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MPPT Integrate with Fuzzy Logic Control Compared with Conventional Techniques

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1 ABSTRACT:

Photovoltaic (PV), which functions on the concept of the photoelectric effect, is considered one of the environmentally beneficial Renewable Energy Sources (RES) that has a large deal of capacity and converts solar energy directly into electricity. Continually changing physical properties of PV systems are dependent on their surroundings. Therefore, it is crucial to regularly track the Maximum Power Point (MPP) in order to get the most power possible from PV. This paper discusses one artificial intelligence control tool, the fuzzy logic controller (FLC), as well as traditional hill climbing methods like perturb and observe (P&O) and incremental conductance (IC) for MPP tracking. Fuzzy controller application results in superior performance versus traditional methods. In comparison to other methods, the MPP stability produced by a fuzzy controller is higher. The amount of energy extracted from PV panels is also contrasted with other methods.

KEYWORDS: Photovoltaic, Renewable energy sources, Maximum power point, Perturb and observe, Incremental conductance, Fuzzy logic controller.

1. INTRODUCTION:

Due to the scarcity of fuel and the rising cost of fuel, the traditional methods of producing energy (such as nuclear, fossil fuels, and thermal) have become more expensive. In addition to being expensive, conventional energy sources have negative environmental effects, which contribute to global warming and the greenhouse effect. [1-2]. Solar power is currently considered one of the encouraging sources of energy. In photovoltaic technology, electricity is produced directly from solar radiation, and this source poses less environmental problems [3-4]. Solar energy has advantages over all conventional sources, however the generation through PV modules is not consistent; it varies depending on the weather (such as the amount of sunshine and the surrounding temperature) [5-6]. As a result, it became necessary to monitor the system constantly and to keep it running at MPP regardless of the weather. The maximum power from a PV module is produced at MPP current and voltage. Different MPPT techniques have been developed and put into use [7]. Each has its own drawbacks and perks. [8-9]. In this essay, a comparison of the control strategies of perturb and observe (P&O), incremental conductance (IC), and fuzzy logic control (FLC) is discussed. Controlling the duty cycle of the dc-dc converter is the major goal. Results indicate that the FLC-based MPPT system increases the system's stability and effectiveness. FLC does not require the exact model's data.

1.1 MODELLINGOFPVSYSTEM

Thin semiconductor wafers (such as silicon or selenium) processed to create an electric field are used in the production of solar cells. A photon with energy equal to or greater than the band gap of the cell

material can release an electron for an electric circuit in a solar cell with a P-N junction arrangement. Many solar cells can be coupled in series and parallel to provide more electricity [10-11]. Below is provided a solar array similar circuit.

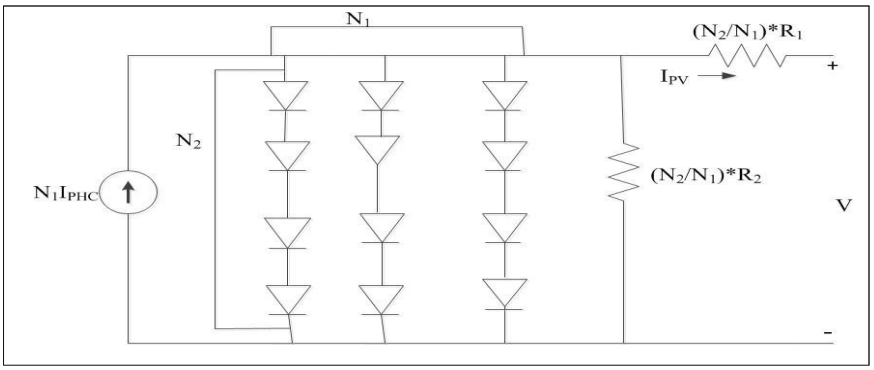


Fig.1.Equivalentcircuitofsolar array

Where IPV= Output current of PV array, N1,N2= Number of cell connected in parallel and series respectively, IPHC= Generated Photo current, IS= Diode reverse saturation current, V= Output voltage of PV array, R1, R2= Series and ParallelresistanceofPVcell,VT=ThermalvoltageofPVcell,K=Boltzmanconstant($1.380*10^{-23}$),q=electroncharge ($1.602*10^{-19}$) , T = Temperature of the P-N junction in Kelivn (K), CI= Current temperature coefficient of ISC, CV= Voltagetemperaturecoefficient ofVOC, S = Insolation, SSTC= Insolation at standard test condition, TSTC=Temperature at standard test condition.

