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Distributed Generation System: Loss Detection of Grid Events *via* Pattern Identification

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Abstract

The purpose of this paper is to discuss the different types of pattern identification methods that are commonly used for loss detection of grid events in renewable energy Distributed Generation (DG) sources. The research paper is divided into four parts: Introduction, background, literature review, and conclusion. The introduction provides an overall overview of the topic, identifying reasons why pattern identification methods are important in recognizing islanding events. The second section of the paper highlights detailed analysis of distributed generation systems and the risks that might arise when islanding is not detected. The literature review analyzes three major pattern identification artificial neural networks, decision tree classifier, and adaptive neuro fuzzy inference system. These three systems use machine learning to train the systems through algorithms to identify islanding and non islanding system. The fourth section is a generalized summary of the entire paper.

Keywords: Loss detection; Grid events; Distributed Generation (DG) systems; Pattern identification methods; Islanding; Artificial neural networks; Decision tree classifier; Adaptive neuro fuzzy inference system

Introduction

Traditional concept for the electric power grid relies on large, centralized grid connected renewable energy sources to transmit electricity across great distances to individual homes and businesses. Due to its reliance on a small number of key nodes, the grid is easily disrupted by events beyond its control, such as transmission line or plant outages, severe weather, and consequent cascade failures and widespread blackouts (Guha 1). The global growth in energy. Demand has put an extreme pressure on the power system. This is due to the high costs associated with upgrading transmission infrastructure and the economic and environmental restrictions placed on the development of new power plants. Because of the drawbacks of the centralized approach, such as high transmission losses and high installation costs, the distributed power generating model is increasingly being pushed as a viable alternative. In contemporary systems, renewable energy source is continuously being used to evolve grids into smart system by allowing bi-directional flow of power. Distributed Generation (DG) units (independent generators that provide electricity into the distribution network) are the building blocks of this architecture. This paper discusses the three main types of pattern identification methods including artificial neural networks, decision tree classifier, and adaptive neuro fuzzy inference system, which are used in the detection of grid events in a renewable energy distributed generation system [1].

Today, a considerable portion of distributed generation source are classified as renewable source including photo voltaic arrays system, mini hydro power plants, and wind energy conversion systems. The reason why renewable energy based distributed generation systems have become popular in recent years is because they improve the energy security of an area since renewable energy is locally available. However, there may be number of operational difficulties associated with connecting DG systems to the electricity grid. Islanding detection is one such challenges. Argue that islanding occurs when a DG system loses contact with the rest of the power grid (140). Due to the potentially terrible consequences of islanding, DG interconnection standards like IEEE 1547 require the use of a reliable and rapid islanding detection method [2]. Passive monitoring has mainly been used in the monitoring of energy frequency and voltage in conventional islanding techniques (Figure 1).

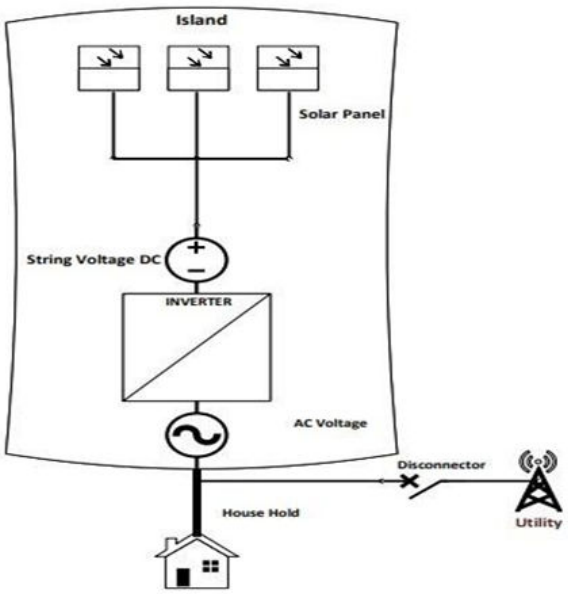

Figure 1: A typical islanding scenario of a DG system.

