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Fuzzy Logic Based SEPIC Converter for Maximum Power Point Tracking in PV System

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ABSTRACT: In this paper, a fuzzy logic control (FLC) is proposed to control the maximum power point tracking(MPPT) for a photovoltaic (PV) system. The proposed technique uses the fuzzy logic control to specify the size of incremental current in the current command of MPPT. As results indicated, the convergence time of maximum power point (MPP) of the proposed algorithm is better than that of the conventional Perturb and Observation (P&O) technique.This paper DEVELOPS a fuzzy controller (FC)-based single-ended primary-inductor converter (SEPIC) for maximum power point tracking (MPPT) operation of a photovoltaic (PV) system along with battery. The FLC proposed plan utilizes the focalized circulation of the enrollment capacity. The heap is encouraged from the battery stockpiling consistently with steady voltage. The battery will be accused of the assistance of PV module and the SEPIC converter, which is controlled by FLC-based MPPT. The proposed FLC-based MPPT with battery will supply more energy to the heap than the with perturb & observe framework.

KEYWORDS:SEPIC Converter, fuzzy controller, photovoltaic (PV) modules, battery.

I.INTRODUCTION

The single-ended primary inductor converter (SEPIC) work as a buck–boost dc–dc converter, where it changes its output voltage according to its duty cycle. The selection of a proper dc–dc converter plays an important role for maximum power point tracking (MPPT) operation. Because of its yield pick up adaptability. Among known converters, the SEPIC, routine buck–boost, and Cuk converters can venture up and venture down the information voltage. Consequently, this converter can exchange vitality for all illumination levels. Another attractive element is consistent yield current, which permits converter yield parallel association, or change to a voltage source with negligible capacitance. The buck or help converters are not ideal, because of the absence of yield voltage adaptability. The SEPIC is picked in light of the fact that the yield voltage can be higher or lower than the information voltage. Likewise the info and yield voltages are dc disconnected. The disconnection is given by the arrangement capacitor c, which obstructs the dc from the supply side to the yield side[1]. An assistant switch and a clasp capacitor are associated. A coupled inductor and an assistant inductor are used to get swell free information current. The voltage multiplier method and dynamic clasp strategy are connected to the ordinary SEPIC converter to build the voltage pick up, diminish the voltage hassles of the force switches and diode. Besides, by using the reverberation between the resounding inductor and the capacitor in the voltage multiplier circuit, the zero-current-exchanging operation of the yield diode is accomplished and its converse recuperation misfortune is fundamentally decreased. Both the SEPIC and the Cuk converter give the decision to have either higher or lower yield voltage contrasted with the information voltage. The MPPT calculation speaks to ideal burden for PV exhibit, delivering fortunate voltage for the heap. SEPIC converters can have a low information current swell, which is one of the upsides of SEPIC converters. In any case, a mass inductor ought to be utilized to minimize the present swell. Info current swell gets to be one of vital prerequisites because of the wide utilization of low voltage sources, for example, batteries, super capacitors, and energy components. The PV board yields exponential bends for current and voltage, where the greatest force happens at the bend's shared knee. The connected MPPT utilizes a kind of control and rationale to search for the knee, which thus permits the SEPIC converter to remove the most extreme force from the PV cluster. The following technique utilized, i.e., irritates and watch (P&O). A following strategy in light of allegorical capacity is proposed to play out the photovoltaic most extreme force point following. With the proposed strategy, the most extreme force estimation is produced using an allegorical arched capacity. At that point a methodical plan is produced to modify the concavity and ideal district of the rough parabola for guaranteeing the iterative union of the proposed technique. Keeping in mind the end goal to affirm the viability of this proposed outline, the methodology has been connected to examine diverse air situations. Among various clever controllers, fluffy rationale is the least complex to incorporate with the framework. As of late, the fluffy rationale controller (FLC) has gotten an expanding thoughtfulness regarding specialists for converter control, engine drives, and different procedure control since it gives preferable reactions over other traditional controllers. The imprecision of the climate varieties that can be reflected by PV clusters can be tended to precisely utilizing a fluffy controller. So as to take the upsides of the fluffy rationale calculation, the MPPT calculation is coordinated with the FLC so that the general control framework can simply give most extreme force exchange from the PV exhibit to the inverter side, regardless of the erratic climate conditions.

