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Analysis of Different Maximum Power Point Technique of Solar PV Connected With Grid

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ABSTRACT: This work is based on the designing of Solar PV and maximum power point technique discussion. As the solar irradiance are non-linear and depends upon the location and climatic conditions of the selected site for solar PV generation plant. For achieving the maximum extraction of solar energy and power production, various techniques has to be analysed and find out the best possible method for that selected site. Methods like perturbation and observation as well as incremental conductance methods are discussed in this work to achieve the best possible power extraction. Simulation results are shown and discussed with the Matlab/Simulink simulation software to validate the proposed control strategy. Few software also introduced for the climate analysis and solar behaviour in the selected zone that will also be helpful for the analysis of control design strategy.

KEYWORDS Maximum power point tracking system (MPPT), Total harmonic distortion (THD), and fuzzy logic control (FLC), Perturbation & Observation (P&O), Pulse width modulation (PWM)

Energy not only plays an important role in our life but also in the overall economy of the country. The requirement for energy is increasing in our daily life due to the industrial revolution. In the most developing country like India, the large share of energy generation mainly depends upon non-renewable energy sources. The gradual depletion of these sources such as fossil fuels, oils, etc. leading the developing countries towards the un-sustainability of civilization. Along with that, the generation of energy through conventional sources is also a reason for greenhouse gases. It has become a global challenge to reduce the emission of greenhouse gasses like CO₂ and CO₃ to ensured secure, clean, and affordable energy. Whereas clean and sustainable energy is perfectly generated through renewable energy sources [1].

The MPPT working principle is based on the maximum power transfer theory. The power delivered from the source to the load is maximized when the input resistance seen by the source matches the source resistance. Therefore, in order to transfer maximum power from the panel to the load the internal resistance of the panel has to match the resistance seen by the PV panel. For a fixed load, the equivalent resistance seen by the panel can be adjusted by changing the power converter duty cycle [2].

The warming of global surface is increasing 0.6 degree Celsius per century. This warming caused by huge release of carbon dioxide and carbon monoxide. This causes acid rain, depletion of ozone layer and radioactive emission these effects can be minimized by searching some effective solution, this solution also include energy conservation with improved energy efficiency.

