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A Novel Fuzzy Based Modeling & Designing Of A Stand Alone Distributed Generation- Storage System In Microgrids

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Abstract: A control algorithm for a standalone solar photo-voltaic (PV)-diesel-battery hybrid system with FUZZY is implemented in this paper. The proposed system deals with the intermittent nature of the energy generated by the PV array and it also provides power quality improvement. The MPPT controller is employed to achieve the maximum power point (MPP) for photovoltaic (PV) panels. The PV array is integrated through a dc– dc boost converter and is controlled using a maximum power point tracking algorithm to obtain the maximum power under varying operating conditions. The battery energy storage system (BESS) is integrated into the diesel engine generator set for the coordinated load management and power flow within the system. Solar photovoltaic (PV) system has gained its own importance in global electrical power generation. PV system may be connected in standalone mode. The intermediate stages present between solar PV system and load is the boost converter with maximum power point (MPP) tracking controller and the inverter with different control techniques. The present work explains about a solar PV system of two stage configuration simulated in standalone mode with simple proportional-integral (PI) controller and fuzzy logic controller (FLC) to regulate dc output voltage. The behavior of PV system has been observed with switching on of an load for a stipulated time period. The performance of solar PV system under disparate running conditions and its associated power curves were presented.

Index Terms: FLC-based fuzzy control algorithm, battery energy storage system (BESS), diesel generator (DG) set, four-leg voltage-source converter (VSC), neutral current compensation, power quality, solar photovoltaic (PV) array, standalone system.

I. INTRODUCTION

A global transition to renewable energy resources is well suited to meet the need for power in remote areas, which lack grid and road infrastructure. The support for the use of renewable energy resources is increasing as global warming is a major environmental concern, and it offers an alternative for future energy supply. Among the available renewable energy resources, solar photovoltaic (PV) power generation is gaining wide acceptance, and it is used for various applications such as household appliances, remote missions, data communications, telecommunication systems, hospitals, electric aircraft, and solar cars. The utilization of the PV power generation is for the reason that it has many advantages such as it gives clean power, is portable in nature, and can be employed for various small-scale applications. However, considering the large fluctuations in the output of PV power, it is imperative to integrate other power sources like a diesel generator (DG) set, battery storage, fuel cells, etc. [2,3] Due to reserve of fossil fuel dwindling and the global warming effect looming large, alternative energies become popular. The most attention of alternative energies is solar energy. There are two types of technology that employed solar energy, namely solar thermal and solar cell. A PV cell (solar cell) converts the sunlight into the electrical energy by the photovoltaic effect. Energy from PV modules offers several advantages, such as, requirement of little maintenance and no environmental pollution. Recently,PV arrays are used in many applications, such as, battery chargers, solar powered water pumping systems,grid connected PV systems, solar hybrid vehicles and satellite power systems. Since PV module has nonlinear characteristics, it is necessary to model it for the design and simulation of maximum power point tracking (MPPT) for PV system applications [1].The performance analysis of standalone systems with PV- and DG-based sources is given in. The design and operation of standalone DG-SPV-battery energy storage (BES) using a peak detection based control approach [4]

An enhanced phase-locked loop (EPLL)-based control approach is shown, wherein three EPLLs are used for extraction of fundamental active and reactive power components of load currents. However, only simulation studies are presented. A composite observer-based control approach for standalone PV-DG-based system is used. However, the authors have provided experimental results, but the control approach is complex and requires tuning of internal parameters[5]. Moreover, a detailed experimental study is used to demonstrate all the features of the system. The proposed system consists of a diesel-engine-driven permanent magnet synchronous generator (PMSG), PV array, and BES. This microgrid is a representative of a typical rural hospital power supply system which needs to ensure uninterrupted constant power supply for 24 × 7 h. Therefore, the PMSG driven by a diesel engine ensures regulated power supply. In order to maintain the efficiency and to reduce the maintenance cost, the DG set is made to operate at 80–100% of its full capacity. This is because, under light-load conditions, the efficiency reduces and the maintenance cost also increases s the DG set is subjected to carbon build up.[6]

According to the fuzzy model representation[7], [8], nonlinear systems can be described byIF–THEN fuzzy rules and is extensively applied to nonlinear systems. The advantages of FLC over conventional controllers are that they do not need an accurate mathematical model, they can work with imprecise inputs, can handle non-linearity, and more robust than conventional nonlinear controllers. The Mamdani type of fuzzy controller used for the control of dc link voltage gives better results as compared to the PI controller [9],[10] Fuzzy controllers uses input fuzzy sets, any type of fuzzy logic, and the general defuzzifier, but the PI controller is difficult to adjust.

The major aim of this paper is to design and analyze control system for PV system in a two stage approach using FLC. In this paper , design of PV array is first discussed along with DC-DC boost converter, control algorithm for MPP i.e. perturb and observe algorithm, fuzzy logic controller to control dc bus.The validity and effectiveness of hybrid system is presented using simulation MA TLAB environment,results developed and detailed analysis has been carried out.

II. ANALYSIS OF THE PROPOSED HYBRID DISTRIBUTED GENERATION (DG) SYSTEM

Usually, to avoid these problems, the DG is operated by keeping a minimum loading of 80% by means of battery charging or the DG is made to turn ON/OFF depending upon the loading. However, the turn ON/OFF of the DG set is usually not recommended as.

A. The load may vary frequently. Therefore, the repeated turn ON/OFF of DG increases the mechanical maintenance.
B. The battery life reduces as the discharging current is high during transient periods. Besides, the PMSG driven by the diesel engine does not re-quire a separate excitation control. The machine is robust, efficient, brushless construction, and with less maintenance. A battery energy storage system (BESS) is incorporated to provide load leveling in the case of variations in PV array output power. The BESS is considered as ideal energy storage for a standalone system as compared to compressed air, super capacitors, fly-wheels, pumped hydro, and superconducting magnetic storage. The implementation of a standalone system devised of PV array, DG set, and BESS intends to fulfill the following requirements
C. To control the point of common coupling (PCC) voltage depending upon the solar irradiance variations, and load fluctuations and unbalances.
D. There is no requirement for the measurement of load for turn ON/OFF of DG.
E. The power quality of the system is improved by reducing the total harmonic distortion (THD) of PCC voltages and DG set currents under IEEE-519 standard.
F. To effectively regulate power flow between source and load.
G. The voltage-source converter (VSC) of BESS provides reactive power compensation and maintains the balanced DG currents. This reduces the vibration of shaft and over-heating of machines.

