large change in supply voltage is required for relatively small change in speed. large change in supply voltage will result in a large change in flux density, hence, this will disturb the magnetic conditions of the motor.

B. By changing the applied frequency

Synchronous speed of the rotating magnetic field of an induction motor is given by,

$$N_s = \frac{120 f}{P} \quad \text{(RPM)} \qquad (6)$$

where, f = feed frequency and P = number of stator poles.

Therefore, the sync speed changes with the frequency change of the feed. The actual speed of the import vehicle is given as N = Ns (1 - s). However, this method is not widely used. Can be used there, the import vehicle is supplied by a dedicated generator (so that the frequency can vary easily by changing the speed of the main conductor). Also, at low frequency, the current motor can be very high due to the decrease in response. And when the frequency increases above the estimated value, the improved torque is reduced and the speed increases.

C. Constant V/F control of induction motor

This is a very popular way to control the speed of imported car. As with the above method, if the supply frequency is reduced and keeps the power supply measured, the air gap will often fill. This will cause excessive stator flux current and disruption of stator flux wave. Therefore, the stator voltage should also be reduced in proportion to the frequency in order to maintain a constant air flow. The size of the stator flux is equal to the measurement of the stator power and mass. Therefore, if the ratio of electrical energy and frequency is kept constant, the flow remains constant. Also, by maintaining a constant V / F, the improved torque remains constant. This method provides high time efficiency. Therefore, most AC speed drivers regularly use the V / F (or variable voltage, variable frequency) method to control speed. Along with several speed controls, this method also provides 'soft start' power.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

D. **Changing the number of stator poles**

From the above equation of synchronous speed, it can be seen that synchronous speed (and hence, running speed) can be changed by changing the number of stator poles. This method is generally used for squirrel cage induction motors, as squirrel cage rotor adapts itself for any number of stator poles. Change in stator poles is achieved by two or more independent stator windings wound for different number of poles in same slots.
For example, a stator is wound with two 3phase windings, one for 4 poles and other for 6 poles. for supply frequency of 50 Hz

- synchronous speed when 4 pole winding is connected, Ns = 120*50/4 = 1500 RP
- synchronous speed when 6 pole winding is connected, Ns = 120*50/6 = 1000 RPM

4.2 Speed control from rotor side

A. Rotor rheostat control

This method is similar to the armature rheostat control of a DC shunt motor. But this method only applies to slip ring motors, as adding external resistance to the rotor of squirrel cage motors is not possible.

B. Cascade operation

In this speed control method, two engines are used. Both are mounted on the same shaft so that both run at the same speed. One car is supplied from the 3phase supply and the other vehicle is supplied from the emf made with the first car with rings. The layout is shown in the following image.

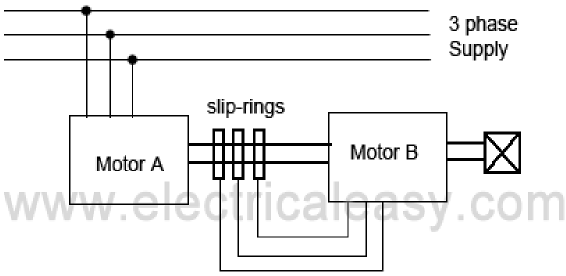

Fig. 4Cascade Control Operation

Motor A is called a large motor and motor B is called an auxiliary motor.
Allow, Ins1 = frequency of car A
Ns2 = car frequency B
P1 = number of car stator poles A
P2 = number of stator poles for car B
N = set speed is also the same for both motors
f = feed frequency
Now, car slip A, S1 = (Ns1 - N) / Ns1.
Rotor frequency generated by emf in vehicle A, f1 = S1f
Now, the future B car is supplied with a rotor induce emf
therefore, Ins2 = (120f1) / P2 = (120S1f) / P2.
now set the value to S1 = (Ns1 - N) / Ns1

$$N_{s2} = \frac{120f(N_{s1} - N)}{P_2 N_{S1}}$$

At no load, speed of the auxiliary rotor is almost same as its synchronous speed.
i.e. N = Ns2.
from the above equations, it can be obtained that

$$N = \frac{120f}{P_1 + P_2}$$

In this way, four different speeds can be obtained

- when only car A works, corresponding speed =. Ns1 = 120f / P1
- where only B car operates, corresponding speed = Ns2 = 120f / P2
- when the completion of the operation is performed, set speed = N = 120f / (P1 + P2)
- when partition reduction is performed, set speed = N = 120f (P1 - P2)

