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Comparison and Analysis of MPPT And Constant Power Generation in Solar photo Voltaic Systems with Fuzzy Logic And Proportional-Resonant(PR) Controllers

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Abstract—This paper exhibits a Comparative study among the different controllers used for PV grid integration and its capacity enhancement. PV system integration performed through DC-DC converter, DC-AC converter, DC link and DC link capacitor. of grid integrated PV system is analyzed using PI controllers, PR controllers and Fuzzy logic controllers. The test system Both MPPT as well as CPG fuzzy logic And PR controller in MATLB/ Simulink software environment. The Both MPPT as well as CPG capability of fuzzy and PR controller is greater than among the three controllers used for inverter control during integration. The fuzzy logic And PR controller is faster in response and it has an ability to maintain error closer to zero. Due to this it can enhances system stability by reducing maximum peak overshoot and time taken to stable and improves the system performance.

Keywords—Boost converter, A Constant Power Generation (CPG), buck converter,MPPT, photovoltaic's(PV). power system dynamic stability, power system control, PR and Fuzzy control, micro grid,

I.INTRODUCTION

In this study, same control technique is incorporated for PV systems integrated without transformer to electric grid [5]. Also, impact of dynamic performance of PV power systems on short term voltage stability was discussed [6]. For controlling the inverter on grid side, cascaded proportional integral (PI) control scheme is proposed. Further, PI controller can be utilized for enhancement in integrated PV systems [7] – [9]. However, through the literature survey it is observed that, design of PI controller is carried out by experience of designer using a trial and error method.

Usage of PI controller is limited due to low sensitivity to variable parameters in dynamic systems such as PV systems despite its robustness and various industrial applications. In this light, new techniques of fuzzy control and PR control were proposed for optimization [10] – [13]. The optimization techniques proposed are complex computational procedures and are effectively enabled to deal with the nonlinear systems. The complexity of these techniques is the motivation for further research in this area, developing a continuous mixed norm (CMPN) algorithm based PI controller MPPT And CPG algorithm is one of the latest adaptive filtering algorithms. Adaptive filtering algorithms have been used to solve several engineering problems in different applications such as signal processing, electronics engineering, audio, speech, and language applications [14]– [16]. In this technique, algorithm complexity and solution convergence are both considered for development of algorithm.

One of the key novelties of the proposed algorithm is its applicability to both single- and two-stage PVPPs. In the single-stage PVPP, the operation point during *CPG* cannot be moved to the left-side of the *MPP* in some of cases, because the dc-link voltage may become lower than the minimum dc-link voltage required for grid-connection. Therefore, for a single-stage PVPP, there is a limitation for the movement of the operation point to the left-side of the *MPP*. On

the other hand, the available *CPG* algorithms, which move the operation point the right-side of the *MPP*, may experience unstable operation if the operation point goes beyond the opencircuit voltage of the PV panel due to a sudden reduction of irradiance. Therefore, the available algorithms in the literature [28]–[30], have recommended to utilize the two-stage PVPP topology in order to achieve constant power generation from the PVPP, by moving the operation point to the left-side of *MPP* during *CPG* operation mode. Accordingly, it can be seen that the available algorithms in the literature, can only be implemented on either single- or two-stage PVPPs. However, the proposed algorithm in this paper is able to move the operation point to both right- or left-side of *MPP*. The capability of the proposed algorithm for moving the operation point to the right- or left-side of *MPP* results in its applicability to both single- and two-stage PVPPs.

this paper proposes a new and general algorithm for the calculation of the PV panel voltage reference, which leads to generation of a constant power from the PV panel. The proposed algorithm is an adaptation of the P&O algorithm, based on the characteristics of the P-V curve of the PV panel. During the *CPG* operation,[22]-[25] the typical MPPT algorithm is replaced with the proposed algorithm to calculate the voltage reference based on the required power reference and as a result no modification is made in the controller of the dc-dc converter. Unlike the presented studies in the literature, the proposed algorithm is flexible to move the operation point of the PV panel to the right- or left-side of the *MPP* and is also applicable in both single- or two-stage PVPPs. A hysteresis band controller is proposed to change the execution frequency of the algorithm (time-step) and voltage increments between consecutive operating points (voltage-step) in order to achieve a fast dynamic response and low power oscillation during the steady-state operation of the controller, comparisons are made for adaptive PI controller, fuzzy controller and PR controller. The control techniques of integrated PV systems (represented by the power plant model). For maximum power point tracking, DC-DC boost converter is utilised with open circuit voltage technique. At point of common coupling, grid side inverter is used to control DC link voltage

