

Implementation of MPPT Control Using Fuzzy Logic in Solar-Wind Hybrid Power System

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Abstract— The renewable energy sources such as Solar energy and Wind energy are complementary by nature. Utilising these natural resources to produce power will reduce the power demand on the conventional power generation sector. One of the applications of Solar-Wind hybrid power system (SWHPS) is to reduce the amount of power consumed from the conventional power generation to charge the storage reserves present in the system. The SWHPS comprises of Photovoltaic array, wind turbine, Permanent Magnet Synchronous generator (PMSG), controller and converter. The efficiency of the SWHPS depends on the MPPT controller, which makes the Photovoltaic (PV) and wind power generation systems to operate at its maximum power. In PV system Perturb & Observe (P&O) algorithm is used as control logic for the Maximum Power Point Tracking (MPPT) controller and Hill Climb Search (HCS) algorithm is used as MPPT control logic for the Wind power system in order to maximize the power generated. This paper presents a comparative analysis of MPPT controller built using P&O for PV system and HCS for Wind power system, with MPPT controller implemented using Fuzzy Logic control (FLC) in the both the renewable sources in the hybrid system. The performance of the different implementation of MPPT controllers in the hybrid system are investigated in this paper in MATLAB, Simulink. The SWHPS with the FLC based MPPT has shown to have a better, faster control as compared with the other controllers.

Keywords—Hybrid power system; MPPT; FLC; Renewable energy; P & O; Wind.

I. INTRODUCTION

Renewable energy sources (RES) such as Solar, Wind, Geothermal, Tidal, Hydro etc. are inexhaustible by nature. The RES have been found promising towards building sustainable and ecofriendly power generation. Due to the limitation of conventional resources of fossil fuels, it has compelled the evolution of hybrid power system. Therefore, new ways to balance the load demand is by integrating RES into the system. Hybrid system enables the incorporation of renewable energy sources and transfers the dependency on fossil fuels, while sustaining the balance between supply and demand. The significant characteristic of hybrid power system includes, system reliability, operational efficiency [1]. The hybrid power system enables to overcome the limitations in wind and photovoltaic resources since their performance characteristics depends upon the unfavorable changes in environmental

conditions. It is probable to endorse that hybrid stand-alone electricity generation systems are usually more reliable and less costly than systems that depend on a single source of energy [2]. On other hand one environmental condition can make one type of RES more profitable than other. For example, Photovoltaic (PV) system is ideal for locations having more solar illumination levels and Wind power system is ideal for locations having better wind flow conditions [3].

For RES especially the variable speed wind energy conversion systems, Permanent Magnet Synchronous generator (PMSG) is gaining popularity. PMSG have a loss-free rotor, and the power losses are confined to the stator winding and stator core. A multi-pole PMSG connected to power converter can be used as direct driven PMSG in locations with low wind speed there by eliminating the gearbox which adds weight, losses, cost and maintenance [4]. A gearless construction of wind conversion system represents an efficient and reliable wind power conversion system. In a PV system, a solar cell alone can produce power of 1 to 2 watt [5]. The solar cell is modeled by two diode model [6]. The solar cells are connected in series and parallel to form a PV panel or module. The PV modules are connected in series and parallel to form a PV array in order to generate appropriate amount of power.

Thus a PV system consisting of PV array, Maximum Power Point Tracking (MPPT) boost converters, and Wind power system consisting of wind turbine, PMSG, rectifier and MPPT boost converter is integrated into Solar Wind hybrid power system (SWHPS). The efficiency and reliability of the SWHPS mainly depends upon the control strategy of the MPPT boost converter. The solar and wind power generation cannot operate at Maximum power point (MPP) without proper control logic in the MPPT boost converter. If the MPP is not tracked by the controller the power losses will occur in the system and in spite of wind and solar power availability, the output voltage of the hybrid system will not boost up to the required value [7]. The output voltage of the PV and Wind power generation are quite low as compared with the desired operating level. So, this output voltage is brought to desired operating value of 220V using Boost converter with MPPT controller at each source. The control logic of the MPPT controlled boost converter for the Wind power generation and PV based generation are selected on the basis of ease of implementation and robustness

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