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International Journal for Modern Trends in Science and Technology, 9(05): 25-29, 2023
Copyright © 2023International Journal for Modern Trends in Science and Technology
ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0905004
Available online at: http://www.ijmtst.com/vol9issue05.html

Grid integrated PV System with ANFIS Based MPPT Controller For Maximum Power output

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To Cite this Article
Ch.Gowtham, G.Brahma Teja, V.S.V Ajay, G.Yogyatha and Dr.R.S Srinivas. Grid integrated PV System with ANFIS Based MPPT Controller For Maximum Power output. International Journal for Modern Trends in Science and Technology 2023, 9(05), pp. 25-29. https://doi.org/10.46501/IJMTST0905004

Article Info
Received: 28 March 2023; Accepted: 28 April 2023; Published: 30 April 2023.

ABSTRACT

The paper aims at developing an innovative approach for maximizing the output power of photovoltaic (PV) panels through the development of an Adaptive Neuro Fuzzy Inference System (ANFIS) based model using Maximum Power Point Tracking (MPPT) controller with a Boost Converter. This proposed model utilizes the ANFIS algorithm to create a system that can adapt to changes in environmental conditions, while the MPPT controller ensures the PV system operates at the maximum power point (MPP). The Boost Converter is utilized to elevate the output voltage of the PV panel to the desired level. Through the combination of ANFIS and MPPT techniques, the proposed model achieves a highly efficient PV system. Simulation results demonstrate that the proposed model has a high conversion efficiency and accurate MPP tracking, even under rapidly fluctuating environmental conditions. This project aims to contribute to the advancement of renewable energy systems, particularly in the field of PV systems.

1. INTRODUCTION

In recent years, there has been a growing interest in the development of sustainable and renewable energy sources. Photovoltaic (PV) systems are a promising technology for generating electricity from sunlight, but their performance is highly dependent on environmental conditions such as temperature, irradiance, and shading. Therefore, maximizing the output power of PV systems is crucial to improve their efficiency and viability as a renewable energy source. One approach to increasing the efficiency of PV systems is through the use of an Adaptive Neuro Fuzzy Inference System (ANFIS) based model using Maximum Power Point Tracking (MPPT) controller with a Boost Converter.

ANFIS is an artificial neural network that combines fuzzy logic and neural networks to create a system capable of adapting to changes in environmental conditions. MPPT controllers are designed to track the maximum power point of the PV system to ensure that the system operates at maximum efficiency, while a Boost Converter is used to step up the output voltage of the PV panelto the required level. This paper aims to provide an overview of the ANFIS based model using MPPT controller with a Boost Converter for maximizing the output power of PV systems. The paper will discuss the various components of the proposed model and how they work together to create an efficient and adaptable PV system. Additionally, the paper will present simulation results to demonstrate the effectiveness of the proposed model in achieving a high conversion efficiency and accurate MPP tracking, even under rapidly fluctuating environmental conditions. Overall, the proposed model has the potential to significantly improve the efficiency and performance of PV systems, which can contribute to the growth and sustainability of renewable energy sources

2. RELATED WORK

Grid integrated PV (photovoltaic) systems have gained significant popularity in recent years due to their ability to generate clean energy and reduce dependency on traditional power sources. One of the key challenges in designing and operating grid integrated PV systems is to extract maximum power from the solar panels, especially under varying environmental conditions.To address this challenge, researchers have developed various maximum power point tracking (MPPT) algorithms that adjust the operating point of the PV system to match the maximum power point of the solar panels. One such algorithm is the adaptive neuro-fuzzy inference system (ANFIS) based MPPT controller, which combines the advantages of fuzzy logic and neural networks to provide efficient and accurate tracking of the maximum power point.The ANFIS based MPPT controller uses a fuzzy inference system to adjust the MPPT duty cycle based on the input variables such as solar irradiance and temperature.

The fuzzy inference system determines the degree of membership of the input variables to different fuzzy sets, which are then combined using fuzzy logic rules to generate an output control signal. The output control signal is then optimized using a neural network to improve the accuracy and speed of the MPPT controller.

The ANFIS based MPPT controller is a promising technology for maximizing the power output of grid integrated PV systems. Its ability to adapt to changing environmental conditions and provide accurate tracking of the maximum power point makes it a valuable tool for improving the efficiency and performance of grid-connected PV systems.

3. COMPONENTS

(A). PV PANEL:

Kyocera Solar's KC130GT is a high-quality photovoltaic (PV) panel that converts sunlight intoelectricity using a unique technology based on crystalline silicon. The KC130GT has a maximumpower output of 130 watts, which means it can generate up to 130 watts of electricity under idealconditions. This makes it a great choice for residential or commercial solar installations. The panelhas an efficiency of up to 16%, which means that it can convert up to 16% of the sunlight it receivesinto usable electricity. This is a respectable level of efficiency, especially for a panel in this price

range. The KC130GT is designed to withstand harsh weather conditions, including heavy snow loadsand high winds. It has a rugged aluminium frame and tempered glass front cover that can protectthe panel from damage. Overall, the KC130GT is a reliable and efficient PV panel that can help youreduce your energy bills and lower your carbon footprint.