Numerous risks arise as a result of islanding for an extended period of time. If islanding is not recognized and remedial action is not performed by the DG protection system, it is likely that power is being mistakenly given back by these DG sources. When power lines that have been disconnected from the grid are still electrified by a nearby DG source, for instance, this poses a risk to field engineers and maintenance employees. Most current DG systems are privately held; therefore, they are mostly out of the hands of power companies. When electricity is cut off to a specific location, known as "islanding," the

DG voltage in that region will no longer be in phase with the rest of the power grid. The islanding detection methods such as pattern identification are required to ensure that a DG source is automatically detected and disconnected from the primary grid [3].

Literature Review

Types of pattern identification techniques

Machine learning strategies employ learnable, adaptive algorithms to determine if an event is islanding or not. These techniques use input and output samples to train and refine classification models. In order to spot islands, algorithms have been described that take into account both the target class and a massive collection of input features (islanding or nonislanding). The three main types of pattern identification methods that are commonly used include artificial neural networks, decision tree classifier, and adaptive neuro fuzzy inference system [4].

Artificial neural networks

It is common practice to use Artificial Neural Networks (ANN) for function fitting, pattern identification, signal forecasting. They are classified as a subset of machine learning algorithms whose reasoning is heavily influenced by the concept of the human brain. These characteristics have found use in the field of power systems, where they have been used for fault classification, power system stabilizer design, voltage stability analysis. Guha assumes that the building blocks of an ANN are a series of layers an input layer, one or more hidden layers, and an output layer that are all complicated coupled to one another. Multiple inverter based DG and hybrid inverter based DG have both been proposed to benefit from ANN based islanding detection algorithms. Today, most renewable energy generation systems use a grid connected inverter to facilitate the transmission of electricity in the grid [5].

Discussion

Decision tree classifier

The islanding detection capabilities of the Decision Tree (DT) method have been thoroughly examined over the years. One form of pattern identification tool is the decision tree classifier, which attempts to find a good answer for all potential inputs by factoring in their statistical variances. A Decision Tree (DT) is a type of sequential flowchart in which each node performs a threshold comparison on an input variable. After comparing the current values of the system parameters to the thresholds, the tree eventually settles on an event classification. The information you provide is used to build the DT and choose the threshold. The leaves, or terminal nodes, of the tree reflect the categorization of the event, while the trunk represents the result of comparing the input parameter with the threshold. In comparison to other pattern identification methods, DT's key benefit is its rapid training time [6].

Adaptive Neuro Fuzzy Inference System (ANFIS)

Many nonlinear classification issues have been resolved with the help of artificial intelligence techniques like neural networks and Fuzzy Logic (FL) inference. According to Laghari, et al. a Fuzzy Logic System (FLS) principal benefits come from its ability to represent nonlinear input/output interactions using a collection of qualitative if then rules. The ANFIS is an effective method for modeling nonlinear and complicated systems with little input and output training data, while nevertheless achieving rapid learning and high accuracy [7]. ANFIS is a dynamic network that integrates FL and neural network architecture. It incorporates the best features of both approaches while removing those that only apply when just one is employed [8]. This makes the ANFIS method the most accurate pattern identification technique for identifying islanding.

Conclusion

Islanding can have severe consequences on a renewable energy distributed generation system, hence the need for having reliable and accurate pattern identification systems for identifying grid events. Some of the potential risks of islanding events include disconnection of the entire grid system as well as risking the lives of maintenance employees and field engineers. There commonly used types of pattern identification methods include artificial neural networks, decision tree classifier, and adaptive neuro fuzzy inference system. Each of these methods uses machine learning to train the system to be able to detect islanding and non islanding events in a grid system. Out of the three, the adaptive neuro fuzzy inference system is the most effective method.

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