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Simulation Study of Photovoltaic System with MPPT Algorithms

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Abstract: ***In this paper we examine a schematic to extract maximum obtainable solar power from a PV module and use the energy for a DC application. This project investigates in detail the concept of Maximum PowerPoint Tracking (MPPT) which significantly increases the efficiency of the solar photovoltaic system. We are study of simulation of PV system with MPPT algorithms. The need for renewable energy sources is on the rise because of the acute energy crisis in the world today.***

Keywords: Boost Converter, Solar cell model, Solar cell

1. Introduction

Several solar technologies, such as domestic hot water heating and pool heating, are already competitive and used in locales where they offer the least-cost option. And in jurisdictions where governments have taken steps to actively support solar energy, very large solar electricity (both PV and CSP) installations, approaching 100 MW of power, have been realized, in addition to large numbers of rooftop PV installations. Other applications, such as solar fuels, require additional R&D before achieving significant levels of adoption.

The objective of this thesis is firstly to review MPPT algorithms. Then the most popular, perturb and observe (P&O), incremental conductance and fuzzy logic control (FLC) are analyzed in depth and tested according to the standard mentioned above. After that, improvements to the P&O and the Incremental conductance algorithms are suggested to succeed in the MPP tracking under conditions of changing irradiance. To test the MPPT algorithms according to the irradiation profiles proposed in the standard, a simplified model was developed, because the simulation time required in some of the cases cannot be reached with the detailed switching model of a power converter in a normal desktop computer. The reason for that is that the computer runs out of memory after simulating only a few seconds with the complete model. Finally, the simplified model is verified by comparing its results with those obtained from a model containing a detailed model of an inverter.

1.2 Different sources of Renewable Energy
1.2.1 Wind power
1.2.2 Solar power
1.2.3 Small hydropower
1.2.4 Biomass

2. Solar Cell & Solar Panel Model

2.1 Solar Cell

A solar cell system converts sunlight into electricity. The basic device of a solar cell system is the solar cell. Cells may be grouped to form panels or modules. Panels can be grouped to form large solar cell arrays. The term array is usually employed to describe a solar cell panel (with several cells connected in series and/or parallel) or a group of panels. Most of time one are interested in modeling solar cell panels, which are the commercial solar cell devices. This paper focuses on modeling solar cell modules or panels composed of several basic cells. The term array used henceforth means any solar cell device composed of several basic cells.

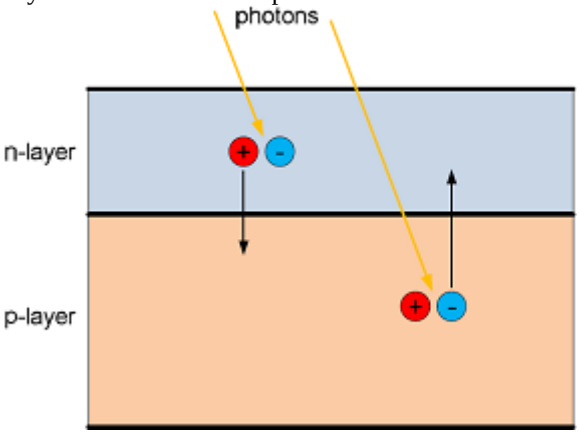


Figure 1.1: Solar cell

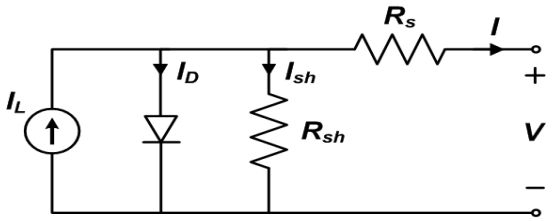


Figure 2.1: Dc equivalent circuit

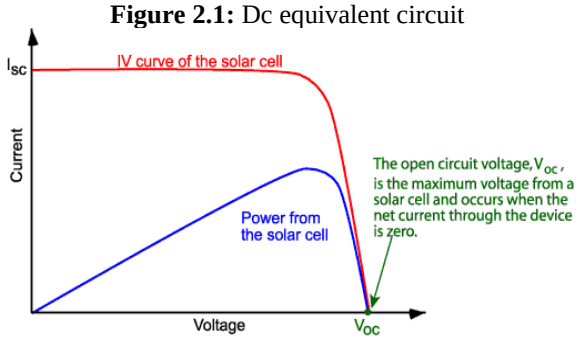


Figure 2.2: Solar Cell I-V characteristic curve

2.2 Solar Panel Model

Photovoltaic modules or solar panels: - A photovoltaic array is a linked assembly of PV modules. Most PV array use an inverter to convert the dc power produced by the modules into alternating current. The modules in a PV array are connected in series to obtain the desired the voltage, the individual string are then connected in parallel to allow the system to produce more current.

