Neural Network System based Solar Photovoltaic cell Fed Multilevel Inverter in water pumping applications

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Abstract. The design and creation of a Modular Multilevel Inverter (MMI) that employs clever techniques to control the Induction Motor (IM) drive in maritime applications linked to water pumping are described in this study. The eleven-stage inverter that is suggested can change the drive speed of an induction motor that is driven by solar panels. According to estimates, pumping systems use about half of the energy used on board a ship. In light of this, this study explores and evaluates proposed low-complexity control architecture for a maritime water pumping situations. To improve the performance of the inverter Fuzzy Logic (FL) dependent controller and neural networks are used. A comparison was made in terms of improved robustness with regard to peak overshootand the controller's settling time. MATLAB/Simulink is used to run the simulations. The obtained results are used to investigate the controller presentation, enhanced power quality through harmonic reduction, improved inverter production voltage, and consistent IM speed variation

Keywords: Modular multilevel inverter, Solar PV system, Induction motor drive.

1. Introduction

In around the world, extensive endeavors been taken by the sea and transportation ventures to disintegrate the degree of air emanations and energy utilization. The discouragement of contamination in the marine climate and coincidental causes are totally trailed by specific guidelines which are outlined by MARPOL [1]. Because of environmental change and worldwide ozone harming substance discharges, the transportation contribute around 3% of worldwide CO2 emanations from diesel motors engaged with marine areas [2]. Notwithstanding the developing worldwide energy emergency brought about by the consumption of traditional energy sources, it likewise include generally in the outflow of unsafe toxins in water and air. The use of diesel motors in the boat produces ozone harming substance and CO2 discharges are slowly expanded and it arrived at 8% in the year 2020 [3]. To defeat the issues looked because of natural contamination in the boat business, an upset advanced towards the execution of sun oriented ability to give clean power from efficient power energy sources. In spite of a steadily expanding worldwide interest attributable torising overall populace, general longing for sunlight based energy alongside further developed power nature of an inverter are the need of great importance [4]. The exhaustion of regular sources causes the developing worldwide power emergency. In any case, it additionally brings about the nursery impact prompting a dangerous atmospheric deviation. The temperature of the ground outside is supposed to increment by 3C to 6C inside the finish of this century [5]. PV based energy is normally the most ideal decision for the majority of the rural and ship application as it require fewer measure of upkeep, present commotion liberated tasks because of the shortfall parts and consumes low space in housetops in boat. Sun oriented photovoltaics framework has executed in transport which conveys expected power consolidating a clever strategy to diminish emanations to expand the environmentally friendly power proficiency and furthermore to liven up the security of power. The sunlight based energy source is incorporated with converters and inverter to interact diverse huge power loads [6]. As of late, a wide scope of investigation in the cutting edge transport is locked in with relationship of environmentally friendly power coordinated converters. Two basic issues happened in converter is voltage straying a recurrence deviation, it prompts sounds bends [7], [8]. The siphoning frameworks in boat absorb around 70% in general power [9], [10]. In transport

power hardware, converter is a significant block utilized for the impetus of engine drives frameworks however endures a ton with misfortune on music. Planned employment researches new advancements in inverter, it is utilized further develop good quality boat by decreasing music by the help of a keen regulator.

2. Test system Case study

The PV with standard and output capacity 150W is considered under normal environmental conditions and ambient temperature to the induction drive fed to the marine boat. The MMI drives the motor at its maximum capacity. A 10W PV system designed with 63 cells is connected in series. The intermediate DC/DC converter with MPPT is operated at its maximum capacity and drives the MMI.

