A Review Paper on Efficient Protection Scheme for Microgrid based on Wavelet Transform and Data-Mining Technique

Abhishek Dixit[1], Santosh Kumar[2]

Department of Electrical and Electronics Engineering

Millennium Institute of Technology & Science, Bhopal,India

Abstract-To resolve the protection issues caused by high penetration of distributed energy resources, this paper proposes an efficient protection scheme for microgrids based on the autocorrelation of three-phase current envelopes. The proposed strategy uses a squaring and low-pass filtering approach for evaluating the envelope of the current signal. Then, the variance of the autocorrelation function is used to extract the hidden information of the distorted envelope to detect the fault signatures in the microgrid. Furthermore, the reactive power is used for determining the fault direction. The proposed scheme was shown to be easy to implement and have good performance under looped and radial configuration for both grid-connected and islanded operation modes. The simulation results showed that the scheme could not only detect, locate, classify, and isolate various types of short-circuit faults effectively but also provide backup protection in case of primary protection failure.

Keywords: autocorrelation function; backup protection; envelope detection; reactive power; squaring and low-pass filtering.

I. INTRODUCTION

The utilization of distributed energy resources (DERs) to generate electric power around the world is increasing owing to the increasing cost and gradual depletion of fossil fuels, and the considerably rising demands for clean power and greenhouse gas emission reduction [1,2]. Enormous scope dispersed vitality assets are infiltrated into the appropriation system to frame a subnetwork called a micro grid. The microgrid is causing customary mass force age frameworks to quickly change into appropriated age frameworks [3,4]. It has the ability to give ecological and financial advantages by providing power locally, shaving top burdens, diminishing line misfortunes, and providing nonstop vitality gracefully with improved dependability and vitality productivity. All things considered, the utilization of the microgrid has a few specialized provokes attributable to its particular qualities and activity, of which, the significant issue is assurance [5, 6]. The execution of the microgrid disturbs the sheltered activity of the regular assurance structure, which is planned accepting huge shortcoming flows and unidirectional force stream. In any case, with the high entrance of circulated generators (DGs) in the microgrid and the capacity of the microgrid to switch across network associated and islanded modes, the sufficiency and heading of issue flows shift as per the framework's inconsistencies [7]. In both low and medium-voltage age frameworks, the bidirectional force emerging from the generators and burdens moves through the defensive gadgets in a microgrid. During network associated activity, most of the shortcoming current is contributed by the lattice; this outcomes in high issue flows. Despite what might be expected, during independent method of activity, flaw flows drop to low levels attributable to the commitment of constrained limit DERs. Under such changing working conditions, the issue examples of the microgrid are not as evident as in customary insurance frameworks. In this manner, the standard overcurrent transfers utilized in ordinary insurance frameworks can't acquire adequate issue data and set aside a long effort to recognize deficiencies, which causes shakiness issues and harm to the hardware, just as affectability and selectivity issues; moreover, it makes it hard to distinguish and order unsettling influences happening in an islanded microgrid and makes assurance all the more testing [10-16].

To ensure the efficient and reliable operation of a micro grid, it is highly important to detect and locate faults to restore power with a minimum outage, and to limit damage- and protection-related problems. Therefore, to maintain a high level of continuity of services and satisfaction of customers under both operating modes, fast and intelligent protection strategies have to be designed through advanced signal processing techniques, which can overcome the aforementioned protection challenges. To thisend, a protection scheme designed for a micro grid should consider the following aspects:

(a) Bidirectional power flow,

(b) Looped feeders, and

(c) Reduced short-circuit current during islanded operation [10,11]

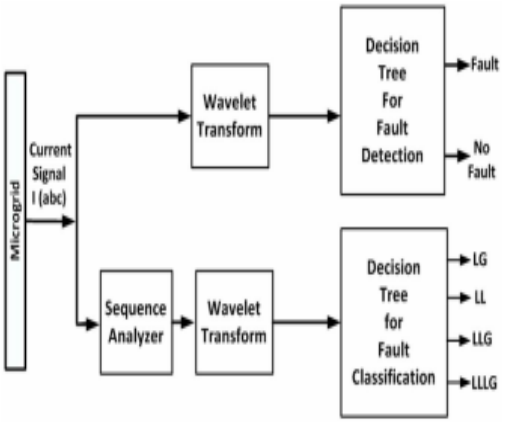

Figure 1: Working of microgrid based wavelet transform.