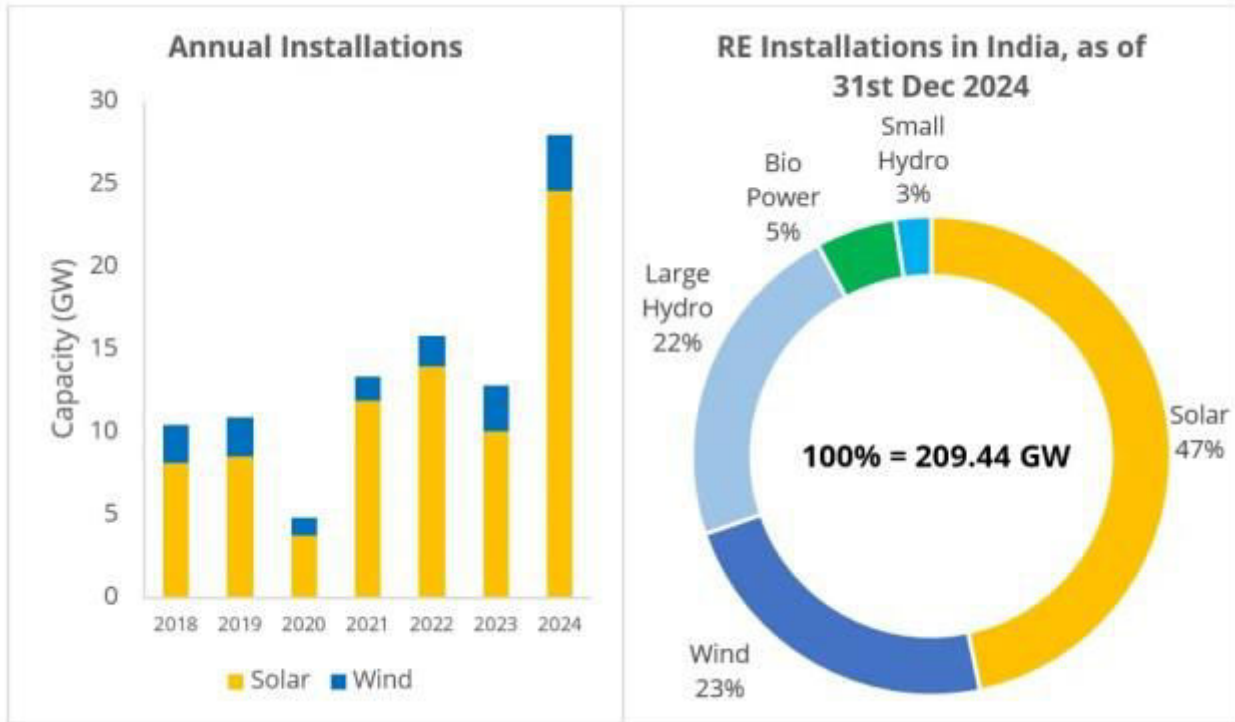


Fig -1: Annual Solar Installation in 2024 adds 24.5 GW

I. MODELLING OF SOLAR PV

Electrical Model of photovoltaic cell

Implements a PV array built of strings of PV modules connected in parallel. Each strings consists of strings connected in series. Parallel strings 40 and series connected modules per strings 10. With open circuit voltage 37.14V and short circuit current 8A.

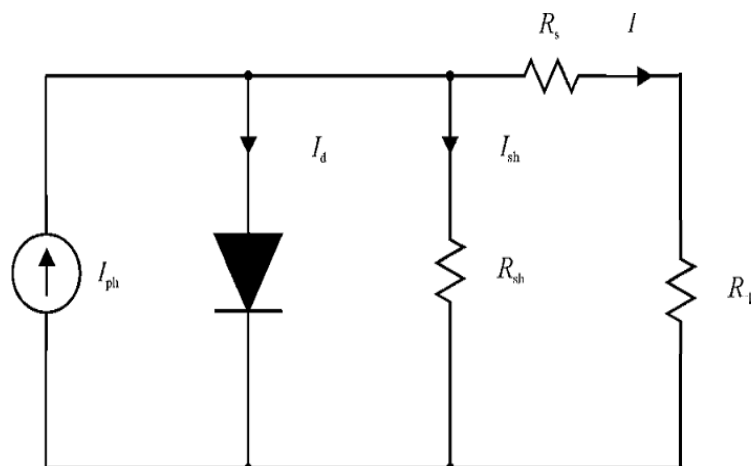


Fig -2: P-V cell Model

$$I = I_D - I_{RP} - I_{ph} \dots\dots\dots (1)$$

$$I = I_{ph} - I_0 - \left[\exp\left(\frac{V + I R_s}{V_T}\right) - 1 \right] - \left[\left(\frac{V + I R_s}{R_p}\right) \right] \dots\dots\dots (2)$$

$$I = n_p I_{ph} - n_p I_{rs} - \left[\exp\left(\frac{q}{K T A} * \frac{V}{n_s}\right) - 1 \right] \dots\dots\dots (3)$$

$$I_{rs} = I_{rr} \left[\frac{T}{T_R} \right]^3 \exp\left(\frac{q E_G}{K A} \left[\frac{1}{T_r} - \frac{1}{T} \right] \right) \dots\dots\dots (4)$$

$$E_G = E_G(0) \frac{\alpha T^2}{T + \beta} \dots\dots\dots (5)$$

$$I_{ph} = [I_{scr} + K_i (T - T_r)] \frac{s}{1000} \dots\dots\dots (6)$$

Where, I_{ph} is the Insolation current, I is the Cell current, I_0 is the Reverse saturation current, V is the Cell voltage, R_s is the Series resistance, R_p is the Parallel resistance, V_T is the Thermal voltage (KT/q), K is the Boltzmann constant, T is the Temperature in Kelvin, and q is the Charge of an electron. [3]

II. BOOST CONVERTER

The PV array system generates DC voltage in nonlinear conditions. The generated voltage is low and variable so it must be of constant amplitude and high in value at the input of the inverter. So the boost converter is necessary to boost the voltage.