Nowadays, the rapid increase in the use of nonlinear loads such as computers, electronics appliances, medical equipment, refrigerators, etc., has emphasized the concern for power quality in the electrical distribution system. These loads inject harmonics and distort the current and voltage waveforms causing poor power quality problems. The possible provision for the mitigation of the power quality problems is with inclusion of custom power devices.Three-phase four-wire loads are also known to suffer from the problem of neutral current due to nonlinearity and unbalance present in the system. This may produce large amount of neutral current which consists of triplen harmonics. The neutral current may cause overloading of the distribution system and causes additional heat losses, which may be dangerous and poses a serious threat to the connected equipment. A four-leg VSC is used for neutral current compensation in addition to mitigate the current harmonics with other reported advantages. Additionally, the flexible operation of the system depends upon implementation of the various control strategies. Some of the control algorithms that have been applied for controlling are multi loop strategy, sliding-mode control, P controller-based technique, FLC-based control method, and enhanced phase locked technique. The authors have failed to discuss the power quality and reactive power compensation.

III. SYSTEM DESIGN AND CONFIGURATION

Integrated control of solar Photo Voltaic (PV) generators with the maximum power point tracking (MPPT) control and battery storage control is to be implemented to provide voltage and frequency (V-f) support to micro grid.A load change in a microgrid may lead to imbalance and it also changes the output voltage and frequency of inverters.In order to stabilize the microgrid, a inverter control is to be developed to deal with loads on the system.The ac voltage is controlled in terms of amplitude and frequency.The loads are fluctuating and they are unbalanced in nature.Output power of PV always fluctuates because of weather condition and therefore combined operation of solar PV and Diesel Generator (DG) provides more reliable and feasible solution to supply power.PV-DG system momentarily results in frequency excursion and PCC voltage at point of common coupling (PCC) due to load changes.To avoid this battery can be integrated with PV-DG system. The effectiveness of the maximum power point tracking (MPPT) schees reduces the inability to discriminate between the MPPT peak and other peaks due to shading.

he intermittency issue arises while coupling microgrid to the utility grid such as voltage,frequency,active and reactive power control will be the challenging issues by enabling their energy exchange to utility grid. Fluctuations in output power due to weather conditions and partial shading are the common problems in PV system .Voltage and frequency of microgrids are strongly impressionable from the active and reactive load fluctuations.Operation of Photovoltaic system from its maximum power point (MPP) is to be incorporated to maintain real power balance of system by using equations (1),(2).

$$f - f_o = -K(P - P_o) \quad (1)$$

$$V - V_o = -K(Q - Q_o) \quad (2)$$

A. Photovoltaic array

Consider a PV panel array composed of solar cells arranged in an *np* -parallel, *ns* -series configuration. Let *v*pv and *i*pv, respectively,denote the output voltage and current of the PVarray. The voltage/current characteristic equation of the PV array can be described by a light-generated current source and a diode. If the internal shunt and series resistances are neglected, the output current of the PV array is given by**(4).** During the modeling of SPVA, two important points on V-I characteristics. The first one is open circuit voltage (Voc) and the second is the short circuit current (lsc). On both of these points the power

generated by the PV array is zero. In this paper, single diode mathematical model for solar cell, given by equations.

This single cell model can be utilized for any configuration of array by multiplying required number of series and parallel cells.A suitable combination of parallel and series connected solar cells makes solar module and series and parallel connection of solar modules makes solar array. Further, the solar panels are connected in series to form solar string. When these solar strings are connected in parallel it makes solar multi string.

$$V_{pv} = \left(\frac{KT}{q}\right) \ln\left(\frac{I_{ph}}{I_{pv}} + 1\right) \quad (3)$$

$$I_{pv} = I_d + I_{sc} + I \quad (4)$$

$$I = I_{ph} - I_S * e^{\left(\left(\frac{V+I*R_s}{N*V_t}\right)-1\right)} - I_{s2}\left(e^{\left(\left(\frac{V+I*R_s}{N_2*V_t}\right)-1\right)} - \frac{(V+I*R_s)}{R_p} \quad (5)$$

$$I_{ph} = I_{pho} * \frac{I_r}{I_{r0}} \quad (6)$$

In above equations, Iph represents photo diode current generated by solar cell; Is is the saturation current of diode D; Isc is the short circuit current; RP is the shunt or parallel resistance inversely related to leakage current to the ground; Rs is the series resistance which signifies internal resistance to current flow and depends upon junction depth impurity and contact resistances. Internal losses are represented by Rs and Rsh, for an ideal cell Rs should be zero whereas Rsh should be infinite, k is Boltzmann's constant, q is the electron charge, T is the working temperature of the cell;V is output terminal voltage of solar cell.Here N1 N2 are number of series and parallel cell respectively.

B.Unification Of Pv Panenel With Dc Converter

To adjust the PV array power, a dc/dc converter is connected to the PV array,.The PV array is connected to the boost converter to meet the requirements. A MPPT controller is designed using P&O algorithm the function of this controller is to maintain the PV panel voltage at the point where maximum power is available. the maximum power point is maximized by the PV voltage and is dependent on various insolation and temperature.

The structure of DC-DC boost converter is consist energy storage element like inductor, capacitor and fast switching devices such as transistor and diodes. Appropriate values of the energy storage element can be find out by using equation(7, 8) based on desired output voltage required by the system.

$$\text{Boost inductor } L = \frac{(DV_{pv})}{(2f_{sh}\Delta V)} \qquad (7)$$

$$\text{Boost capacitor } C = \frac{(DI_d)}{(f_{sh}\,\Delta V)} \qquad (8)$$

Where Vpv, D, Llil, Id, LlV, fsh are Output voltage of PV panel, boost converter's Duty cycle, ripple Input current,current at Output ripple Output voltage and Switching frequency respectively,DC-DC boost converter has been used to steps-up input voltage. D is the duty ratio of the pulsewidth-modulated (PWM) signal to control the switching MOSFET and this ratio can be calculated by

$$\text{Duty ratio } D = 1 - \frac{V_{in}}{V_o} \qquad (9)$$

Where Yin and V 0 are input and output voltage respectively. From equation (9) it can be inferred that with the adjustmentin duty ratio of boost converter, it can be electronicallyadjustable. With the control in switching moments of thetransistor power provided at the end of the converter can becontrolled. So by the control in power flow through the dutycycle adjustment out power will be constant even in case ofload variation.

