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Step Incremental Conductance MPPT for Solar PV System Based on Fuzzy Logic Controller

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Abstract

Due to strong industrial expansion, the need for electrical power has increased in recent years. As more than just a by-product of this increased dependence on fossil fuels, resource depletion occurs, and renewable sources such as solar, wind, and wave energy sources have begun to operate as an electricity source and are now playing a key role. Solar energy has been widely used in power systems, particularly in the form of photovoltaic (PV) generating units. Control scheme is a technique for obtaining electricity from a solar photovoltaic system under changing environmental circumstances. The proposed research compares two control methods: incremental conductance algorithm and fuzzy logic, in order to maximise the efficiency of a solar PV system. The algorithms described above change the switching frequency of the power converter to monitor a solar PV array's global MPP. In MATLAB/Simulink, the simulation is run, and the performance is evaluated. The simulated findings imply that the fuzzy logic controller performs better than the incremental conductance technique.

Keywords: MPPT, Fuzzy logic, Solar PV system, Boost converter, Conductance algorithm

1. Introduction

A spate of solutions for optimizing the efficiency have been presented in recent years (MPP). Obtaining maximum power is simple and successful when partial accessible voltage and short-circuit current approaches are used. The MPPT is a technique that tracks the array's peak energy and enhances the system's power output by adjusting the current and voltage ratio. There are several alternative MPPT techniques that may be used to enhance the

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productivity of a PV system. These approaches are based on a variety of configurations and range in sophistication, expense, and productivity of manufacture. The goal of this study is to examine two MPPT algorithm solutions for improving solar efficiency.

2. Block Diagram

Figure 1 depicts the suggested schematic diagram. Solar energy is derived from a solar panel that receives varying irradiances and temperatures. The voltage and current levels out from photovoltaic array are inputs to the fuzzy logic algorithm, as well as the switching frequency calculated is used to operate the DC-DC boost converter's PWM generator. The greatest power is generated by the dc-dc converter, which is subsequently provided to the loads.

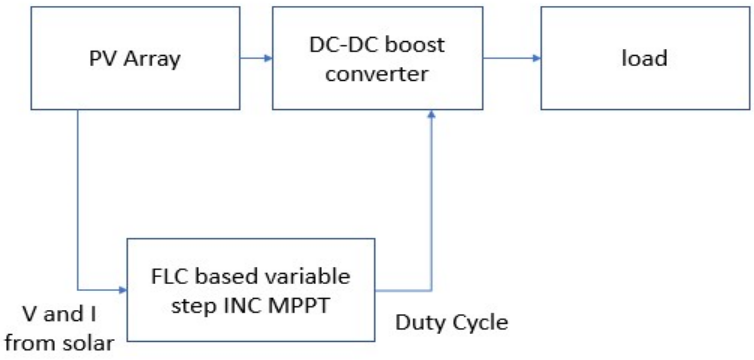

Figure 1. Block diagram

2.1 Incremental Conductance Algorithm

Because of its ease of installation and simplicity, this Incremental Conductance approach is the most widely utilised in Photovoltaic systems applications. The MPP is calculated by comparing the photovoltaic system's impedance to the converter's functional resistivity reflected across the array terminals. The incremental conductance (IC) could be used to detect when the setpoint should be disturbed after the System response has reached the MPP. The dP/dV and –I/V correlations can be employed to determine the direction of a perturbed MPPT operating frequency if this requirement is not satisfied. IC can monitor exponentially expanding and dropping intensity conditions with great accuracy because dP/dV is negative whenever the Maximum power point is on the correct side of the MPP and positively when it is on the left of the MPP. The method's medium complexity and delayed response, as well as higher weather conduction unpredictability, are disadvantages.

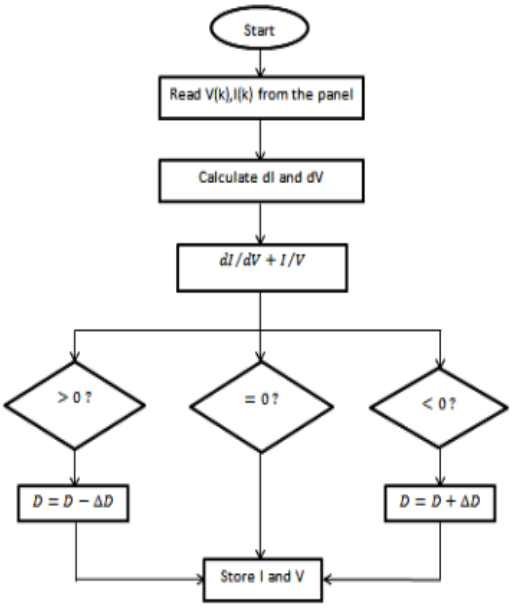

Figure 2. The Incremental Conductance Algorithm as a flow diagram

2.2 Fuzzy Logic Controller Algorithm

Artificial Intelligence (AI) is an engineering field concerned with the creation of computer programmes based on research into intelligent behavior and the reality of human reasoning. Fuzzy logic is a subset in artificial intelligence technique. The concept of an input variables, which is variable whose values are words rather than numbers, is the starting point for understanding fuzzy logic. Fuzzy logic is a type of logic that uses fuzzy set theory to represent connected types of objects with inadequately boundaries and degrees of participation. The fuzzy logic system is more versatile than the classical and traditional techniques.

