FEASIBILITY STUDIES OF THE LOCAL VOLTAGE ESTIMATOR IN SELECTION OF ESTIMATION OF PARAMETERS FOR IEEE 30 BUS SYSTEM

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Abstract

The standard IEEE 30-bus system and an actual WECC 2001-2003 Winter (case ID 213SNK) planning case was used to test the accuracy and feasibility of the local voltage estimator formulation. The simulations of local voltage estimator and power flow on IEEE 30 bus system are all done with 30 MATLAB programs, while the simulations of local voltage estimator and power flow on WECC system are done with C/C++ program and BPA Power Flow package. The standard IEEE 30-bus system is a widely used test case for power system researchers. The local control areas are chosen such that the buses within 3 tiers of the control bus are included. Before the tests on the local voltage estimator, let us choose a proper parameter α for this system to approximate the voltage changes on outside buses.

Paper Identification

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Introduction

There are various optimization methods have been proposed to solve the optimal power flow problem in iterative techniques, some of which are refinements on earlier methods. These include:

Gradient descent method: is a first-order optimization algorithm. To find a local minimum of a function using gradient descent, one takes steps proportional to the negative of the gradient (or of the approximate gradient) of the function at the current point. Newton's method: is a method for finding successively better approximations to the zeroes (or roots) of a real-valued function. Linear programming methods: is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. Quadratic programming methods: is a special type of mathematical optimization problem. It is the problem of optimizing (minimizing or maximizing) a quadratic function of several variables subject to linear constraints on these variables. Interior point method: are a certain class of algorithms to solve linear and nonlinear convex optimization problems.

So far we have been primarily concerned with the economical operation of a power system. An equally important factor in the operation of a power system is the desire to maintain system security. Security of supply is a measure of the power system's capacity to continue operating within defined technical limits even in the event of the disconnection of a major power system element such as an interconnector or large generator or any piece of equipment in the system due to either internal or external causes such as lightning strikes, objects hitting transmission towers, or human errors in setting relays. Reliability is a measure of the power system's capacity to continue to supply sufficient power to satisfy customer demand, allowing for the loss of generation capacity. Hence, the EMS has to operate the system at minimum cost, with the guaranteed alleviation of emergency conditions such as violations of operating limits, contingencies. System security can be said to comprise three major functions that are carried out in an energy control center: System monitoring: supplies the power system operators with pertinent up-to-date information on the conditions of the power system. Telemetry systems measure and transmit the data, and then digital computers in a control center process and inform the operators in case of an overload or out of limit.

Contingency analysis: this model possible system troubles (outages) before they occur i.e, it carries out emergency identification and "what if" simulation. This allows the system operators to locate defensive operating states where no single contingency event will generate overloads and/or voltage violations. Corrective action analysis: permits the operator to change the operation of the power system if a contingency analysis program predicts a serious problem in the event of the occurrence of a certain outage. Thus, this provides preventive and post-contingency control.

Review of Literature

The alternate heuristic voltage control differs from the model-based voltage control in that the state estimator model is assumed to be unavailable; hence the switching effects can not be evaluated by power flow computation. For the heuristic approach of voltage control, the challenge is how to "predict" or "estimate" the load bus voltage changes after a switching action under different topology/load conditions. In this chapter, a local voltage estimator (LVE) is formulated to approximate the bus voltage changes after a switching action by using only the local measurements from SCADA before switching. The evaluation of the security degree of a power system is a crucial problem, both in planning and in daily operation. Without considering dynamic issues, power system security must be interpreted as security against a series of previously defined contingencies, therefore, the concept of security and its quantification are conditioned, F. C. Chan and Y. Y. Hsu,1981. Operations personnel must know which line or generation outages will cause flows or voltages to fall outside limits, F. Kumar, O. P. Malik and G.S. Hope, 1987. To predict the effects of outages, contingency analysis techniques are used. Security assessment or Contingency analysis procedures model single failure events (i.e., one-line outage or one-generator outage) or multiple equipment failure events (i.e., two transmission lines, one transmission line plus one generator, etc.), one after another in sequence until "all credible outages" have been studied. For each outage tested, the contingency analysis procedure checks all lines and voltages in the network against their respective limits, H. Hemmati, S. M. S. Boroujeni, 2011. The list of contingencies to be processed whose probability of occurrence is high. The question is how to select the contingencies to analyze in detail in such a way that none of the problematic ones would be left unattended, also taking into account the required speed of response imposed by real time operation, I. Monga, G. Kaur, A. Kaur and Kanika Soni,2010. One way to gain speed of solution in a contingency analysis procedure is to use an approximate model of the power system. For many systems, the use of linear sensitivity method which shows the approximate change in line flows for changes in generation on the network configuration /derived from the DC load flow method/ provides adequate capability, N. Wang and D. Chen,2013.

