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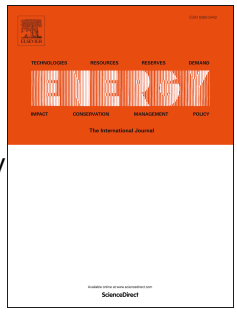

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Mahmoud Dhimish, Violeta Holmes, Bruce Mehrdadi, Mark Dales, Peter Mather

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Photovoltaic Fault Detection Algorithm Based on Theoretical Curves Modelling and Fuzzy Classification System

Mahmoud Dhimish, Violeta Holmes, Bruce Mehrdadi, Mark Dales, Peter Mather

Department of Computing and Engineering, University of Huddersfield, Huddersfield, United Kingdom

Abstract

This work proposes a fault detection algorithm based on the analysis of the theoretical curves which describe the behaviour of an existing PV system. For a given set of working conditions, solar irradiance and PV modules' temperature, a number of attributes such as voltage ratio (VR) and power ratio (PR) are simulated using virtual instrumentation (VI) LabVIEW software. Furthermore, a third order polynomial function is used to generate two detection limits for the VR and PR ratios obtained using VI LabVIEW simulation tool.

The high and low detection limits are compared with measured data taken from 1.1kWp PV system installed at the University of Huddersfield, United Kingdom. Samples lie out of the detection limits are processed by a fuzzy logic classification system which consists of two inputs and one output membership function.

In this paper, PV faults corresponds to a short circuited PV module. The obtained results show that the fault detection algorithm can accurately detect different faults occurring in the PV system, where the maximum detection accuracy of before considering the fuzzy logic system is equal to 95.27%. However, the fault detection accuracy is increased up to a minimum value of 98.8% after considering the fuzzy system.

Keywords: Photovoltaic Faults, Fault Detection, Fuzzy Logic, PV Hot Spot Detection, LabVIEW.

1. INTRODUCTION

Despite the fact that Grid-Connected Photo-Voltaic (GCPV) systems have no moving parts, and therefore usually require low maintenance, they are still subject to various failures and faults associated with the PV arrays, batteries, power conditioning units, utility interconnections and wiring [1 and 2]. It is especially difficult to shut down PV modules completely during faulty conditions related to PV arrays (DC side) [3]. It is therefore required to create algorithms to facilitate the detection of possible faults occurring in GCPV systems [4].

There are existing fault detection techniques for use in GCPV plants. Some use satellite data for fault prediction as presented by M. Tadj et al [5], this approach is based on satellite image for estimating solar radiation data and predicting faults occurring in the DC side of the GCPV plant. However, some algorithms do not require any climate data, such as solar irradiance and modules' temperature, but instead use earth capacitance measurements in a technique established by Taka-Shima el al [6].