Nonlinear Sliding Mode based Maximum Power Tracking Control of Photovoltaic System Under Partial Shading Conditions

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Contents:

Introduction :

Solar energy is considered to be the most popular renewable energy around the world and is capable of converting into different types of energy. Every second, approximately 4.2 million tons of solar mass is converted to different types of energy, and because the sun weighs 333 times the weight of the earth, solar energy can meet energy requirements for the next 5 billion years [1]. MPPT control is a way to improve the efficiency of PV system .The conventional perturb and observe (P&O) algorithm and incremental conductance (INC) algorithm can track the maximum power point of the PV arrays under normal operation conditions [1]. When a PV system is partially shaded, its output power curve can have multiple peaks. Partially shading is a condition that is closed by some cells in the solar panel .This means that some of the cells in the solar panel are not receiving sunlight ,which can reduce the overall power output of the panel. Therefore, the conventional MPPT control may fall into local maximum power point (LMPP) rather than global maximum power point (GMPP), which reduces the efficiency of the PV systems seriously [2]. Many new MPPT algorithms have been developed to work better under partial shading conditions. it is shown in [3] that the LMPPs of the PV arrays have monotonically decreasing characteristic at both sides of the GMPP and the authors propose a new GMPPT algorithm accordingly, but this method is not applicable to complex shaded conditions. Reference [4] determines whether the partially shadow is occurred and the location of the GMPP by measuring the output voltage of each PV module in PV arrays, which increases the cost and complexity of the system. Reference [5] propose GMPPT control strategies based on particle swarm optimization (PSO) and artificial neural network (ANN) respectively. These intelligent algorithms generally have the drawbacks such as parameter tuning difficulties, complexity and inefficiency. A MPPT control strategy based on SMC under uniform insolation conditions has been presented in [6], the experimental results show that this method is robust to environment changes and load variations. However, no application of MPPT control strategy based on SMC under partially shaded conditions have been presented. Therefore, this paper proposed a new GMPPT method based on SMC under partially shaded conditions.

Problem Statement:

Partial shading is a major problem for PV systems, as it can lead to significant losses in power output. Nonlinear SMC is a promising technique for MPPT of PV systems under partial shading conditions, but current SMC controllers are not robust enough to handle the variations in solar irradiance and temperature that can occur under these conditions. Additionally, current SMC controllers may not be able to track the global maximum power point (GMPP) quickly and accurately under rapidly changing partial shading conditions. A successful outcome of this project would lead to the development of a more efficient and reliable way to operate PV systems under partial shading conditions. This could have a significant impact on the adoption of PV systems, as it would make them more viable for a wider range of applications.

Aims and Objectives:

The Main aims and Objectives includes:

- To track the maximum operating point of a photovoltaic system under partially shading conditions.
- To maximize the efficiency of PV array.

Literature Review:

The literature review contains a brief discussion of some recent work to track the maximum operating point of a photovoltaic system under partially shading conditions through different methods. Each project has different way of tracking the maximum operating point of a photovoltaic system and different proposed method of working of the model.

In 2017, Ahmad Magdy and Mustafa I. Marei [7] introduce a hybrid maximum power point tracking (MPPT) technique for photovoltaic PV arrays working under partial condition . In this research a traditional MPPT , Algorithm such as perturb and observe (P&O) or incremental conductance (IC) can combine with the artificial neural network (ANN) technique . To predict the global maximum power point (GMPPT) region by estimating its voltage boundaries .

In 2011 kashif Ishaque zainal salam ,Hamed taheri [8] introduce a maximum power point tracking algorithm based on particle swarm optimization(PSO) that is capable of tracking global MPP under partial shading conditions.

We proposed nonlinear sliding mode based maximum power point tracking control of a Photovoltaic System under partially shading conditions. In this model, we use controller for maximum power point tracking (MPPT) which can improve the efficiency of the PV system. PV array is a nonlinear system, so a nonlinear controller is more suitable for maximum power point tracking (MPPT) applications.

Methodology:

The main components used are

- PV array
- DC-DC Convertor
- Pulse Width Modulator
- SMC Based GMPP Tracker
- Load

PV Array:

A photovoltaic array is the complete power-generating unit, consisting of any number of PV modules and panels. Each photovoltaic (PV) module is made of multiple interconnected PV cells. The cells convert solar energy into direct-current. PV modules are sometimes called solar panels.

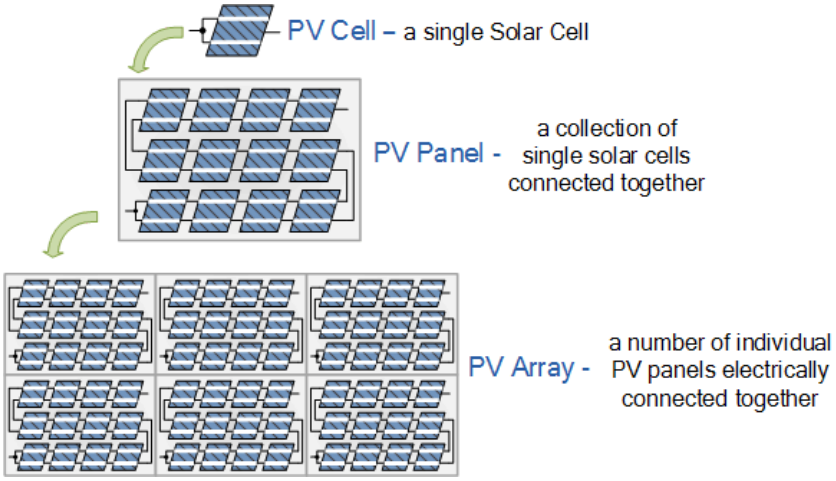

Fig.1 PV array

DC-DC Convertor :

The DC-to-DC converters convert one level of DC voltage to another level.