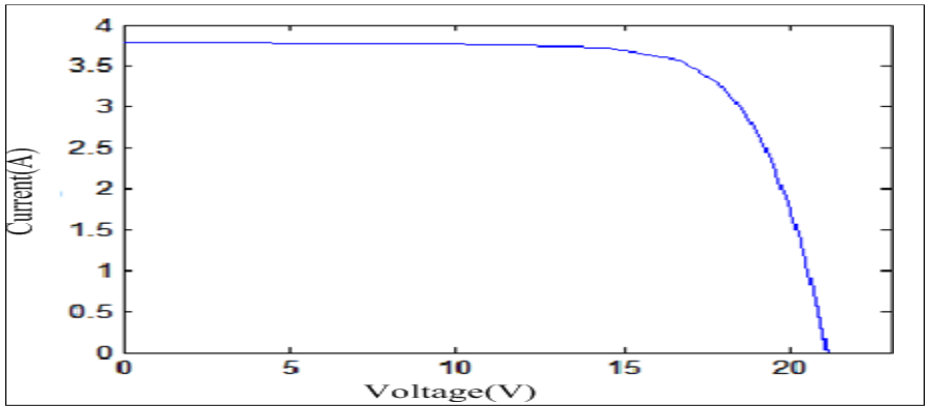
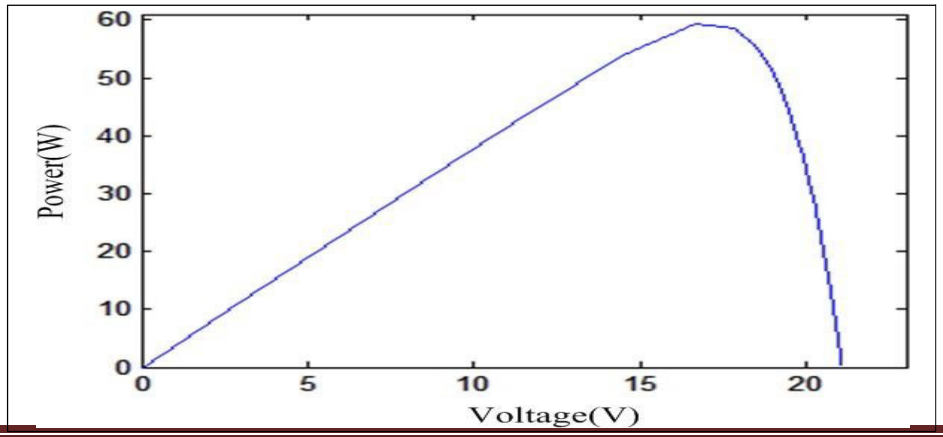


