# ABSTRACT

Power system state estimation is the heart of data processing activities of modern electric utility energy control center. By using real time measurements and historical data base, power system state estimator detects errors in measurements and the data base; and calculates an optimal estimate of the system state vector of the bus voltage magnitudes and angles. This optimal state estimate and corrected data base are then used by the security monitoring and operation and control functions of the center. Most state estimation programs in practical use are formulated as overdetermined systems (Pozrikidis, 2008) of nonlinear equations and solved as weighted least square problems (refer to section 2.1.1).

This research involves finding the least squares solution of the power system state estimation problem, $\mathbf{H}^T\mathbf{R}^{-1}\mathbf{H}\,\Delta\mathbf{x} = \mathbf{H}^T\mathbf{R}^{-1}\left[\mathbf{z} - \mathbf{f}(\mathbf{x})\right]$ (refer to section 2.3.1) and to develop a program to implement the said algorithm. The application of orthogonal decomposition method using Householder transformation (refer to section 3.3) is used to solve the least-squares problem in power system state estimation. Consequently, the basic idea in solving the state estimation problem is to avoid the formation of the cross product of weighted jacobian matrices $\mathbf{H}^T\mathbf{R}^{-1}\mathbf{H}$ (also called gain matrix) to alleviate the numerical ill-conditioning problem in state estimation. The orthogonal decomposition method avoids the formation of the gain matrix by triangularizing it directly with QR factorization and Householder transformation (refer to section 3.3.2), which is found to be numerically more stable. Furthermore, its ability to handle very wide ranges of weights obviates the need for special treatment of zero injections equality constraints thus greatly simplifying the state estimator implementation as well as eliminating sources of numerical ill-conditioning.

The application of the Householder transformation can cause severe "intermediate" fill-ins (non-zero elements generated by transformation); these fill-ins will be annihilated eventually, but they can cause excessive storage. Despite that, the proposed orthogonal decomposition method using Householder transformation involves good compromise between numerical stability, computational efficiency, and implementation simplicity.