Two PV Arrays in Mismatched Environmental Conditions based Inverter with Grid Connection using Fuzzy Logic based MPPT Control

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Abstract - *Solar PV cells-based inverters are very much in demand these days. Sometimes the PV arrays are mismatched due to different environmental conditions which may lead to voltage fluctuations and distortions in the output voltage and current of the inverter. The existing PV inverters are not having much stable outputs in this case. In this paper, a new control system is designed for two PV array based solar inverter, which will have distortions less than 1% for both voltage and current. The controller uses Fuzzy logic based MPPT (Maximum Power Point Tracking) design in combination with existing PI (Proportional Integral) controller for the gate switching mechanism. The gate signals are optimized for different environmental conditions and are proved to be more efficient than the existing methods without fuzzy logic. Fuzzy logic controller in MPPT improves the precision of the solar PV inverter with two mismatched PV arrays.*

Key Words: PV, inverter, Maximum Power Point Tracking (MPPT), Fuzzy, Proportional Integral (PI).

Introduction:

The significant purpose of a PV framework is to confirm ideal execution of particular PV projects in a PV exhibit. On the other hand, the projects are presented to various ecological conditions emerging because of distinction in insolation level and additionally contrast in temperature of working. [1] The nearness of issues in working state of modules altogether diminishes the power yield from the PV exhibit. [2] The issue including some of the confounded natural conditions gets noteworthy if the quantity of modules associated in arrangement in a PV exhibit is enormous. [3] So as to achieve wanted size for the information of DC interface voltage of the inverter of a

frame associated transformer less PV framework, the necessity of arrangement associated modules turns out to be high. [4] Thus, the power yield from a framework associated transformer less PV framework, for example, single stage inverter-based frameworks got from bridges and unbiased point brace inverter-based frameworks get influenced altogether. [5]

The interest of inexhaustible assets has been expanding quickly because of the problems related to ecological and need of vitality. Solar photovoltaic vitality is right now one of the most well known and sustainable power source assets on the earth. Inverter is a fundamental part in matrix associated PV frameworks. [6] This survey centres around the gauges of inverter for framework associated PV framework, a few inverter projects for interfacing PV boards to the three stage or single-stage matrix with their favourable circumstances and impediments. Right now, converter structure utilized for inverter is completed and correlation of different inverter projects is in limelight according to their effectiveness, vitality gathering, cost, concealing impact and unwavering quality. The PV power age framework is applied to legitimately change solar vitality into electrical vitality using solar cells. The principle parts of the framework are controller, battery, booster, solar cell and inverter. [7] They are all characterized by high dependability, long assistance life, no contamination, and creating power autonomously, which gets the kindness of national ventures and has huge potential for future improvement. In this way, the improvement and usage of solar vitality is an extremely superb strategy for understanding the trouble of power supply in remote

region. These frameworks are the suitable applications, where modest quantity of power has a great worth, so making PV financially cost serious with other small amount of producing sources. [8] These frameworks were the primary business application for earthly PV frameworks. They give power at a low upkeep for a wide scope of uses, for example, media transmission, water siphoning, vaccine refrigeration and navigational guides. [9]

By presenting a buck and boost inverter arranged in the circuit of SPGCT PV inverter, the energy extracted by MEC is increased in future, as an outcome of the nearness of the middle boost organize, the prerequisite of arrangement associated PV circuits in a PV exhibit has decreased. The mathematical formation and manageable procedure of the offered inverter guarantee that the greatness of spillage current related with the PV exhibits stays inside as far as possible. [10] Further, the voltage worry across the active gadgets is diminished nearly significantly contrasted with that of the plans introduced, thus high recurrence activity without expanding the exchanging misfortune is guaranteed. High recurrence activity likewise prompts the decrease in the size of the uninvolved components. Thus, the working proficiency of the proposed conspire is high. In this paper, a new algorithm is proposed for the buck boost type inverter in mismatched environment.

