GRID CONNECTED PV SYSTEM WITH A ARTIFICIAL NEURAL NETWORK CONTROL

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ABSTRACT

A PV array, a DC-DC boost converter, a DC-AC inverter, and a modified neural network controller make up the suggested system. Solar energy is converted into electrical energy by the PV array and sent into the DC-DC boost converter to raise the voltage. The DC voltage is transformed into AC voltage by the DC-AC inverter and then delivered into the grid. By anticipating future solar irradiation and modifying the operating parameters of the DC-DC boost converter and DC-AC inverter correspondingly, the improved neural network controller is employed to increase system performance. The controller makes use of a neural network algorithm that has been trained using historical data on solar irradiance and the accompanying system performance metrics. The suggested system is modelled.

Keyword : - *Solar photovoltaic system, Neural network, and MPPT algorithms.*

1. Introduction

A form of solar power generation system that is connected to the electrical grid is a grid-connected PV system. It comprises of a control system, an inverter, and solar panels. The solar panels transform solar energy from the sun into DC electrical energy, which the inverter subsequently transforms into AC electrical energy. The control system is in charge of controlling the PV system's power output and making sure that it is in sync with the electrical grid. A type of control system called a modified neural network control system makes use of artificial neural networks (ANNs) to manage a PV system's output. Machine learning algorithms known as ANNs are based on the structure and operation of the human brain. They are teachable and flexible.

PV array characteristics

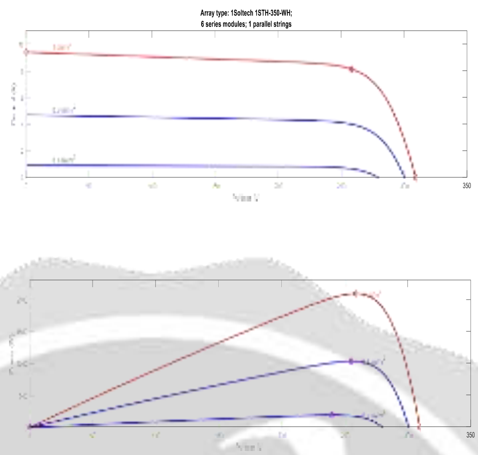


Fig. 1The PV array's P-V characteristics.

2. PV System Components

Many parts work together in a typical photovoltaic (PV) system to produce electrical energy from sunshine. A PV system's primary parts are:

1. PV modules: These are the essential element of a PV system. Several solar cells make up these devices, which use sunlight to create direct current (DC) electricity. PV modules are available in a variety of shapes and sizes, and their output power is measured in watts.
2. Inverter: In order for the DC electricity generated by the PV modules to be compatible with the electrical grid, the DC electricity must be transformed to alternating current (AC). The DC electricity is changed into AC electricity using an inverter.
3. Batteries (optional): To store extra energy generated throughout the day for use at times of little sunlight or high energy demand, batteries can be added to a PV system. This could improve the system's dependability and energy independence.
4. Charge Controller: In order to prevent overcharging or premature discharge of the batteries, a charge controller limits the amount of charge moving into and out of the batteries.
5. DC-DC Converter (optional): A DC-DC converter is used to increase or decrease the voltage of the DC electricity generated by PV modules. This is crucial since the PV modules' voltage varies depending on the amount of sunshine and may not meet the inverter's requirements.

Together, these elements enable the creation of solar-powered electricity that can be used immediately or saved for later use. The PV system's specific requirements and the application it is intended for will determine the size and arrangement of each component.