The function of DC side capacitor is to maintain DC link voltage and keep output voltage free from ripples and to provide active power during transients and behave as energy storage element. The value of DC link capacitor is based on three factors which are boost converter design, ripple current and instantaneous energy. DC link voltage should be greater than the twice of phase voltage of the system and dc capacitor voltage is given by euation (10)

$$\text{DC link capacitor voltage } V_{dc} = \frac{(2\sqrt{2}V_{Ll})}{\sqrt{3}m} \qquad (10)$$

c. design of ac inductor

AC inductance (Labe) of VSC is decided by the variousparameters like the ripple current L1i, switching frequency fs, modulation index (m), dc link voltage (V de) and overloadfactor(h) and the value of L can be select by (11)

$$\text{Ac inductor design } L_{abc} = \frac{(\sqrt{3mV_{dc}})}{\sqrt{3m}} \qquad (11)$$

IV. STAND-ALONE HYBRID SYSTEM

The standalone system consists of a PV array along with a boost converter, maximum power point tracking (MPPT) controller, diesel-engine-driven PMSG, a four-leg VSC with BESS, and three-phase four-wire ac loads as shown in Fig. 1. The voltage at the PCC is restored by coordinating the reactive power through VSC control. Under varying conditions of generation and loads, BESS offers charging during the daytime when the insulation is large and the load is less. The battery discharges to compensate for any deficits. The DG set operates while maintaining the system frequency.

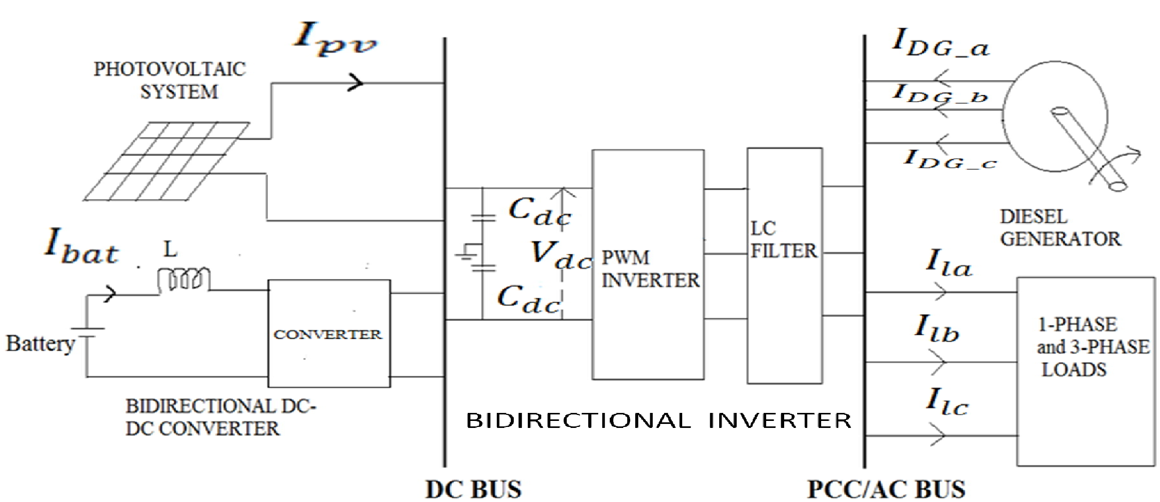

Fig.1.stand alone hybrid system

A. Pi controller for regulation of dc link voltage

PI control is becoming more popular because of its ability to maintain the exact set point.Establishing the design and implementation of the conventional PI controllers at various operating points of the inverter. Simulation is done by using MATLAB and the controller is subjected to various disturbances of the input voltage and load changes.

1) *PI control mode :*As the name suggests it is a combination of proportional and an integral controller the output (also called the actuating signal) is equal to the summation of proportional and integral of the error signal. Now let us analyze proportional and integral controller mathematically. As we know in a proportional and integral controller output is directly proportional to the summation of proportional of error and integration of the error signal.

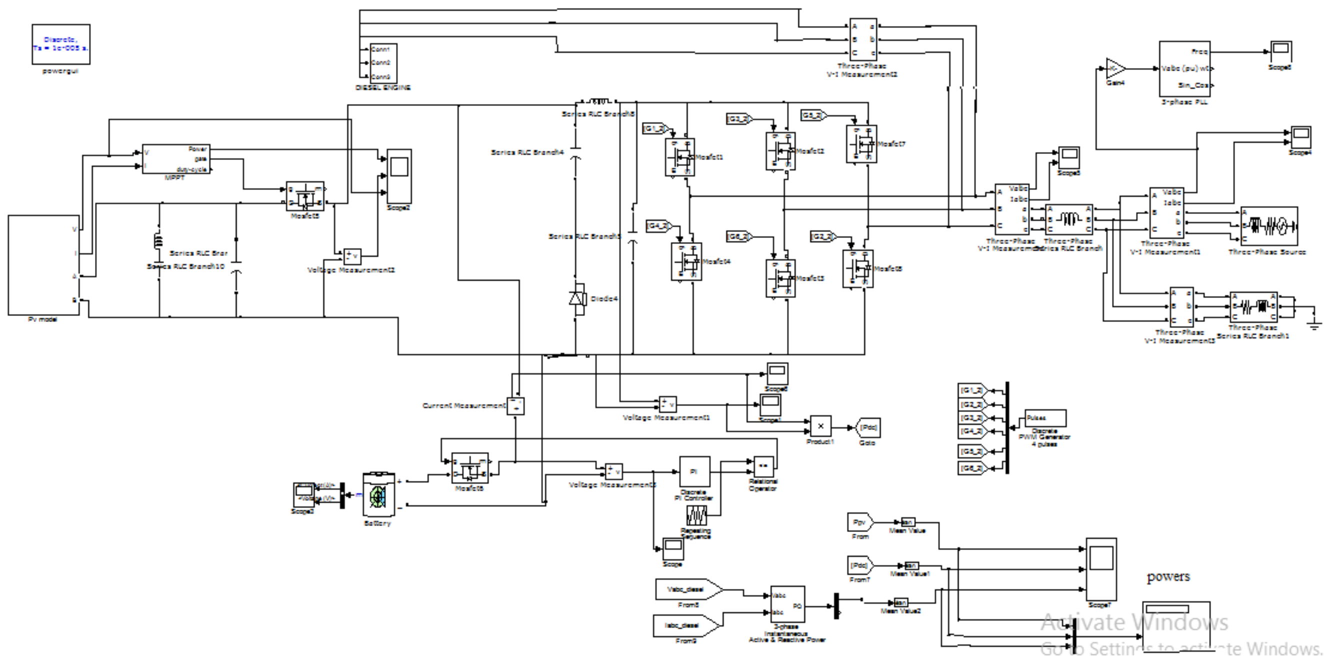

Fig.2 .Simulink model of hybrid system with pi controller

B. Fuzzy Logic Controller For Regulation Of Dc Link Voltage

In present work, PI controller and FLC is implemented in voltage regulator block to minimize the error produced and to maintain dc link voltage constant with changes in load. As shown in "Fig. 6 ", FLC is implemented and its output voltage response has been compared with output response of model implemented by using traditional PI controller. FLC, a nonlinear controller has gained wide popularity because of its logical response to nonlinear behaviour of the input parameters. Mamdani and Tagachi-Sukeno (T-S) are two design methods available in FLC, of which Mamdani method is used in present model. The steps involved in FLC are fuzzification, rule base with fuzzy inference system and defuzzification process. Fuzzification process converts crisp input values into fuzzy membership values, then process it by fuzzy inference system as per rule base. De fuzzification process again converts back the fuzzy membership values into crisp output values. The input to FLC is error 'e' and change in error 'Δe' given.