Implementation:

In this section, the implementation work done in MATLAB Simulink for simulation of two PV array-based inverter is presented. Also, the results obtained between the existing and proposed system for PV mismatched inverter are presented.

Fuzzy Logic based Control System:

In fuzzy logic controller, the first inputs are PV current and voltage, which are then converted to error in power and change in power error. Certain rules are applied on this by dividing the range of different inputs to membership type of functions like Negative big, Negative small, Zero, Positive small and Positive big. According to these membership type of functions,

outputs are received by applying the rule set. This is shown in further implementation and results section. The toolbox used is fuzzy toolbox as given in MATLAB.

Instead of incremental conductance, here, fuzzy logic controller is applied for higher accuracy. In figure 1, the circuit diagram is taken as existing to make comparison for results, in order to improve this circuit, fuzzy logic is applied.
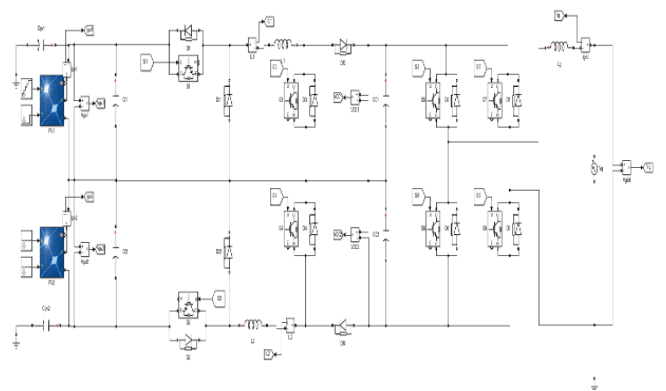
Figure 1: Final Model for Two PV array Inverter

In figure 2, the fuzzy logic controller is presented, in the subsystem the power is calculated which results in change in power that is distorted and change in its error of power as two inputs which are multiplexed and fed to the fuzzy logic type of controller after applying the delays in order to process the rules. This output added with a factor that will enhance the duty ratio and a duty ratio output is generated.
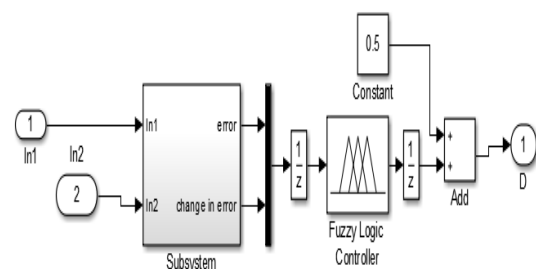
Figure 2: Fuzzy Logic Controller for Two PV inverter

In figure 3, the subsystem is defined for giving error and change in error output from the current and voltage from PV arrays. Here, two fuzzy logic controllers are applied for each PV array because the PV arrays are mismatched and may create different outputs and errors.
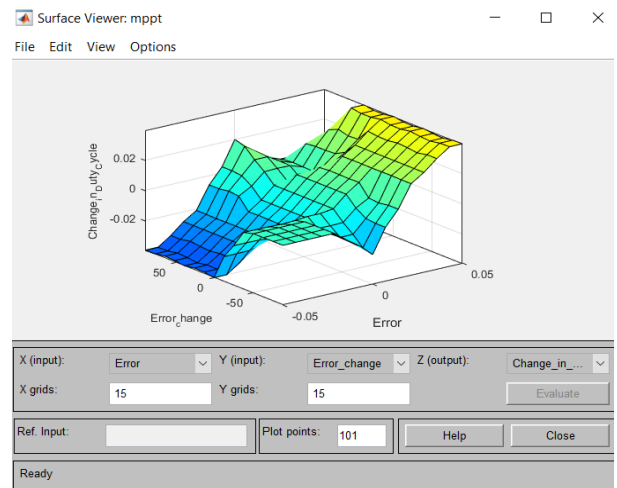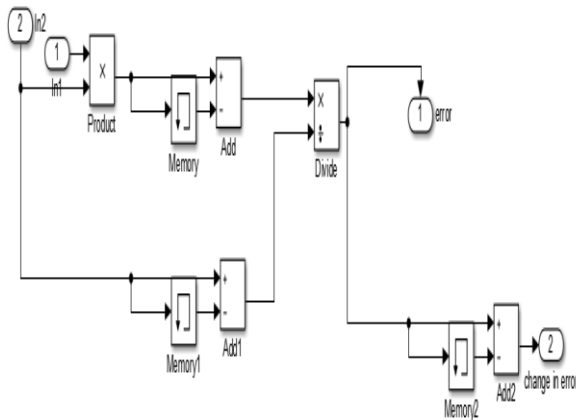