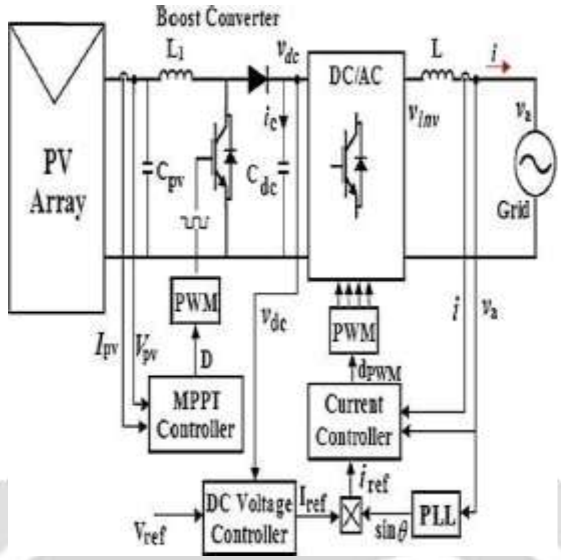


Fig. 2.1. a grid-connected single phase, two-stage photovoltaic system

3. MPPT algorithms

It is more challenging to determine the maximum power because it is influenced by meteorological factors (temperature and irradiance). As a result, maintaining the system's maximum power under diverse climatic conditions becomes more difficult. The static converter's duty cycle is often adjusted until the MPP is reached. To achieve optimal performance, In the literature, a number of MPPT algorithms have been reported. The next sections have presentations of a few of them.

3.1. Incremental Conductance Method

Maximum power point tracking (MPPT) systems for photovoltaic (PV) solar panels employ the control algorithm incremental conductance. The maximum power point (MPP) of the panel is maintained despite variations in solar irradiation and temperature by changing the load or source impedance. MPPT aims to maximize the amount of power that can be extracted from the solar panel.

$$\frac{dP}{dV} = \frac{d(VI)}{dV} = I\frac{dV}{dV} + V\frac{dI}{dV} = V\frac{dI}{dV} + I$$

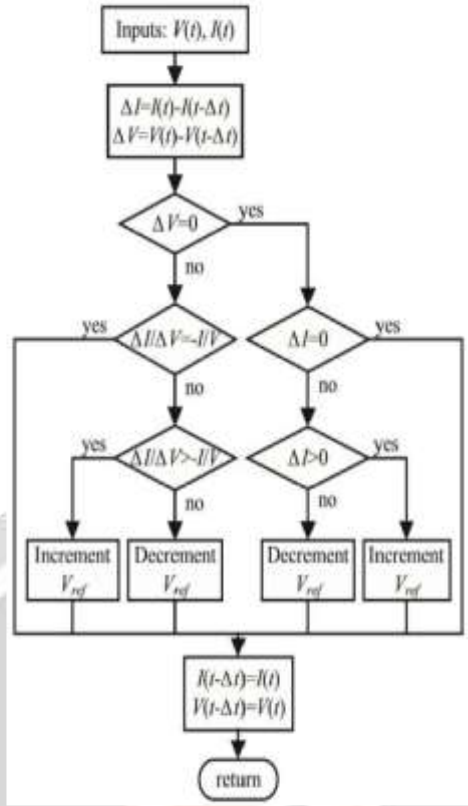


Fig.3.1. Flow chat of Incremental Conductance Method

4. Neural Network

The NN is a mathematical representation of biological neural networks that is used to tackle challenging issues. Its objective is to forecast an output using the network's inputs and training targets. A multilayer network is required for difficult tasks. The following offers three layers (input, hidden and output layers).

$$H = O + 0.75 \times L \text{ and } H < 2 \times L \ (2)\ (2)$$

where L represents the number of input neurons, O represents the number of output neurons, and H represents the number of hidden neurons.

Due to the boost converter being controlled by the duty cycle, this latter can be created either directly by NN or indirectly (modified- NN). One of the two featured architectures in this work is the direct architecture.