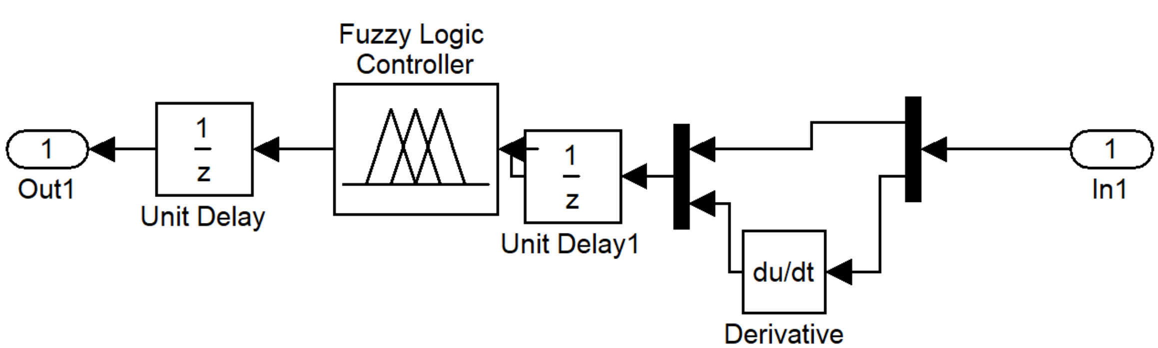

fig. 3 Architecture of flc

The output of FLC is which is fed as reference d-axis current to current regulator block in order to control the active power to be produced by inverter A total of 25 fuzzy rules has been used, given in "Table 1" with linguistic variables like positive large (pl), positive compact (pc), zero (zo), negative compact (nc) and negative large (nl). The membership functions used at input and output of FLC in standalone mode.

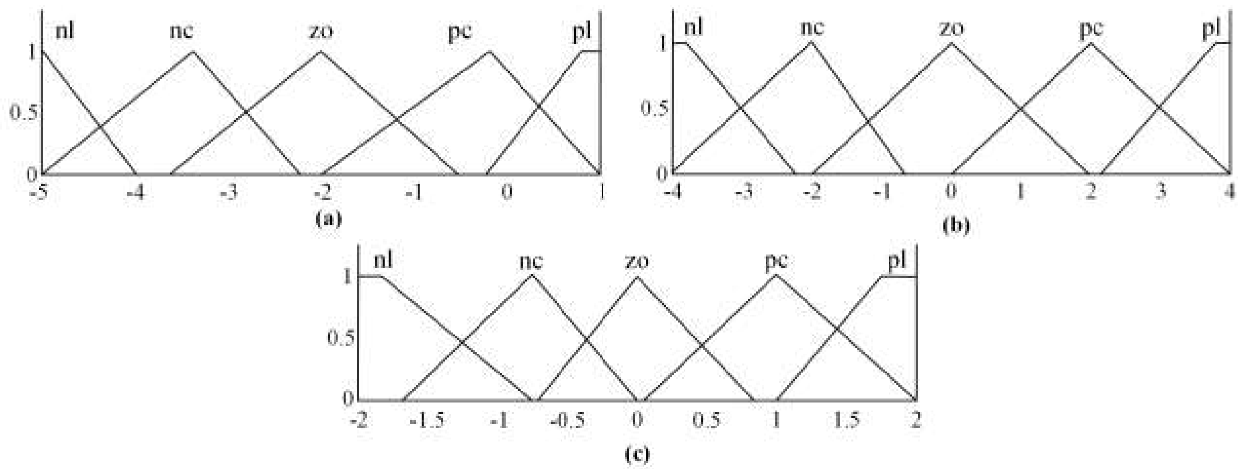

Fig. 4.Membership functions of FLC in standalone mode of operation at (a). Input 'e', (b). Input 'Δe', and (c). Output

		Δe				
		nl	nc	zo	pc	pl
e	nl	nl	nl	nc	nc	zo
	nc	nl	nc	nc	zo	pc
	zo	nc	nc	zo	pc	pc
	pc	nc	zo	pc	pc	pl
	pl	zo	pc	pc	pl	pl

Table 1.Fuzzy rule base matrix.

A PV array with power at output side of inverter in standalone mode have been simulated in MATLAB/SIMULINK platform. The parameters of KC200GT solar PV module was used in above work, as mentioned in [19] and its values are given in "Table 2". In order to produce the required amount of power, the number of strings that has to be connected in parallel is given by NPP, whereas each string will consist of NSS number of series connected PV modules. The other parameters used in the implemented model of PV system is given in "Table 3". The four models that has been simulated along with the variation in load are: PV system connected in standalone mode and grid connected mode with PI controller and FLC in Voltage Regulator block. In standalone mode, PV array has been modelled in such a way that it will be able to supply power when required by load. The behaviour of implemented model was observed at the output side of inverter while switching load from lower value to higher value and vice versa.

Table 2. KC200GT PV module parameters.

