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ANFIS-Based Control of a Grid-Connected Renewable Energy System using MMPT Algorithms

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ABSTRACT

In this paper utilization of a boost converter for control of photovoltaic power using Maximum Power Point Tracking (MPPT) control mechanism is presented. First the photovoltaic module is analyzed using SIMULINK software. For the main aim of the project the boost converter is to be used along with a Maximum Power Point Tracking control mechanism. The MPPT is responsible for extracting the maximum possible power from the photovoltaic and feed it to the load via the boost converter which steps up the voltage to required magnitude. The main aim will be to track the maximum power point of the photovoltaic module so that the maximum possible power can be extracted from the photovoltaic. The algorithms utilized for MPPT are generalized algorithms and are easy to model or use as a code. The algorithms are written in m files of MATLAB and utilized in simulation. Adaptive Neuron-Fuzzy Inference system (ANFIS) is a kind of artificial neural network. It integrates both neural networks and fuzzy logic principles. ANFIS in a more efficient and optimal way, one can use the best parameters obtained by genetic algorithm. Both the boost converter and the solar cell are modeled using Sim Power Systems blocks.

Keywords : **MPPT, ANFIS, Genetic algorithme, Sheduling algorithme.**

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I. INTRODUCTION

The One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Demand has increased for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard.

The continuous use of fossil fuels has caused the fossil fuel deposit to be reduced and has drastically affected the environment depleting the biosphere and cumulatively adding to global warming. Solar energy is abundantly available that has made it possible to harvest it and utilize it properly.Solar energy can be a standalone generating unit or can be a grid connected generating unit depending on the availability of a grid nearby. Thus it can be used to power rural areas where the availability of grids is very low. Another advantage of using solar energy is the portable operation whenever wherever necessary.

In order to tackle the present energy crisis one has to develop an efficient manner in which power has to be extracted from the incoming solar radiation. The power conversion mechanisms have been greatly reduced in size in the past few years. The development in power electronics and material science has helped engineers to come up very small but powerful systems to withstand the high power demand.

But the disadvantage of these systems is the increased power density. Trend has set in for the use of multi-input converter units that can effectively handle the voltage fluctuations. But due to high production cost and the low efficiency of these systems they can hardly compete in the competitive markets as a prime power generation source. The constant increase in the development of the solar cells manufacturing technology would definitely make the use of these technologies possible on a wider basis than what the scenario is presently.

The use of the newest power control mechanisms called the Maximum Power Point Tracking (MPPT) algorithms has led to the increase in the efficiency of operation of the solar modules and thus is effective in the field of utilization of renewable sources of energy.

II. LITERATURE SURVEY

The topic of solar energy utilization has been looked upon by many researchers all around the globe. It has been known that solar cell operates at very low efficiency and thus a better control mechanism is required to increase the efficiency of the solar cell. In this field researchers have developed what are now called the Maximum Power Point Tracking (MPPT) algorithms.

In the paper [1], Pablo García et.al said and describes and evaluates an adaptive neuro-fuzzy inference system (ANFIS)-based energy management system (EMS) of a grid-connected hybrid system. It presents a wind turbine (WT) and photovoltaic (PV) solar panels as primary energy sources, and an energy storage system (ESS) based on hydrogen (fuel cell–FC-,hydrogen tank and electrolyzer) and battery. All of the energy sources use dc/dc power converters in order to connect them to a central DC bus. An ANFIS-based supervisory control system determines the power that must be generated by/stored in the hydrogen and battery, taking into account the power demanded by the grid, the available power, the hydrogen tank level and the state-of-charge (SOC) of the battery. Furthermore, an ANFIS-based control is applied to the three-phase inverter, which connects the hybrid system to grid. Otherwise, this new EMS is compared with a classical EMS composed of state-based supervisory control system based on states and inverter control system based on PI controllers. Dynamic simulations demonstrate the right performance of the ANFIS-based EMS for the hybrid system under study and the better performance with respect to the classical EMS.

In the paper [2], Mummadi Veerachary et.al said on the use of a SEPIC converter in the field of photovoltaic power control. In his report he utilized a two-input converter for accomplishing the maximum power extraction from the solar cell.

In the paper [3], P. S. Revankar et.al said and even included the variation of sun's inclination to track down the maximum possible power from the incoming solar radiations. The control mechanism alters the position of the panel such that the incoming solar radiations are always perpendicular to the panels.

In the paper [4], M. Berrera et.al said compared seven different algorithms for maximum power point tracking using two different solar irradiation functions to depict the variation of the output power in both cases using the MPPT algorithms and optimized MPPT algorithms.

In the paper [5], M. G. Villalva et.al in his both reports has presented a comprehensive method to model a solar cell using Simulink or by writing a code. His results are quite similar to the nature of the solar cell output plots.

