FUZZY LOGIC CONTROLLER FOR PHOTOVOLTAIC ARRAY SIMULATOR

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***ABSTRACT*-This paper proposes the simulation of photovoltaic (PV) cell operated in various conditions. A DC-DC Buck converter is used to produce the simulated voltage from a high input voltage. The mathematical model of photovoltaic (PV) cell is modelled and some of the parameters are refer to data sheet to make it accurate. The users have to enter the ambient temperature (Ta) and irradiance (G) to simulate the PV voltage. Here the fuzzy logic controller is designed as a feedback compensator for fast response and error reduction. Finally, the proposed model with fuzzy controller was implemented in MATLAB and its performance compared with a PID Controller shows a significant improvement.**

Key words: photovoltaic, Buck converter, mat lab, ambient temperature, irradiance.

I. INTRODUCTION

Sun produce a light energy that contains photons convert into electric energy known as photovoltaic cell (PV). In our daily life the power is very essential; Energy source of the PV cell is interesting. The demand of solar energy is developed while compare last 20 years.it is no pollutant and renewable energy. They have several applications and it is fast developing energy source because of the rise in energy is need. Number of solar PV cell is increase in series output of current is high, increase in parallel output of the voltage is high [1] [5].

The PV cell module of the output is depends on irradiance (G) and cell temperature depends on ambient temperature (Ta).The simulation is mainly proposed as power source to verify repeatability and reliability. The converter operated in steady state same as in transient condition in all probable grid/insolation [9]. The PV array is imitate by linear amplifier using particular photo sensor.it is considered when the temperature is not varied. In the model error will occur when the single photo sensor produce different from the cell in series resistance (R_s), ideality factor (A), reverse saturation current (I_o). SIMULINK/MATLAB model of PV cell have a varying parameter such as ambient temperature (T_a) and Irradiance (G) [2] [9].

The design of feedback loop is stable and switching the process is correctly. This paper the fuzzy logic controller is design, the output simulation result as same as the input voltage. The output is equal to the input voltage, output voltage is produced depends on D (duty cycle) [11]. Simulations results are shown in graph and compare the results are also shown in graph. The performance of Fuzzy logic controller is better than the PID controller in Fig V (a) [1].