II. RELATED WORK

[1]The single -ended primary inductor converter (SEPIC) acts as a buck-boost dc–dc converter, where it changes its output voltage according to its duty cycle. The selection of a proper dc–dc converter plays an important role for maximum power point tracking (MPPT) operation. Due to its output gain flexibility. Among known converters, the SEPIC, conventional buck–boost, and Cuk converters have the ability to step up and step down the input voltage. Hence, this converter can transfer energy for all irradiation levels. Another desirable feature is continuous output current, which allows converter output parallel connection, or conversion to a voltage source with minimal capacitance. The buck or boost converters are not preferable, due to the lack of output voltage flexibility. The SEPIC is chosen because the output voltage can be higher or lower than the input voltage. Also the input and output voltages are dc isolated. The isolation is provided by the series capacitor c, which blocks the dc from the supply side to the output side [1].An auxiliary switch and a clamp capacitor are connected.

[2] A coupled inductor and an auxiliary inductor are utilized to obtain ripple-free input current. The voltage multiplier technique and active clamp technique are applied to the conventional SEPIC converter to increase the voltage gain, reduce the voltage stresses of the power switches and diode. Moreover, by utilizing the resonance between the resonant inductor and the capacitor in the voltage multiplier circuit, the zero-current-switching operation of the output diode is achieved and its reverse-recovery loss is significantly reduced. Both the SEPIC and the Cuk converter provide the choice to have either higher or lower output voltage compared to the input voltage. The MPPT algorithm represents optimal load for PV array, producing opportune voltage for the load. SEPIC converters can have a low input current ripple, which is one of the advantages of SEPIC converters. However, a bulk inductor should be used to minimize the current ripple. Input current ripple becomes one of important requirements due to the wide use of low voltage sources such as batteries, super capacitors, and fuel cells.

[3] The PV panel yields exponential curves for current and voltage, where the maximum power occurs at the curve's mutual knee. The applied MPPT uses a type of control and logic to look for the knee, which in turn allows the SEPIC converter to extract the maximum power from the PV array. The tracking method used, i.e., perturbs and observe (P&O).A tracking method based on parabolic function is proposed to perform the photovoltaic maximum power point tracking. With the proposed method, the maximum power calculation is made from a parabolic convex function. Then a systematic scheme is developed to adjust the concavity and optimal region of the approximate parabola for ensuring the iterative convergence of the proposed method. In order to confirm the effectiveness of this proposed design, the approach has been applied to investigate different atmospheric scenarios. Among different intelligent controllers, fuzzy logic is the simplest to integrate with the system. Recently, the fuzzy logic controller (FLC) has received an increasing attention to researchers for converter control, motor drives, and other process control because it provides better responses than other conventional controllers. The imprecision of the weather variations that can be reflected by PV arrays can be addressed accurately using a fuzzy controller. In order to take the advantages of the fuzzy logic algorithm,

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the MPPT algorithm is integrated with the FLC so that the overall control system can always provide maximum power transfer from the PV array to the inverter side, in spite of the unpredictable weather conditions.

[4] It presented the first paper on fuzzy set theory in 1965. Since then, a new language was developed to describe the fuzzy properties of reality, which are very difficult and sometime even impossible to be described using conventional methods. Fuzzy set theory has been widely used in the control area with some application to dc-to-dc converter system. A simple fuzzy logic control is built up by a group of rules based on the human knowledge of system behavior. Matlab/Simulink simulation model is built to study the dynamic behavior of dc-to-dc converter and performance of proposed controllers. Furthermore, design of fuzzy logic controller can provide desirable both small signal and large signal dynamic performance at same time, which is not possible with linear control technique. Thus, fuzzy logic controller has been potential ability to improve the robustness of dc-to-dc converters. The basic scheme of a fuzzy logic controller is shown and consists of four principal components such as: a fuzzification interface, which converts input data into suitable linguistic values; a knowledge base, which consists of a data base with the necessary linguistic definitions and the control rule set; a decision-making logic which, simulating a human decision process, infer the fuzzy control action from the knowledge of the control rules and linguistic variable definitions; a de-fuzzification interface which yields non fuzzy control action from an inferred fuzzy control action [10].

