A Review on Classification and Detection of Faults in a Photovoltaic System

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Abstract— The fast development of solar industry in past many years has increase the importance of PV systems. One of the main aims of research in developing integrated PV systems is to enhance the efficiency, availability and reliability of the system. In spite of the fact that a lot of work has already been done on technological design to enhance the system's efficiency, progress in the direction of diagnosis of faults in a PV system is yet to be done. If faults occuring in a PV system aren't detected on time, then it may not only result in decrease in the generation of power but may also question the availability and dependency and ultimately the "security" of the entire system.

Keywords: PV, N-Type, P-Type, PV Array

I. INTRODUCTION

The recent generation of electricity from renewable resources relies in order to narrow the growing gap between supply of electricity and demand. The most important renewable source of energy present today is the sun.

In comparison to other traditional power-generating technologies, solar energy not only shows positive attributes for individuals but it also shows the same for any community on a local, national and even global level.

The fact that solar energy has an infinite supply is one of the key reasons for its use. Sunlight is the source of solar energy. The sun is a steady source of energy that is accessible all across the earth. For the past 4 billion years, it has provided solar energy to the world.

Another important reason to use solar energy is that it is a renewable and sustainable source of energy with very little negative influence on the environment. Many traditional forms of electricity generation contribute to dangerous gas emissions by releasing carbon dioxide, nitrous oxide, sulphur dioxide, or mercury into the atmosphere, however solar energy does not emit any of these poisonous gases and has no impact on global warming, acid rain, or smog.

II. REVIEW OF LITERATURE

He, Weiguo et al., (2021) With the widespread attention and research of distributed photovoltaic (PV) systems, the fault detection and diagnosis problems of distributed PV systems has become increasingly prominent. To this end, a distributed PV array fault diagnosis method based on fine-tuning Naive Bayes model for the fault conditions of PV array such as open-circuit, short-circuit, shading, abnormal degradation, and abnormal bypass diode is proposed. First, in view of the problem of less distributed PV fault data, a fine-tuning Naive Bayes model (FTNB) is proposed to improve the diagnosis accuracy. Second, the failure sample set is used to train the model. Then, the maximum power point data of the PV inverter and the meteorological data are collected for fault diagnosis. Finally, the effectiveness and accuracy of the proposed method are verified by the analysis of simulation. In addition, this method requires only a small number of fault sample sets and no additional measurement equipment is required, which is suitable for real-time monitoring of distributed PV systems.

Bharath et al., (2020) Photovoltaic (PV) energy has become one of the main sources of renewable energy and is currently the fastest-growing energy technology. As PV energy continues to grow in importance, the investigation of the faults and degradation of PV systems is crucial for better stability and performance of electrical systems. In this work, a fault classification algorithm is proposed to achieve accurate and early failure detection in PV systems. The analysis is carried out considering the feature extraction capabilities of the wavelet transform and classification attributes of radial basis function networks (RBFNs). In order to improve the performance of the proposed classifier, the dynamic fusion of kernels is performed. The performance of the proposed technique is tested on a 1 kW single-phase stand-alone PV system, which depicted a 100% training efficiency under 13 s and 97% testing efficiency under 0.2 s, which is better than the techniques in the literature. The obtained results indicate that the developed method can effectively detect faults with low misclassification.

Djalab, Aicha et al., (2020) During their operation, PV systems can be subject of various faults and anomalies that could lead to a reduction in the effectiveness and the profitability of the PV systems. These faults can crash, cause a fire or stop the whole system. The main objective of this work is to present a sophisticated method based on artificial neural networks ANN for diagnosing; detecting and precisely classifying the fault in the solar panels in order to avoid a fall in the production and performance of the photovoltaic system. The work established in this paper intends in first place to propose a method to detect possible various faults in PV module using the Multilayer Perceptron (MLP) ANN network. The developed artificial neural network requires a large database and periodic training to evaluate the output parameters with good accuracy. To evaluate the accuracy and the performance of the proposed approach, a comparison is carried out with the classic method (the method of thresholding). To test the effectiveness of the proposed approach in detecting and classifying different faults, an extensive simulation is carried out using Matlab SIMULINK.

Lazzaretti et al., (2020) Photovoltaic (PV) energy use has been increasing recently, mainly due to new policies all over the world to reduce the application of fossil fuels. PV system efficiency is highly dependent on environmental variables, besides being affected by several kinds of faults, which can lead to a severe energy loss throughout the operation of the system. In this sense, we present a Monitoring System (MS) to measure the electrical and environmental variables to produce instantaneous and

historical data, allowing to estimate parameters that ar related to the plant efficiency.