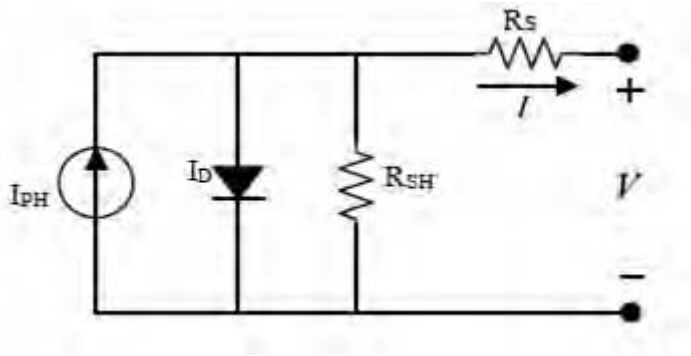


FIG.I (a). Equivalent circuit of PV cell

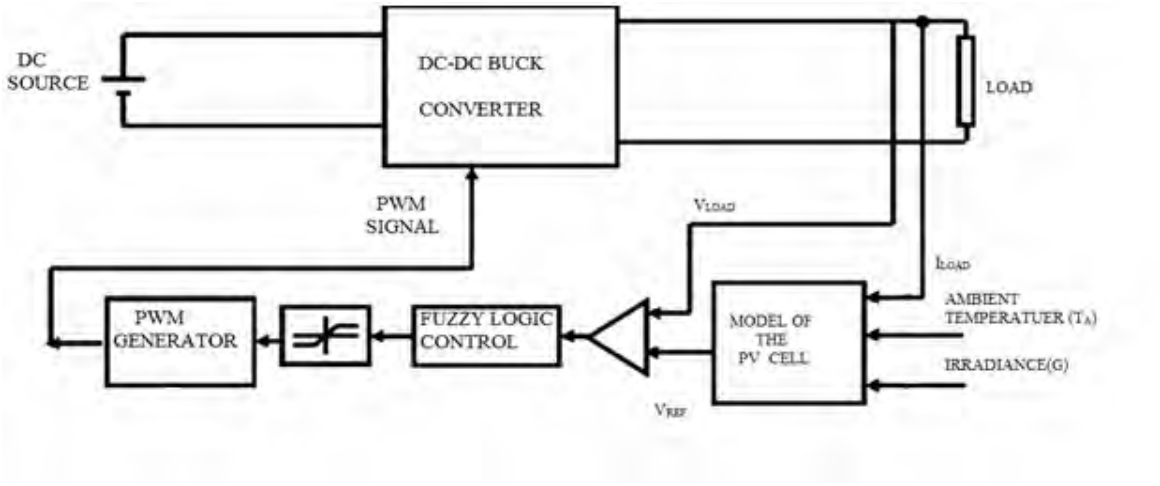


FIG. I (b). Schematic diagram of PV cell

II. MODEL OF PV CELL

The model of PV cell is operated in all condition and it will depend on ambient temperature, irradiance. The model is modelled in mat lab. The user can enter the value of the parameters such as irradiance (G), ambient temperature (Ta). Some of the parameters are given to the model. To find diode current (I_d) have formula. We know whether the value of model is produced voltage correct or not. For that purpose in real time we have to check values are same, the ambient temperature is measured by the resistance temperature detector (RTD) and irradiance is measured by light dependent resistor (LDR). It shows the photoconductivity, the photo resistor is a semiconductor it will absorb the photons and frequency. When resistor reducing light power is increased (irradiance). Photo resistor is used to track the light that is irradiance.