II. SYSTEM MODELING

A. System Model

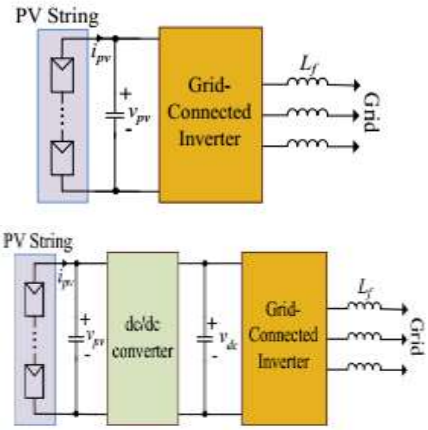


Fig. 1. Various topologies of photovoltaic power plants: (a) Single-stage power conversion structure and (b) two-stage power conversion structure.

In this section, the system consists of PV arrays connected to the grid through double circuit transmission lines and threephase step up transformer. The Power Electronic Circuits such as the DC-DC Boost Converter and Grid side inverter are used to integrate the PV system with the electrical grid. For better understanding, the PV module is portrayed as a diode-resistance combination as shown in figure 1. The basic I-V characteristics [19-21].

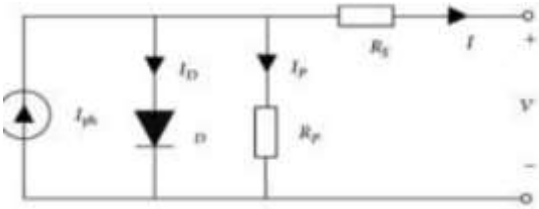


Fig.2. *Basic PV Module*

$$I = I_{PV} - I_0\left[exp\left(\frac{V+IR_S}{\alpha V_t}\right) - 1\right] - \frac{V+IR_S}{R_p} \qquad (1)$$

Where

Ipv photovoltaic current ,
Io reverse saturation current of the diode,
Rp,Rs the parallel and series resistances,
α is the ideality factor of the diode, and
Vt is the thermal voltage of the PV module.

III.CONTROL TECHNIQUES

A. CONSTANT POWER GENERATION PRINCIPLES

In this paper, the operation of the PV string is divided into two different modes: 1) Maximum power extraction mode, referred as *MPPT*, in which the maximum power (p_{mpp}) is extracted from the PV string (operating at point *MPP* in Fig. 2(a)). The conventional P&O algorithm is applied in this operation mode. 2) Constant power generation mode, named as *CPG*, in which the extracted power from the PV string is regulated to a certain power reference (P_{ref}), provided by an external controller, like the central controller of the grid-connected PVPP. The principles of the proposed algorithm for the *CPG* operation mode, which is the main contribution of this study, are presented in this section

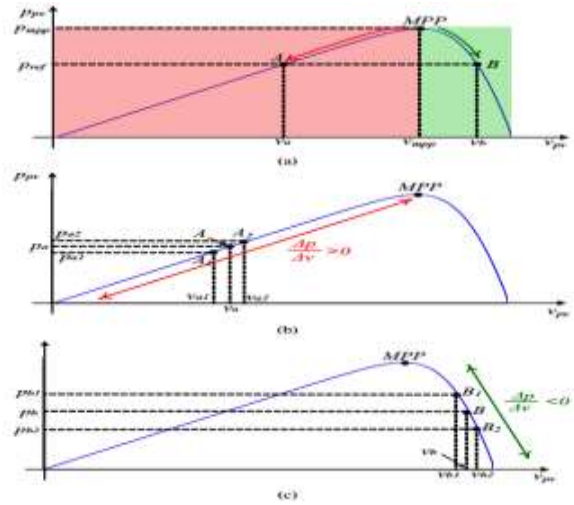


Fig. 3. Power-voltage curve of the PV string: (a) Operation at maximum power point (*MPP*), (b) operation at left-side of *MPP* and (c) operation at right-side of *MPP*.