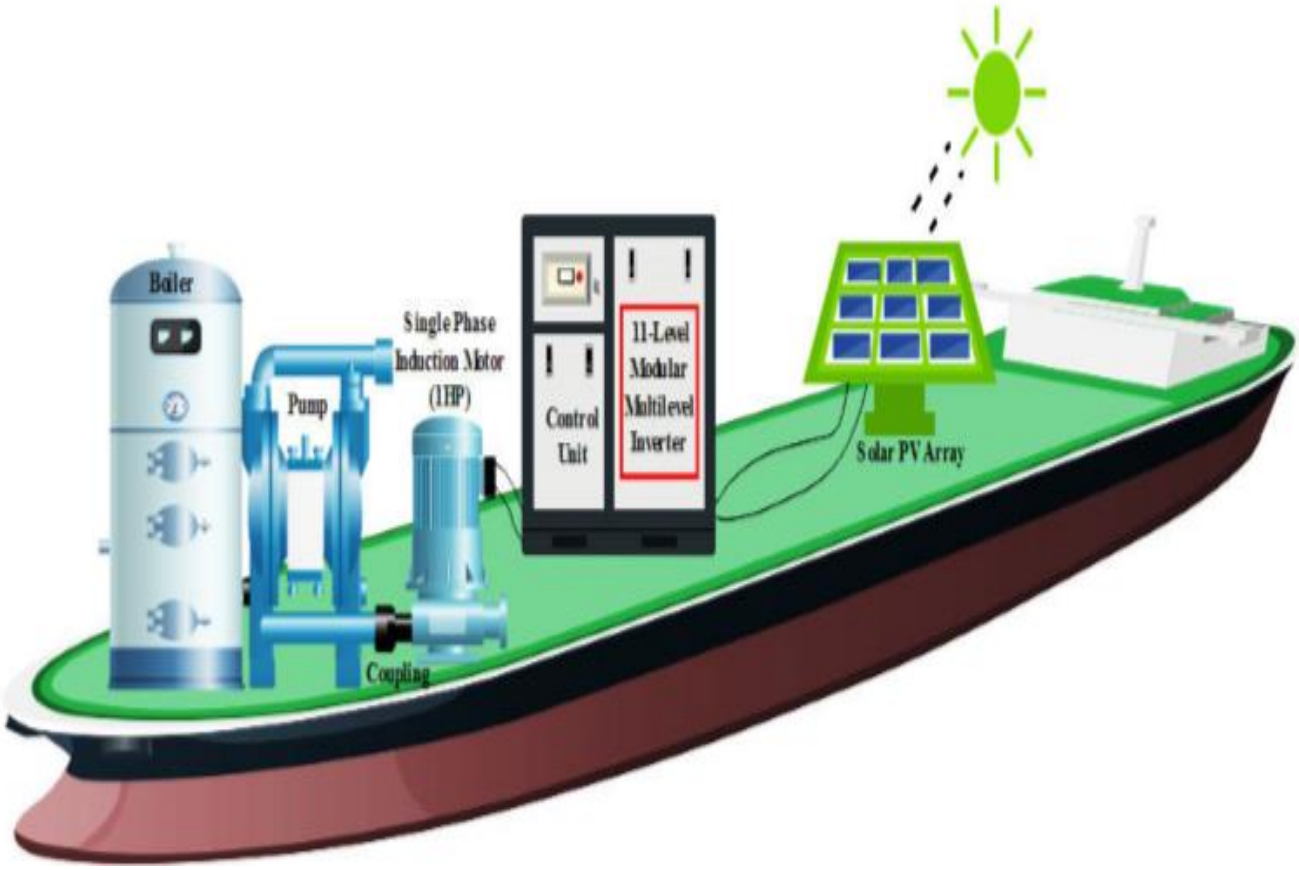

Figure.1: Block diagram.

