MODELING AND SIMULATION OF SPV SYSTEM FOR IMPROVED POWER OUTPUT USING DC-DC CONVERTER

A THESIS

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ABSTRACT

Renewable energy tracking become one of the interesting area in recent years due increased energy demand all over the world and issues related to environment. Out of all renewable energy sources, solar energy has gained much more attention due to its availability, cleanness and inexhaustible nature. But power produced by the photovoltaic system is stochastic in nature due to the variation of solar irradiation and temperature throughout the day. In order to track the varying power, a DC-DC converter with maximum power point tracking (MPPT) algorithm is used. DC-DC converters act as an impedance matching unit in between the PV panel and load. By controlling the converter duty ratio, input impedance of the converter is made equal to output impedance of the PV panel and load matching is achieved to draw maximum power from the PV panel.

The work documented in this thesis has been categorized into six chapters. A review on various solar cell technologies, various models of PV panel, temperature, irradiance and partial shading effects on PV panel and different types of PV system has been included in the chapter 1. Problem statement and motivation, objective of the present study and thesis organization are also provided in this chapter.

In Chapter 2, detailed review on various parameter extraction methods, MPPT techniques and DC-DC converters used for MPP tracking are described in detail. Merits, demerits and performance of each parameter extraction methods are explained first. Subsequently, literature survey on various MPPT techniques are presented with merits, demerits, cost, dynamic response, precision of tracking, static response, robustness, effectiveness under partial shading conditions (PSC's) and rapidly changing atmospheric conditions. Finally, literature survey on different topologies of DC-DC converter and their improved version used for MPP tracking is given.

In Chapter 3, an improved adaptive particle swarm optimization (APSO) algorithm is proposed to extract the unknown parameters of single diode model of a PV module. The effectiveness of proposed algorithm has been checked for varying temperature conditions. The proposed method alleviates singularity problem during convergence, exhibits faster convergence and it is more accurate than conventional PSO based parameter extraction algorithm.

In Chapter 4, improved single ended primary inductor converter (SEPIC) topology has been proposed for MPPT application. Working of modified SEPIC converter has been explained using theoretical analysis and simulation results. Small signal modeling technique has been used to develop the transfer function and to carry out stability analysis of the converter. Comparison of the proposed converter topology with conventional SEPIC converter is presented. Simulation and experimental results show that switched inductor (SI)-SEPIC converter is able to improve gain and is able to regulate output voltage over wide range of input voltage.

In Chapter 5, an improved PSO based MPPT technique for solar power tracking is presented. Convergence speed and tracking accuracy of PSO are improved by decreasing inertial weight and cognitive coefficient linearly from larger value to smaller value and increasing social coefficient linearly from relative smaller value to larger value. Three different patterns were utilized to experimentally validate the effectiveness of the proposed method. Experimental results show that the average tracking efficiency and tracking speed of the proposed technique is greater than that of conventional PSO and it was found that the proposed method can obtain the GMPP in all the test cases no matter where the GMPP locates.

Finally, in Chapter 6, the conclusions of this thesis are made and suggestions for continuation of work in future are also presented.