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Maximum power point tracking (MPPT) techniques: Recapitulation in solar photovoltaic systems

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ABSTRACT

Unfilled gap of prolonged energy demand by conventional energy sources and consent of global warming as its vulnerable outcome provides a vent to search compatible option. Augmentation in use of solar energy reveled through last 3 decades portrays its heterogeneous rewards in the prevailing energy scenario. Nevertheless solar PV system arises as viable option in the critical power system era its low efficiency energy conversion attribute necessitates an efficient power conversion system. The non-linearity of *I–V* (current–voltage) characteristic and its alteration for an assorted insolation and temperature values may enable the alteration in terminal voltage. This may deviates maximum power point due to which the available maximum power delivery to load can be differed. Literature of this field reiterated that the uniform insolation and partial shading condition demands undeniable need of maximum power point tracking. Nonetheless through investigation in this direction furnishes the availability of a bunch of such techniques; each of them posses its own pros and cones. This ubiquitous trait of available maximum power point tracking (MPPT) techniques unfolds the complexity in its precise selection. To diminish such complexity this paper offers a state of art of various MPPT technique and their comprehensive comparative analysis based on 110 standard research articles. The focus of this paper is to offer a better commencement and to furnish valued information for investigators of this field.

Contents

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1. Introduction

Electricity demand is growing with highest rate of all the energy consumed worldwide. Thus the mankind is facing a massive challenge of never ending increase in energy demand as a result of overall socio economic growth [1–2]. The declining fossil fuel resources and tremendous rate of its consumption to battle the prevailing industrial revolution diverges us on the peak of consumption of fossil fuel. Incompatibility of conventional sources to fulfill this bottomless valley of energy requirements, energy security, and especially the sky-rocketing hike of fossil fuels prices gives a work force direction to invent compatible option [3–5]. Despite of these unprovoked concerns, the global warming as an unavoidable outcome of carbon emissions by the conventional energy sources proves to be a momentous driver for renewable energy sources deployment. Ubiquitous accessibility of renewable energies like solar and wind offers a striking solution to comply all these requirements. Continuous efforts of researchers have shown an increased efficiency in both the conversion and transport of these energy sources. Thus they arises as an attractive alternative option to conventional solution [6–7]. It is a trend which is almost certain to evolve in upcoming power generation. All-pervading and copious availability of solar energy has an outstanding potential to make a significant contribution to the world's energy needs. Two ways to extract the solar energy are solar thermal plants and solar cells i.e. photovoltaic cells. In prevailing renewable energy projects the photovoltaic cell (Solar PV) is on the leading edge as the promising future energy technology option [8]. The direct conversion of solar radiation to electrical energy by PV cells has a number of significant advantages. However its proficient extraction demands accomplishment of some significant challenges such as energy fluctuation, huge investment low energy conversion efficiency of module, and energy cost [9–11]. Reducing energy cost of PV system is a big issue since maintenance requirement is very low and the only real cost savings to be made is in efficiency enhancement. Recent literature reveals that research efforts target to enhance the power output of the module in terms of MPPT. A photovoltaic (PV) module has non-linear *I*–*V* (current–voltage) characteristics and its *P*–*V* (power–voltage) characteristics shows that there exist only one point (P_{max}) where the module deliver maximum power as shown in Fig. 1. This point also varies with the change in insolation and temperature as shown in Figs. 2 and 3. Thus the mismatch between load and source characteristics curtails the availability of maximum possible accessible power delivery to load which causes a significant power loss. An electronic circuitry used to match the characteristics of module with respect to maximum power to avoid this power loss is called maximum power point tracker (MPPT).

Approximately 40 various methods are reported in literature to track the maximum power point, some of them are very much close to other method as to their operating principle. This paper