Fig.2.I-VResponseofPV module



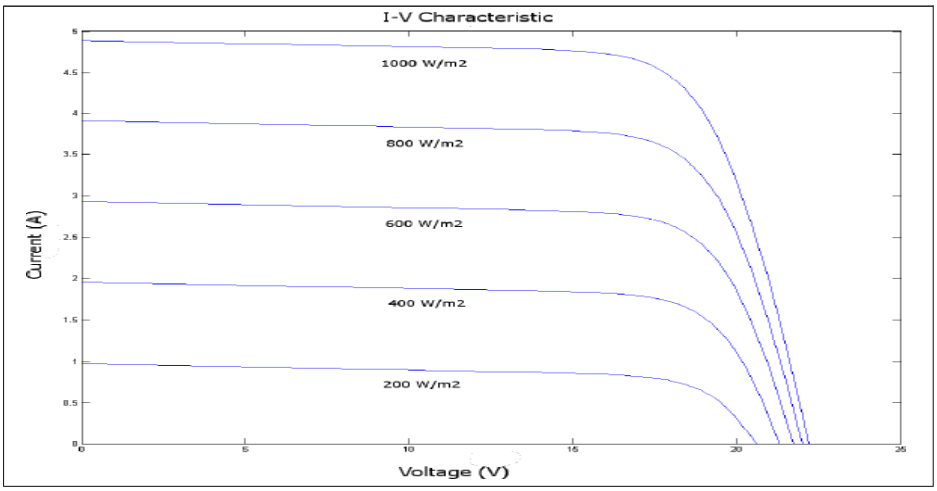


Fig.3.P-VResponseofPV module
Fig.4.I-VResponseofPVmoduleatdifferentInsolation

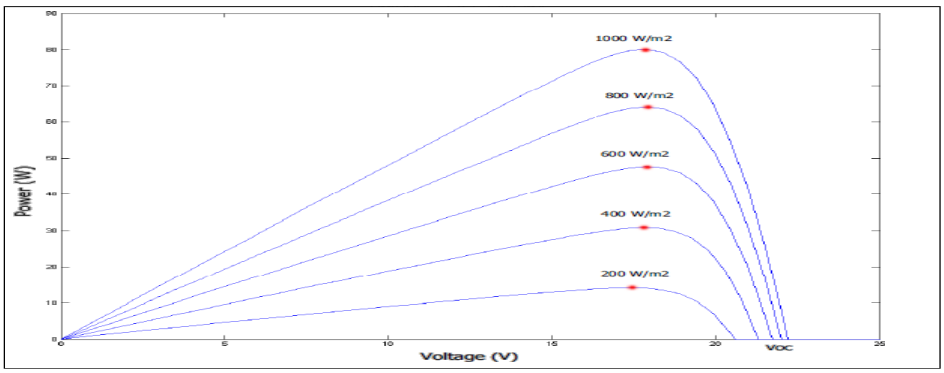


Fig.5.P-VResponseofPVmoduleatdifferentInsolation

The P-V and I-V response of solarcell clearthat to enhance the efficiency of PV system, it is requiredto operate system at MPP for specific current and voltage.

1.2MPPTTECHNIQUES

A specialised circuit known as the MPPT is used to consistently ensure that the operating point is at the maximum power point or very close to it. Voltage and current fluctuate in response to changes in temperature and insolation, hence an MPPT is required to track a single point, or MPP, at which PV modules function at their most efficient levels. This MPP is controlled by a controller to a DC-DC converter, which essentially controls the converter's duty cycle. Below is a solar system using the MPPT technology.

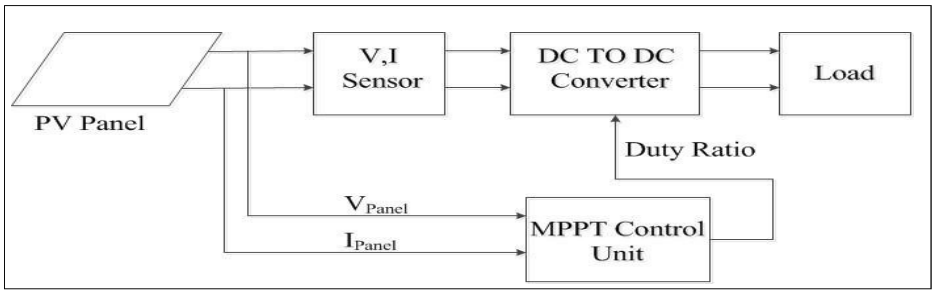


Fig.6.PVModulewithMPPT Unit

There are various MPPT algorithm have been discussed in literature. Here a comparative study of P&O, IC and Fuzzy logic control technique is done, implementation through DC-AC converter is also done.

A.

B. Perturbandobserve (P&O)

It issimplestandmost discussed MPPT techniquetoimplement [12].Aperturbation isapplied in thepanel voltageand then power is tested. If the perturbation is in same direction of power than consider it otherwise change the direction. These steps arerepeated until MPP is obtained. The flow chart of P&O is given below-