Figure 3: Subsystem for Power Error and Change in Error

Figure 4: Fuzzy File Toolbox for Power Error and Change in Error and Output

In figure 4, the fuzzy logic controller toolbox is presented, which shows the rules used are mamdani for the fuzzy logic controllers.

Figure 5: The Surface View of Rules range

In figure 5, the rules defined in two PV arrays fuzzy logic controller are shown in a surface view graph.

Results

After applying the proposed work which includes, fuzzy logic in the existing controller, the figure 6, shows the PV power, current and voltage, which is now stable for both PV arrays.
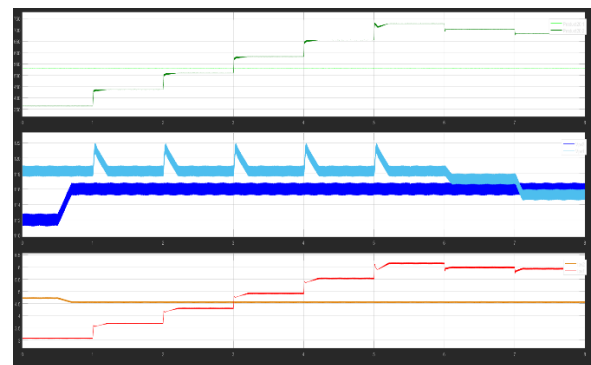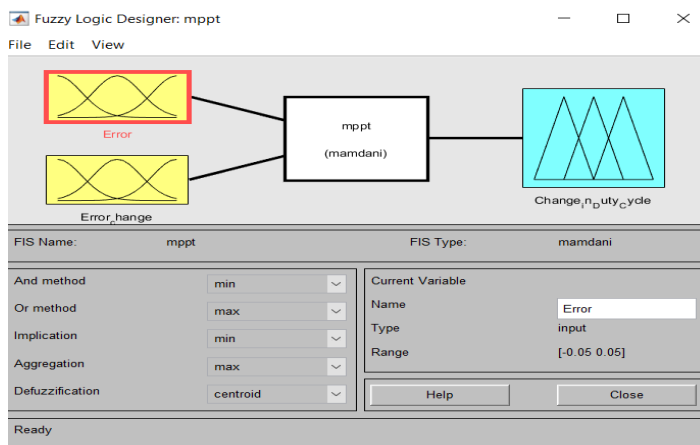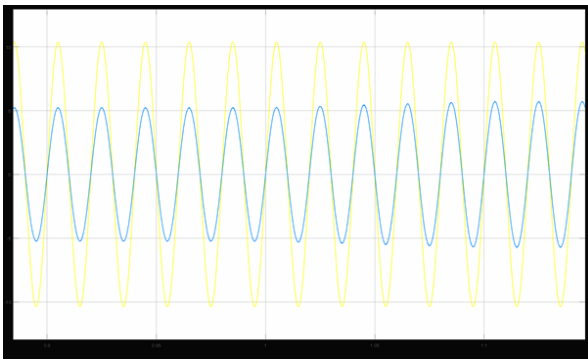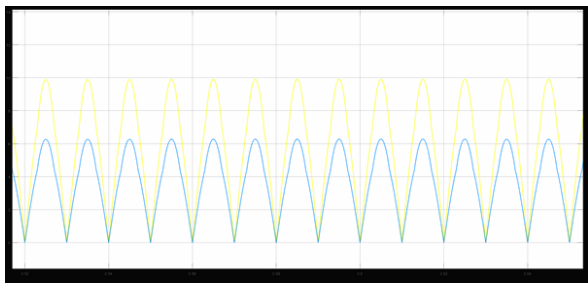