II. LITERATURE SURVEY

In this section the comparison of the techniques which are proposed by several authors in order to perform fault detection as well as the classification is performed.

In this paper [1] author explained Fault detection is essential in microgrid control and operation, as it enables the system to perform fast fault isolation and recovery. The adoption of inverter-interfaced distributed generation in microgrids makes traditional fault detection schemes inappropriate due to their dependence on significant fault currents. In this paper, we devise an intelligent fault detection scheme for microgrid based on wavelet transform and deep neural networks. The proposed scheme aims to provide fast fault type, phase, and location information for microgrid protection and service recovery. In the scheme, branch current measurements sampled by protective relays are pre-processed by discrete wavelet transform to extract statistical features. Then all available data is input into deep neural networks to develop fault information. Compared with previous work, the proposed scheme can provide significantly better fault type classification accuracy. Moreover, the scheme can also detect the locations of faults, which are unavailable in previous work. To evaluate the performance of the proposed fault detection scheme, we conduct a comprehensive evaluation study on the CERTS microgrid and IEEE 34-bus system. The simulation results demonstrate the efficacy of the proposed scheme in terms of detection accuracy, computation time, and robustness against measurement uncertainty. In this paper [2] author presents an intelligent protection scheme for microgrid using combined wavelet transform and decision tree. The procedure begins at recovering current signs at the transferring point and preprocessing through wavelet change to infer compelling highlights, for example, change in vitality, entropy, and standard deviation utilizing wavelet coefficients. When the highlights are extricated against blamed and unfaulted circumstances for each-stage, the informational collection is worked to prepare the decision tree (DT), which is approved on the inconspicuous informational collection for shortcoming recognition in the microgrid. Further, the shortcoming characterization task is done by including the wavelet based highlights got from succession segments alongside the highlights got from the current signs. The new informational index is utilized to fabricate the DT for deficiency identification and arrangement. Both the DTs are broadly tried on an enormous informational collection of 3860 examples and the test outcomes demonstrate that the proposed handing-off plan can adequately secure the microgrid against defective circumstances, remembering wide varieties for working conditions. In this paper [3] author disclosed To determine the security issues brought about by high entrance of dispersed vitality assets, this paper proposes a proficient insurance plot for microgrids dependent on the autocorrelation of three-stage current envelopes. The proposed procedure utilizes a squaring and low-pass sifting approach for assessing the envelope of the current sign. At that point, the change of the autocorrelation work is utilized to extricate the shrouded data of the mutilated envelope to identify the deficiency marks in the microgrid. Moreover, the receptive force is utilized for deciding the fault heading. The exhibition of the proposed security plot was checked on a standard medium-voltage microgrid by performing recreations in the MATLAB/Simulink condition (Version: R2017b). The proposed conspire was demonstrated to be anything but difficult to actualize and have great execution under circled and outspread design for both framework associated and islanded activity modes. The recreation results indicated that the plan couldn't just identify, find, arrange, and seclude different kinds of short out issues adequately yet additionally give reinforcement security if there should arise an occurrence of essential insurance disappointment. In this paper [4] author clarified Microgrids have accumulated a lot of consideration inside the previous decade and turning into a fundamental resource in the vitality business. The capacity to coordinate manageable vitality age techniques into the dispersion arrange is one of the principle explanations behind microgrids ubiquity. A wide assortment of Distributed Generation (DG) including wind and other smaller scale turbine age, photovoltaic age alongside vitality stockpiling, makes the microgrid suitable in both lattice associated and islanded modes while diminishing the force misfortunes. There are different specialized difficulties to be handled so as to collect the maximum capacity of microgrids, and