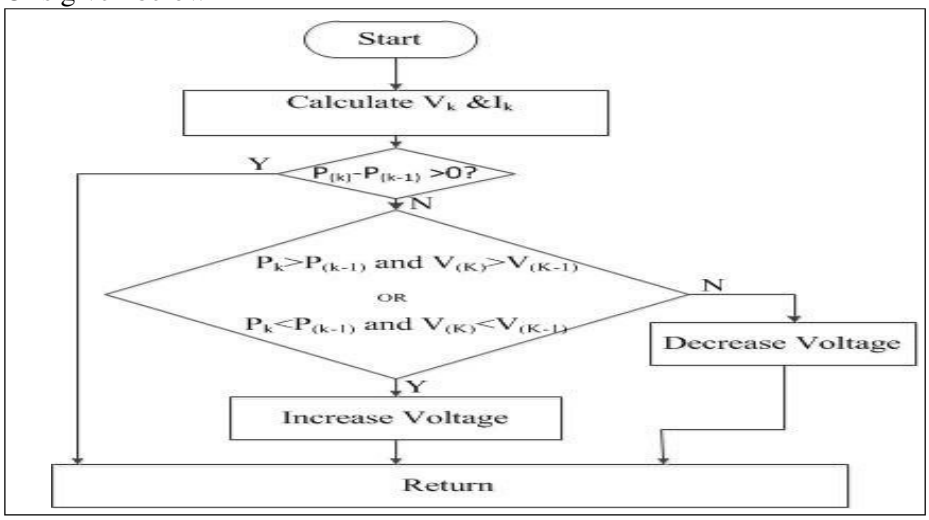


Fig.6.FlowchartofP&O

C. ncrementalConductance(IC)

The basic idea of this MPPT technique is depend on the slope of the derivative of power versus voltage which is zero, positive and negative at MPP, left of MPP and right of MPP respectively. In this technique the incremental conductance is compare with instant conductance [13]. On the basis of the result there is a decrement and incrementinreferencevoltageuntilMPPisobtainwhileP&Oisnaturallyoscillatearoundthe MPP.Theflow chart is given as-

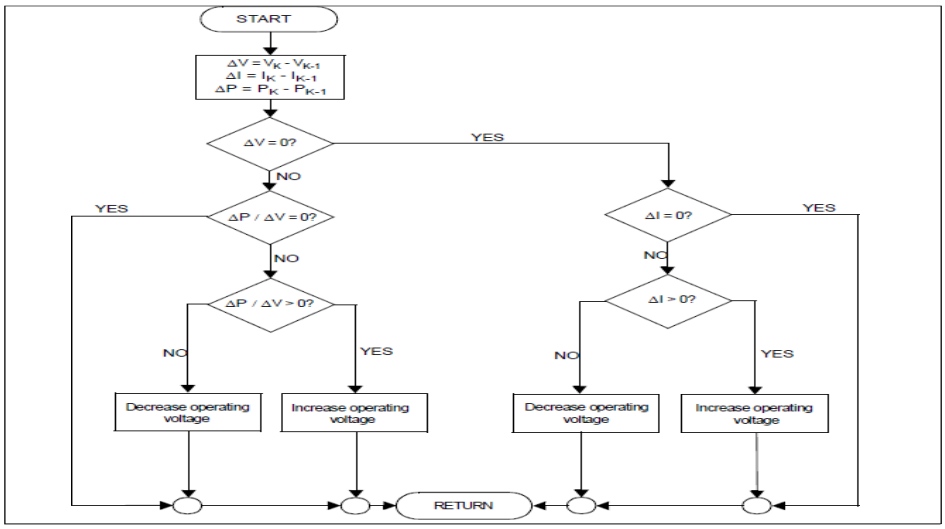


Fig.7.FlowchartofIC

D. Fuzzylogiccontrol(FLC)

Itisanewtechniquetoobtainthepeakpowerbycontrolling MPPinthesystem[14].Itconsistsofthreeparts:

