IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9523

Application of Fuzzy Logic and (KNN) to classify and determine location of Faults for Solar System

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Abstract: Solar energy is most abundant energy source in the universe, PV technology is experiencing a rapid growth over the past few years. But abnormal conditions such as faults, low irradiance etc. lead to the reduction in the available output power from a photovoltaic array. To ensure performance and safety of the PV system, it is necessary to develop techniques that can efficiently localize the faults occurred. This paper presents a detection scheme for faults in the Solar system. If undetected, faults can considerably lower the output of solar systems, damage the panels, and potentially cause fire hazards. The presented fault detection scheme employs Multi-Resolution Signal Decomposition (MSD) technique and two machine learning algorithms namely Fuzzy Logic and K-Nearest Neighbour (KNN) to classify the fault and determine its location. Simulation results verify the accuracy, reliability and scalability of the presented scheme.

Keywords: Fault detection, K-Nearest Neighbour (KNN) algorithm, Maximum Power Point Tracking (MPPT),Machine Learning algorithm, Photovoltaic (PV) array, ground-fault protection devices (GFPDs.

I. INTRODUCTION

Solar energy is the most readily available and free source of energy. Solar energy can be used directly for heating and lighting home and buildings, for generating electricity, cooking food, hot-water heating, solar cooling, drying materials, and a variety of commercial and industrial uses.Solar energy can be converted into thermal energy with the help of solar collectors and receivers known as solar-thermal devices. PV-created direct current (DC) electricity that can be used as such is converted to alternating current (AC) or stored for later use. This type of solar electricity is more expensive than that produced by traditional sources. But over the past two decades, the cost gap has been closing. Solar photovoltaic technology has emerged as a useful power source of applications such as lightning, meeting the electricity needs of villages, hospitals, telecommunications, and houses. [1].

Electricity demand is increasing day by day. Demand fulfilment is one of the major task in Power system. Solar system plays vital role to fulfil the demand. Also, solar system has advantages that renewable energy source, clean energy, ad abundant availability, due to electricity generation by using PV Plant is more popular in now days. The rapid development reveals some technical issues, PV system associated with different types of fault, among the numerous possible faults such as ground fault, line-to-line fault, hot spot formation, polarity mismatch, arc fault, open fault, bypass diode failure, and dust/soil formation in a PV array, ground fault, line-to-line fault, and arc fault are reported to be the major reasons behind catastrophic failures resulting in electrical fires.[2]

II.FAULTS IN PV ARRAY

As shown in Fig.1, a typical grid-connected PV system consists of several major components, including the PV modules as power sources, power conditioning unit (i.e., PV inverter) integrated with MPPT algorithm, electrical connection wirings, and protection devices, such as OCPDs and ground-fault protection devices (GFPDs).
Several types of fault could happen inside PV arrays, such as line-line faults, ground faults, opencircuit faults, and mismatch faults. Among these faults, line-line faults and ground faults are the most common faults in solar PV arrays, which potentially involve large fault current or dc arcs.[3].

III PROPOSED FAULT DETECTION SCHEME

The proposed fault detection system is based on multi-resolution signal decomposition technique which is based on wavelet transformation which uses a series of high and low-pass filters successively to extract the low frequency components, and the high frequency components. There are two types of wavelet transforms, continuous wavelet transform and discrete wavelet transform. Discrete wavelet transform is typically used with digital signal processing platforms. Machine learning algorithms are used to classify the type of fault occurred. This system is designed, focusing

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on detecting LL and LG faults, that result in output losses in PV system. Other schemes might be employed in parallel for detecting other types of faults. The proposed process is a result of various simulation studies and signal analysis that is described below.