III. PROPOSED SYSTEM

In this paper, the voltage level increments or abatements relying upon the most extreme force. Besides, the controller changes the voltage level by changing the obligation cycle of the pulse width-modulated (PWM) signal, which tracks the reference signal. A sinusoidal reference sign is contrasted with the yield signal with produce an as far as anyone knows zero mistake signal. Another reference sign is utilized to look at the SEPIC's yield, to accomplish the greatest force. This reference sign is versatile, changing its shape as indicated by climate conditions**.** The SEPIC dc–dc converter together with the MPPT and the fuzzy controller with battery. The design of the fuzzy controller was done using Mamdani's method for the converter. The maximum power point can be achieved in case of a grid-connected system, a full-load condition, or using battery charging in case of a standalone system. However, if the load need is lower than PV capacity, the PV voltage will move right in the PV curve, achieving the opportune power. This case happens even if the batteries of the standalone system are full and the load is lower than PV power. In grid-connected systems, the load is always there due to the huge number of clients. Therefore, the maximum power point can always be achieved subject to the load need.

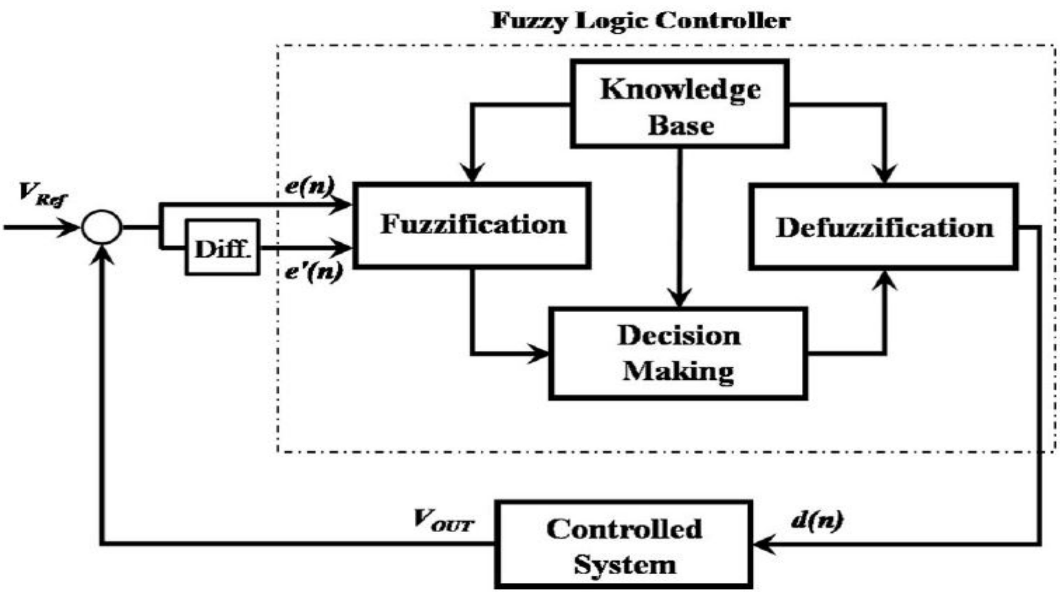

Fig. 1. Structure of the proposed FLC.

