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The Comparative Study of Combined Incremental Conductance-Fuzzy Logic Algorithm with Conventional Incremental Conductance Algorithm MPPT Technique for SPV System

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***Abstract*: This paper illustrated a hybrid MPPT composed of two methods: incremental conductance (INC) and Fuzzy Logic (FL) control. This method is able to track maximum power point (MPP) under variable solar irradiance. In addition to that, it generates a modulation signal to adjust the duty cycle of boost converter to ensure fast MPPT process. In order to validate both of the effectiveness and the usefulness of the proposed system, simulation analysis and comparative studies including other known methods are conducted. The results show that the proposed method can track MPP under different solar irradiance and can reduce fluctuation around MPP area.**

***Keywords*: Maximum power point tracking (MPPT), Incremental Conductance (INC), Fuzzy Logic (FL), Solar Photovoltaic (SPV).**

1. Introduction

The Renewable energy sources, recently, have played an important role around the world. This is due to several factors, such as environment, oil crisis, high price, shortcoming of conventional energy sources, and so forth. In this context, Solar Photovoltaic (SPV) energy sources acquired attention around the world. SPV systems are able to directly convert solar energy into electricity. This phenomenon is also called Solar Photovoltaic effect. Some advantages are offered by Solar Photovoltaic systems such as it is clean, sustainable, and easy to maintain energy. Hence, the SPV system can be considered as the most disseminated renewable energy source and is utilized in several applications, such as transportation, phone application, as well as satellite systems. On the other hand, SPV systems' efficiency is typically influenced by climate condition, including solar irradiance (G) and temperature (T). Maximum power point tracking technique (MPPT) increase the efficiency of SPV systems. Several MPPTs have been proposed and continuously developed to maintain SPV system operation at maximum power point (MPP). Generally, there are several types of MPPT method such as perturbation and observer (P&O), incremental conductance (INC), and fuzzy logic (FL) controller. P&O algorithm is a MPPT method that is frequently applied due to its simplicity. To achieve MPPT using P&O, when the operating point move toward MPP, the operating voltage of SPV system must be perturbed in desired direction. On the other hand, when the operating point of SPV system move away from MPP, the operating voltage must be perturbed in reversed direction .Today a number of papers have focused on hill climbing (HC) and P&O algorithms because their simple structure and easy implementation . Nevertheless, these methods are often fluctuating around MPP, especially, when the climatic condition is changing rapidly and due to changing load. However, incremental conductance (INC), which is based on the working mechanism of the slope of SPV power curve versus voltage, is zero at the MPP. The INC itself, typically, uses fixed iteration step size. Fixed iteration step size mechanism has a limitation in dynamic performance. To acquire fast response and to reduce fluctuation around MPP as well, a hybrid method is proposed in this paper. The proposed tracker combines two algorithms: INC algorithm and Fuzzy Logic (FL) controller. The aim of the proposed system is to decrease the shortcoming of conventional INC algorithm. Moreover, the proposed system decreases fluctuation occurring around MPP. Furthermore, another attainment of the proposed hybrid tracker to be able to improve the steady-state performance as well. Boost converter is typically used to boost the input voltage, especially low voltage dc sources as SPV cells, and so forth. In addition to that, this converter is integrated to SPV system to achieve maximum power point tracking function. Recently MPPTs plays an important role in maximize the output power and hence increasing the efficiency, of renewable energy sources, especially SPV systems.

2. Proposed approach

The proposed MPPT system contains a boost converter, Solar Photovoltaic module, a controller that includes INC algorithm and fuzzy logic. Solar Photovoltaic module's inputs are solar irradiance (G) and temperature (T). The output of Solar Photovoltaic module is fed to the boost converter. Furthermore, the INC algorithm employs both of the voltage sensor and current sensor outputs. As described previously, the error (E) is zero if the sum of the incremental instantaneous and the incremental conductance is zero. This condition fulfills MPP condition. The INC's error (E) is be of the FLC's inputs. Furthermore, the FLC's output is the change of duty cycle, which is employed by Pulsed width modulation (PWM), which is used to drive the power MOSFET. In case study, the value of inductor and capacitor (C) is 25 μH and 1μF, respectively, and the value of the load resistor is 6 Ω.In the proposed hybrid algorithm between INC algorithm and fuzzy logic control algorithm the output of INC algorithm is error (E) applied into fuzzy logic control (FLC). The error, coming from INC algorithm is processed to obtain change error (dE); which can be obtained as follows:

$$dE = E(n) - E(n-1) \quad (1)$$

3. Conclusion

In this paper, a hybrid of INC algorithm–FLC is employed to Achieve MPPT of Solar Photovoltaic systems. Moreover, the proposed MPPT system is simulated in Matlab/Simulink environment. Based on comparison between conventional INC and proposed hybrid MPPT, the performance of the proposed system proved better results, compared to those of conventional INC. In addition, there is no fluctuation exists around MPP when the hybrid algorithm is integrated in boost converter.

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