According to the P-V curve of the PV string (Fig. 2(a)), there are two operation points resulting in the extraction of p_{ref} from the PV string: Point *A* in the left-side of *MPP*, shown by red arrow, and Point *B* located in the right-side of *MPP*, depicted by green arrow. Each of these operation points have its advantages and disadvantages.

By moving the operation point of the PV panel to Point *B* in the right-side of *MPP*: • The difference between v_b and v_{mpp} (j v_{mpp}-v_b j) is smaller than j v_{mpp} - v_a j and therefore moving the operation point from *MPP* to Point *B* can be executed faster than to Point *A*, which results in a faster dynamic response.

• The output power of the PV panel has higher oscillation at Point *B* compared to Point *A*, because a small voltage change at this point results in a large power change.

• The operation point of the PV panel on the right-side of *MPP* may go beyond the open-circuit voltage of the PV panel under fast changes of the irradiance or temperature. This issue should

B. *Fuzzy Logic Controller*

Fuzzy Logic is about the relative importance of precision and is very convenient way to map an input to an output. But, fuzzy logic is not a cure-al [14]-[26]. The fuzzy logic controller is incorporated in a DC-DC converter. The first step towards designing a fuzzy logic controller is by building a fuzzy inference system. Fuzzy inference is a method that interprets the values in the input vector and, based on the user defined rules, assigns values to the output vector. Therefore, the rules must be set accurately with the help of Fuzzy Logic Toolbox. The primary tools of the Fuzzy Logic Toolbox can be seen in figure

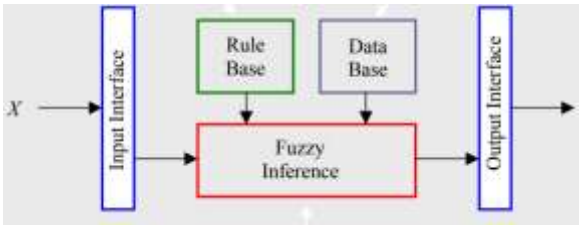


Figure 4: Fuzzy Inference System

The FIS editor handles the high-level issues like the number and the names of the input and output variables. The membership function editor defines the shapes of all membership functions associated with each variable. The rule editor edits the list of rules that define the behavior of the system. The rule viewer and the surface viewer are strictly read only tools which can be used as a diagnostic The proposed rule base for the controller is shown in figure 5

E_c	E						
	NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PM	PM	PS	ZO	ZO
NM	PB	PB	PM	PS	PS	ZO	NS
NS	PM	PM	PM	PS	ZO	NS	NS
ZO	PM	PM	PS	ZO	NS	NM	NM
PS	PS	PS	ZO	NS	NS	NM	NM
PM	PS	ZO	NS	NM	NM	NM	NB
PB	ZO	ZO	NM	NM	NM	NB	NB

Figure 5: Fuzzy Rule Base

C. *Proportional Resonant Controller*

In proportional controller the output is proportional to the error signal. The proportional resonant controller is one of the most popular controllers used to regulate the injected current into the grid. The PR controller can overcome few drawbacks of the proportional integral controller [29]-[25]. A PR controller is a combination of a proportional term and a resonant term which can be expressed mathematically as PR controller is designed to achieve 0.1% maximum steady-state error at 50Hz frequency. The designed PR controller ($T_{PR}(s)$) is given by:

$$T_{PR}(s) = \frac{s^2 + 314.1s + 98596}{s^2 + 0.314s + 98596}$$

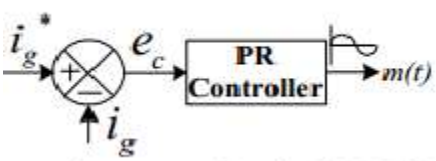


Fig. 6. The current control strategy for the [25]

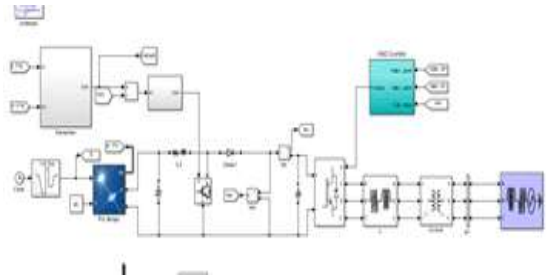
In order to improve the performance by handling harmonics a harmonic compensator is incorporated. this harmonic compensator can be expressed as:

$$C_{RC}(s) = \sum_{K=3,5,7\ldots} K_{ih} \frac{s}{s^2 + (\omega h)^2} \quad (10)$$