V_{oc}	$32.9\ V$
I_{sc}	$8.21\ A$
a	1.3
K_I	$0.0032\ A/K$
R_s	0.221Ω
R_p	$415.405\ \Omega$
N_s	54
k	$1.3806503\ X\ 10^{-23} J/K$
q	$1.60217646\ X\ 10^{-19} C$

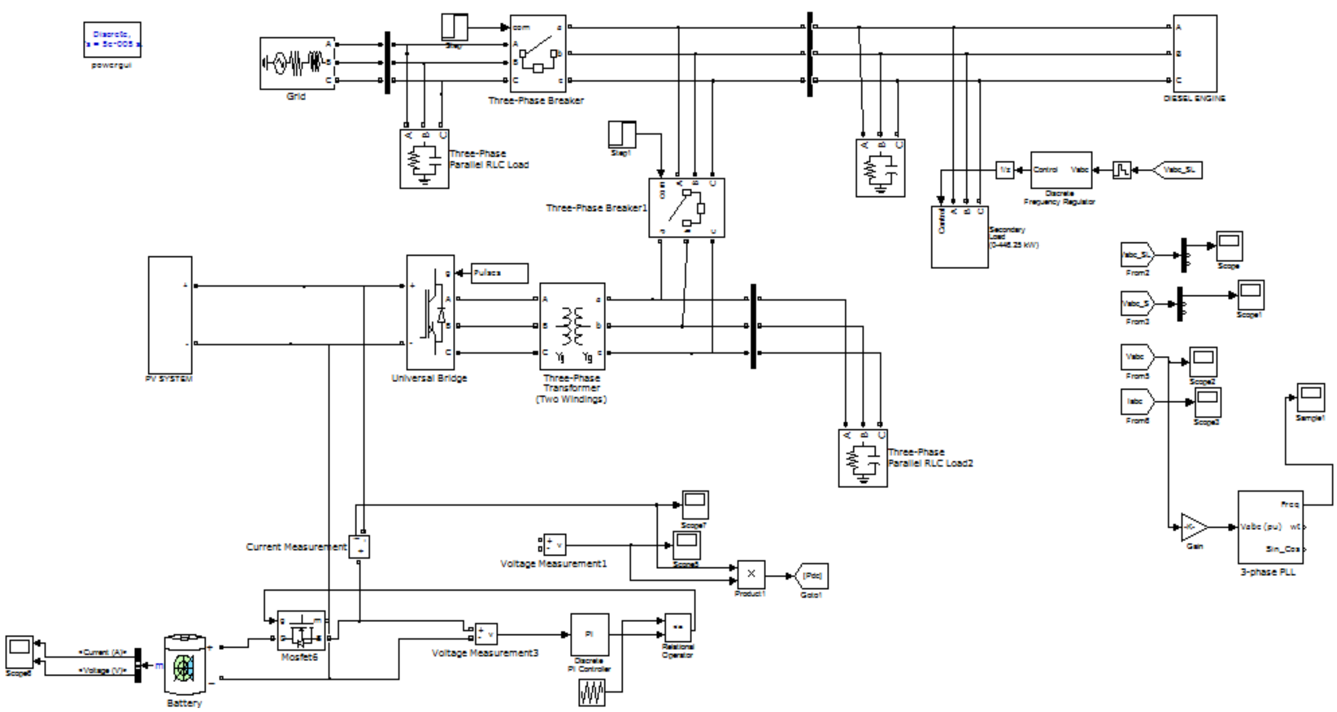

Fig. 5Simulation Circuit of Proposed System

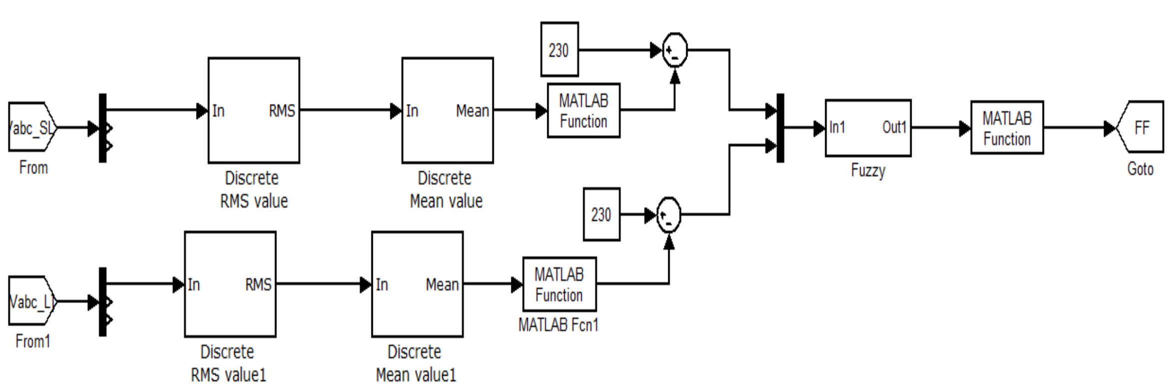

Fig. 6 FUZZY control loop Simulation Circuit

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Table 3.Other parameters used in PV System

Inductance of Boost Converter L_b	0.5 H
DC Link Capacitance	0.012 F
Nominal DC bus voltage	500 V
Inductance of Filter L	125 μH
Resistance of Filter R	3 mΩ
Transformer rating	25000/260 V, 200 KVA