C. By injecting EMF in rotor circuit

In this way, the speed of the inlet motor is controlled by injecting the voltage into the Rotor circuit. It is required that the voltage (emf) injected must have the same frequency as the normal slide. However, there is no limit to the injected category. If we inject a emf that is in a different phase from the rotor that is made in emf, the rotor resistance will be increased. If we inject a phase emf with a rotor-caused rotor, the rotor resistance will decrease. Therefore, by changing the injected phase category, the speed can be controlled. The great advantage of this method is the widespread anger of speed control (above normal and below normal) can be achieved. The emf can be installed in various ways such as the Kramer system, Scherbius system etc.

D. Sensorless vector control

Wireless vector control for induction motors has become very popular due to the reliability and concern of maintanence [1 - 6]. The exact speed and torque of the imported vehicle can be determined based on the dynamic features of the imported vehicle using vector control theory and high-performance digital signal processor (DSP). The indirect velocity vehicle control vector requires precise speed details; therefore a speed sensor is often used on the car shaft to measure the speed of the car.

However, the speed sensor increases costs and requires a connection line between the control system and the vehicle, which can lead to unstable operation of the control system due to interference from the signal line. In addition, direct operation of servo motor control is required in the system in some cases where the attachment of the speed sensor is not possible. Wireless vector control that can accurately control the input motor without speed sensor has been of great interest, and the results of the studies have provided various speed measurement algorithms and wireless control methods [7].

Prof et et al. [8] read at speeds using the rotor slots ripple generated at stator voltages and currents due to the fluctuations in the number of rotors. This method had a problem with low speed due to the limitations of the frequency-to-voltage converter as well. Kim et al. [9] Measure the rotor speed using an extended Kalman filter. However, the Kalman filter is very complex and requires very powerful microprocessors. In industrial applications, speed sensors, and non-sensor solutions, are used. Because of the potential for speed sensor sounds and concerns about care and economic factors, there is a tendency to infuse speed sensors with computer solutions [10]. Although a comprehensive review of sensory drivers has been set out in [3], there are still some problems related to wireless control of induction motors [10].

One of the problems driven by electricity is the sensitivity of the system to inaccuracies and changes in the parallel circuit parameters [11 - 11]. In this paper, our aim was to propose a new speed measurement method using MRAS to improve the performance of wireless vector control for a three-phase input vehicle. The current stator and rotor flux have been used as state variants to measure speed. The current stator error was reported as the first level function of the speed limit error value. In addition, it was validated by the space vector modulation algorithm. Therefore, this method can provide a faster measurement and can be considered to be more robust for parameter variability compared to other MRAS methods. The proposed MRAS approach could improve the performance of an unreasonable vector controller in low-speed and zero-speed regions.

By means of vector control, the flux currents and torque are separated to control the sequence of the output torque of the imported vehicle. To achieve this, vector control requires precise details of the angle of rotor flux. The angle of rotor flux is indirectly predicted by vector control using the speed of the vehicle measured from the speed sensor attached to the rotor shaft. Although a vector controller using a speed sensor can accurately control the servo process, some problems occur due to the speed sensor. Therefore, wireless speed control has been of great interest due to its ability to control torque without the speed sensor [7, 14 - 17].

4.3 Proposed MRAS

In Fig. 5, reactive power MRAS speed estimation structure was given. The stator voltages and currents in the αβ steady reference frame are needed for this module. Two sets of automotive performance measurements are available for reference and flexible models. The reference model does not contain the rotor speed, and the estimated rotor speed based on the operating power calculated from the reference model is required for the variable model.

