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A Soft Computing Approach to Voltage Collapse Forecasting and Mitigation of Power System

ABSTRACT

The modern power systems normally operate at heavily loaded condition and often faced with the steady increase in load demand. In spite of adoption of many precautionary measures, still all over the world, collapse of power systems or grid failure are common which incur huge losses of tariff as well as industrial production. Normally, these blackouts are avoided by severing a critically loaded line but it causes aftermath effects, like oscillations and instability problem leading to grid failure or blackout. Thus the ability to maintain voltage stability of stressed power systems has become a major concern for practical operation.

The economic, environmental, right of way and geographical resources are forcing, the power systems to operate closer to the limits. Due to these factors, in the last two decades, a large number of system collapses have occurred all over the world. These collapses were primarily due to reactive power deficits resulting in voltage instabilities. Secondly, often, they were unable to meet the sudden (sharp rise) in load demand, in the form of quick supply of the real/ active power. A distinguishing feature of this problem was that in a large number of instances the first phase of instabilities evolved very slowly, about 3-30 minutes. Therefore, often the stability is enhanced and the grid collapse is prevented by interrupting/severing a healthy loaded line.

The voltage stability, like any other stability, is a dynamic problem. However, certain useful information such as the loadability limit, proximity of the operating point to this limit, the amount of corrective measures to be applied to achieve a desirable voltage stability margin etc., can be easily obtained from static analysis. The dynamic analysis, on the other hand, can be used to study as to how the system proceeds toward voltage instability and collapse. Therefore, new techniques are needed with computational intelligence for prediction and mitigation of the power system collapse or blackouts.

However, because of the simplicity, computational efficiency and sensitivities available for optimization, static tools have been very popular in voltage stability analysis and enhancement. In the present research work, the focus has been primarily on steady state voltage stability related analysis and enhancement to prevent the grid collapse. For this purpose ANN based analytical methods are proposed and stability is achieved using reactive power control at different location. Moreover, ***Powerworld*** simulator is also used separately to verify the proposed technique.

Further, a novel series impedance/ resistance control method is also proposed, to enhance the stability and to prevent the collapse of the power system by reducing the load (total power demand) on the power system, without interrupting/severing any load line. For this purpose, a series resistance is inserted in the most affected line to decrease the load on the power system and to enhance the power system stability and to avoid cascaded tripping leading to the total grid failure or collapse. The proposed method is verified and established using *NEPLAN* software.