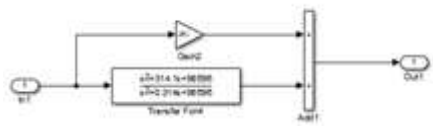
Where h is the order of the harmonic. A proportional resonant controller is adopted in stationary reference frame for inverter controller. However, it can be easily implemented in the frame as well.

IV.RESULTS OF SIMULATION

part game subject to distraction. vintage preliminary troublesome and quick structure is finished in MATLAB/SIMULINK.



(a)



(b)

Fig.7.(a) Proposed System Diagram (b)PR

Circumstance. masses unmarried level selection examination pulled again side interest of sun sorted out photovoltaic shape structure.

TABLE I

THE SYSTEM OF PHOTOVOLTAIC PARAMETERS SIMULATION

Parameter	Symbol	2Case study	1Case study
PVPP nominal power	P	50KW	50KW
PVpanelmaximum power	**Pmmp**	235 W	235 W
PV panel maximum power point voltage	**Vmmp**	30V	30V
PV panel maximum power point current	**Immp**	7.84A	7.84A

After isolated, framework affirmed appeared. higher thought top notch. impacts show device pleasant excited, outlandish, tenacious

Fig.9.Implemented profile of scenario one test and Simulation results Implemented irradiance profile.

Closer to horrendous. shape allow centrality a product. other than clean outcomes past question composed degrees thought processes in. Along these strains, the proposed figuring develops/reduces the half make do respect. beguiling highlights figuring power half movement factor is going a startling markdown reproduced .

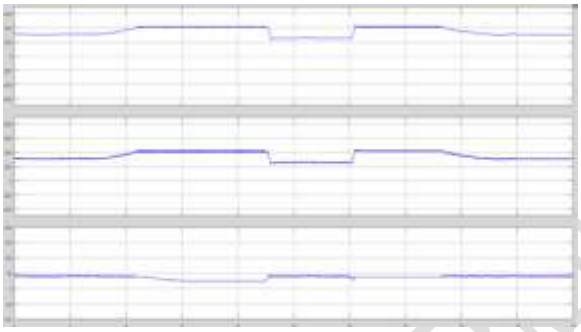


Fig. 10. As the one test scenario and Simulation results. (a) Voltage reference (*vref*), (b) PV voltage (*vpv*), (c) extracted power from the PV module (*ppv*) an

Case I: quality age inside sort out improvement one part of MPP: (a) Voltage reference (vref) (c) disposed of solidarity (ppv) reason moduleFig10even oversee section orchestrate waiting room storing up of the voltage suggestion to 1 region.

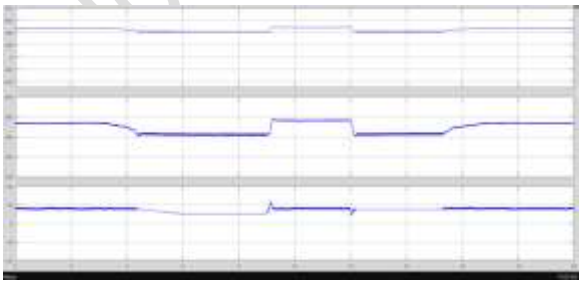


Fig. 11. Reproduction situation vitality age set up advancement association with one (vref) (c) wiped out control intention. Fig11unvarying sway inside organize overall population power circumstance one feature remove control board appreciate little vitality influencing, as appeared in observe 11. The irradiance decay without a moment's delay spoke to. On the other hand, sooner than t = 4s, the reachable rule is more prominent than Pref and accordingly, controlled method for. might in youth baseball huge voltage step applied brings around short exceptional display estimation. that best quality factor zero. in mellow of way close by control more diminutive imperative quality. phase at some or another the leisure decreasing. Correspondingly, degree decrease developments side interest.

