A Hybrid Particle Swarm Optimization for Distribution State Estimation

Naka, S.; Genji, T.; Yura, T.; Fukuyama,Y.

Author Affiliations: Kansai Electric Power Co., Japan; Fuji Electric Co., Japan.

Abstract: This paper proposes a hybrid particle swarm optimization for a practical distribution state estimation. The proposed method considers nonlinear characteristics of the practical equipment and actual limited measurements in distribution systems. The method can estimate load and distributed generation output values at each node by minimizing the difference between measured and calculated voltages and currents. The feasibility of the proposed method is demonstrated and compared with an original particle swarm optimization based method on practical distribution system models. Effectiveness of the constriction factor approach of particle swarm optimization is also investigated. The results indicate the applicability of the proposed state estimation method to the practical distribution systems.

Keywords: Distributed generation, distribution state estimation, hybrid particle swarm optimization, modern heuristic method, voltage regulator.

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A Probabilistic Methodology for Distribution Substation Location

Khodr, H.M.; Melian, J.A.; Quiroz, A.J.; Picado, D.C.; Yusta, J.M.; Urdaneta, A.J.

Author Affiliations: Universidad Simon Bolivar, Venezuela; AES-Venezuela; Universidad de Zaragoza, Spain.

Abstract: A probabilistic methodology is presented, conceived to assist electric system planning engineers in the selection of the distribution substation locations, taking into account the hourly load changes or the daily load cycle. The hourly load centers for each of the different hourly load scenarios are calculated deterministically. These location points, properly weighted according to their correspondent load magnitude, are used to calculate the best fit probability distribution. This distribution is used to determine the maximum likelihood perimeter of the area where the substation should preferably be located. Results are presented and discussed for the application of the methodology to a real case, assuming three different bivariate probability distributions: the Gaussian distribution, a bivariate version of Freund's exponential distribution, and the Weibull probability distribution.

Keywords Power distribution planning, substations, probability.

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Human Factors Aspects of Power System Voltage Contour Visualizations

Overbye, T.J.; Wiegmann, D.A.; Rich, A.M.; Sun, Y.

Author Affiliations: University of Illinois at Urbana-Champaign, USA.

Abstract: This paper presents experimental results associated with human-factors aspects of utilizing color contours to visualize electric power system bus voltage magnitude information. Participants were divided into three groups: the first group saw only one-line numeric data, the second only one-line contour data, while the third saw both. The purpose of the experiment was to determine how quickly participants could both acknowledge low voltage violations and perform corrective control actions. Results indicated the contour-only visualization resulted in the quickest voltage violation acknowledgments, while the numeric-data-only visualization resulted in the quickest solution times. Testing was done using a modified version of the IEEE 118 bus system.

Keywords Power system operations and planning, voltage visualization, contouring, human factors.

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Use of ARMA Block Processing for Estimating Stationary Low-Frequency Electromechanical Modes of Power Systems

Wies, R.W.; Pierre, J.W.; Trudnowski, D.J.

Author Affiliations: University of Alaska at Fairbanks, USA; University of Wyoming, USA; Montana Tech, USA.

Abstract: Accurate knowledge of low-frequency electromechanical modes in power systems gives vital information about the stability of the system. Current techniques for estimating electromechanical modes are computationally intensive and rely on complex system models. This research complements model-based approaches and uses measurement-based techniques. This paper discusses the development of an auto-regressive moving average (ARMA) block processing technique to estimate these low-frequency electromechanical modes from measured ambient power system data without requiring a disturbance. This technique is applied to simulated data containing a stationary low-frequency mode generated from a 19-machine test model. The frequency and damping factor of the estimated modes are compared with the actual modes for various block sizes. This technique is also applied to 35-minute blocks of actual ambient power system data before and after a disturbance and compared to results from Prony analysis on the ringdown from the disturbance.

Keywords Estimation, Interconnected power systems, power system modeling, power system monitoring, power system transients, power system state estimation, power system stability, power system control, signal analysis, signal sampling.

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Hydrothermal Market Simulator Using Game Theory: Assessment of Market Power

Villar, J.; Rudnick, H.

Author Affiliations: Pontificia Universidad Católica de Chile.

Abstract: The aim of this work is to build a model able to simulate a hydrothermal electric power market based on simple bids to a power exchange. The model studies the behavior of different market agents in a short-term horizon and delivers information about spot prices, use of water, and other relevant variables. Initially, a thermoelectric market is simulated through a static model based on Cournot concepts. The addition of hydroelectric power stations and time dependencies is made later, using a dynamic programming algorithm to build a dynamic model. In each stage and state of the dynamic programming, a Nash-Cournot equilibrium is determined to assess the behavior of the thermoelectric power stations (static model). Different strategies that firms can follow and the consequences of each one of them are analyzed. Market power mitigation effects of physical and financial bilateral contracts are also investigated. A case study with data on the Chilean power system is presented and analyzed.

Keywords Power sector deregulation, electric market, market power, Cournot, oligopoly, game theory.

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A Hybrid Method for Observability Analysis Using a Reduced Network Graph Theory

Korres, G.N.; Katsikas, P.J.

Author Affiliations: National Technical University of Athens, Greece.

Abstract: This paper presents a hybrid topological-numerical approach for observability analysis in power system state estimation. By partitioning the network in observable areas, a reduced network is formed, where each area is represented by a supernode and each line between areas as a branch. We select as areas the flow islands, being the maximal connected components of flow measured branches. Only boundary nodes and injections at flow islands are retained for numerical