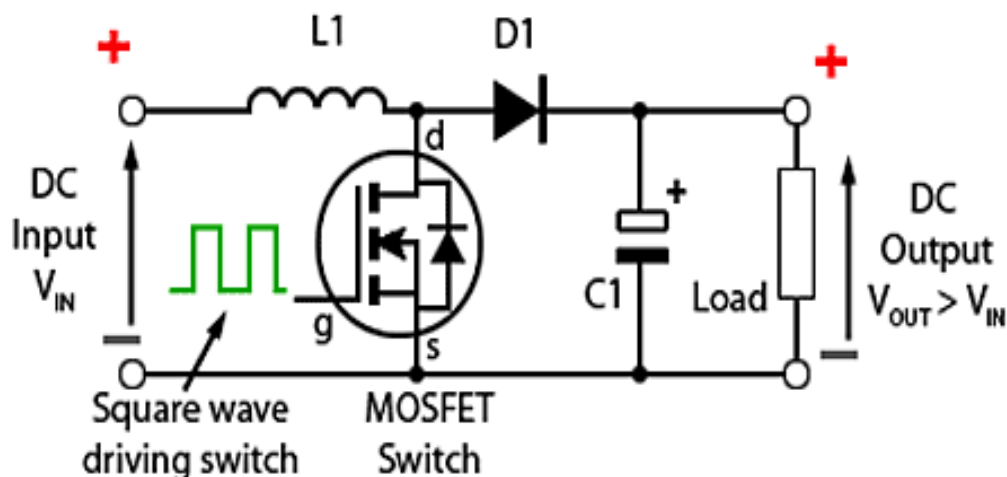


Fig -3: Equivalent circuit of boost converter

The Fig.3 shows a step up or PWM boost converter. It consists of a dc input voltage source V_g ; boost inductor L , controlled switch S , diode D , filter capacitor C , and the load resistance R . When the switch S is in the on state, the current in the boost inductor increases linearly and the diode D is off at that time. When the switch S is turned off, the energy stored in the inductor is released through the diode to the output RC circuit. In this way we get the desired output voltage by this boost converter. We can easily regulate its output voltage by varying the output resistance. [4]

$$V_{out} = \frac{1}{1-D} V_{in} \dots\dots\dots (7)$$

$$R_{pv} = (1 - D)2R_{out}\dots\dots\dots (8)$$

III. PERTURBATION AND OBSERVATION METHOD

Voltage and current from the PV module are fed into the Algorithm. The power output increases when the operating Voltage increases. The system increases the operating voltage until the power output begins to decrease. Once this happens, the voltage is decreased to get back to the maximum power output value. This algorithm applied in the DC–DC buck converter as shown in Figure proposed model.