$$I_d = I_{SAT} * [\exp (v_d/v_t) - 1]$$

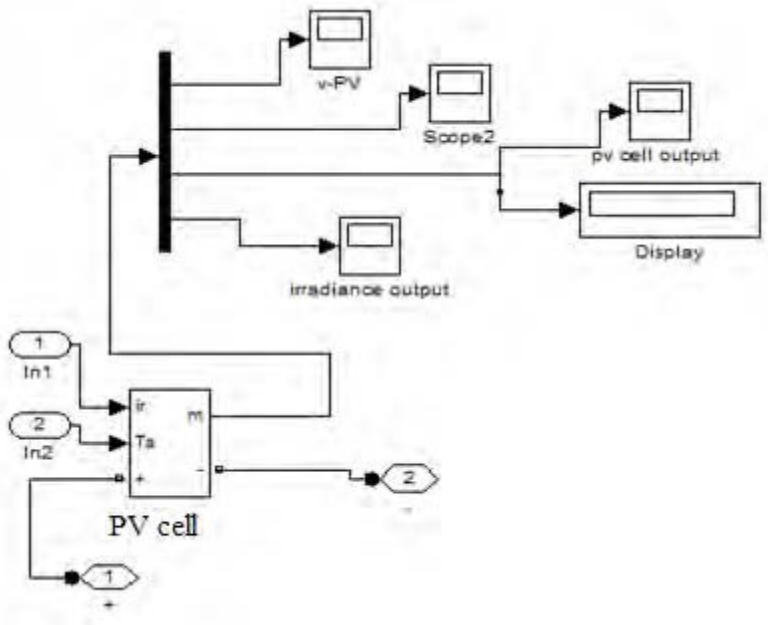


FIG: II (a). Model of PV cell

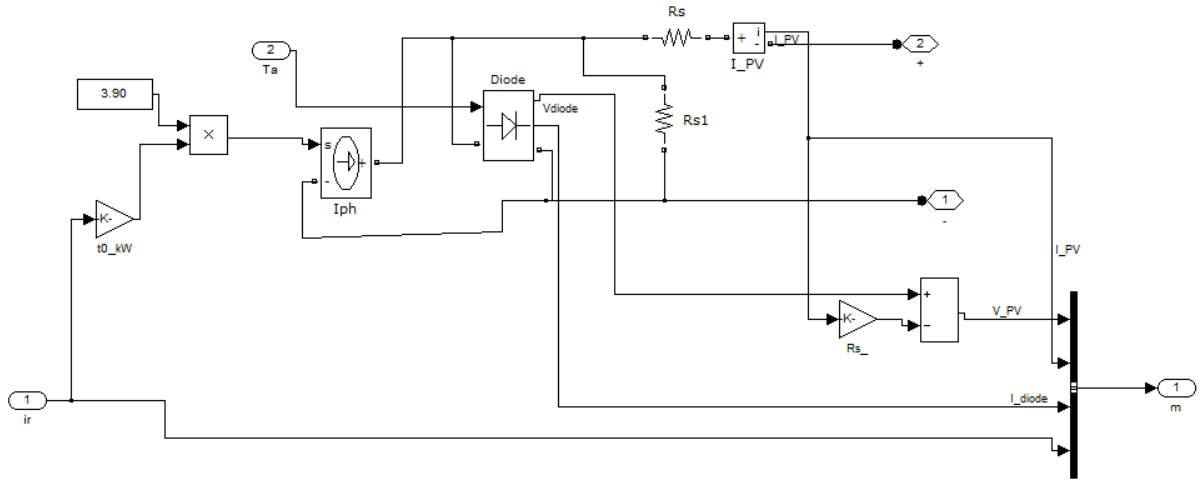


Fig. II (b). Subsystem of PV Cell

III. DC-DC BUCK CONVERTER

The buck converter is step down voltage, the buck converter is indicate the low voltage produced at the output. It is non-linear due to switching position. The buck converter operates in two modes continuous and discontinuous mode, current on the inductor not ever drops to zero in continuous mode and discontinuous mode depends on energy intake by the load through the current in the inductor drops towards zero [8].

When the switch is ON, DC source is supply power which outcome of production voltage from the resistor. Switch is OFF, resistor will discharge the energy from inductor and capacitor. The buck converter is model with help of MATLAB/Simulink. The pulse width modulation (PWM) generates the signal with respect to width of the signal. It is modulate the duty cycle by PWM signal and it control the amount of signal ON/OFF duty cycle send to dc-dc converter.

$V_0 = DV_S$

Where, D= duty cycle;

$D = T_{ON} + T_{OFF}$

V_S= supply voltage;

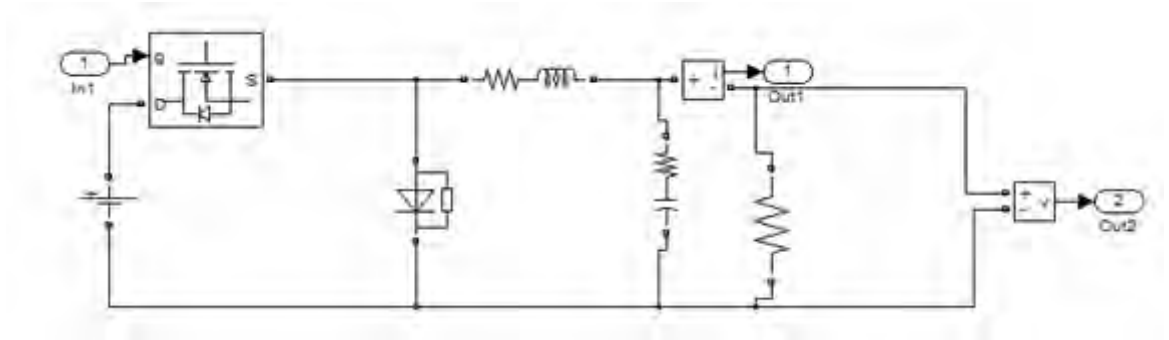


Fig. III. Model of Dc-Dc Buck converter

IV.FUZZY LOGIC CONTROLLER

The fuzzy logic controller (FLC) is designed with five membership function, named as Negative small (NS), Negative big (NB), Zero (ZO), Positive Small (PS), and Positive Big (PB). In FLC the Mamdani method is used. In membership function Triangular shapes are implemented. In FLC have two input error and change in error but in this paper we are used error and integrated error. The error will integrated given input of FLC.