Figure 6: The output power, current and voltage from PV arrays
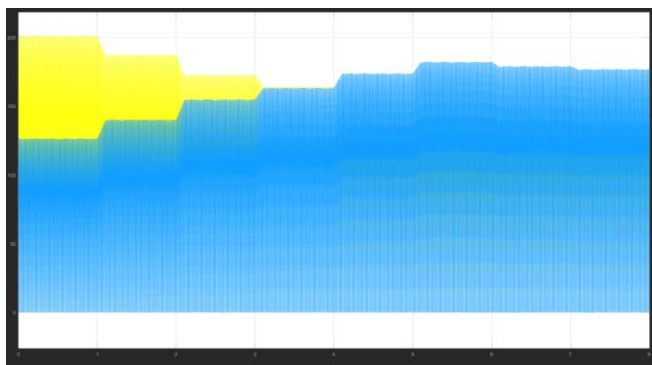
Figure 7: Output Current and Voltage of Inverter

In figure 7, the zoomed output of current and voltage shows sine wave, which is perfectly fine.
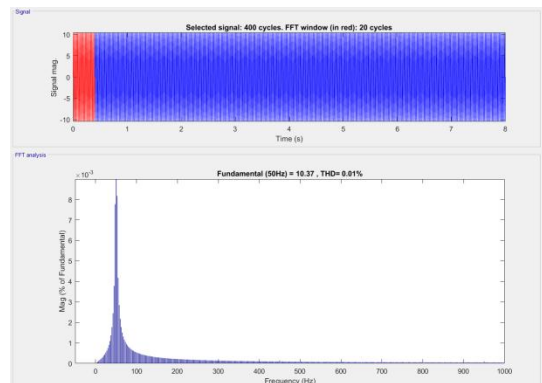

Figure 8: Inductor Currents

In figure 8 and figure 9, the currents and capacitor voltages are shown for inverting mechanism and buck boost.
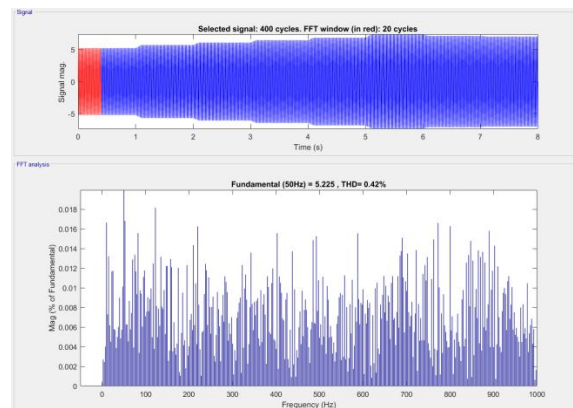

Figure 9: Capacitor Output Graphs

Figure 10: THD for Output Voltage

In figure 10 and 11, the output for proposed technique based THD (Total Harmonic Distortion) is given.

Figure 11: THD for Output Current

Conclusion

In this section, conclusion is discussed. Following conclusion is made from results presented in previous chapter. In this paper, two PV arrays in mismatched environmental conditions are implemented to form an inverter with lesser harmonics. The work is successfully carried out with simulation results in MATLAB Simulink. The harmonics are reduced below 0.5% and the outputs give efficiency over 99.5%. The output current and voltage waveform show accurate output. Also for PV outputs, low fluctuations are observed. The fuzzy logic controller proves to be best in terms of accuracy as it also takes the uncertain conditions of the errors and change in error of the power in MPPT. The results are verified in simulation from MATLAB.

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