ABSTRACT

In recent years, voltage instability has been responsible for several major network collapses. Voltage stability is concerned with the ability of a power system to maintain acceptable voltage at all buses in the system under normal operating conditions and after being subjected to a disturbance. A power system enters a state of voltage instability when there is a disturbance, increase in load demand, or change in system condition which causes a progressive and uncontrollable decline in voltage. The main factor causing voltage instability is the inability of the power system to meet the demand for reactive power. Contingency analysis is an important component of the security function, which is considered to be an integral part of the modern energy management system at energy control centers. It is also applied in voltage stability to estimate post-contingency P-V and Q-V curves and maximum transfer capability.

With the increasing size of power system, there is a thrust on finding the solution to maximize the utilization of existing system and to provide adequate voltage support, where the flexibility of power is needed. Voltage stability problems normally occur in heavily stressed systems. While the disturbance leading to voltage collapse may be initiated by a variety of causes, the underlying problem is an inherent weakness in the power system.
In this work, Linear estimation method is used to approximate the values when more than one type of errors are encountered which lead to erroneous estimate in power system. The estimation of errors can be decreased using computational numerical method and the values can be optimized to improve the result based on Genetic Algorithm (GA). IEEE 14-bus and IEEE 57-bus test systems are used for contingency analysis. From the test results, it is found that the estimated post-outage voltages are larger than or equal to the corresponding results from conventional method. The post-outage reactive power generations and flows are obtained for the proposed test systems. The obtained mean error and standard deviation are less compared to the results presented in the literature.

Flexible AC transmission System (FACTS) devices if placed optimally can be effective in providing voltage support, controlling power flow and reduce the system loss. Among the FACTS devices Static Var Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC) and Unified Power Flow Controller (UPFC) are considered in this proposed work. The optimal rating and location of FACTS devices are obtained by (i) minimizing the real power loss (ii) voltage profile improvement (iii) voltage stability enhancement and (iv) minimizing the total cost.

In this work, the optimization of power system is analyzed using Fast Voltage Stability Index (FVSI) and L-index approaches. Both the indices were found falling between 0 and 1 in their intended range. When the system is stable, these indices are close to 0. When the system is in critical condition with regard to voltage instability, the indices moved towards 1. The line with
The highest FVSI value is considered as critical line and the load bus connected in the line is said to be vulnerable bus in the system. The bus with highest L-Index value is considered as critical bus. Using these indices the location of FACTS devices are identified. In this work, the optimal rating of FACTS devices is found with Bacterial Foraging Optimization technique which gives the global optimal solution with less computational burden.

In this proposed work, optimal rating of Static Var Compensator (SVC), Thyristor Controlled Series Compensator (TCSC) and Unified Power Flow Controller (UPFC) are obtained using Bacterial Foraging Optimization Algorithm (BFOA). The Bacterial Foraging technique is a computational intelligence based technique that is not largely affected by the size and non-linearity of the problem and can converge to the optimal solution in many problems where most analytical methods fail to converge. The effect of these devices on line flows and bus voltage profile has been studied by placing them at optimal ratings dictated by Bacterial Foraging Algorithm. The proposed algorithm used in this work has been written in MATLAB software. The effectiveness of the developed algorithm has been tested on IEEE 14- bus system in FVSI approach and 6- bus, IEEE 14- bus and IEEE 30- bus test systems are used in L-index approach. Based on the test results, it is found that TCSC produced better result compared with SVC. UPFC produced best result compared with SVC and TCSC.