Table 1. With two inputs I/V and dI/dV, fuzzy rules are used to generate the duty cycle for the INC technique

dVpv \ dPpv	NB	NS	ZE	PS	PB
NB	PS	PB	NB	NB	NS
NS	PS	PS	NS	NS	NS
ZE	ZE	ZE	ZE	ZE	ZE
PS	NS	NS	PS	PS	PS
PB	NS	NB	PB	PB	PS

The fuzzified all inputs for the controllable parameters are fuzzified using a mixture of if-then methods. Fuzzy rules that are based on the system's operation and experience. The fuzzy rules in this study comprise twenty-five fuzzy control rules that address a certain set of membership functions.

3. Simulation Results

Figure 3 illustrates a MATLAB/SIMULINK model of a PV model with a power converter that uses the incremental conductance technique.

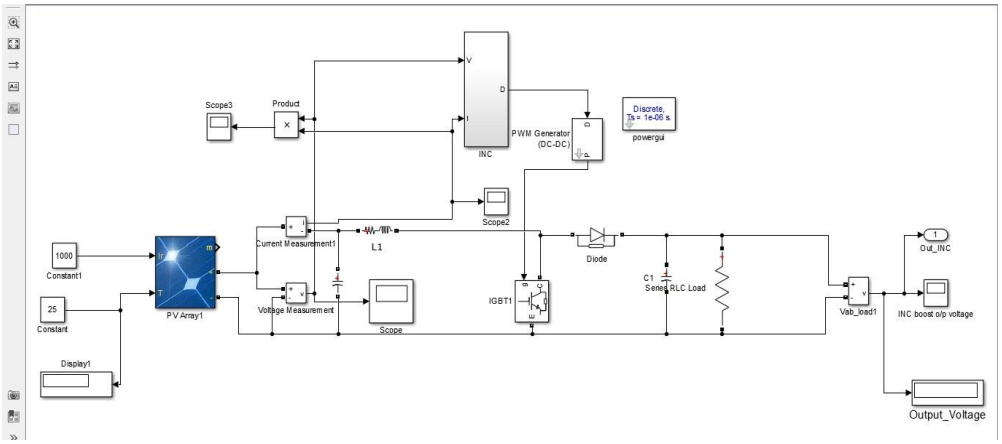

Figure 3. Incremental conductance simulation module

By measuring the current and voltage, the PV module's system can be obtained. The INC algorithm takes the potential and current values module as inputs. The result is the switching frequency, which is checked under various operational situations. The DC-DC converter raises the output voltage to compensate for changes in input power.

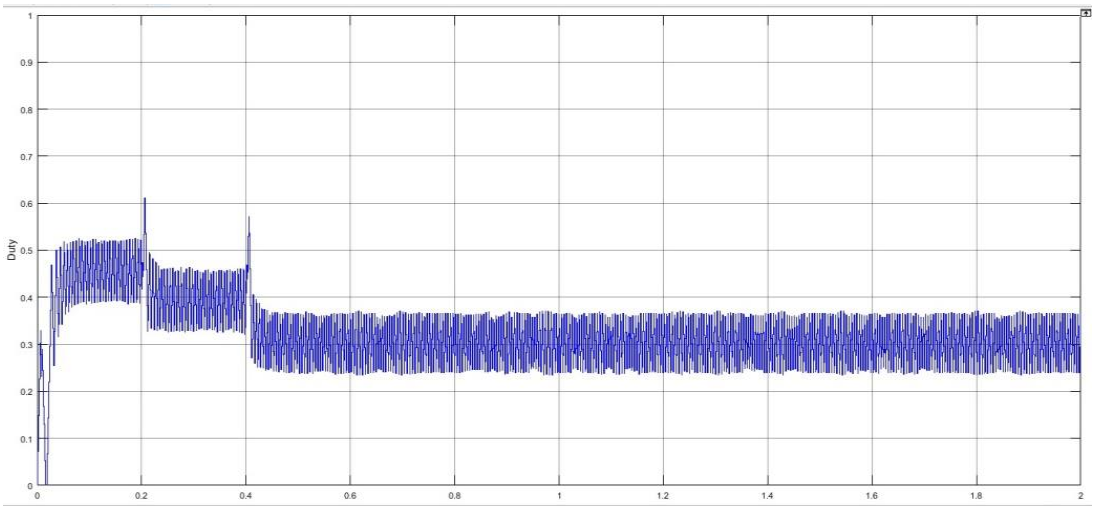

Figure 4. Output for the incremental conductance algorithm

This fig.4 shows the output for the incremental conductance algorithm for different irradiance such as 1000w/m^2 800w/m^2 600w/m^2.