insurance is one of them. Different arrangements were presented, driven by the advancement of insurance strategies. One of the most encouraging methodologies for microgrid insurance is versatile assurance. This paper contains an efficient audit on versatile insurance of microgrids, including a wide scope of materialness variations, their qualities, and disadvantages. It likewise investigates the best in class explores that use computational insight to accomplish versatile insurance. These arrangements are right now at the skirt of thoroughly reclassifying insurance arrangements with an increasingly adaptable and solid framework that will be applied all inclusive. In this paper [5] author clarified the deficiency current degree of microgrid is distinctive between islanded mode and matrix associated mode. This circumstance corrupts the presentation of conventional overcurrent assurance plans. Consequently, this paper proposes a security strategy dependent on highlight cosine and differential plan. Initially, highlight cosine is proposed; it utilizes circle condition and least squares to evaluate the unified conduct about voltage and current. Furthermore, shortcoming current heading and highlight cosine are examined when deficiency happens at various areas of a run of the mill microgrid, and afterward the distinction of highlight cosine among defective and solid segment areas is acquired. Thirdly, in view of highlight cosine and differential plan, the differential heading is characterized and used to identify broken segment area. Ultimately, different time area reproduction contextual analyses, including diverse microgrid activity modes, establishing protections, faulted sorts, defective segment areas, and clamor impact, are directed and exhibit that the proposed assurance has high precision.

Table 1: Summary of Computational Methods.

Authors	Methods	Purposes	Tasks
James J. Q. Yu , Member [1]	Wavelet Transform and Deep Neural Networks.	Fault Diagnosis	The simulation results demonstrate the efficacy of the proposed scheme in terms of detection accuracy, computation time, and robustness against measurement uncertainty.
Debi Prasad Mishra [2]	Decision Tree (DT),	Diagnosis	The new data set is used to build the DT for fault detection and classification.
Shazia Baloch 1 , Saeed Zaman Jamali 2 [3]	The proposed strategy uses a squaring and low-pass filtering approach for evaluating the envelope of the current signal.	Diagnosis & Identification	The simulation results showed that the scheme could not only detect, locate, classify, and isolate various types of short-circuit faults effectively
T S SSenarathna [4]	Integrated and data-driven fault detection and diagnosis scheme	Diagnosis Strategy	Normal and fault conditions
Lai Lei,1,2 Cong Wang [5]	Distributed Generation (DG)	Detection & identification Detection algorithm	These solutions are currently at the verge of totally redefining protection solutions with a more flexible and reliable system that will be applied globally.

In the above table 1 the comparative analysis over previously used algorithms is given.

III. KEY FEATURES OF MICROGRID SYSTEM

1. Benefits the earth through the absence of ozone depleting substance emanation through low/zero-discharge age advances

2. Separate control plans are required to work inside both specialized and efficient cutoff points

3. Through Islanding, microgrids can work in any event, during utility disappointments expanding the unwavering quality levels

4. Use of battery-based vitality stockpiling frameworks can be costly in both commencement and support

5. Can add to top shaving of the framework arrange by appropriated age during top hours

6. Intermittent nature of the sustainable power sources

7. Used to jolt remote regions which experience issues in interfacing with the essential framework

8. Protection Challenges because of the circulated age

9. An perfect answer for the CHP prerequisites of clients by expanded in general vitality effectiveness

10. The monetary preferred position of creating own power for a lower cost than from the principle utility and even by trading the vitality back to the matrix

IV. PROBLEM DEFINITION

- Protection problem gets complicated when the microgrid switches between mesh and radial topologies.
- A protection scheme for the microgrid must address the problems related to bidirectional power flow and different levels of fault current in islanded and grid-connected mode.
- DNN is combined with DWT to solve the microgrid fault detection problem from the data-driven viewpoint;

V. CONCLUSION

The proposed research develops a new protection scheme for microgrids with the wavelet transform and data-mining model. Initially the current is preprocessed to extract most effective statistical features which contain the transient information. Further, the wavelet based features are used to build the data-mining models for final relaying decision. The proposed DT model provides significantly improved performance over existing over current relays. Even though another data-mining model RF provides similar performance like the DT, however, being a black-box solution, the RF faces implementation difficulty as compared to the transparent datamining model DT. The most important issue is the use of time–frequency information for building the data-mining models which improves the dependability and reliability of the relay. As the wavelet transform is very fast, thus the response time for fault detection.

REFERENCES

[1]. James J. Q. Yu , Member, IEEE, YunheHou, Intelligent Fault Detection Scheme for Microgrids With Wavelet-Based Deep Neural Networks, IEEE TRANSACTIONS ON SMART GRID, VOL. 10, NO. 2, MARCH 2019.