Four main parts in the fuzzy logic controller Fuzzification, Defuzzification, Rule base, Inference mechanism

FUZZIFICATION: It will interface just modify the inputs and so they can be understood and compare the rules. Input variable values are measure. Input data is converting into linguistic variables in fuzzy set.

RULE BASE: It will supply the experimental knowledge action of process depends of specialist. IF-THEN rules are considered in fuzzy rules. The linguistic variables are contained in precondition and consequents.

INFERENCE MECHANISM: It is the seed of the FLC, it is ability of simulation of human decision production to achieve close reasoning. The rule implication wherever human information can easily be inserting to linguistic rules.

DEFUZZIFICATION: It is used to produce a non-fuzzy decision or control action from an indirect fuzzy control action through the inference mechanism.

e/∫e	NB	NS	ZO	PS	PB
NB	NB	NB	NB	NS	ZO
NS	NB	NB	NS	ZO	PS
ZO	NB	NS	ZO	PS	PB
PS	NS	ZO	PS	PB	PB
PB	ZO	PS	PB	PB	PB

IV (a). Rule Base

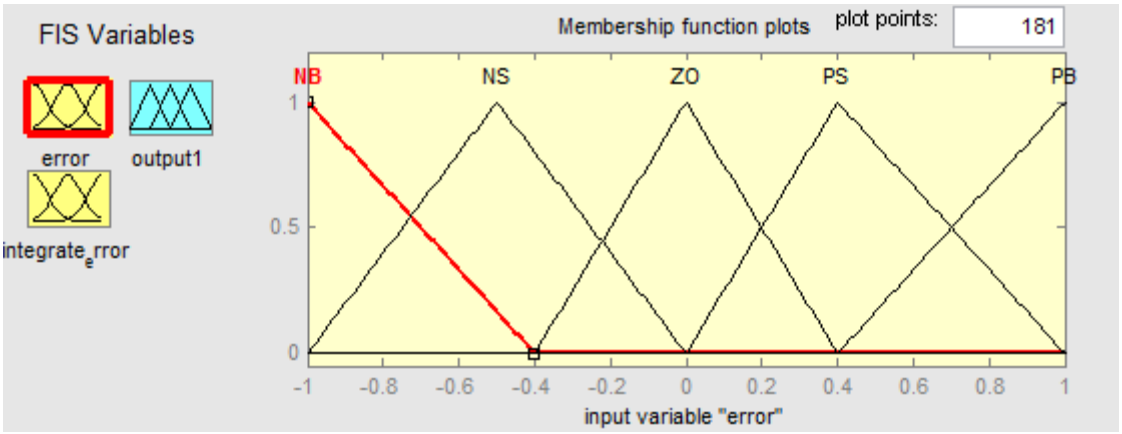


FIG: IV (b). Membership Function for Error

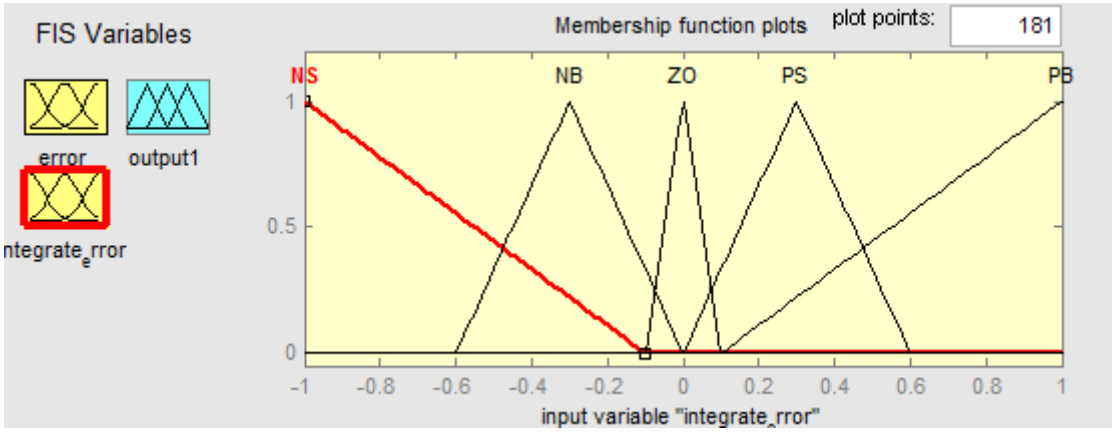


FIG: IV (c). Membership function of Integral Error

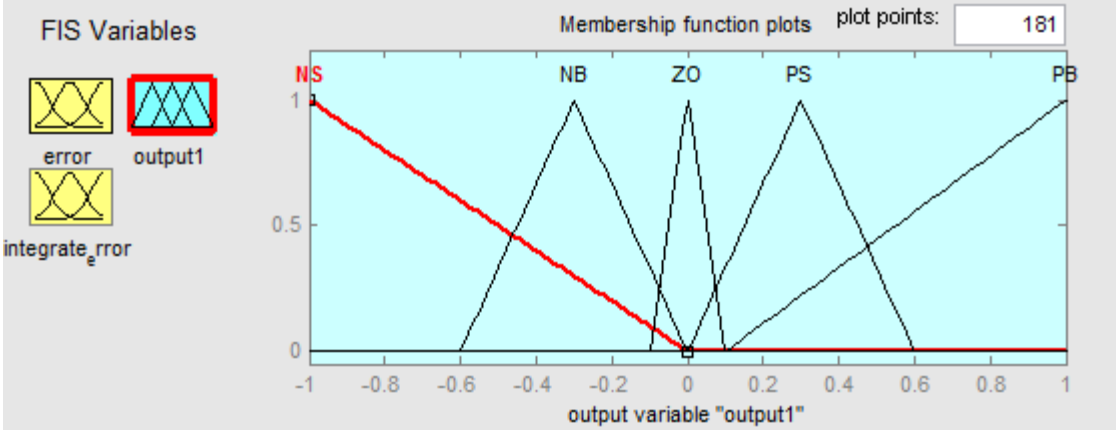
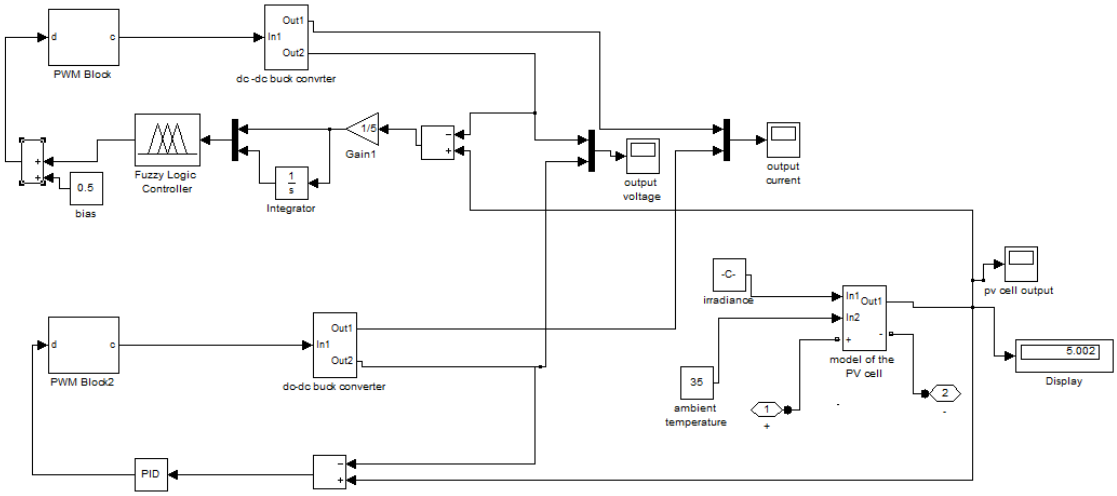