(B). BOOST CONVERTER:

A boost converter is a type of DC-DC converter that is commonly used in PV systems to step up theDC voltage produced by the PV panel to a higher voltage level that is suitable for charging a batteryor powering an AC load. In the context of ANFIS (Adaptive Neuro Fuzzy Inference System) basedMPPT (Maximum Power Point Tracking) control for PV systems, a boost converter is used inconjunction with the ANFIS model and the MPPT controller to adjust the operating point of thesystem to maximize the power output. The boost converter typically consists of an inductor, a diode, a capacitor, and a switch. During the boost operation, the switch is turned on and the inductor ischarged with current from the input voltage source (i.e., the PV panel). When the switch is turnedoff, the inductor discharges its energy to the output capacitor, which steps up the output voltage. The ANFIS model is used to predict the optimal operating point of the PV system based on input datasuch as irradiance, temperature, and voltage.

The MPPT controller then uses this prediction to adjust the duty cycle of the boost converter toensure that the PV system operatesat the maximum power point. By adjusting the duty cycle of the boost converter, the MPPTcontroller can vary the output voltage of the PV system to match the optimal operating pointpredicted by the ANFIS model the boost converter is an essential component in ANFIS based MPPTcontrol for PV systems. It is used in conjunction with the ANFIS model and the MPPT controller toadjust the operating point of the system and maximize the power output.

(C). MPPT CONTROLLER:

MPPT (Maximum Power Point Tracking) controller is a critical component in a PV (Photovoltaic)system that ensures that the PV system operates at its maximum power output point. The maximumpower point of the PV system is the point at which the PV panel produces the maximum amount ofpower for a given set of operating conditions, such as temperature, irradiance, and voltage. TheMPPT controller continuously monitors the operating conditions of the PV system and adjusts theoperating point of the system to ensure that it operates at the maximum power point. This isachieved by adjusting the duty cycle of a DC-DC converter, such as a boost converter or buckconverter, which is used to convert the DC voltage produced by the PV panel to a voltage suitablefor charging a battery or powering an AC load. The MPPT controller typically uses a feedback loop toadjust the duty cycle of the DC-DC converter. The feedback loop compares the output power of thePV system with the maximum power that could be produced under the current operating conditions,and adjusts the duty cycle of the DC-DC converter to maximize the power output. There are severaltypes of MPPT controllers, including Perturb and Observe (P&O), Incremental Conductance, andFractional Open-Circuit Voltage (FOCV) methods. Each method has its advantages anddisadvantages, and the choice of method depends on the specific requirements of the PV system

(D). ANFIS MODEL:

The ANFIS model proposed depends on the zero-order Sugeno fuzzy model. The Sugeno fuzzy modelhas built-in features for training the fuzzy controller. It is time efficient and less complex. The outputof the PV array implies two main factors—irradiance hitting over it and temperature. Therelationship between the output power and these two factors are studied through correlationanalysis. The maximum voltage (Vm) generated at a given instance is considered as the output and isfed into a duty generator. The duty cycle generator is a basic pulse width modulator which comparesthe ANFIS output with the measured voltage and produces the duty pulse for the boost converterbased on the difference between the two voltages. The Sugeno fuzzy model with two inputs and oneoutput

4. METHODOLOGY

The methodology for implementing a grid integrated PV system with an ANFIS based MPPT controller for maximum power output can be broadly divided into three main steps: system design, simulation and experimental validation.

(a)System Design: The first step is to design the grid integrated PV system and select the appropriate components such as solar panels, inverters, MPPT controllers, and other balance of system components. The ANFIS based MPPT controller can be designed using software tools such as MATLAB, Simulink or other suitable software.

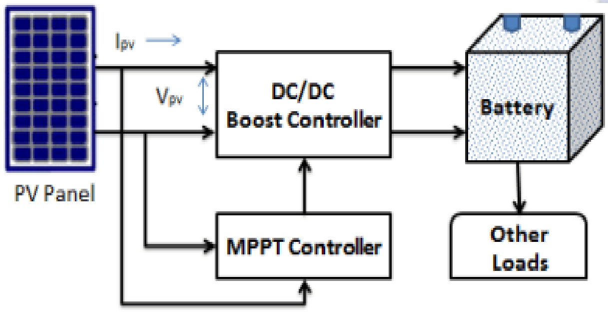
(b)Simulation: The second step is to simulate the designed system using software tools to evaluate its performance under various environmental conditions. The simulation can be carried out using mathematical models and simulation software to predict the system behavior and identify potential issues that may arise during operation.