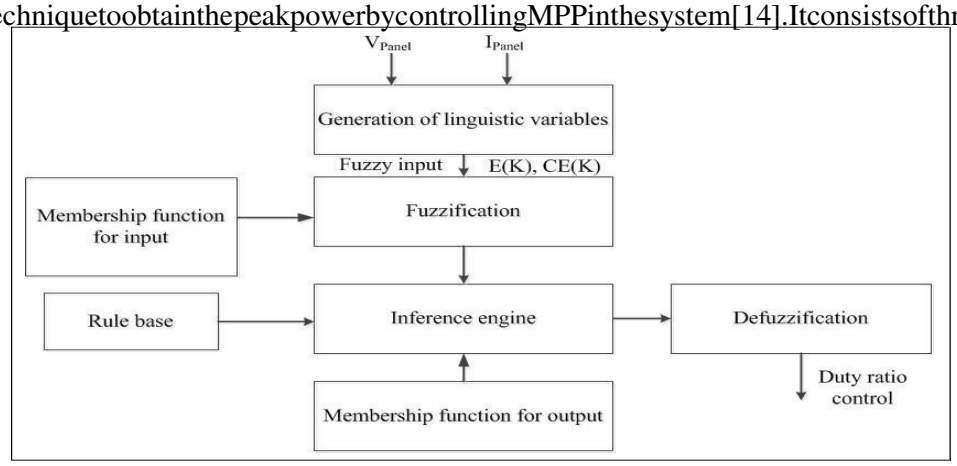


Fig.8.ComputationalflowdiagramofFLC

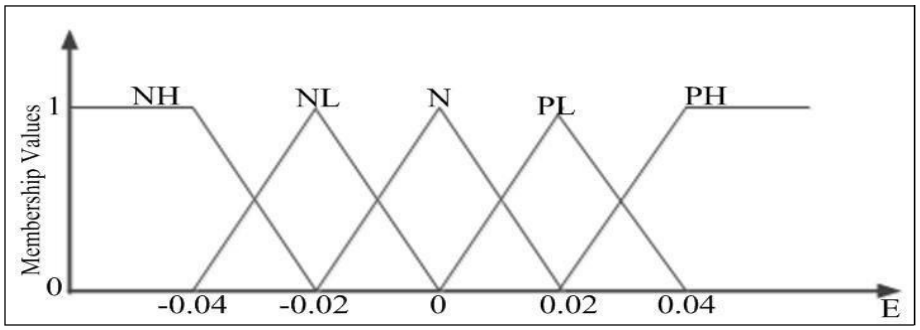
a) Fuzzification

Therealparameter areconvertedintothefuzzyvariable [15]. In thisproposed work twoinputvariablearetaken i.e. error (E) and change in error (CE). The expression for E and CE at instant K is given below.

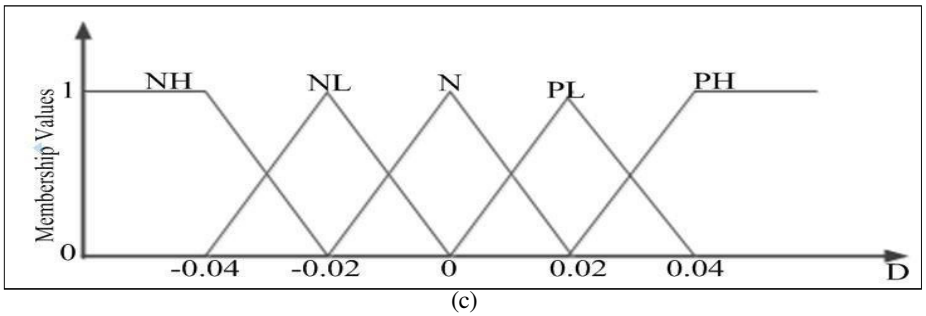
$$E(K)=\frac{P_{PV}(K)-P_{PV}(K-1)}{I_{PV}-I_{PV}(K-1)} \quad (4)$$

$$CE(K)=E(K)-E(K-1) \quad (5)$$

TheinputE(K) demonstrates that at instant 'K'the workingpointislies on left andright oftheMPP and CE(K) shows the track of movement of this point.

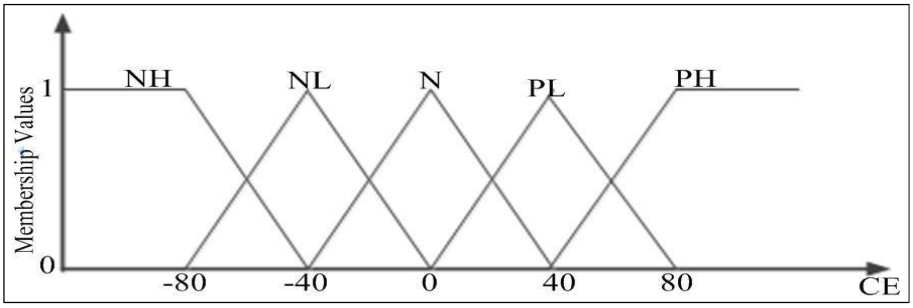


(a)



(c)

Fig.9.Membershipfunctionfor(a)inputE,(b)inputCE,(c)outputD



b) InferenceEngine

Thefuzzyinput obtain byfuzzification wereassociated with rules in this part. Itisnecessaryto fuzzified thecrispinput toachievetherespectivelinguisticvaluebeforerulesareevaluated.Therulesaregiveninmatrixform.Theconsideration for linguistic variables are: NH (Negative Huge), NL (Negative Lesser), N (Nil), PL (PositiveLesser), PH (Positive Huge).