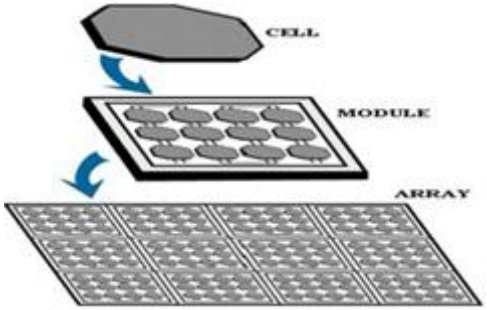


Figure 2.3: photovoltaic hierarchy

3. Boost Converter

As stated in the introduction, the maximum power point tracking is basically a load matching problem. In order to change the input resistance of the panel to match the load resistance (by varying the duty cycle), a DC to DC converter is required.

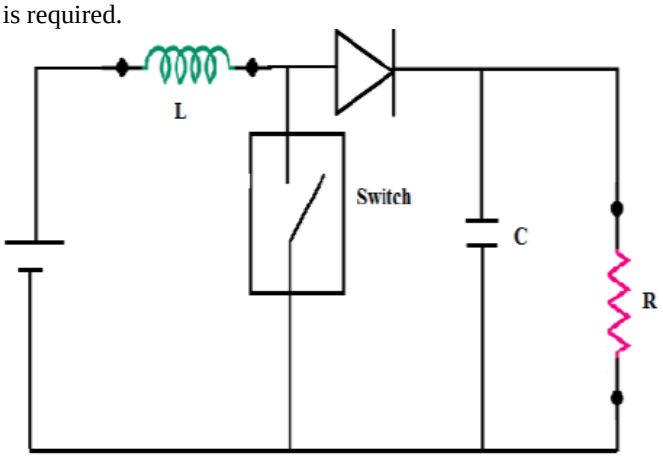


Figure 2.4: Circuit diagram of a Boost Converter

4. Maximum Power Point Tracking Algorithms

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel. According to Maximum Power Transfer theorem, the power output of a circuit is Maximum when the Thevenin impedance of the circuit (source impedance) matches with the load impedance. Hence our problem of tracking the maximum power point reduces to an impedance matching problem.

4.1 Different MPPT Techniques

There are different techniques used to track the maximum power point. Few of the most popular techniques are:
1) Perturb and Observe (hill climbing method)
2) Incremental Conductance method
3) Fractional short circuit current
4) Fractional open circuit voltage
5) Neural networks
6) Fuzzy logic

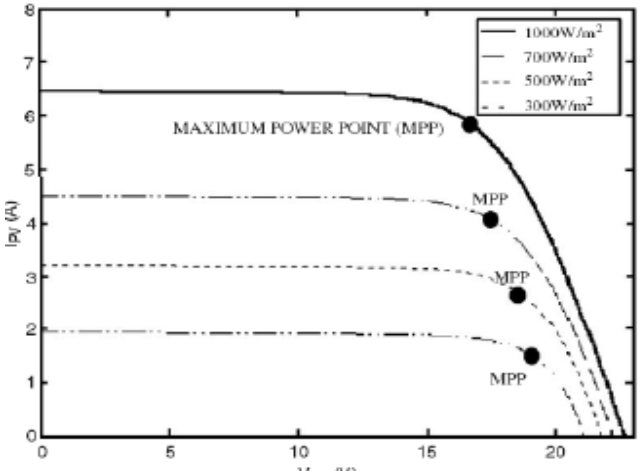


Figure 4.1: I-V Characteristics at four different radiation levels

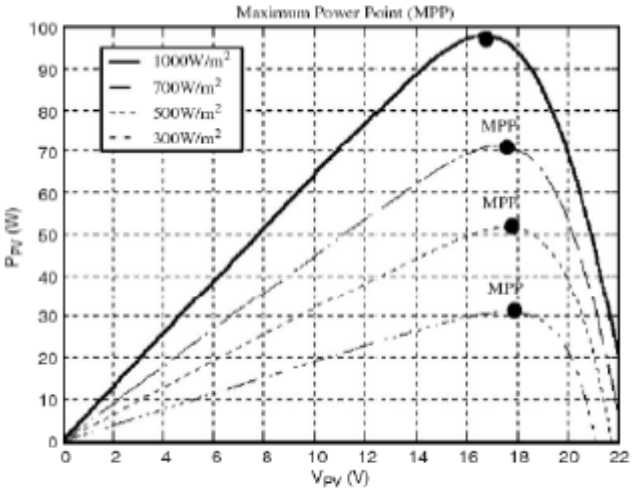
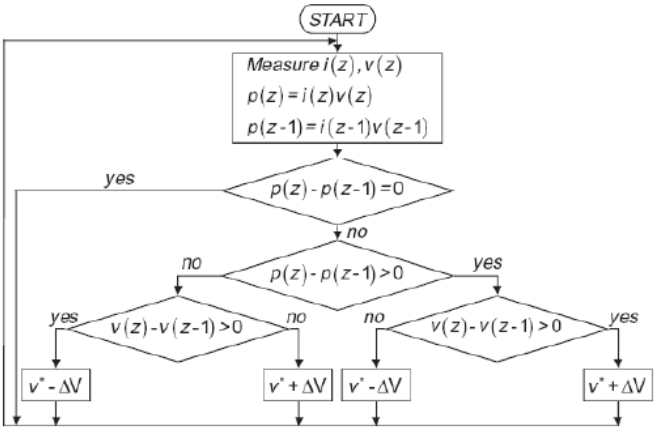


Figure 4.2: P-V Characteristics at four different radiation levels

The point marked as MPP is the Maximum Power Point, the theoretical maximum output obtainable from the PV panel.