Material and Method

In this study, the local voltage estimator formulated earlier will be evaluated with numerical examples. The standard IEEE 30-bus system and an actual WECC 2001-2003 Winter (case ID 213SNK) planning case was used to test the accuracy and feasibility of the local voltage estimator formulation. The simulations of local voltage estimator and power flow on IEEE 30 bus system are all done with 30 MATLAB programs, while the simulations of local voltage estimator and power flow on WECC system are done with C/C++ program and BPA Power Flow package.

Tests on IEEE 30 Bus System

The standard IEEE 30-bus system is a widely used test case for power system researchers. The local control areas are chosen such that the buses within 3 tiers of the control bus are included. Before the tests on the local voltage estimator, let us choose a proper parameter α for this system to approximate the voltage changes on outside buses. The results are shown as in the following table

α	Bus 10 (19 Mvar)			Bus 24 (4.3 Mvar		
	Max error		Total error	Max error		Total error
0.75	25	0.0039	0244	20	-0.0018	0.0044
0.85	12	0.0031	0.0167	24	0.0015	0.0028
0.95	19	0.0053	0.0270	24	0.0019	0.0032

Table 1 Selection of estimation parameters for IEEE 30 bus system.

It is obvious from the above table that α = 0.85 is the best for this system in terms of both maximum error and total error and will be applied in the following tests. The IEEE 30 bus test case is slightly modified to facilitate the test. All capacitors are switched out and all voltage set points of generators are set to 0.01 lower than their original values. The tests include switching in each of the shunt capacitors, changing ratios of each transformer, and adjusting voltage set points of all generators. Table 2, show the simulation results. Control First tier buses and Max error bus Cap. Action

Tier	Bus	*V0 VPF*	*VLVE*	*VERR*	Total err
1	6	1.0080	1.0102	1.0103	0.0001
1	9	1.0397	1.050	1.051	0.0004

			9	3	
1	10	1.0233	1.045 1	1.046 0	0.0009
1	17	1.0206	1.039 9	1.040 0	0.0002
1	20	1.0116	1.029 7	1.031 9	0.0021
1	21	1.0118	1.032 7	1.033 7	0.0007
1	22	1.0127	1.033 2	1.033 2	0.0006
3	18	1.0138	1.022 7	1.031 9	0.0035
1	22	1.0283	1.038 1	1.032 5	0.0003
1	23	1.0214	1.027 2	1.027 7	0.0003
1	24	1.0124	1.021 6	1.022 6	0.0012
1	25	1.0110	1.017 3	1.017 3	0.0003
3	20	1.0263	1.029 7	1.028 3	0.0037

Table 2 Estimation results for capacitor switching on IEEE 30 bus system.

Control First tier buses and Max error bus LTC Action

Conclusion

The standard IEEE 30-bus system is a widely used test case for power system researchers. The local control areas are chosen such that the buses within 3 tiers of the control bus are included. Before the tests on the local voltage estimator. The tests include switching in each of the shunt capacitors, changing ratios of each transformer, and adjusting voltage set points of all generators.

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