Table1.RuleBase

CE / E	NH	NL	N	PL	PH
NH	N	N	NH	NH	NH
NL	N	N	NL	NL	NL
N	NL	N	N	N	PL
PL	PL	PL	PL	N	N
PH	PH	PH	PH	N	N

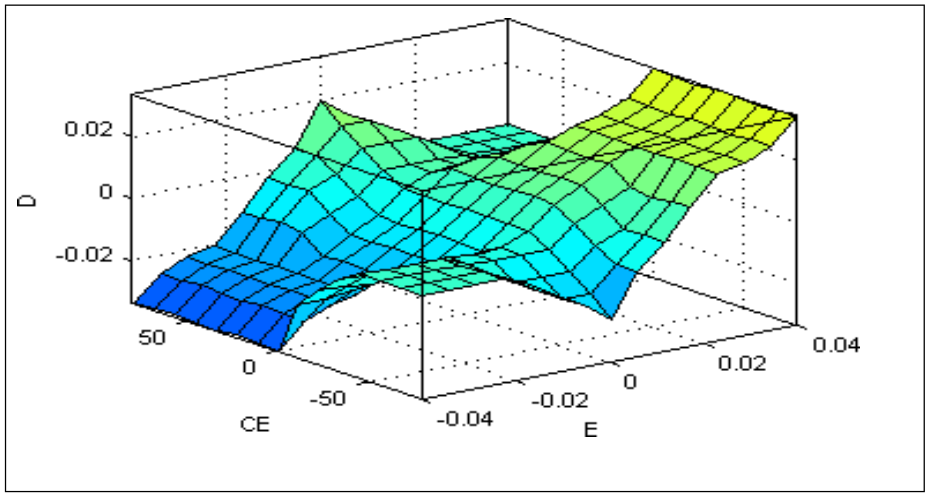


Fig.10.3-Ddiagramofrulebase

c) Defuzzification

It is required to convert the fuzzyinformation obtain from inference engine into realistic term this process is known as defuzzification. It can be done by two method Centre of area (COA) and Max criterion method. Here COA method is used.

2. SIMULATIONMODEL

TheproposedmodelshowninFig.11issimulatedthroughMATLAB/SIMLUINKsoftware.ThePVmodul eisconnected with MPPT control unit.The output of MPPT control unit (i.e. change in dutyratio or pulse generated for triggering of boostconverter)isappliedforcontrollingactionofDC-DCconverter.TheoutputofDC-DCconvertercanbeprocessed through DC-AC converter for supply to the load.