FIG: IV (d). Duty cycle

V. Comparing the Simulatiom Results



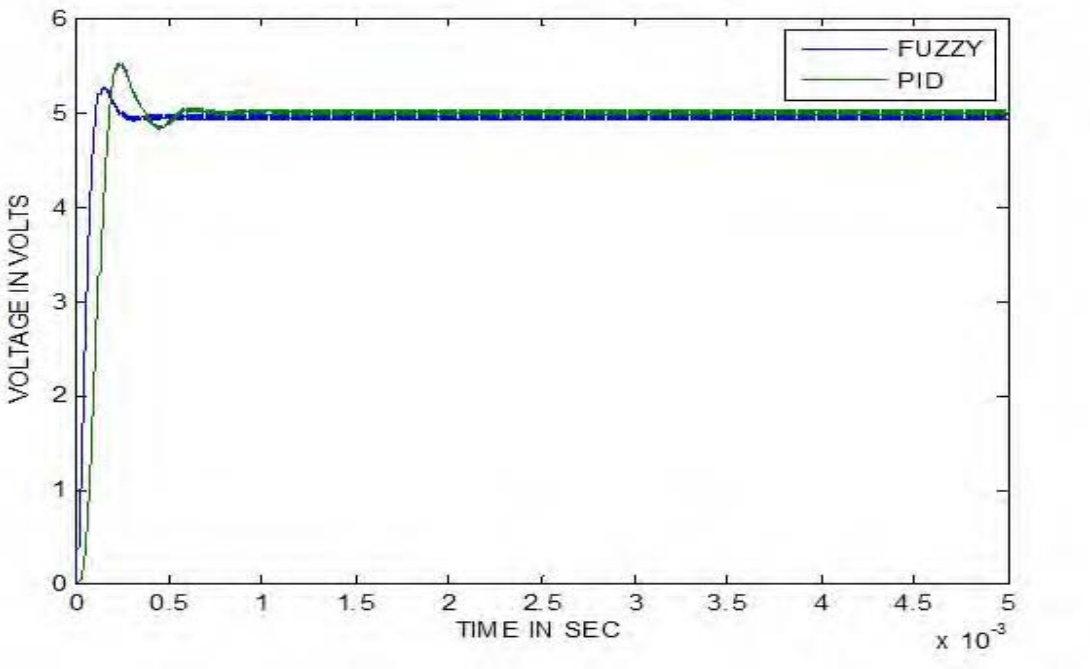


Fig: V (a) .Performance Comparison of FLC and PID

TABLE.I. Performance comparisons

controllers	Rising Time	Settling time	Over shoot percentage
Fuzzy logic	1.12	3	5.6
PID	1.865	7	7.8

TABLE II: Parameter values

PARAMETER	VARIABLE	VALUE
SERIES RESISTANCE	R_S	0.000192 ohm
REVERSE SATURATION CURRENT	I_O	9.25*10^-6 A
DIODE IDEALITY FACTOR	A	1.8 A
SWITCHING FREQUENCY	f_S	100 KHZ
SUPPLY VOLTAGE	V_g	25 V
LOAD RESISTANCE	R	1 ohm
CAPACITANCE RESISTANCE	RC	5 m –ohm
PHOTO CURRENT	I_{PH}	3.9 A
INDUCTANCE RESISTANCE	RL	80 m-ohm

VI. CONCLUSION

Model of the PV cell is simulated to work in all condition. The simulation of the PV cell is modelled with help of MATLAB that is equal to any PV panel. The user can enter the parameters like an ambient temperature (Ta) and irradiance (G). PV cell has no considerable time constant. The simulation results shown and compared. The simulations are very useful to give input and model the converter to test for PV panel to load.

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