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IV. FLC ALGORITHM

In FLC outline, one ought to distinguish the principle control variables and decide the sets that depict the estimations of each semantic variable. The information variables of the FLC are the yield voltage mistake e(n) and the change of this blunder e_(n). The yield of the FLC is the obligation cycle of d(n) of the PWM signal, which manages the yield voltage. The fluffy standards of the proposed PV SEPIC dc–dc converter can be spoken to in a symmetric structure, as appeared in Table I. In addition, the enrollment elements of the yield variables are nine term fluffy sets with traditional triangular shapes, i.e., negative enormous (N4), negative huge (N3), negative little (N2), negative little (N1), zero (Z), positive little (P1), positive little (P2), positive huge (P3), and positive huge (P4). The Mamdani fluffy derivation strategy is utilized for the proposed FLC, where the greatest of least creation system is utilized for the surmising and the focal point of-gravity technique is utilized for the defuzzification procedure. It represents an engaged enrollment capacity, where the sets go toward zero. the enrollment capacities in It are ensured to create the steady yield signal. The outline of the engaged enrollment capacity values relies on upon the way of the sign. The info signal qualities are amongst −100 and 100 in view of the mistake signal, which is resultant from the distinction between the yield signal and the wanted reference signal. Likewise, the greater part of mistake qualities are focused from −20 to 20. The sharpness of the control sign is extremely fundamental for minimizing the mistake sign to zero in brief time; wherefore, the beat enrollment capacity is utilized to design the control signal fluffy sets. The FLC execution changes with unsymmetrical conveyance of enrollment capacities, where both joined and unique sorts of asymmetry will be considered with shifting degrees of the unsymmetrical participation capacities.

V. PROPOSED MPPT-BASED SEPIC CONVERTER

The fluffy controller is connected to the SEPIC converter to impersonate the new reference signal originating from the MPPT. The new obligation cycle $\delta(k)$ of the SEPIC converter switch was balanced either by including or by subtracting the past obligation cycle $\delta(k-1)$ with the obligation cycle's annoyance step size. Condition (1) displays the connection between the present and past obligation cycles, i.e., $\delta(k) = \delta(k-1)\ \Delta\delta$ (1) where $\Delta\delta$ is the adjustment in obligation cycle, coming about because of the change of reference sign. The MPPT control procedure is connected to accomplish another reference voltage for the fluffy controller, which changes the obligation cycle of the PWM signal for the SEPIC converter. The P&O calculation has a straightforward structure and requires couple of parameters (i.e., force and voltage); that is the reason it is broadly utilized as a part of numerous MPPT frameworks. The P&O technique annoys the obligation cycle and contrasts prompt force and past force. In view of this correlation, the PV voltage decides the bearing of the following annoyance. P&O demonstrates that, if the force slant increments and the voltage slant increments additionally, the reference voltage will increment; else, it will diminish. The downside of a large portion of the fluffy based MPPT calculations is that the following point is found far from the greatest force moment that the climate conditions change. Nonetheless, a downside of P&O procedure is that, at relentless state, the working point sways around the most extreme force guide giving ascent toward the misuse of accessible vitality, especially in instances of consistent or gradually shifting barometrical conditions. This can be fathomed by diminishing the progression size of bother. The progression size of the P&O strategy influences two parameters: exactness and velocity. Exactness increments when the progression size declines. Be that as it may, exactness prompts moderate reaction when the ecological conditions change quickly. Step sizes ought to, in this way, be picked well to accomplish fast and precision. The MPPT converter was done utilizing MATLAB/Simulink. The main reproduction utilized the trademark conditions of the PV exhibit, while the second reenactment utilized the sun powered board module given in Simulink. The MPPT calculation was constructed through (.m) record and connected with Simulink. The SEPIC circuit was assembled by means of Sim Power tool stash. It demonstrates the bends for force versus voltage, at 25 ◦C and 50 ◦C, for radiation varieties, from 250 W/m2 to 1000 W/m2. For recreation purposes, the PV board values and the quantity of PV clusters were taken relying upon the trial setup, The reference voltage signal, following the most extreme force.

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VI. SIMULATION RESULTS

Reproduction was connected on MATLAB/Simulink to check the functional usage of the proposed SEPIC fluffy controller. It displays the reference signal for the SEPIC's yield, where it tracks the most extreme force. The yield voltage of the proposed FLC based MPPT with battery at consistent burden condition are appeared here.