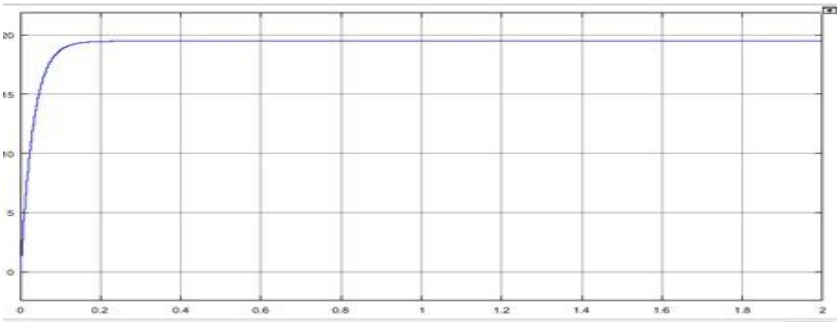

Figure 5. Boost converter output for INC

This fig.5 shows the output for the boost converter for different irradiance such as 1000w/m^2 800w/m^2 600w/m^2.

4. Simulink Block for Fuzzy Logic Control

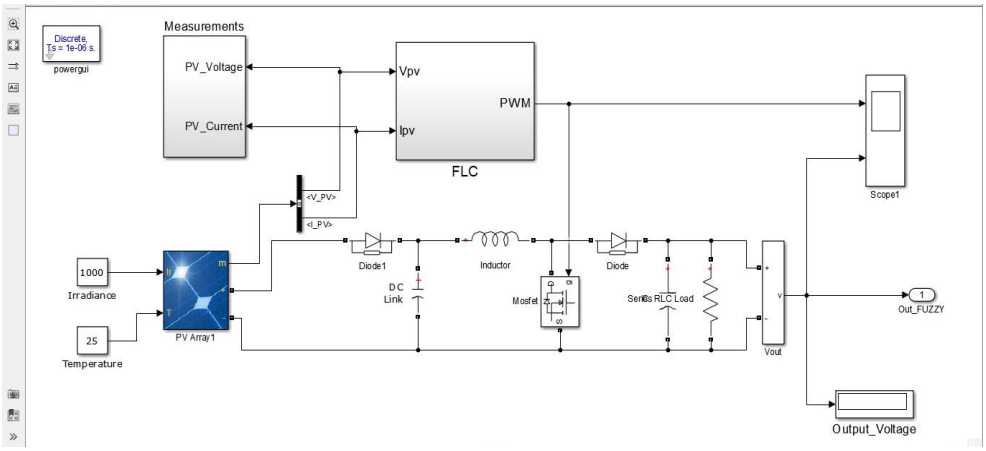

Figure 6. Simulink block of fuzzy logic control

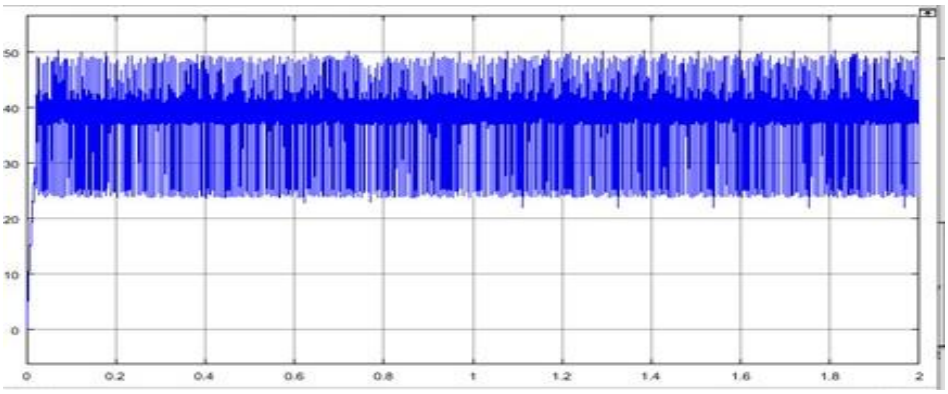

Figure 7. Boost output of fuzzy MPPT

By monitoring the current and voltage, the PV component's power may be estimated. The voltage and current of the PV modules are utilised as inputs to the fuzzy logic control algorithm. The outcome is the duty cycle, which is checked under various operational situations.

5. Conclusion

In attempt to get the most out of a PV system, the incremental conductance technique can follow rapidly changing irradiance situations. Solar PV systems have a basic problem: their efficiency is poor, their prices are high, and their output changes with cloudy weather conditions. As a result, a good MPPT controller is required. After a comparison investigation, it is determined that the Fuzzy Controller is more effective than the IC regulator. With FLC, output power can be increased and also fluctuation can be eliminated, and react rapidly to changing weather conditions. The Fuzzy controller outperforms the incremental conductance technique in terms of obtaining the MPP. It is built and tested under various operating situations to validate its performance. To verify its performance under various operating conditions, it is constructed in MATLAB/SIMULINK. The fuzzy MPPT approach offers a better output, according to simulation findings.

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