



Power Improvements in Grid-Connected PV System Using Hybrid Technologies

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Abstract. In recent trends, photo-voltaic (PV) is mostly build upon competitive technological development of power quality (PQ) issues. In this article, a hybrid control strategy is implemented with multi-level inverter (MLI) to improve PQ features. As a result, the combination of these controllers with suitable level of MLI could improve the PQ features in a significant way.

Key words. Multi-level inverter (MLI), Photo-voltaic (PV) energy, Power quality (PQ), Hybrid control, Electrical microgrids (MGs).

1. Introduction

Nowadays, Technologies in RES have got more opportunities for promoting PV for generating electric power. At present, the counting of renewable source of energy and its sizes are extending to growing rapidly, correspondingly with the influence of power system [1]. The electrical grids are steadily developing because of its stable technical confrontation it would have to meet; the involvement of distributive generation, renewable source of energy, power flow with bidirectional, etc.

In this powerful setting, it is a requirement that this system can able to sustain increasing the count of users although assurance to few conditions. By connecting more number of renewable sources into the grid required to be addressed carefully to suppress few power quality parameters [2]. Nowadays, by connecting RES with the power grid have reached notable penetration and it can affect the quality of power and stability of grid. By using phase locked loop (PLL) algorithm, control some of the parameters and reduced the inaccuracy to provide better operation [3].

In recent trends, there is a massive development in both domestic and industrial appliances. Power systems with the badness that leads to damage produce their components owing to process of overheating. In these power systems, there are, in addition, some common problems such as harmonic distortion, voltage sag, transient, spikes etc. [4]. Multi-Level Inverter gives the output value as high from the voltage of medium source.

This technique is performed to produce the system with improved power quality and, in addition, reduces the stress voltage on the load. One of the most important devices used for eliminating the distortion is filter [5]. By the use of filter, compensating the disturbance of harmonics and enhance the system improvement. When the system is connected with load, efficiency of filter is based on harmonic disturbance of both the current and voltage. Filters included in the system provide controlling the reactive power, correction of power factor and filtering the harmonics [6].

2. Literature Review and Objective

In this section, a discussion of various existing techniques that are developed for effective power supply in grid connected PV-array, including improvement of the power quality, are presented. In particular, some of them are shown in Table 1.

Nowadays, MLI with novel control strategy provides the better results for reduction of THD and switching loss. For calculating the switching angle, a hybrid control strategy is the excellent choice for predicting the angle. And also it can provide the specific fundamental voltage by eliminating the harmonics.

- Reduction of THD in current waveforms will increase the performance of the system and also make the output voltage as stable one.
- Provide specific switching frequency through proper control strategy to reduce the harmonic distortion and switching loss.
- By using novel technique to reduce the current THD, inverter cost and filter size gets reduced to improve the efficiency.
- By minimizing the switching loss provide the result with accuracy and make robust with lower dynamic response.

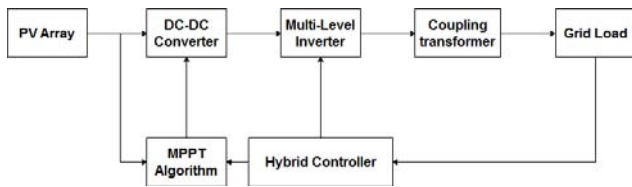


Fig. 1. General block diagram of proposed method.

3. Proposed Method

The PV array generates electric power with the help of PV radiations and the output from the PV is DC. The highest power from the PV can be extracted from the maximum power point. However, the effectiveness of the PV is depending upon the irradiance and cell temperature, which deviates the power from the maximum power. Therefore, a control technique is required to track the MPP according to this change. The low irradiance can also cause PQ problems in the distribution grid.

The general block diagram of a grid-tied PV system is as shown in Fig. 1. Due to the energy demand of the electric utilities, PV is utilized in the grid-connected system to provide the essential power to the end users. However, the high penetration level of the PV in the distribution system affects the system performance in terms of power quality, stability and voltage regulation.