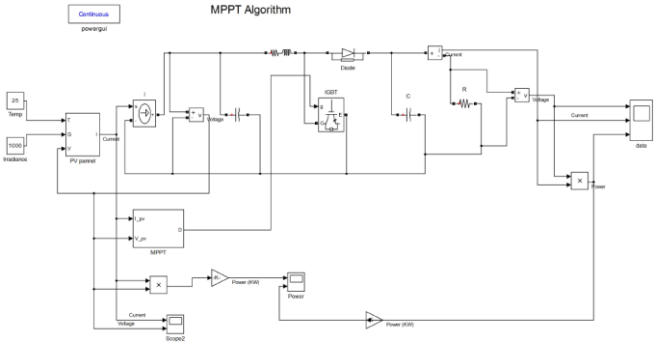
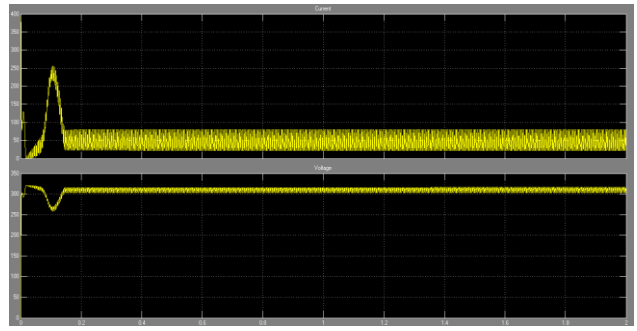


Figure 5.2: SIMULINK Model of MPPT (PV) system



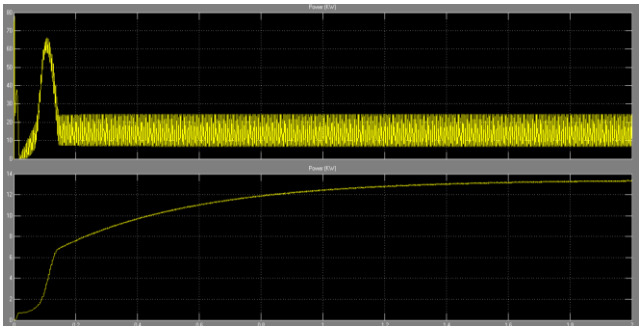


Figure 5.3: Output waveform of pv panel (voltage,current,power)

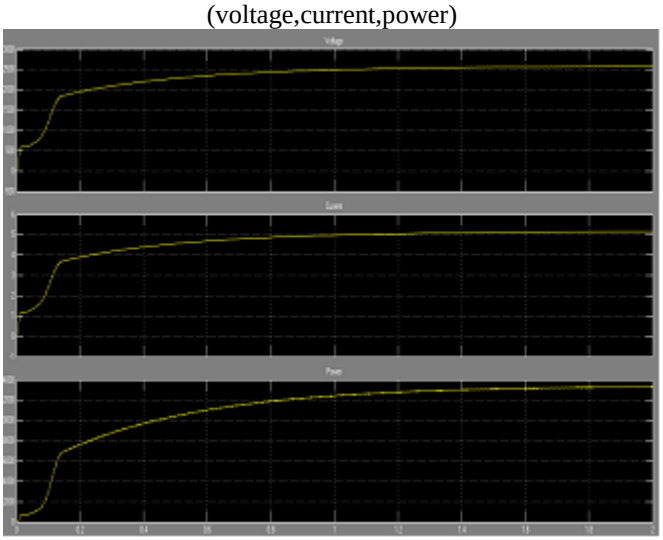


Figure 5.4: Voltage, current & power waveform PV System with MPPT

5. Conclusion

In this paper we study successfully a schematic to extract maximum obtainable solar power from a PV module and use the energy for a DC application. This project investigates in detail the concept of Maximum PowerPoint Tracking (MPPT) which significantly increases the efficiency of the solar photovoltaic system. we are study of simulation of pv system with MPPT algorithms .

6. Future Work

Improvement to this project can be made by tracking the maximum power point in changing environmental conditions. Environmental change can be change in solar irradiation or change in ambient temperature or even both. This can be done by using Simulink models to carry out MPPT instead of writing it code in Embedded MATLAB functions. In the Simulink models the solar irradiation and the temperature can be given as variable inputs instead of constant values as done here.

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