Chapter 12
Artificial Neural Network (ANN) in Network Reconfiguration for Improvement of Voltage Stability

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ABSTRACT

Issues related to power system voltage levels have become increasingly important issue during last two and half decades. In power networks, low voltage situations may result in the loss of stability, voltage collapse and eventually to cascading power outages. Large number of incidents of voltage collapse has been reported in different countries across the globe. A simple indicator that has the potential in real time, i.e. L indicator has been used to find voltage profile at different switching condition and simulated using ANN in network reconfiguration for the improvement of voltage stability. A method for improving voltage stability in a power network comprising of multiple lines and switches has been suggested in this chapter based on system reconfiguration approach. ANN based fast and efficient methodology has been developed to obtain the optimum switching combination to achieve best voltage stability. The proposed scheme has been tested on an IEEE 14-bus system.

1. INTRODUCTION

Intelligent algorithms are algorithms with an element of artificial intelligence. They can decide their next course of action based on the current state of the system. The ability to take self-guided decisions is called *heuristic*, which comes from experience. Some algorithms follow human defined heuristics and some follow nature's heuristics. Those following human defined heuristics are called Artificially Intel-

DOI: 10.4018/978-1-7998-0414-7.ch012

ligent Algorithms, and those following nature's, are called Nature Inspired Algorithms. Hill-Climbing (HC), Depth First Search (DFS), Minimal Spanning Tree (MST), etc. are some of the artificially intelligent algorithms, while Genetic Algorithms (GA), Artificial Neural Networks (ANN), Particle Swarm Optimization (PSO) etc. are some naturally intelligent algorithms. The advantage of such algorithms is that they make use of human or natural intelligence to reach a solution in a short time preventing the investigator from taking exhaustive approaches.

The breakthrough of artificial intelligence in the electric power system which started in the mid-eighties has resulted in the development of numerous expert systems and knowledge-based system tools for solving various power system problems (Huneault, Rosu, Manoliu, & Galiana, 1994). Lot of works in the field of power system protection, distribution planning, design and management have been reported which utilized artificial intelligence. Over the last decade, a number of papers have been reported in the field of distributed automation using Hardware based systems and as well as various soft computational techniques (Warwick, Ekwue, Arthur & Aggarwal, 1997). The present discussion proposes the applications of ANN for optimal operation of a power system at highest voltage stability and minimum active and reactive power losses.

2. OVERVIEW OF VOLTAGE STABILITY ISSUES IN GENERAL

Issues related to power system voltage levels have become increasingly important during last two and half decades. In power networks, low voltage situations may result in the loss of stability, voltage collapse and eventually to cascading power outages. Large number of incidents of voltage collapse has been reported in different countries across the globe (Taylor, 1994) & (Aboytes & Arroys, 1987).

It is a well-established fact that there is a strong relationship between real power transmission (MW) and rotor angle (δ), and reactive power transmission (MVAR) and the voltage (Chakrabarti & Mukhopadhyay, 1989) & (Aboytes & Arroys, 1987). In other words, the availability of MW is dictated by machine angle, which in turn is decided by the input to the prime mover. On the other hand, voltage magnitude is related to MVAR availability at that point of time. Voltage instability can be ascribed to lack of VAR support necessary to maintain the voltage profile within specified levels (Davidson, 1975) at certain load condition.

Voltage stability is concerned with maintaining 'acceptable voltage levels' all system buses under normal conditions as well as when the system is being subjected to a disturbance. The main causes of voltage instability are lack of reactive power resources, heavy loading and severe contingencies. During instability, voltage magnitude of some of the system buses decrease gradually and then rapidly to reach the collapse point (Aboytes & Arroys, 1987). The excess load on the transmission lines, large distance of the generating sources, and lack in local reactive compensation (Chakrabarti & Mukhopadhyay, 1989) are the also caused the voltage instability.

Some of the researchers have been developed a number of voltage stability indicators in the last two decades. Due to this fact, accurate preventive control actions can be taken easily with the help of voltage stability index. Voltage stability assessment can be done with the help of different indicators (L-index indicator, V-Q sensitivity indicator, Voltage Collapse Proximity Indicator (Warwick, Ekwue, Arthur, & Aggarwal, 1997), which involves numerous load flow solutions under both normal and abnormal operating conditions like outage of transmission lines, outage of some generating source etc.