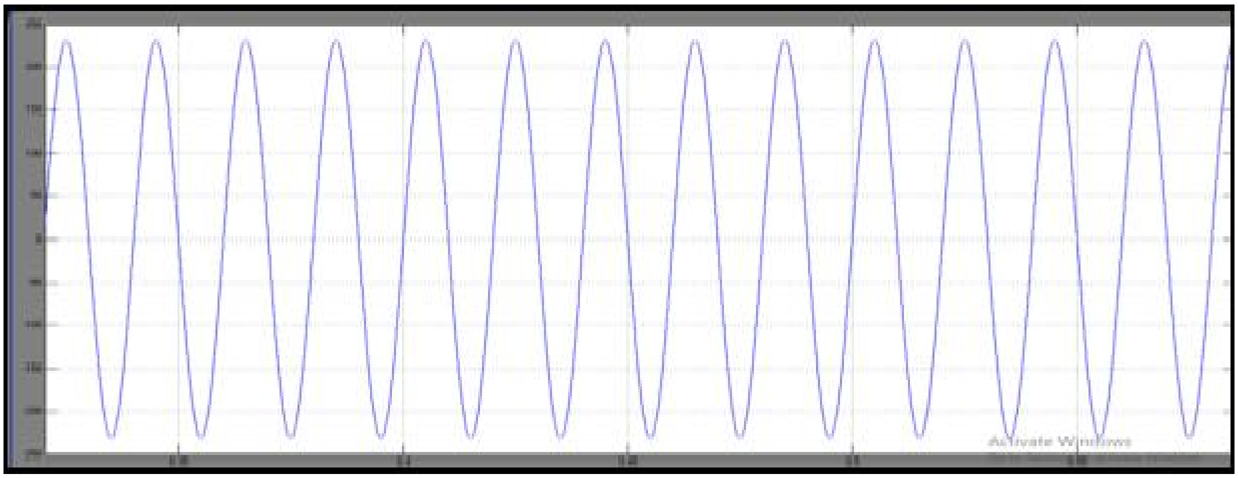


Fig. 8 single phase bus voltage of the Proposed FUZZY System

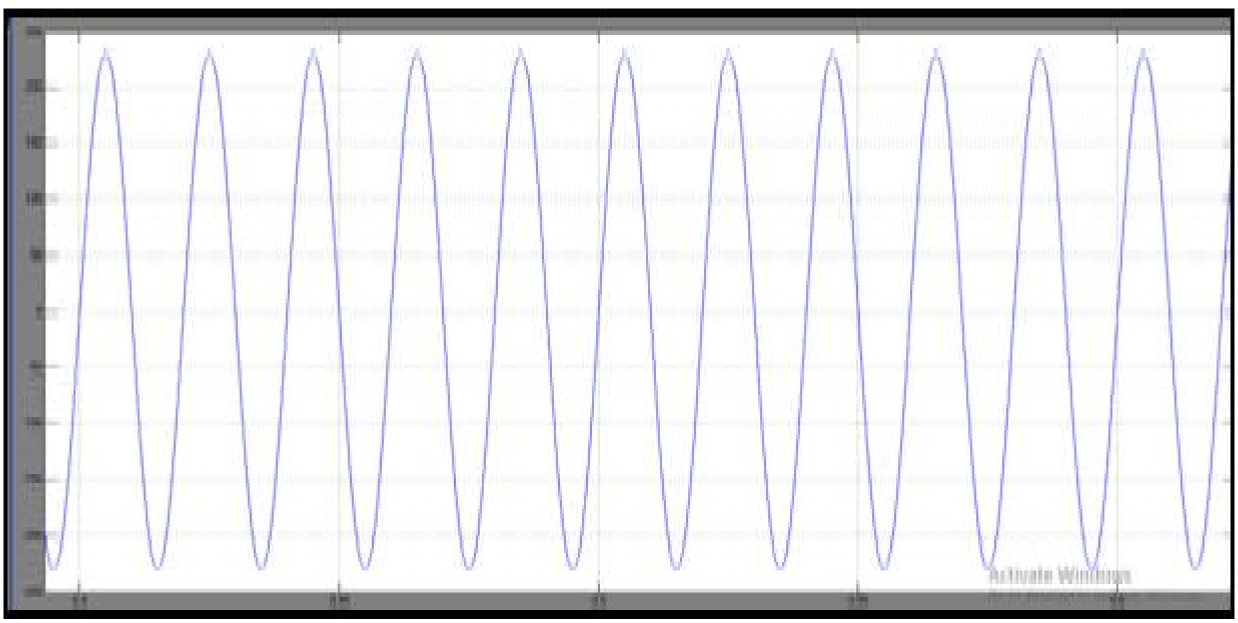


Fig. 9 single phase load voltage at the pv-battery system

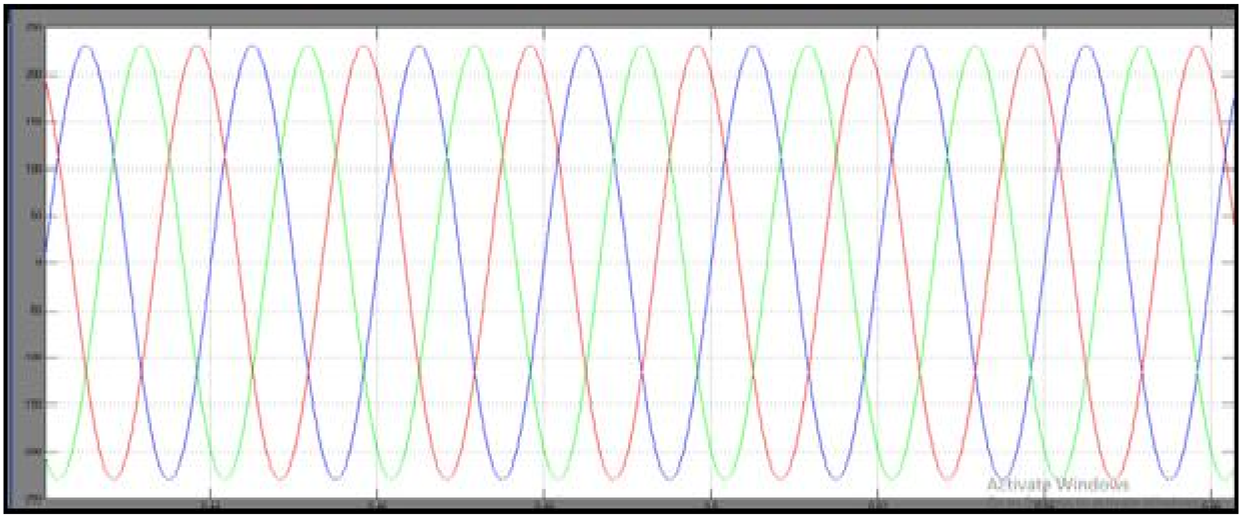


Fig. 10 Three phase standalone grid voltage

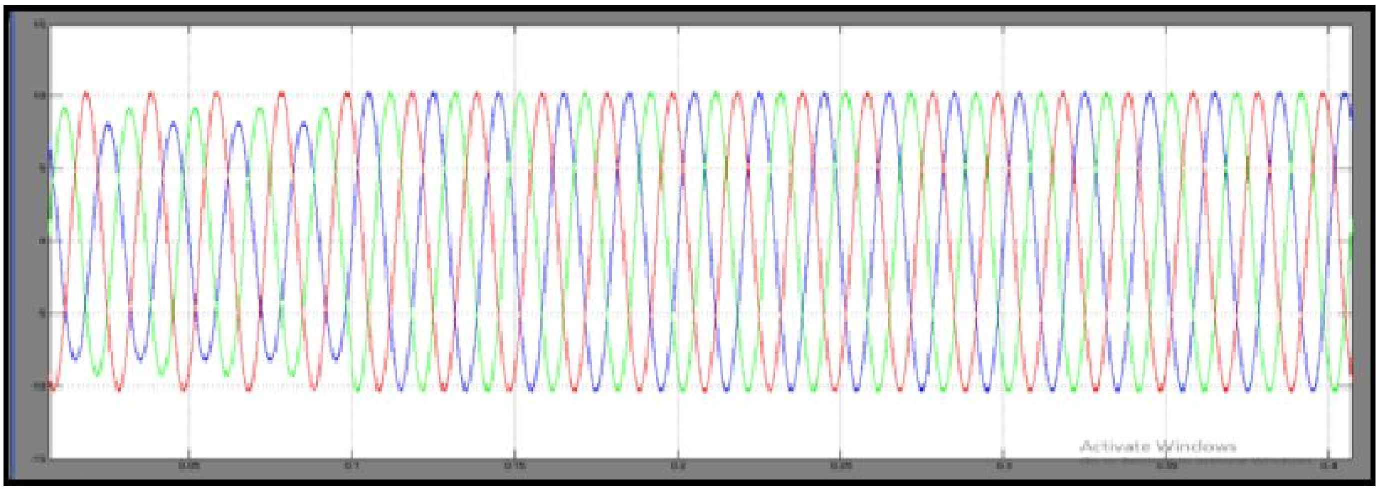


Fig. 11Three phase standalone grid current

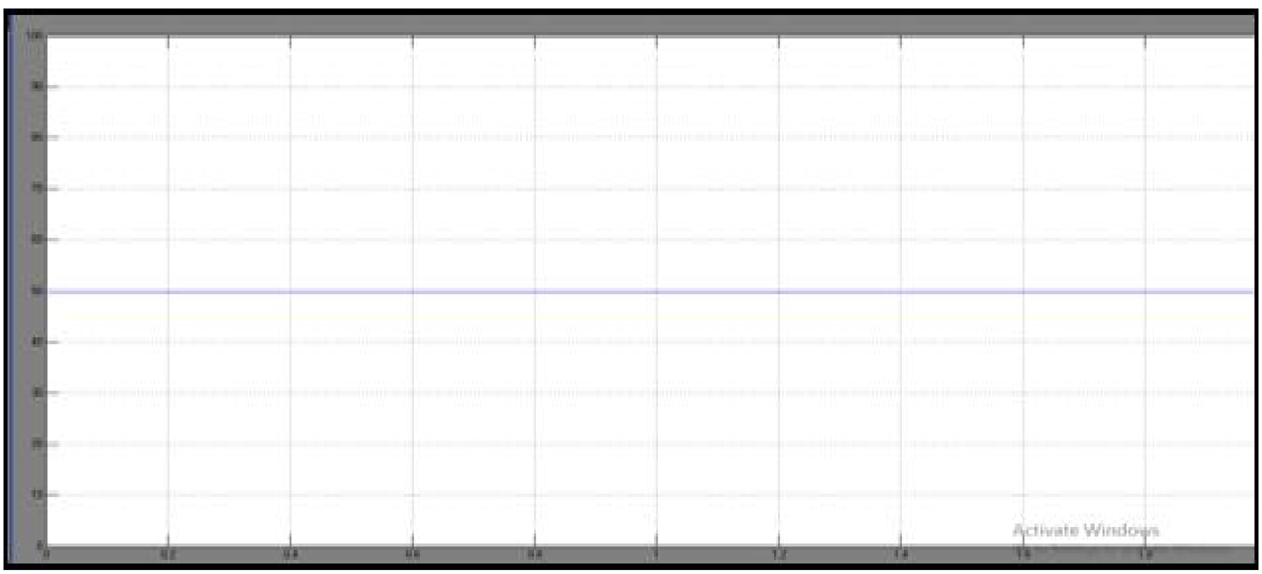


Fig. 12Three phase standalone grid frequency

Type of model	Transient time in secs at different positions		
	At the instant of starting	When the additional load is switched on	When the additional load is switched off
I. Standalone mode of operation of PV system			
a. With PI controller in voltage regulator block	0.71	0.65	0.4
b. With FLC in voltage regulator block	0.25	0.3	0.1

Table 4 Comparision with two controllers

V. CONCLUSION

In this proposed system an intelligent FUZZY control algorithm of MPPT for the PV system is used to track the Maximum Power Point. This proposed method is implemented to reduce the drawbacks of the PI controller. An optimized control based on a hierarchical controller has been implemented for standalone hybrid power systems. The proposed method includes an control algorithm to achieve the MPP for different types of PV panels. This indicates the FUZZY-based model developed in this work can predict the MPP for a PV panel with high accuracy. Simulation results were obtained by developing a detailed dynamic hybrid system model. FLC voltage regulator limits the transient time with minimum time and it was found that the hybrid topology exhibits excellent performance under various operating conditions, and maintain the SOC between 40% - 80%.

REFERENCES

[1] C.-S. T. Huan-Liang Tsai, and Yi-Jie Su, "Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK," the World Congress on Engineering and Computer Science 2008, San Francisco, USA,