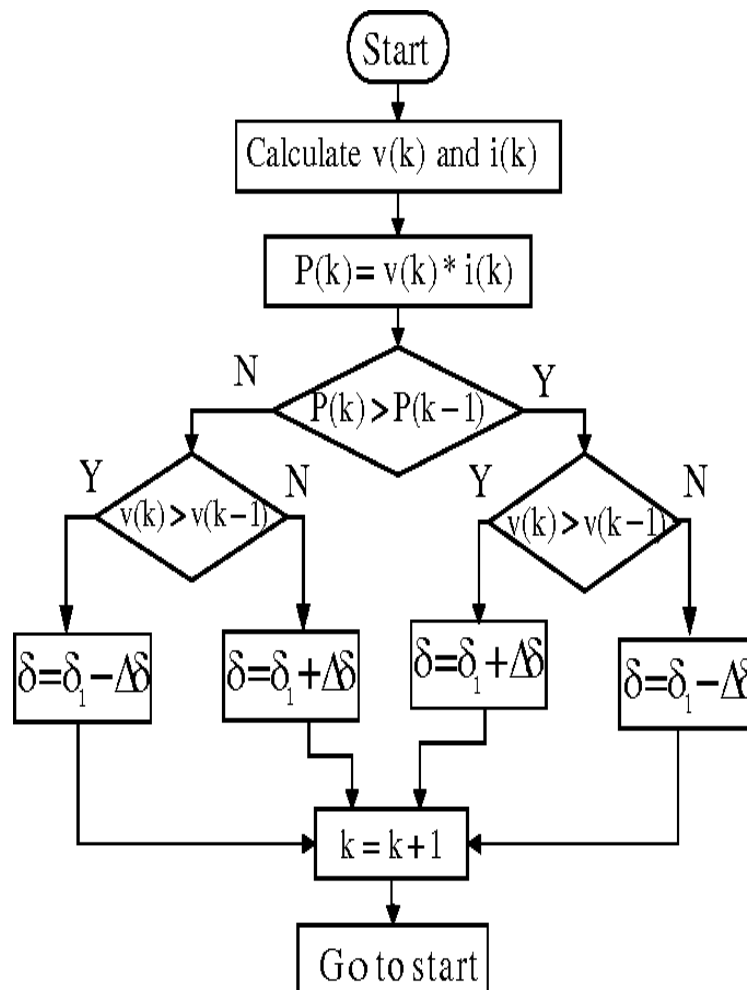


Fig -4 Flowchart with perturbation and observation

IV. FUZZY LOGIC CONTROL

Fuzzy logic is a powerful tool since it allows the control of the system whose parameters are unknown or incomplete and as a result difficult to model mathematically. Fuzzy logic control consist of three main stages: input, processing and output. At the input stage membership functions are used to fuzzify the input values. The now fuzzified input is fed into

the processing stage where an inference mechanism applied the appropriate rule from the knowledge base to come up with a set of fuzzy outputs. This output is then defuzzified using an appropriate technique. [5]

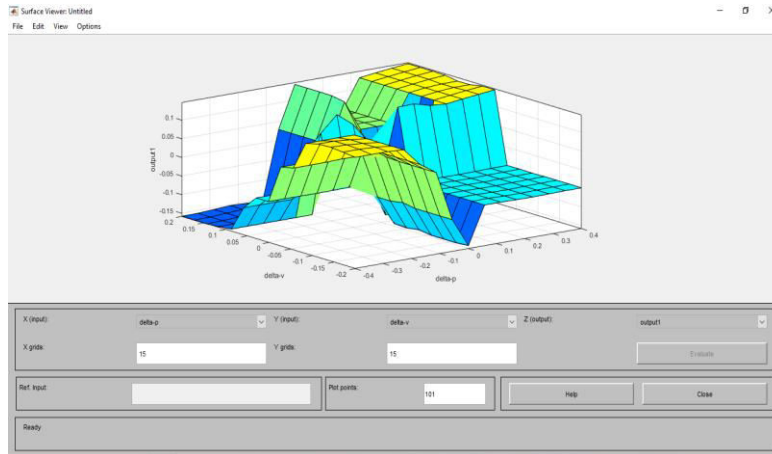


Fig -5 Surface view of fuzzy control



Fig -6 Rule view of control system

V. RESULT AND DISCUSSION

The proposed model in which a wind turbine has been designed and connected to grid for the study of simulation outputs and in the pitch angle control the fuzzy logic based control system has been placed with the predefined rule table, the simulation results shows a sinusoidal three phase voltage and three phase current with smooth waveform.

