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Early Detection of Voltage Instability in Distribution System utilizing Phasor Measurement Units

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Extended Abstract

Power system automation leads to a great jump in detecting and solving the system problems. Due to the serious problems of system voltage collapse, an early prediction online voltage instability detector is discussed in this paper. Early prediction of voltage collapse has great advantages in reducing lot of reliability and economical problems.

The voltage instability detector utilizes the voltage and current phasor readings of connected Phasor Measurement Units (PMU) to the distribution terminals. The simulated detector depends on two parallel concepts for voltage collapse prediction, to give faster and precious response. These concepts are clarified in the main two simulated alarming parts of the detector algorithm. The first part of the algorithm is a comparison for the online terminal current and voltage phasors from the PMUs, with an offline calculated Look-up table. The Look-up table represents the permissible maximum current I_{Lm} and minimum voltage V_{Lm} phasors for each terminal. The values of I_{Lm} and V_{Lm} phasors are computed using Particle Swarm Optimization (PSO) technique. The objective function of the PSO depends on the system Thevenin equivalent as seen from the load terminal, which is connected to the PMU. The second main part of the algorithm is based on the online computation of the ratio of the Thevenin equivalent system impedance to the terminal load impedance (Z_{th}/Z_L) of the network, utilizing the readings of the connected PMU. The variation in Thevenin voltage is also used in voltage instability prediction. The Thevenin equivalent of the system contributes in voltage instability detection of the system.

The simulated voltage instability detector is applied to two unified power systems. The first system is a system depicted from the distribution network of the Egyptian Unified Electrical Power Network (UEPN), which is shown in Fig.1. Both Fig. 2 and Fig. 3 represent samples of the UEPN system results for the second part of the algorithm. The second system is a part of United Kingdom distribution power system. The simulated detector gives effective results. It reacts with the systems changes in good and reasonable behavior.

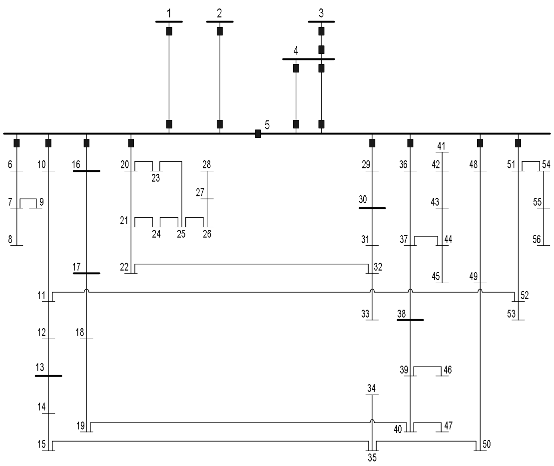

Fig. 1. Egyptian UEPN: 56- bus test system model

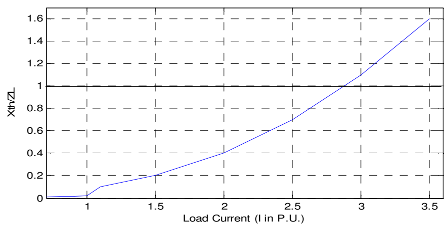

Fig. 2. The ratio of Thevenin impedance to load impedance versus the load current variation for node 36 in the UEPN of Egypt

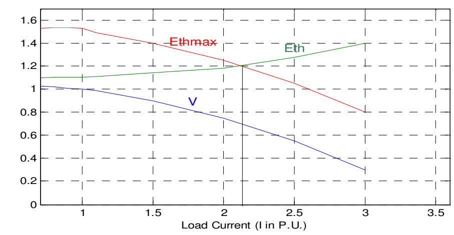

Fig. 3. The response of E_{th}, V_L, and E_{thmax} to the load current variation for node 36 in the UEPN of Egypt