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Fault Detection in photovoltaic system by using wavelet transform and fuzzy logic: A Review

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Abstract: *The main purpose of this paper is detection of fault in PV(Photovoltaic) system. Faults are in the form of DC side short circuit faults which consist of photovoltaic panels which is connected in series or parallel. Under low irradiance conditions fault detection is very difficult so such faults detect by using wavelet and fuzzy algorithm. If this faults are not detected then faults can gives lower output energy and panel can be damage. The proposed method of fault detection is totally based on Wavelet transformation and fuzzy logic system.*

Keywords: *Fuzzy inference system (FIS), wavelet transform, Photovoltaic array, fault detection*

I. Introduction

T HE solar sector has been growing largely over the past few years due to high availability, energy independence, environmental compatibility, short installation time required, and low cost for maintenance. The trends indicate that the capacity of photovoltaic (PV) installations in the United States in 2012 have increased by 80% compared to that of 2011 and 65% large as compared to the last 10 years. As the renewable energy demands increase, it is predicted that the utilization of solar energy will grow even further. A photovoltaic (PV) system directly converts solar energy into electricity [1]

Due to largely increasing demand for clean renewable energy resources and particularly to PV desirable characteristics such as energy independence, environmental compatibility, high availability, low cost of maintenance and short installation time recent years have witnessed growing deployment of PV power plants. The dramatic development of PV technologies and solar power farms has exponentially increased the global PV installed capacity from 1.3GW in 2000 to 177GW in 2014 [2], [3]. As the associated costs decrease, the total installed PV capacity increases and constitutes a higher portion of the total installed renewable energy capacity [4]. These rapid developments revealed certain technical issues that, if unresolved, may hinder full realization of solar PV economic and environmental benefits. These issues include, line to line faults, module failures and ground faults in the PV arrays that without proper protection schemes in place, can damage the panels and cause DC arcing hazards with fire risks and also provide unexpected loss of both revenues and energy.

PV array DC-side faults principally different from conventional power system faults. Since fault current magnitude of PV arrays is much lower, rendering it difficult to be detected, the immediate impact of the fault might be minimal. Particularly, faults that occur under low irradiance, such as mornings/evenings or in cloudy days, might not be able to activate protection devices [2], [5]. Fault detection strategies designed for PV arrays must be able to diagnose and clear such faults to enhance the reliability and efficiency of solar power plants. The next section presents a brief description about problem and a review of the existing fault detection methods in the technical literature papers.

As well known, a PV system is composed of a number of various interconnected elementary blocks (PV panels), and its performance can be even dramatically impacted by the failure of only one of them. However, it is very arduous to keep the whole system under control to ensure effective maintenance as the number of blocks is very large. As a result, highly specialized monitoring tools devised to identify malfunctioning conditions are particularly sought [6].

II. Literature Review

A. *Fault Detection for Photovoltaic Systems Based on Multi-Resolution Signal Decomposition and Fuzzy Inference Systems Zhehan Yi, Student Member, IEEE, and Amir H. Etemadi, Member, IEEE*

This paper presents line to line fault detection and line to ground fault detection in PV array by using MPPT. MPPT is used to maximize the PV array output power at different irradiance level. This paper proposed a fault detection scheme for PV array based on Multi-resolution signal decomposition (MSD) and fuzzy inference system (FIS). Under another cases fault occur in low irradiance condition or with high impedance the boundaries of feature level between fault and normal cases difficult to detect but FIS is ideal platform for deal with such problem. In this work the problem of fault detection on the DC side of PV array is addressed. In this paper the inputs are PV array output current and voltage and solar irradiance. The MSD technique is used to

extract four different features based on these three inputs. The result of this paper for 25% L-L fault is 84.9% and for 50% L-L fault is 96.91. This is highest result among all papers.

B. ***Monitoring and Diagnostics of PV Plants by a Wireless Self-Powered Sensor for Individual Panels Pierluigi Guerriero, Fabio Di Napoli, Gianlorenzo Vallone, Vincenzo d'Alessandro, and Santolo Daliento***

This paper state that how to measure the operating voltage and current, open-circuit voltage, and short-circuit current of the photovoltaic array by using an innovative sensor. The sensor does not require additional cables thanks to a wireless communication and a power supply section based on energy harvesting. The sensor also measures the actual operating point without any effect on the production of energy. The energy loss estimation is performed by comparing each panel with the best performing one in the plant in terms of energy production, on the assumption that the optimizer always reaches the maximum power point (MPP). However, this method suffers from two drawbacks, it leads to increase in system complex is the first and the second is it dc power optimizers may not be compatible with old-generation inverters, thus being often inadequate for the monitoring of already installed plants.

C. ***Detection of Internal Resistance Change for Photovoltaic Arrays Using Extremum-Seeking Control MPPT Signals Xiao Li, Yaoyu Li, Member, IEEE, John E. Seem, Member, IEEE, and Peng Lei***

This paper state that the cost of solar energy is reduced by using fault diagnosis method and maximum power point tracking (MPPT) method. Here MPPT method is developed by extremum-seeking control (ESC) methods which is used for searching the unknown or time varying input parameter of nonlinear plant and used for changing the PV internal resistance. Buck converter is used in PV system for voltage controlling purpose. Here ESC of MPPT is also used for multi-input of multistring PV system. The PV system is connected in parallel and series for getting high amount of voltage and current. For analysis and control implementation a standpoint, changing the internal resistance by ESC .This simulation is divided in to two part first is single-string case and another is multistring case. For both cases shunt internal resistance is clearly demonstrated, which strongly validates the proposed scheme.