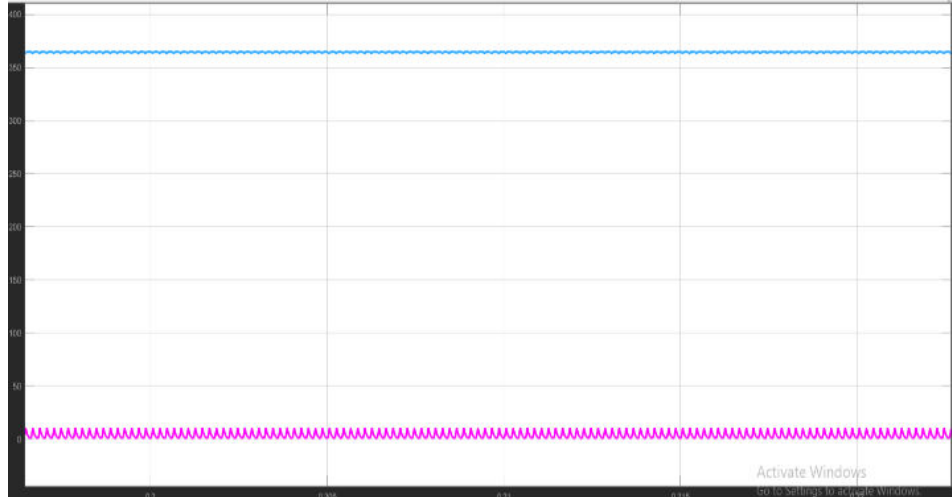


Fig. 7 Voltage and current output from P&O model



Fig. 8 Power from P&O model

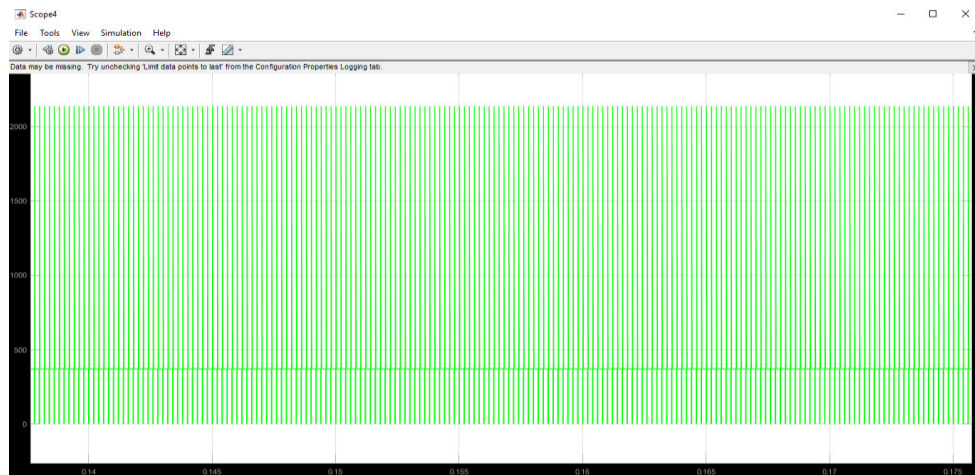


Fig. 9 Output voltage from fuzzy

VI. CONCLUSION

The proposed model describes the solar PV with 40 parallel strings and series connected modules per string is 10 comprising of 230 watts. In this model to enhance the output we use maximum power point tracking system by P&O algorithm to get the maximize output. In our next step we are going to connect this DC output voltage as the input of the inverter with the PWM based control system and connect it to the load to analyze the outputs. A separate model also been designed to connect the fuzzy logic control system, the simulation results shows that according to site climatic condition and other parameters the control system can be designed. The output voltage of fuzzy based control system is also in the desired output value. The outputs can be deliver to the inverter system to make it ready to connect with grid where we can get smooth sinusoidal output voltage and current waveforms. The harmonics are the major issue due to all these systems. Filters can be used to reduce the harmonics distortion in the system. In the next phase the weather conditions will also be analyzed to design the whole system.

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