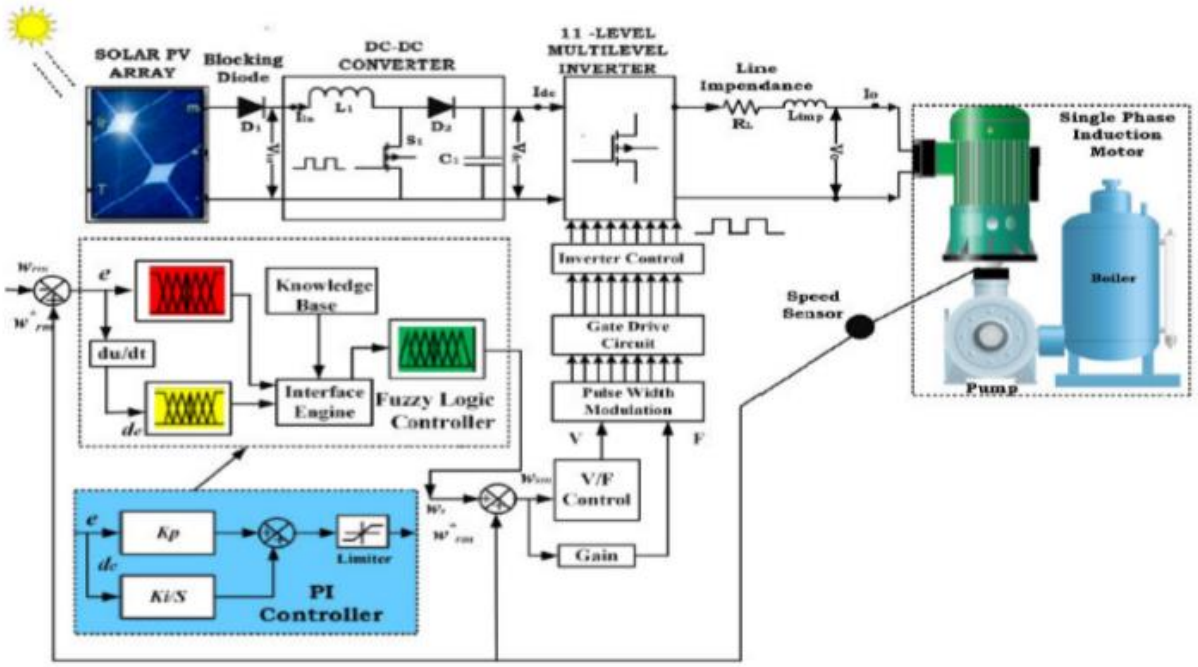

Figure.2: Fuzzy controller design for proposed system

3. Proposed Controller

The PI controller is recommended with 3 various techniques. Due to several benefits PI regulator is selected for the proposed implementation. The proposed PI trial and error approaches with tunes the proportional and integral parameters well. To get constant torque and speed closed loop control is implemented. Fuzzy controller is very efficient in tuning these parameters and it incorporates the human thinking. Hear the fuzzy controller is implemented to serve the following purposes to control the momentum of motor and reducing error using rule base system. The suggested FL controller is designed to accomplish two major modules: (1) predicting IM speed and (2) decreasing speed error utilizing a rules-based method while simultaneously degrading harmonics. The rule base of the implemented fuzzy system is presented below.

Table 1Fuzzy Rule base specifications

e/ce	NB	NS	ZE	PS	PB
NB	ZE	NS	NB	NB	NB
NS	ZE	NS	NB	NS	NB
ZE	PB	PS	ZE	NS	NB
PS	PB	PS	PS	ZE	NS
PB	PB	PB	PB	PS	ZE

4. Simulation results

The obtained output voltage response of MMI inverter is shown in fig.3. From the fig.3, 11 level output voltage response it is clear that almost sinusoidal voltage is obtained. Figure.4, figure.5 and fig,6 are illustrate the speed answer of IM drive with PI, fuzzy and Neural networks.