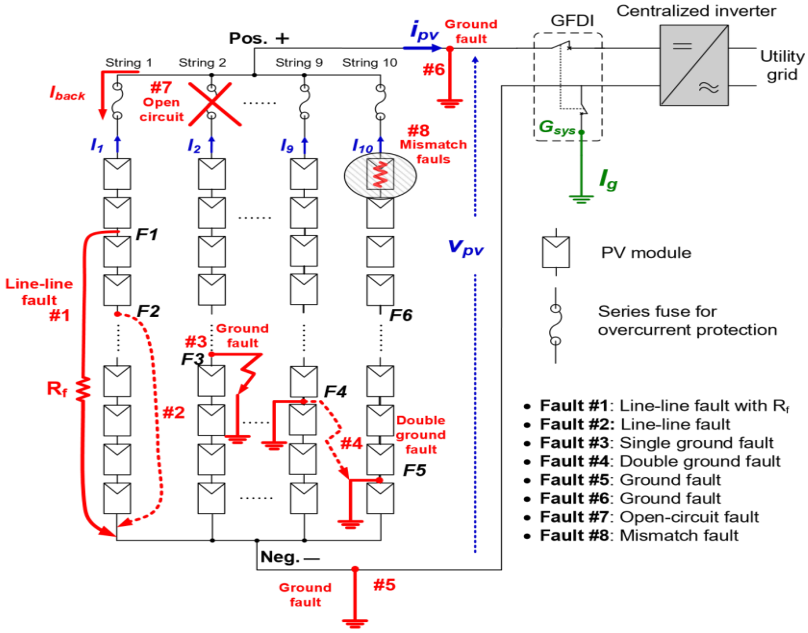

Fig. 1Schematic diagram of a grid-connected PV system, including various types of faults in the PV array [4]

• A. PV Model

In order to verify and evaluate the performance of presented scheme, simulation and various case studies are carried out in MATLAB software. A 6x3 PV array is modelled based on widely used configuration shown in Fig. 2 (6 modules in series along with 3 strings in parallel).

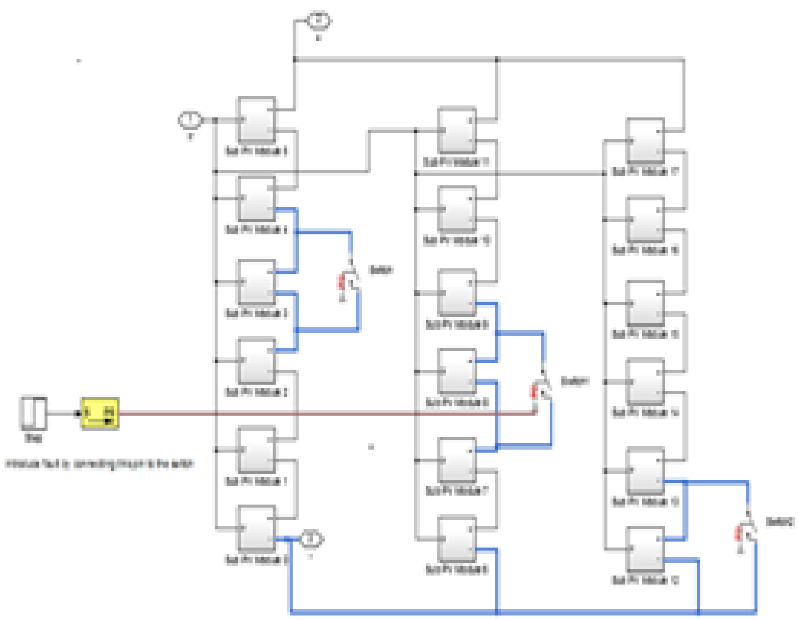

Fig 2 Simulation Model PV System

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IV Fault Detection and Classification

This paper presents a detection scheme for detecting LL and LG faults in PV systems. Simulation studies of above proposed model demonstrate the performance of system under such fault cases. Discrete Wavelet Transform (DWT) analyzes the signal at different frequency bands with different resolutions by decomposing the signal into coarse approximation and detail information. The decomposition of the signal into different frequency bands is obtained by successive highpass and lowpass filtering of the time domain signal.

For classification of fault, we are using here fuzzy system, fuzzy membership function for proposed system input and output variables shown in fig no.3 and fig no.4 and fuzzy rules are as follows;

If (input 1 is input 2) then (output is LL)
If (input 1 is input 1) then (output is LG)
If (input 1 is input 3) then (output is NF)