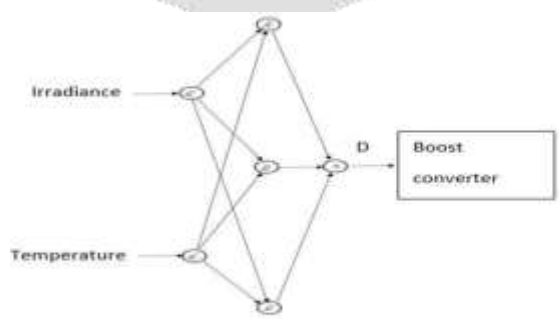


Fig.4.1. The direct duty cycle NN architecture

5. The Simulation results

The MATLAB/SIMULINK platform is used to model the single phase two-stage photovoltaic grid connection, allowing for the management of the injected current, dc link voltage, and MPP. Moreover, the impact of climatic variation on the system's output performance. The simulation of the neural network MPPT algorithm is then carried out, along with study of the stability, time response, oscillation, and overshoot. Figure 2 shows the single phase, two stage architecture of a grid-connected solar system. The following is a model of the grid- connected, single-phase, two-stage photovoltaic system. Under standard test conditions (STC), a boost converter is connected to a 2341W PV array that is controlled by an MPPT algorithm. between the inverter and the boost converter, a dc link capacitor is added to maintain a continuous dc link and lessen harmonics around the switching frequency. Irradiance and temperature variations are guaranteed by a signal builder. To evaluate the appropriate functioning around of MPP for all the PV panels, Several MPPT algorithms are used in a single MPPT control system. The capabilities of the simulated MPPT algorithms are tested under a variety of sun irradiances and temperatures in order to showcase their features. A step time of Ts=5x10-6s is used for the execution of each simulation.

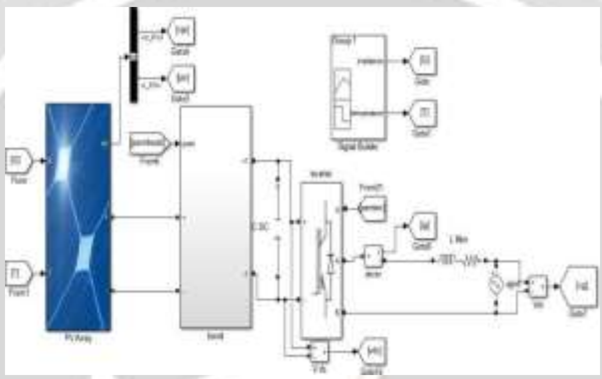
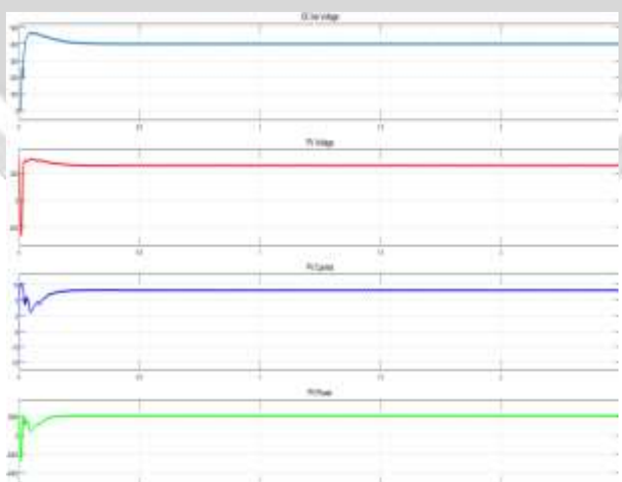