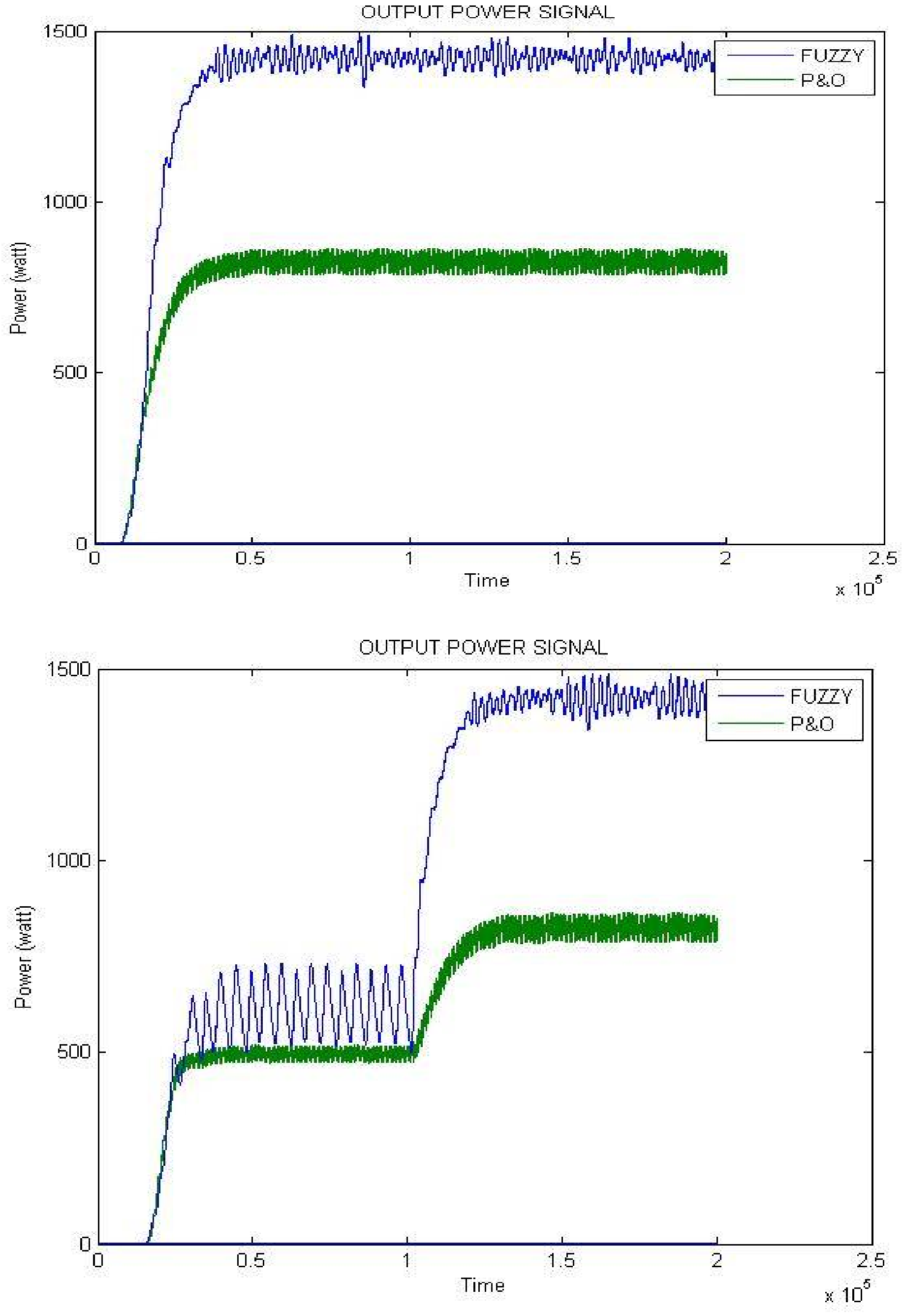

Fig.6 Output Power Signal

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VII. CONCLUSION

From the consideration of all the above points we conclude that In this paper, a fuzzy logic control (FLC) is proposed to control the maximum power point tracking(MPPT) for a photovoltaic (PV) system. The proposed technique uses the fuzzy logic control to specify the size of incremental current in the current command of MPPT. As results indicated, the convergence time of maximum power point (MPP) of the proposed algorithm is better than that of the conventional Perturb and Observation (P&O) technique. An FLC-based MPPT scheme for the SEPIC converter system for PV power applications has been presented.The battery will be charge with the help of SEPIC converter. The proposed FLC-based MPPT scheme for the SEPIC converter could be a potential candidate for real-time PV inverter applications under variable load conditions.

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