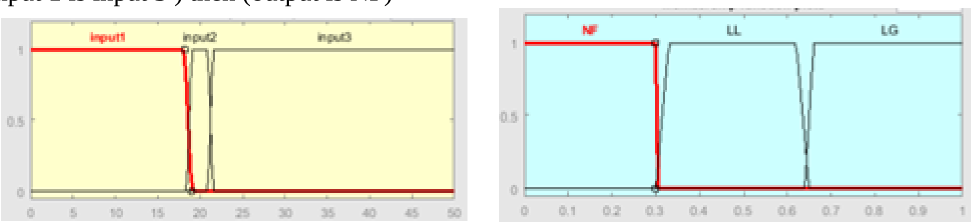

Fig 3 FIS Membership function input and output variables

IV. SIMULATION RESULT

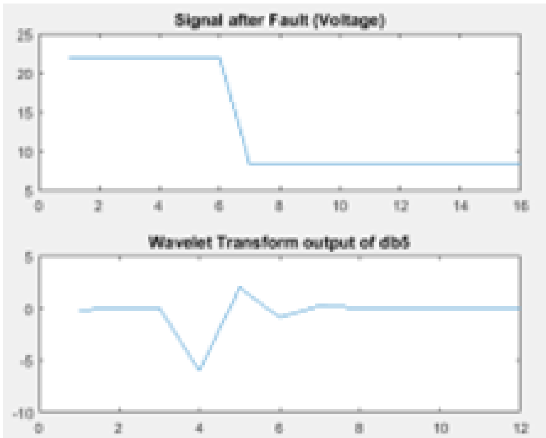

Fig 4 Waveform after Fault occurs in PV Array with wavelet transform

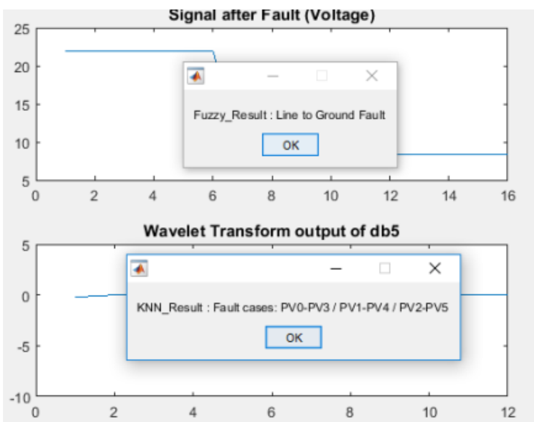

Fig 5 fuzzy classifies the fault and KNN locate the fault

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V EXPERIMENTAL SET UP

To verify the performance of the proposed algorithm, a small-scale PV array is set up (Fig.8), which consists of a PV array (3x3), a switch between the PV array and the inverter, and the data collecting station. The system is not system-grounded but is equipment-grounded.20 cases of LL faults with 10% mismatch with fault impedances (0 □) and generated at 4s waveform for Voltage is shown in fig no. are applied to the PV array. Result is discussed in Table no.

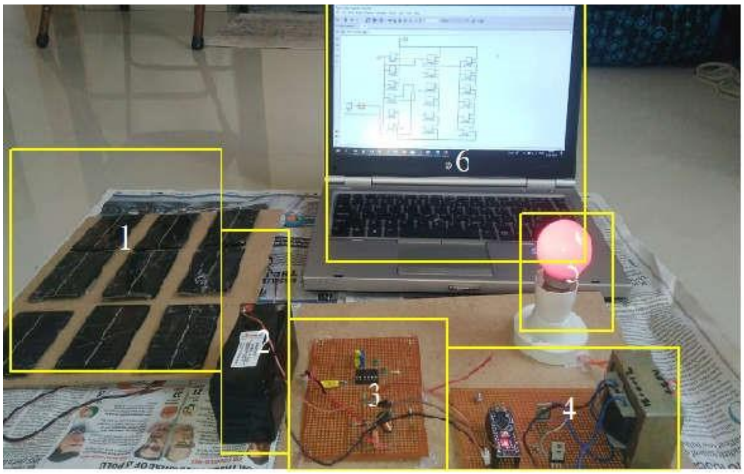

Fig 6 1) PV panel 2) battery 3) MPPT 4) Inverter 5) lamp load 6) Data station collecting

Table no 1.1Hardware result

Mismatch Percentage %	Fault Impedance 0□	Accuracy In %
10	10/20	50

II. CONCLUSION

The detection solar system faults is addressed in this presented paper. The first scheme is an improved fuzzy module which classifies the detected fault accurately and the second scheme is developed using KNN module which classifies as well as locates the fault. A simple and efficient detection scheme using MSD is also presented in this paper. Signals and are processed for classifying the faults. With the help of Fuzzy Logic classifies the occurred fault, whereas, with the help of, KNN classifies and locates the occurred faults. Simulation based case studies demonstrate the performance of the presented fault detection scheme. Also, both the classification schemes are compared and it has been observed that both schemes detect faults almost accurately whereas KNN also shows the fault location precisely, Verified the result by simulation and Hardware.

REFERENCES

[1] Utpal Gangopadhyay, "State of Art of Solar Photovoltaic Technology" Hindawi Publishing Corporation Conference Papers in Energy.

[2]M. Alam, F. Khan, J. Johnson, and J. Flicker, "A comprehensive review of catastrophic faults in PV arrays: Types, detection, and mitigation techniques," IEEE Journal of Photovoltaics, vol. 5, no. 3, pp. 982–997, May 2015.

[3]. Y. Zhao, J. F. de Palma, J. Mosesian, R. Lyons, and B. Lehman, "Line–line fault analysis and protection challenges in solar photovoltaic arrays," IEEE Transactions on Industrial Electronics, vol. 60, no. 9, pp. 3784–3795, Sept 2013.

[4]. Y. Zhao, "fault detection, classification and protection in solar photovoltaic arrays," Master thesis, August 2015