In the paper [6], Ramos Hernanz et.al said that has successfully depicted the modeling of a solar cell and the variation of the current-voltage curve and the power-voltage curve due the solar irradiation changes and the change in ambient temperature.

III.PROPOSED SYSTEM

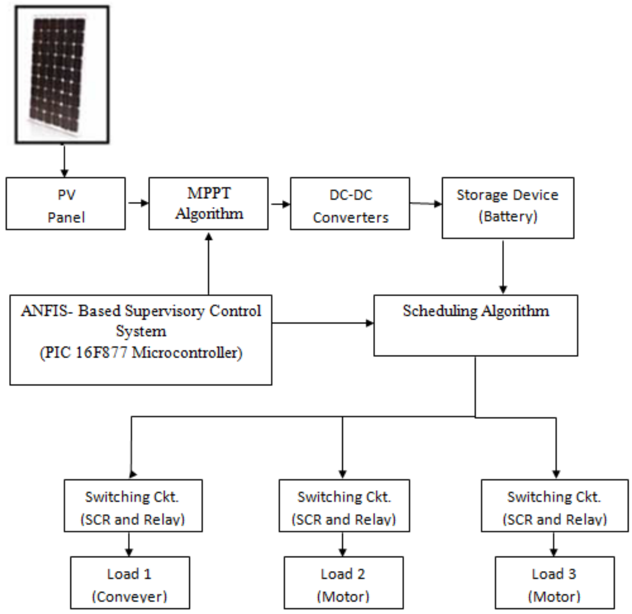

Fig 1. Block Diagram

MPPT Algorithm:

The efficiency of a solar cell is very low. In order to increase the efficiency, methods are to be undertaken to match the source and load properly. One such method is the Maximum Power Point Tracking (MPPT). This is a technique used to obtain the maximum possible power from a varying source. In photovoltaic systems the I-V curve is non-linear, thereby making it difficult to be used to power a certain load. This is done by utilizing a boost converter whose duty cycle is varied by using a mppt algorithm. Few of the many algorithms are listed below and A boost converter is used on the load side and a solar panel is used to power this converter.

DC-DC Converter:

Boost converter steps up the input voltage magnitude to a required output voltage magnitude without the use of a transformer. The main components of a boost converter are an inductor, a diode and a high frequency switch. These in a co-ordinated manner supply power to the load at a voltage greater than the input voltage magnitude. The control strategy lies in the manipulation of the duty cycle of the switch which causes the voltage change.

PIC Microcontroller:

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General

Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller. The first parts of the family were available in 1976; by 2013 the company had shipped more than twelve billion individual parts, used in a wide variety of embedded systems.
Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage, some with provision for erasing memory. All current models use Flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is 8-bit, 16-bit and in latest models, 32-bit wide. Program instructions vary in bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The instruction set also varies by model, with more powerful chips adding instructions for digital signal processing functions.

IV. APPLICATION AND ADVANTAGES

Application:

1) Because of Maximum power transfer to storage there is improvement in device charging time.
2) Increases backup capacity with the use of scheduling algorithms.
3) Good switching capability.

Applications:

1) Industrial Power Management for various loads like Motors, Conveyers etc.
2) Can be Used Smart Grid Energy Networks
3) Can used to schedule load of home Appliances

V. CONCLUSION

When MPPT is used there is no need to input the duty cycle, the algorithm iterates and decides the duty cycle by itself. But if MPPT had not been used, then the user would have had to input the duty cycle to the system. When there is change in the solar irradiation the maximum power point changes and thus the required duty cycle for the operation of the model also changes.

But if constant duty cycle is used then maximum power point cannot be tracked and thus the system is less efficient. The various waveforms were obtained by using the plot mechanism in MATLAB. There is a small loss of power from the solar panel side to the boost converter output side. This can attributed to the switching losses and the losses in the inductor and capacitor of the boost converter. This can be seen from the plots of the respective power curves.

REFERENCE

1) Pablo García, Carlos Andrés García, Luis M. Fernández, Member, IEEE, Francisco Llorens and Francisco Jurado, Senior Member, IEEE has published paper which describes and evaluates an adaptive neuro-fuzzy inference system (ANFIS)-based energy management system(EMS) of a grid-connected hybrid system.

2) Mummadi Veerachary has given a detailed report on the use of a SEPIC converter in the field of photovoltaic power control. In his report he utilized a two-input converter for accomplishing the maximum power extraction from the solar cell.

3) P. S. Revankar has even included the variation of sun's inclination to track down the maximum possible power from the incoming solar radiations. The control mechanism alters the position of the panel such that the incoming solar radiations are always perpendicular to the panels.

4) M. Berrera has compared seven different algorithms for maximum power point tracking using two different solar irradiation functions to depict the variation of the output power in both cases using the MPPT algorithms and optimized MPPT algorithms.

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