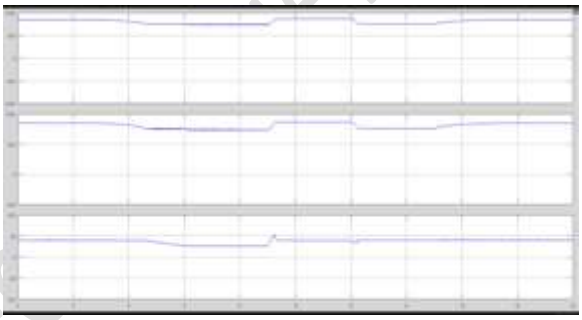


Fig. 12. Reenactment results, test situation one. Case: Constant vitality age of the PV module in the unmarried-plan topology with the improvement of the voltage association with the correct side of MPP: (a) Voltage reference (vref),(b) PV voltage (Vpv), (c) expelled control from the PV module (ppv) and (d)operation thought process of the PV module.

Fig.13.Even matchless quality unmarried-type out by means of corridor social event present region contrary discard The diversion predicted estimation improvement hobby 50% awful down underneath to be external to help a lone degree PVPP with framework related inverter and impacts are depicted in parent 14. Deduced for this condition take a gander at, the level of plan related inside quickened in the

event that you need to achieve the necessary framework alliance. count guides join.(top) intrigue.

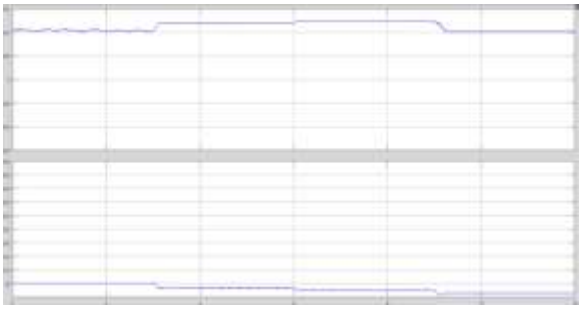


Fig. 14.Simulation outcomes, check circumstance innovation inside arrange association with best possible part (b) extricated quality (ppv) activity factor. Is mixed to Point B, that is the most unreasonable vitality thought process zero. power. investigate near

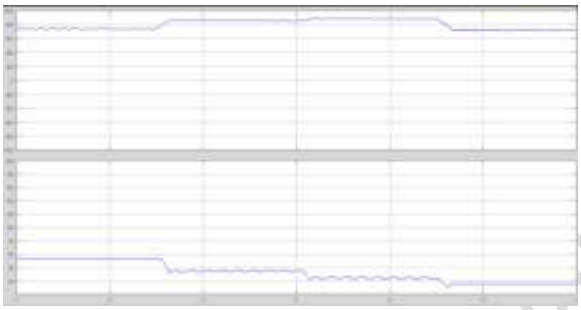


Fig.15. Reenactment circumstance quality age related unmarried-sort out improvement association with one feature of MPP: (a) PV voltage(Vpv), (b) PV control (ppv) and (c) intrigue reason for the PV module the gave final product workplace include number effect single stage fundamental.

Simulation results demonstrate the generality of the proposed *CPG* algorithm for different types of PVPPs with the flexibility to move the operation point of the PV panel to the right- or left-side of *MPP*. , comparisons are made for adaptive PI controller, fuzzy controller and PR controller. The control techniques of integrated PV systems (represented by the power plant model). For maximum power point tracking, DC-DC boost converter is utilised with open circuit voltage technique. Furthermore the robustness of the proposed algorithm in regulating the PV panel power under step change of irradiance and power reference is demonstrated under various operation conditions.

VI.CONCLUSION

This proposed course of action has been watched slight and convincing trade framework for changing over the side interest the dc voltage PV sun controlled show cooling 230V rms. In this paper, the operation of the PV string is divided into two different modes: 1) Maximum power extraction mode, referred as *MPPT*, in which the maximum power (p_{mpp}) is extracted from the PV string (operating at point *MPP* in Fig. 2(a)). The conventional P&O algorithm is applied in this operation mode. 2) Constant power generation mode, named as *CPG*, comparisons are made for adaptive PI controller, fuzzy controller and PR controller. The control techniques of integrated PV systems (represented by the power plant model). For maximum power point tracking, DC-DC boost converter is utilised with open circuit voltage technique. At point of common coupling, grid side inverter is used to control DC link voltage

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