Fig -5.1: The setup of the computer-simulated system

5.1. PV Characteristics of PV array



5.2.With a change in Solar radiance

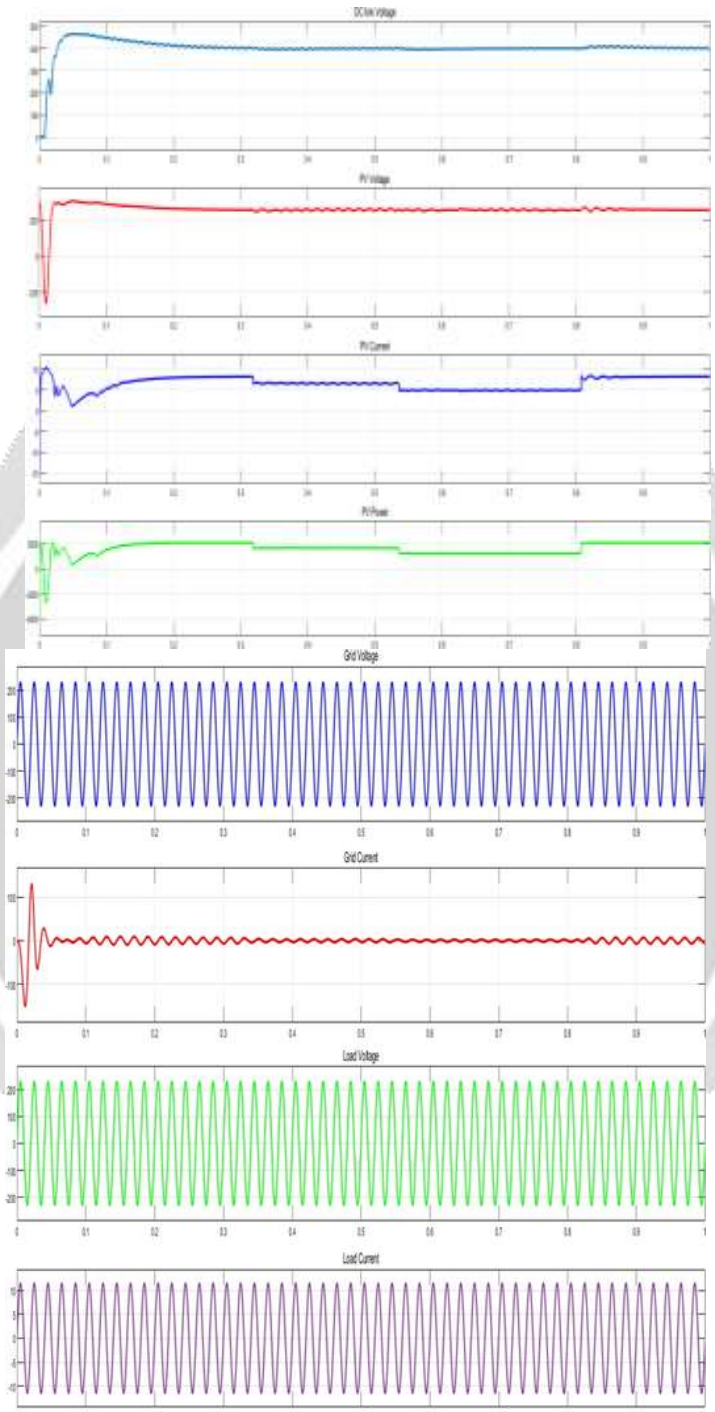


Fig .5.2. PV grid characterstics with change in solar irradiance

6. Conclusion

The MATLAB/SIMULINK platform delivers good simulation results for a single phase, two-stage, grid-connected solar system. Its performance is supported by highly accurate control of the injected current, the maximum power point, and the dc link voltage (MPP). As a result, overall harmonic distortion produces a power factor of 1.THD of 2.96% under the typical test parameters (STC). When the irradiance is at its maximum and the temperature is at its lowest, the higher power is obtained under different climatic conditions. On the other hand, despite the high temperature and low irradiance, the dc link voltage ripple is minimal and the THD is significant. To extract MPP, a variety of different maximum power point algorithms are used (MPPT). For this, two successful MPPT algorithms based on neural networks (NN) have been developed. Using a multilayer network with a back-propagation algorithm and 625 data samples, a high level of training has been affected. Further more established is a comparison of the NN algorithms generated by Incremental Conductance (Incremental Conductance), Open Circuit Voltage (OCV), and Perturb and Observe (P&O). The OCV method, P&O, NN algorithms, and incremental conductance all respond in a timely manner. Every algorithm tracks the maximum power in steady state, with the exception of the OCV, which has a significant error rate. Even though the OCV oscillates the most, its power is much below the theoretical maximum. NN algorithms show less MPP oscillation than do conventional methods. The smoothest response is produced by the modified-NN. Under rapidly shifting climatic conditions, the OCV approach has the greatest overshoot, followed by P&O, Incremental Conductance, NN, and modified-NN (reference PV voltage).

7.References

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