IEEE Transactions on Power Systems, Vol. 10, No. 1, February 1995

An Efficient and Robust Eigenvalue Method for Small-Signal Stability Assessment in Parallel Computers

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Abstract—**Small signal stability analysis of interconnected power systems is presently performed through the partial computation of the eigenvalues/eigenvectors of very large matrices. Parallel processing has already been efficiently used in this analysis [1]. In this paper, a parallel version of the Bi-iteration method and of a new Hybrid method specially developed for parallel processing are introduced and their performance compared with the results obtained with the parallel Lop-sided Simultaneous Iterations algorithm [1]. These algorithms were implemented in an Intel iPSC/860 parallel computer with hypercubic topology. The results presented in the paper were obtained for a model of a large practical power system.**

Keywords—**Parallel Processing, Small-Signal Stability, Power Systems, Eigenvalues/Eigenvectors, Modal Analysis, Large Scale Dynamic Systems**

I. Introduction

Small signal stability analysis in large scale electrical power systems is presently performed through the computation of the dominant eigenvalues and their corresponding eigenvectors. The set of differential and algebraic equations representing the power system is linearized around an operating point and kept in its non-reduced form [2, 3, 4, 5].

The algorithms for the partial computation of the eigenvalues and eigenvectors operate directly on the non-reduced Jacobian matrix of the system, which is highly sparse. The use of efficient sparsity techniques allows the analysis of large scale power systems that would not be possible using conventional QR eigenvalues/eigenvectors calculation routines [6] owing to the excessive computation time and memory requirements.

The commercial availability of parallel computers has been attracting the attention of engineers interested in fast solutions to power system problems [7, 8]. The small-signal stability area is particularly attractive to parallel processing application due to the high processing requirements and the natural concurrence of the numerical computations. Parallel algorithms for the partial eigenvalue/eigenvector computations [1] would allow small signal assessment on-line in Energy Management Systems of the future. There is also interest in the speedup of these algorithms for off-line applications.

Many algorithms that had been abandoned in sequential processing are being reconsidered for parallel processing due to several technical reasons. The growing use of parallel processing [9] is most likely going to stimulate a trend towards more robust algorithms, albeit more expensive in sequential processing, provided they present potential for efficient parallelization.

In this work, parallel versions of the Bi-iteration (BI) method and a new Hybrid method, produced from a combination of the BI and the Inverse Iteration methods, are introduced and their performance compared with that of the parallel Lop-sided Simultaneous Iterations (LSSI) algorithm [1].

The results presented in the paper were obtained using a large scale test system derived from a practical model used for transient stability studies of the interconnected Brazilian power system.

II. Algorithms Utilized for the Partial Eigensolution of Large Matrices

The presently available algorithms for partial eigensolution can efficiently calculate the dominant eigenval-

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94 SM 558-7 PWRS A paper recommended and approved by the IEEE Power System Engineering Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1994 Summer Meeting, San Francisco, CA, July 24 - 28, 1994. Manuscript submitted January 4, 1994; made available for printing May 3, 1994.