Pulse Width Modulator :

PWM is a way to control analog devices with a digital output. Another way to put it is that you can output a modulating signal from a digital device such as an MCU to drive an analog device.

Block Diagram :

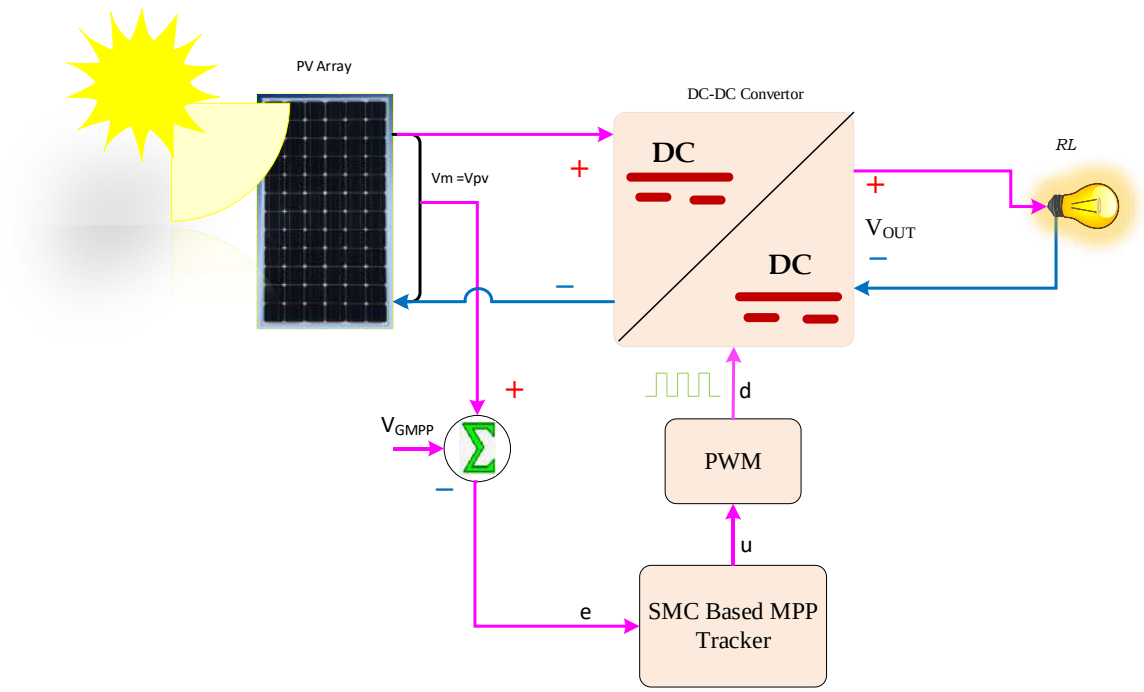

Fig .2 Block Diagram

Work plane:

Tasks	Duration/Schedule
PV Array Design	Oct
DC-DC Convertor Mathematical Modeling	Nov
Proposed GMPPT Controller Design	Dec
Proposed GMPPT Controller Fine tuning	Jan 2024
Results	Feb
Progress Report	Mar
Thesis	Apr-May

SDGS **Mapping with the Nonlinear Sliding Mode Based Maximum Power Point Tracking Control of a Standalone Photovoltaic System**

S.NO	PLOS	SDGS	JUSTIFICATION
1.	Engineering Knowledge (PLO 1)	Quality Education (SDG 4)	Global Maximum power point is the point where the output of the PV array has the maximum power and voltage.
2.	Design/Development of Solutions (PLO 3)	Industry, Innovation and Infrastructure (SDG 9)	The proposed method will help in increasing the efficiency of PV arrays by tracking the global maximum power point under partial shaded condition.
3.	Modern Tool Usage (PLO 5)	Decent Work and Economic Growth (SDG 8)	MATLAB MS Visio
4.	The Engineer and Society (PLO 6)	Good Health and Well-Being (SDG 3)	The proposed method is better than other.
5.	Ethics(PLO 8)	Peace, Justice and Strong institutions(SDG 12)	Written material and contributions are unique.
6.	Lifelong Learning (PLO 12)	Partnerships For the Goals (SDG 17)	Individual and teamwork is involved. Group discussions were

			arranged. Group members are cooperative to achieve the learning and improvement in goals for the telecommunication industry**.**

Conclusion:

In this paper, an SMC based method is designed to achieve the maximum power point for a solar photovoltaic system under partial shaded condition. Two phases are involved for the achievement of MPP. In first phase the sliding surface is designed and in second phase discontinues law is designed. In SMC based method, the chattering has been minimized, maximum power is attained, the overshoot in output power is controlled and the output is also very smooth at different irradiances.

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