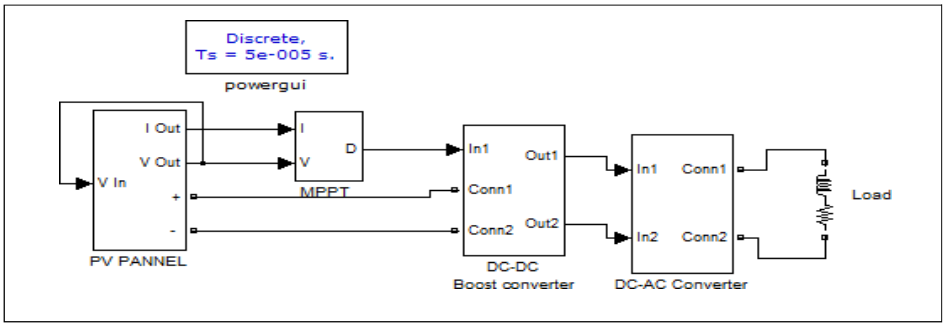


Fig.11.SimulationdiagraminMATLAB/SIMULINK

II. SIMULATIONRESULTS

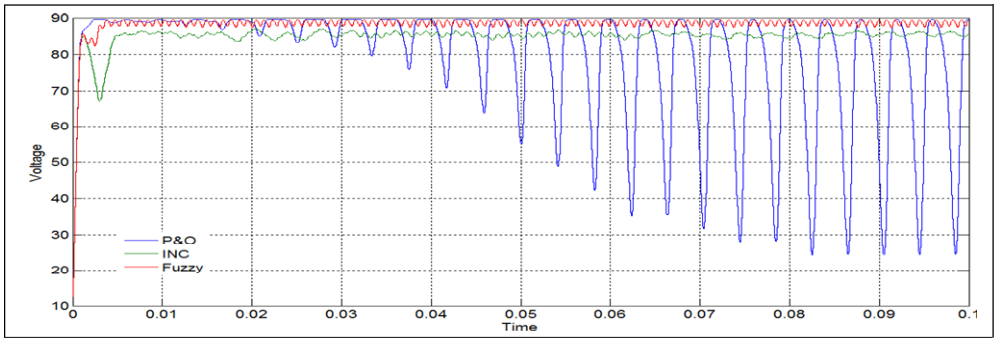


Fig.12.Comparisonofsolarpanelvoltage

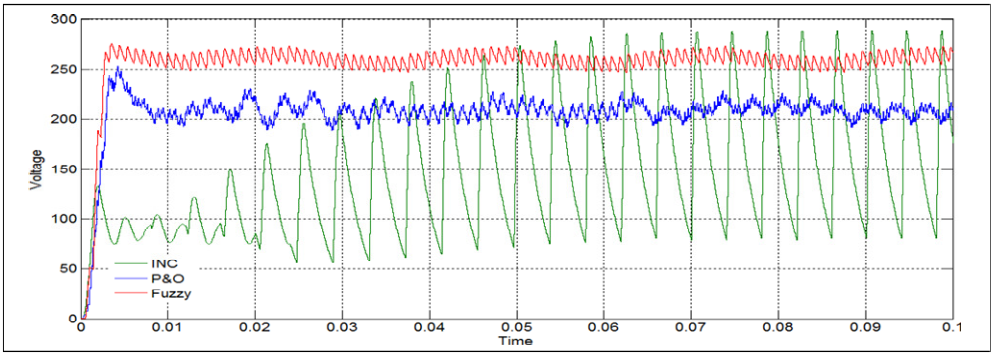


Fig.13.ComparisonofDC-DCconverter voltage

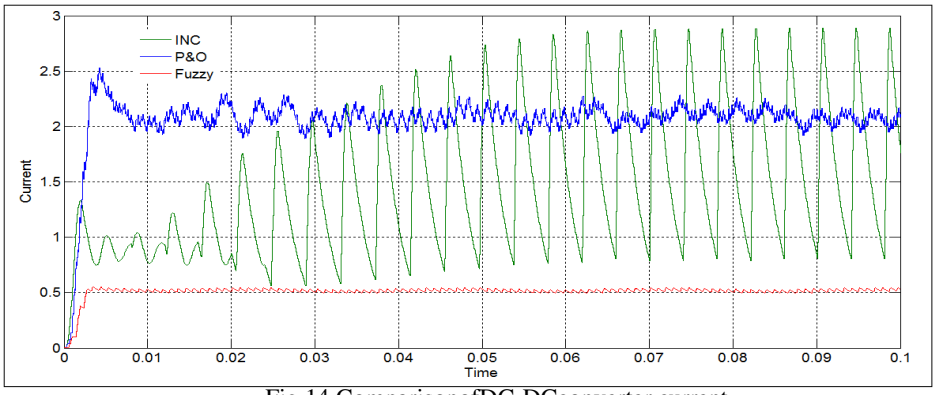


Fig.14.ComparisonofDC-DCconverter current

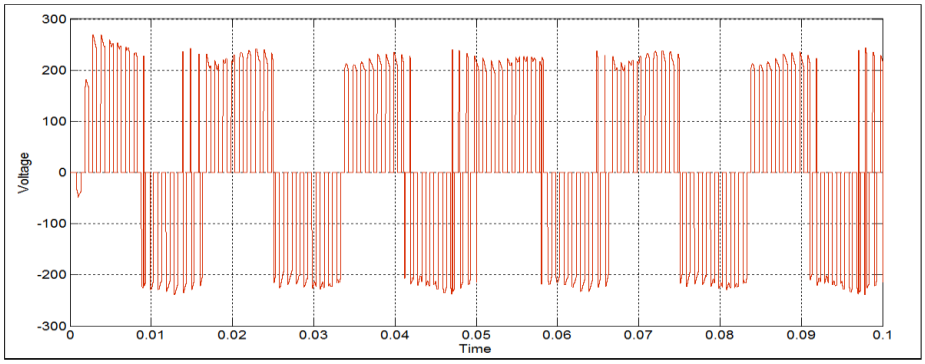


Fig.15.OutputofDC-ACconverterwithFLC

CONCLUSION

A comparative study of three MPPT control unit (P&O, IC and Fuzzy logic) is presented in this paper. Comparison is done on the basis of panel voltage, output of DC-DC converter. Result shows that Fuzzy logic controller gives better responsethan conventionalhill climbingtechniquesin termsofmaximum power pointtraction. This FLCbased MPPT system can be implemented to the grid with DC-AC converter Which can work as a fundamental unit for intermittent system.

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