In the configuration process, both power conversion stages (DC-DC and DC-AC) are convoluted between PV and grid. The grid tied PV structure comprises of a PV panel, DC-DC converter, MLI and the grid. Nowadays, the boost converters are used widely in the industries due to the requirement of variable DC supply. The intermediate DC-DC converter fitted between the PV array and the inverter acts as an interface between the output DC voltage of the PV modules and the DC link voltage at the input of the voltage source inverter.

The voltage of the PV array is variable with unpredictable atmospheric factors, while the bus voltage is controlled to be kept constant at all load conditions. But the effectiveness of the PV array is depending upon the irradiance and cell temperature, which deviates the power from the maximum power. The feedback from the grid (Voltage, Current, THD, Active/Reactive power) is given to the controller which is already contains the input PV power also.

4. Conclusion and future Work

MLIs have been extensively employed to improve the PQ of the PV systems. However, the need for large number of components, higher standing voltage, and high harmonic content in the output of a conventional MLI greatly affects the system efficiency. Here, in this research, a hybrid control strategy (for example; hybrid Neural Network with Whale Optimization Algorithm (or) hybrid Shuffled Frog Leap Algorithm with Ant Lion Optimizer (or) Glow-worm Swarm Optimization with Rule based techniques) will be implemented with suitable level of inverter (5 level (or) 15 level (or) 27 level with less number of switches) to reduce

the PQ issues present in the system. The hybrid control strategy will be applied to determine the optimum switching angles for the MLI which will reduce the complexity of the calculations.

The final version of this paper digest will show the main results obtained of the designed hybrid control strategy, implemented with a multi-level inverter (MLI) to improve PQ features, and the modeling carried out in order to predict and assure the stability of the aforementioned design.

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Table I: Characteristics of the inverter.

| Authors | Methodology | Advantages | Limitations | Performance Metrics |
|------------------------------------|---|--|---|--|
| A. I. Ali, <i>et al.</i> , [7] | Introduced a modified efficient variable step Perturb and Observe (VSPO) algorithm to solve the Maximum Power Point (MPP) under a rapidly changing insolation problem. | The proposed algorithm improves the system response and reduces the steady state voltage oscillations, which improve the system efficiency. | The output power of the proposed algorithm tracks the irradiance profile, however, the output power is decreased due to the temperature rise. | Active & reactive power, current, grid current voltage, reference & actual voltages and tracking efficiency. |
| H. A. Mosalam, <i>et al.</i> , [8] | Implemented a fuzzy logic methodology to control a grid- connected PV system through Z-source inverter using maximum constant boost control method. | The system response using FLC is more suitable than the traditional PI controller in terms of less overshoot and less settling time. Also, the system is more stable speedily and softly at the desired value with less oscillation. | The proposed method did not achieved better performance than the PI control system only, when the MPPT block changes the reference maximum power. | Active power, power factor, grid currents and PV output power are used for the validation. |
| M. Lakshmi, and S. Hemamalini, [9] | Designed a decoupled control of grid connected PV system using Fractional Order Proportional- Integral (FOPI) controller. | This feature of FOPI controller improves the system efficiency by reducing the losses caused by THD during the variable irradiation and load condition. The significant reduction in the grid current THD is achieved by injecting less oscillation current to the grid. | The inductance of a LCL filter is small as compared to the L filter to minimize the harmonics at the switching frequency. The increase in amplitude at resonant frequency causes instability of the overall system. | DC link regulation, system response and output current. |
| M. Aourir, <i>et al.</i> , [10] | Presents the control development of a single stage grid- connected PV system using a nonlinear cascade controller based on average state space model. [A single-phase half-bridge inverter] | A multi-loop controller is designed by using back-stepping and Lyapunov approaches for the power factor correction objective ensure the power balance between the grid and PV panels. | However, the residual ripples of low amplitude affects all signals in the control system. | DC bus voltage, grid current, PV panels power, grid power, harmonic content and power factor. |