[2]. Debi Prasad Mishra, SubhransuRanjanSamantaray, Senior Member, IEEE, and GezaJoos, Fellow, IEEE, A Combined Wavelet and Data-Mining Based Intelligent Protection Scheme for Microgrid, 1949-3053 © 2015 IEEE.

[3]. Shazia Baloch 1 , Saeed Zaman Jamali 2 , Khawaja Khalid Mehmood 3 , Syed Basit Ali Bukhari 3 , Muhammad Saeed Uz Zaman 1 , Arif Hussain 1 and Chul-Hwan Kim 1,*, Microgrid Protection Strategy Based on the Autocorrelation of Current Envelopes Using the Squaring and Low-Pass Filtering Method, 8 May 2020.

[4]. T S SSenarathna and K T M UdayangaHemapala*, Review of adaptive protection methods for microgrids, 11 September 2019.

[5]. **Lai Lei**,[1,2] Cong Wang,[1] Jie Gao,[3] Jinjin Zhao,[2] and Xiaowei Wang[4,5,] , A Protection Method Based on Feature Cosine and Differential Scheme for Microgrid, 10 Mar 2019.

[6]. M. A. Zamani, T. S. Sidhu, and A. Yazdani, "A protection strategy and microprocessor-based relay for low-voltage microgrids," IEEE Trans. Power Del., vol. 26, no. 3, pp. 1873–1883, Jul. 2011.

[7]. P. Mahat, C. Zhe, B. Bak-Jensen, and C. L. Bak, "A simple adaptive overcurrent protection of distribution systems with distributed generation," IEEE Trans. Smart Grid, vol. 2, no. 3, pp. 428–437, Sep. 2011.

[8]. E. Sortomme, S. S. Venkata, and J. Mitra, "Microgrid protection using communication-assisted digital relays," in Proc. IEEE Power Energy Soc. Gen. Meeting, Minneapolis, MN, USA, 2010, p. 1.

[9]. H. Nikkhajoei and R. H. Lasseter, "Microgrid protection," in Proc. IEEE Power Eng. Soc. Gen. Meeting, Tampa, FL, USA, 2007, pp. 1–6.

[10]. T. S. Ustun, C. Ozansoy, and A. Zayegh, "Modeling of a centralized microgrid protection system and distributed energy resources according to IEC 61850-7-420," IEEE Trans. Power Del., vol. 27, no. 3, pp. 1560–1567, Aug. 2012.

[11]. T. S. Ustun, C. Ozansoy, and A. Ustun, "Fault current coefficient and time delay assignment for microgrid protection system with central protection unit," IEEE Trans. Power Syst., vol. 28, no. 2, pp. 598–606, May 2013.

[12]. M. A. Zamani, T. S. Sidhu, and A. Yazdani, "A communication-based strategy for protection of microgrids with looped configuration," Elect. Power Syst. Res., vol. 104, pp. 52–61, Nov. 2013.

[13]. S. R. Samantaray, G. Joos, and I. Kamwa, "Differential energy based microgrid protection against fault conditions," in Proc. IEEE PES Innov. Smart Grid Technol. (ISGT), Washington, DC, USA, 2012, pp. 1–7.

[14]. M. A. Haj-ahmed and M. S. Illindala, "The influence of inverter-based DGs and their controllers on distribution network protection," in Proc. IEEE Ind. Appl. Soc. Annu. Meeting, Lake Buena Vista, FL, USA, 2013, pp. 1–9.

[15]. E. Casagrande, W. W. Lee, H. H. Zeineldin, and N. H. Kan'an, "Data mining approach to fault detection for isolated inverter-based microgrids," IET Gener. Transm. Distrib., vol. 7, no. 7, pp. 745–754, Jul. 2013.

[16]. P. Piagi and R. H. Lasseter, "Autonomous control of microgrids," in Proc. IEEE Power Eng. Soc. Gen. Meeting, Montreal, QC, Canada, 2006, p. 8. [17] A. Yazdani and R. Iravani, Voltage-Sourced Converters in Power Systems: Modeling, Control, and Applications. Hoboken, NJ, USA: Wiley, 2010.