[2] P. Arun, R. Banerjee, S. Bandyopadhyay, Optimum sizing of battery-integrateddiesel generator for remote electrification through design-space approach",Energy 33 (7) (July 2008) 1155–1168

[3] R.W. Wies, R.A. Johnson, A.N. Agrawal, T.J. Chubb, Simulink model for eco-nomic analysis and environmental impacts of a PV with diesel-battery systemfor remote villages, IEEE Transactions on Power Systems 20 (2) (May 2005)692–700.

[4] A. Elmitwally, M. Rashed, Flexible operation strategy for an isolated PV-dieselmicrogrid without energy storage, IEEE Transactions on Energy Conversion 26(March (1)) (2011) 235–244.

[5] C.V. Nayar, Recent developments in decentralised mini-grid diesel power sys-tems in Australia, Applied Energy 52 (2–3) (1995) 229–242.IEEE Std. 1561-2007, IEEE Guide for Optimizing the performance and Life ofLead-Acid Batteries in Remote Hybrid Power Systems.

[6] K. Y. Lian, T. S. Chiang, C. S. Chiu, and P. Liu, "Synthesis of fuzzy model-based designed to synchronization and secure communication forchaotic systems," IEEE Trans. Syst., Man, Cybern. B, Cybern., vol. 31, no. 1, pp. 66–83, Feb. 2001

[7] S. Boyd, L. E. Ghaoui, E. Feron, and V. Balakrishnan, Linear Matrix Inequalities in System and Control Theory. Philadelphia, PA: SIAM,1994.

[8] Georgios Tsengenes, Georgios Adamidis "Comparative Evolution of Fuzzy-PI and PI Controlled Method for a Three Phase Grid Connected Inverter" Power Electronics and Applications EPE AUG-Sept 2011, pp 1-10.

[9] Suresh. Mikkili, A. K. Panda, "Real-time implementation of PI and fuzzy logic controllers based shunt active filter control strategies for power quality improvement", International Journal of Electrical Power and Energy Systems, Vol. 43, Issuel, pp. 1114-1126, Dec. 2012.