(c)Experimental Validation: The final step is to validate the performance of the designed system in the field. This involves setting up the PV system in a real-world environment and collecting data on its performance under varying environmental conditions. The data collected can be compared with the simulation results to evaluate the accuracy and reliability of the ANFIS based MPPT controller.

The experimental validation step is crucial to verify the performance of the designed system under real-world conditions and identify any issues that may have been overlooked during simulation. The validation can be carried out using standard test procedures such as IEC 61853 or other appropriate standards.

5. BLOCK DIAGRAM

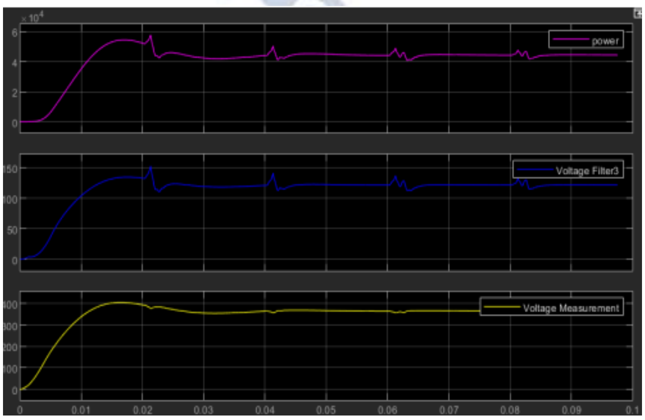
The block diagram of a grid integrated PV system with an ANFIS based MPPT controller for maximum power output consists of several components arranged in a specific sequence. The block diagram helps to visualize the flow of energy and control signals in the system.Thebasic components of the block diagram include the solar panels, ANFIS based MPPT controller, DC-DC converter, inverter, and the grid. The solar panels convert sunlight into DC power, which is then fed into the DC-DC converter. The ANFIS based MPPT controller adjusts the duty cycle of the DC-DC converter to ensure maximum power transfer from the solar panels to the DC bus.



- The DC-DC converter steps up the voltage of the DC bus to a level suitable for the inverter. The inverter then converts the DC power into AC power and feeds it into the grid.
- The ANFIS based MPPT controller continuously monitors the operating conditions of the system and adjusts the duty cycle of the DC-DC converter to ensure maximum power output under varying environmental conditions.
- The block diagram also includes monitoring and control components such as sensors, dataacquisition systems, and communication interfaces. These components are used to monitor the performance of the system and communicate with external devices such as the grid operator.

6. SIMULATION RESULTS

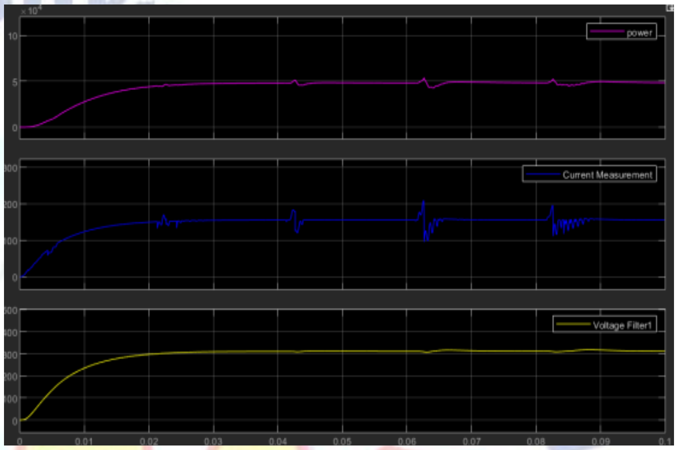
(A) Without MPPT :



At temperature: 30 At irradiance: 1000

DISCUSSION: We observe that from the above graphs, due to variations in the temperature the voltage and power also going to be vary because of this reason we are unable to connect the output power to the grid and also there is a voltage and power drop

(B) With MPPT :



At temperature: 30 At irradiance: 1000

DISCUSSION: From the above graphs we can see that whatever problem we faced in the case of without MPPT The following cases are obtained: 1. constant voltage 2. maximum power

7. SIMULATION RESULTS

In conclusion, the integration of an ANFIS based MPPT controller in grid-connected PV systems offers a promising solution for maximizing the power output of solar panels. The ANFIS controller provides accurate and efficient tracking of the maximum power point under varying environmental conditions, thereby improving the performance and efficiency of the system. The block diagram provides a visual representation of the flow of energy and control signals in the system, which is useful for understanding the behavior and performance of the system. Overall, the use of ANFIS based MPPT controllers in grid integrated PV systems offers a viable approach towards achieving sustainable and efficient power generation.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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