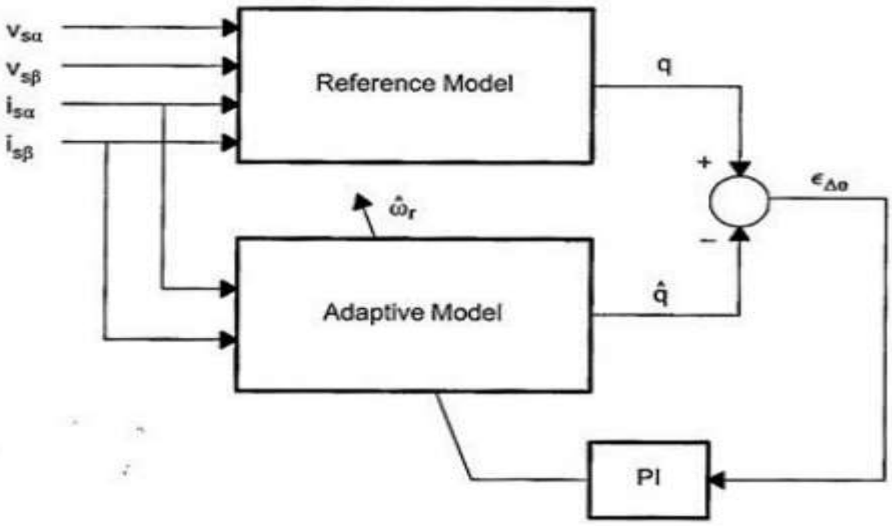

Fig. 5. A schematic diagram of a rotor speed estimation structure using MRAS

4.4 Fuzzy logic

Uncertain logic has two different meanings. In a nutshell, an abstract concept is a logical system, which is an extension of the suggested concept. However, in the broadest sense logic fuzzy (FL) is almost identical to the notion of unconventional sets, the notion of categories of objects with delicate boundaries where membership is a matter of standard. With this view, the incomprehensible concept in its lesser sense is the FL branch. Even with its simplest meaning, the mysterious concept differs in both intellectual and material elements from many traditional rational systems.

In Fuzzy Logic Toolbox ™ software, incorrect logic should be interpreted as FL, that is, incomprehensible logic in its broadest sense. The basic ideas under FL are clearly and concisely stated in the Foundations of Fuzzy Logic. What might be added is that the basic concept supported by FL is linguistic diversity, that is, variables in its word values rather than numbers. In fact, most FLs can be seen as a way of making a computer with words rather than numbers. Although words are naturally more specific than numbers, their use is very close to human emotion. In addition, word-for-word exploits the tolerance of non-compliance and thus reduces the cost of the solution.

Another basic concept in FL, which plays a major role in many of its programs, is that of incomprehensible law if, or, simply, incomprehensible law. Although systems are based on laws that have a long history of use in Artificial Intelligence (AI), what is lacking in such systems is the way they deal with unintended consequences and complex objections. In a mysterious way, this approach is given by a calculus of incorrect rules. A number of obscure rules serve as the basis for what might be called the Fuzzy Dependency and Command Language (FDCL). Although the FDCL is not explicitly used in the toolbox, it is actually one of its key components. There is a lot of use of an abstract concept, an abstract concept solution, in fact, the translation of a human solution into FDCL.

The growing trend seems to be related to the use of the opposite concept in combination with neurocomputing and genetic algorithms. In general, fuzzy thinking, neurocomputing, and genetic algorithms can be considered as key components of what might be called soft computing. Unlike traditional, hard computing, soft computing takes the imagination of the real world. The guiding principle of a soft computer is: Use the tolerance of ambiguity, uncertainty, and limited reality to achieve the slope, durability, and low cost of the solution. In the future, soft computing could play a more important role in the conception and design of its systems.

Among the various combinations of soft computer systems, the most obvious at this time are the fuzzy logic and neurocomputing, which lead to neuro-fuzzy systems. Within the abstract understanding, such systems play a very important role in the formation of rules from perception. An effective method developed by Dr. Roger Jang for this purpose is called ANFIS (Adaptive Neuro-Fuzzy Inference System). This method is an important tool in the toolbox.

V. Conclusion

With the above results it can be concluded that the speed of the import vehicle is more stable with a lower elevation value and less settling time. A car controlled by a 49rules unobtrusive controller has better performance compared to a PI controller. Torque and stator flux, independently controlled. The car starts well. The reference speed is determined by a DC link voltage controller that controls the voltage across the DC connector and the speed measured by the supply terminal coupling to the pump assembly law. The power of the PV array is stored at a high power level during the irradiance switch. This is achieved by using a growing MPPT algorithm. The model is driven by graphs that make up the Simulink model in terms of time.

The input source PVA can be replaced with fuel cell or wind farm (connected to controlled rectifier) for multiple renewable source feeding the converter. The speed regulator can be updated with neuro fuzzy controller for more faster response of speed with reduced settling speed and ripple in the value.

VI. Acknowledgment

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