[10] Jui-Liang Yang,Ding-Tsair Su and Ying-Shing, "Research on MPPT and Single-Stage Grid-Connected for Photovoltaic System" WSEAS Transactions On Systems,Vol. 7, pp.1117- 1131, October 2008.

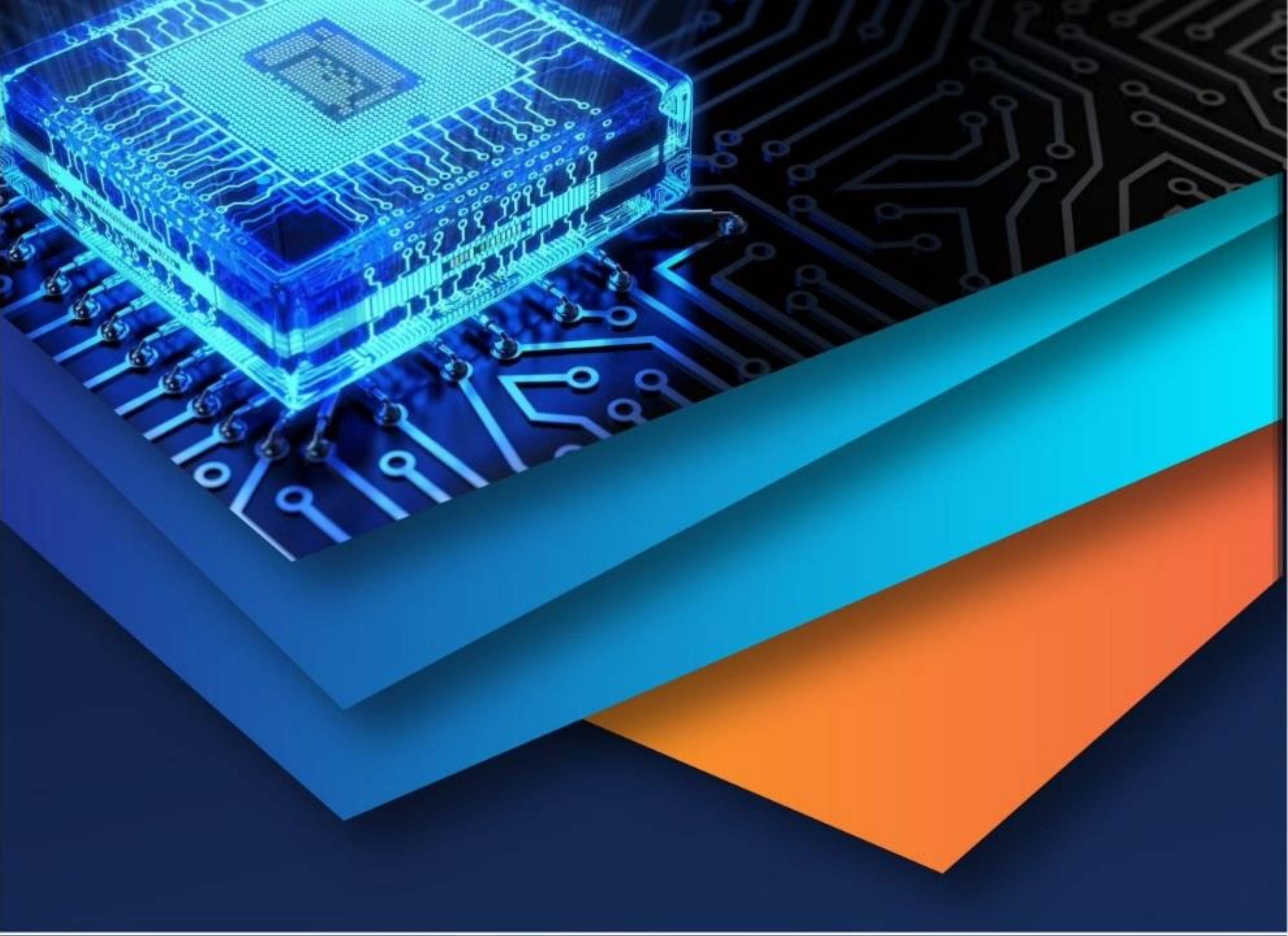
[11] Trishan Esram and Patrick L. Chapman, "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques", IEEE Transactions on Energy Conversion, Volume 22, No. 2, pp.3766-3771,June 2007.

[12] B. Szabados and W. Fangnan, "A maximum power point tracker control of a photovoltaic system," in Proc. IEEE Instrum. Meas. Technol. Conf.2008, pp. 1074–1079.

[13] H. Ying-Tung and C. China-Hong, "Maximum power tracking for photovoltaic power system," in Proc. 37th IAS Fuzzyu. Meeting. Ind. Appl. Conf.Rec., 2002, vol. 2, pp. 1035–1040. [5] Shuai Jiang, Dong Cao and Yuan Li, "Grid-Connected Boost-HalfBridge Photovoltaic Microinverter System Using Repetitive Current Control and Maximum Power Point Tracking", IEEE Transactions On Power Electronics, Vol. 27, No. 11,pp.4711-4723, December 2012.

[14] Chih-Lung Shen, Cheng-Tao Tsai, Jye-Chau Su ,and Yi Chan, "GridConnection Single-Stage Photovoltaic Inverter System with DoubleLinear-Approximation MPPT",IEEE Transaction Power Electronics, Vol. 7,No. 3 ,pp.2324-2330,June 2011.

[15] Roger Gules, Juliano De Pellegrin Pacheco, Hélio Leães Hey and Johninson Imhoff, "A Maximum Power Point Tracking System with Parallel Connection for PV Stand-Alone Applications", IEEE Transactions on Industrial Electronics, Volume 55, No. 7,pp.1887-1894, July 2008.
[16] Ait Cheikh.M.S and Abdelkader Mami, "Voltage Oriented Control Applied to a Grid Connected Photovoltaic System with Maximum Power Point Tracking Technique", American Journal of Applied Sciences, Volume 10, 2007.
[17] Rosa A. Mastromauro, Marco Liserre, Tamas Kerekes and Antonio Dell' Aquila, "A Single-Phase Voltage Controlled Grid Connected Photovoltaic System with Power Quality Conditioner Functionality", IEEE Transaction,Vol.8,pp.2765-2774,December 2008. [10] Jung. Y.S, Choi.J.Y and Kim.G.S, "A novel two-mode MPPT control algorithm based on comparative study of existing algorithms",Elsevier Journal,pp.455-463,2004.
[18] Samer Alsadi, Basim Alsayid, "Maximum Power Point Tracking Simulation for Photovoltaic Systems Using Perturb and Observe Algorithm", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, December 2012.



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