III. Methodology

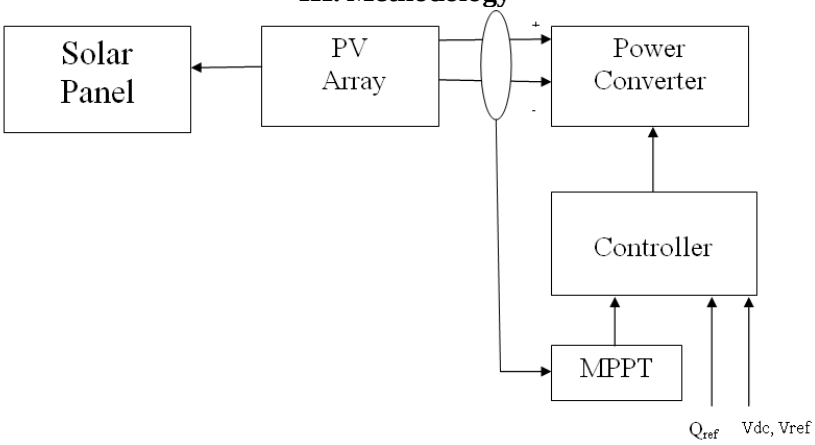

Fig. Block diagram of Fault Detection in photovoltaic system

Most widely used configuration for this system are pv array, power controller, convertor, maximum power point tracking (MPPT)

1. ***PV array*** **-**In this system the photo voltaic plates are connected to each other in series firstly to provide required voltage and then the series strings are connected in parallel to provide necessary current [2].

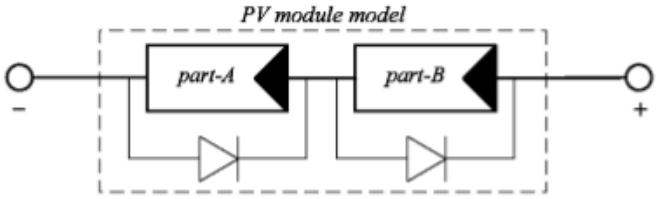

Fig.2(a)*Representation of pv model*

Fig show that the how pv plates are connected in series.

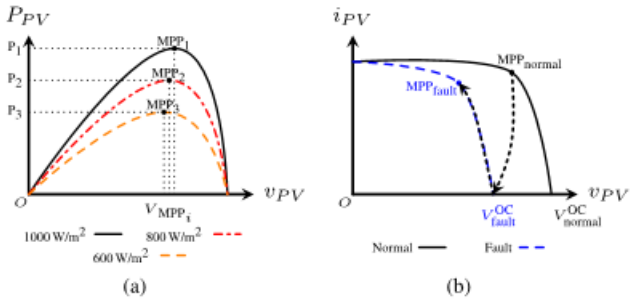

Fig 2(b) characteristics of output voltage

Fig 2(b) shows that the output voltage characteristics for different irradiance levels. When output voltage increased at the maximum power point (MPP1)the output power is also increased but the voltage of array is decreases which is $V_{MPP1.}$ As irradiance level changes, the curve also changes.

2. Power Convertor

The power convertor is used to convert the power which is required. Here first DC to DC convertor is used which is connected to pv array grid system. DC to DC convertor is nothing but the chopper which is used for converting variable DC power into fixed DC power.The output of pv array is nothing but in DC but which is variable ,this variable DC power is converted into fixed DC by this convertor.

For the next side of DC to DC convertor the DC to AC convertor that is nothing but invertor is connected in series with this first convertor. The power which is output of pv array is in DC form which is converted in to AC by using invertor.

3. Controller

The controller is connected to the converter, which is used for the controlling purpose. The output which is given by the convertor is controlled by controller. The dc voltage and the reference voltage both are controlled by controller.

4. MPPT

MPPT is nothing but the maximum power point tracking .By using MPPT the fault detection is more difficult. Especially under low irradiance condition. When fault is occur the point of voltage which is at normal condition is shifted to new voltage point and the curve is obtained which is shown in fig2(b)

Fuzzy Logic

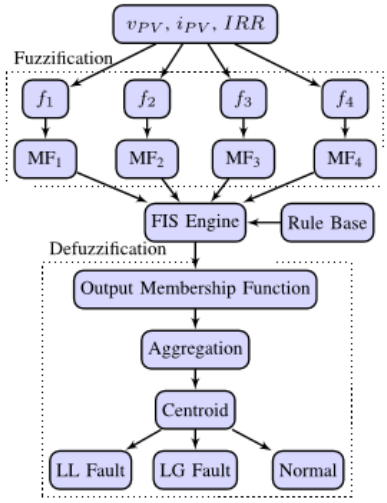

Fig3. Fuzzy logic

Fig 3 shows that the fuzzy inference system which is used for detection of fault It is nothing but the if and then process.

IV. Conclusion

The problem of fault detection in DC side of pv array is determined by using MPPT and fuzzy logic. MPPT is nothing but the maximum power point tracking which is used for under irradiance condition menace when fault is occur it give another voltage point. And another method is used which is fuzzy inference system which is used for detection of fault.

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