Shinde, Poonam and Deore, S R (2020) Solar energy is that the foremost abundant, inexhaustible and clean of all renewable energy resources. Interest in electrical solar PV power generation has accumulated in recent years due to its benefits. This wide distribution of physical phenomenon panel production wasn't followed by watching, fault detection and designation functions to verify higher gain. In this paper, real time fault analysis and fault detection is done by using Back propagation. By simulating various fault conditions, the performances of a faulty electrical solar photovoltaic module have been compared with respect to its faultless model by quantifying the precise differential residue which can be associated with it. The deformations and faults induced on the I-V curves and P-V curves have been studied to generate data for neural network analysis for different types of faults. Five different fault cases like module to module fault, module - ground faults, short circuit fault, and different shading patterns of modules and solar cells are considered. The MATLAB simulation model's results show the respective results for various fault conditions along with variation of different solar irradiation which commonly occur in the photovoltaic systems.

Rao, Sunil et al., (2019) In this paper, we describe a Cyber-Physical system approach to fault detection in Photovoltaic (PV) arrays. More specifically, we explore customized neural network algorithms for fault detection from monitoring devices that sense data and actuate at each individual panel. We develop a framework for the use of feedforward neural networks for fault detection and identification. Our approach promises to improve efficiency by detecting and identifying eight different faults and commonly occurring conditions that affect power output in utility scale PV arrays.

Sonawane, Pramod et al., (2019) With rapid growth of photovoltaic (PV) market throughout the world, fault detection & diagnosis in PV system got the equal importance. Early detection of fault will be useful in order to increase the efficiency, the result of measurement & life of photovoltaic system. If these PV faults not detected & corrected earlier it will seriously affect the energy output of plant. This monitoring & fault detection can be done on site or distantly.

Zaki, Sayed A. et al., (2019) Among several renewable energy resources, Solar has great potential to solve the world's energy problems. With the rapid expansion and installation of PV system worldwide, fault detection and diagnosis has become the most significant issue in order to raise the system efficiency and reduce the maintenance cost as well as repair time. This paper presented a method for monitoring, identifying, and detecting different faults in PV array. This method is built based on comparing the measured electrical para meters with its theoretical parameters in case of normal and faulty conditions of PV array.

Alajmi, Masoud et al., (2018) Most solar power stations contain hundreds, even thousands, of photovoltaic (PV) modules. Monitoring a solar power station and diagnosing faults in real time are a primary challenge in maintaining the normal operation. A traditional fault detection process is cumbersome and time consuming. In this paper, we are applying a hybrid method for fault detection and localization in serial-parallel configuration using a network of current-voltage sensors-based frame work to detect and localize open- circuit, short-circuit, and hotspot faults. Data-analysis is used through a classifier to allow for better fault diagnosis such as the recognition of the environmental factors within a hotspot fault class.

Khelil, C Karamostefa et al., (2017) This article proposes the modelling, detection and classification of the faults of a grid connected photovoltaic system by artificial neural networks. The validation of our study required a real meteorological data such as (Module Temperature, Solar Irradiance) as well as electrical data (Impp, Vmpp) of the month of March 2014, the system is composed of sixteen Photo-voltaic modules connected to network of the station CDER in Algiers, Algeria. The fault detection algorithm compares the measured and the simulated data by artificial neurons mentioned above, using the percentage of linearity ratio method. The system proved a good efficiency between the measured and the simulated values as well as the remarkable results of the detection algorithm.

Saidi Khadidja et al., (2017) This work investigates and compares two alternative MPPT methods, the Incremental Conductance method and the Perturbation and Observation Method (P&O). The first phase entails investigating various types of PV system components, such as PV modules, DC-DC converters, and MPPT controllers. The second phase entails a comparison of the two metho dologies, which is then followed by simulation.

M.Mano et al., (2016) The classification and detection of various defects in a grid-connected PV system are presented in this study. The first and most important stage is to recognise, investigate, and identify any issue that could arise in a PV system. This document covers all potential forms of faults that can arise on both the AC and DC sides of the system.

R. Hariharan et al., (2016) The maximum usable power from a PV array is reduced due to various sorts of defects and partial shade. As a result, it's critical to detect partial shading issues in a PV array in order to improve the system's efficiency and dependability. This study discusses various approaches for detecting flaws as well as partial shading under various irradiance levels. The method described in the study can be used to classify PV array status in three different situations: normal operation, partial shading, and fault.

Samah Laamami et al., (201) We can study and assess the performance of a PV array caused by various sorts of faults during shading with the help of this research. The performance of a PV array is affected by a variety of parameters such as temp erature, irradiance, partial shade, and PV array layout. The performance of a PV system should be improved, thus the first and most important goal is to find defects that can reduce the PV system's efficiency. In addition, the PV and IV Characteristic curves of a PV array created with MATLAB at various solar irradiances are investigated in this work.

III. CONCLUSION

Under partial shading, snow cover, or soiling conditions, the P-V curves show several peaks. Special MPPT schemes to track the GP in these circumstances would be beneficial.

Although the methods utilised in this study can distinguish a variety of flaws, they are unable to detect the location of the fault inside the PV array. It would be advantageous to develop more ways for determining these places.

Finally, further study might consider the situation when two or more faults occur at the same time.

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