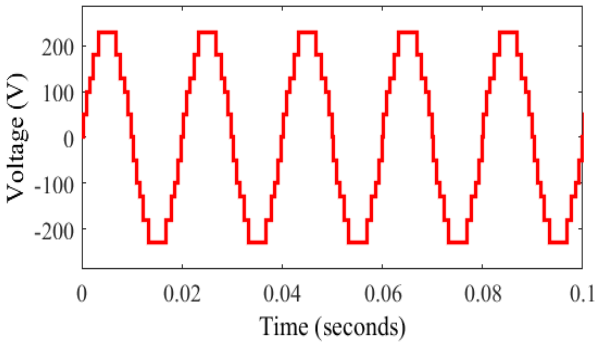

Fig.3. Output response of output voltage

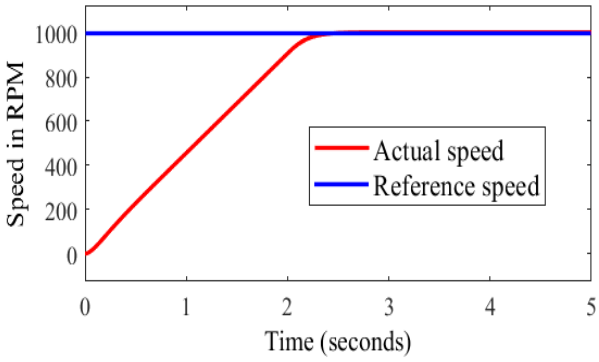

Figure.4: Speed response drive with PI controller

The above graph Fig .4. is between Time in seconds and speed in RPM with PI controller, in this case the actual speed in RPM will be raised and meet the reference speed of 1000RPM at 2.1 seconds. The actual speed is shown in RED color and Reference speed is shown in BLUE color.

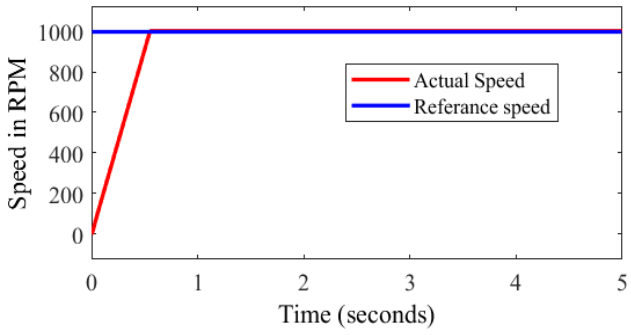

Fig.5. Speed response drive with fuzzy controller.

The above graph Fig .5. is between Time in seconds and speed in RPM with fuzzy controller, in this case the actual speed in RPM will be raised and meet the reference speed of 1000RPM at 0.5seconds. The actual speed is shown in RED color and Reference speed is shown in BLUE color.

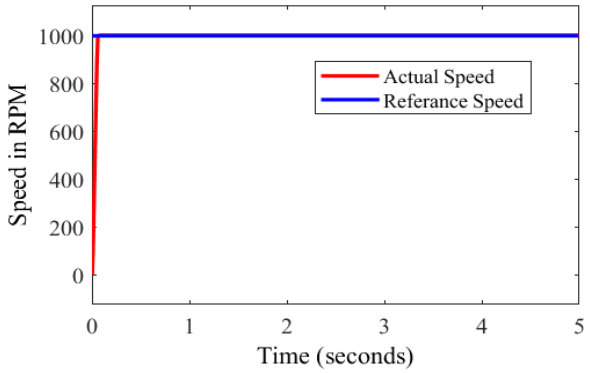

Fig.6. Speed response drive with Neural controller.

The above graph Fig .6. is between Time in seconds and speed in RPM with neural controller, in this case the actual speed in RPM will be raised and meet the reference speed of 1000RPM at 0.1seconds. The actual speed is shown in RED color and Reference speed is shown in BLUE color.

Table 2: Rise Time comparison of PI, FUZZY and ANN Controllers.

Name of the Controller	Rise Time in sec
Pi Controller	2.1
Fuzzy Controller	0.5
Proposed ANN Controller	0.1

5. Conclusions

Based on the simulation findings, it is clear that the proposed intelligent control strategies, such as fuzzy and neural, resulted in a better response of the IM drives as compared to the speed control of the IM drives using a PI controllers. The APOD PWM method based MMI inverter produces almost sinusoidal 11 level output voltage. The proposed work is important because it will deliver good quality base power to inverter drives used in maritime water pumping applications. To study its potential for water pumping systems intended for marine recommendations, a PV fed MMI for speed estimation of IM drives was investigated. The inverter is connected to PV system, it is subsequently fed to an induction motor. And controller will receives feedback on motor speed in order to produce suitable PWM pulses for the control of inverters. By the use of FL, PI and NN controllers, IM will be progressively start and the speed will be increase to get required speed.

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