DECOMPOSITION TECHNIQUE FOR EFFICIENT COMPUTATION OF SMALL-SIGNAL STABILITY PROBLEMS IN LARGE POWER SYSTEMS

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Abstract - This paper describes a decomposition technique to be used in connection with algorithms for the solution of small-signal stability problems of large power systems [1]. This technique decomposes the complete system into one internal system and several interconnected external systems and allows efficient use of parallel computation. This technique is also valuable in frequency response studies, on a uniprocessor computer, when the applied disturbance and monitored outputs are all located within the internal system.

I. INTRODUCTION

Reference 1 presents efficient algorithms for the solution of small-signal stability problems of large power systems. These problems include the calculation of dominant eigenvalues, frequency response plots of transfer functions between any two variables in the system and step response solutions by numerical integration.

This paper describes a technique to be used in connection with these algorithms which decomposes the complete electric system into one internal system and several external systems. The formulation developed is general and each external system can be connected to any other external system and to the internal system through various boundary buses. There is no need for system stability considerations to define the external and internal systems, since the decomposition technique is just used as a mathematical tool for efficient solution.

The decomposition technique finds application in three instances:

1 - To solve large problems on uniprocessor computers with reduced core capacity. The decomposition technique is then used to break apart the complete power system into smaller subsystems which are individually solved.

2 - To save computation time on a uniprocessor computer when using the frequency response algorithm described in [1]. In this case it is assumed that the applied disturbance and monitored outputs are all located within the internal system [2].

3 - To speed up the solution of power system small-signal stability problems through use of parallel computation [3].

The power of the algorithms proposed in [1] rests in the fact that the electric network equations are expressed in their unreduced form. This fact also accounts for the efficiency of the decomposition technique, which is similar and equally as flexible as those proposed in [4,5] for the solution of steady-state power system problems.

II. MATHEMATICAL FORMULATION

Reference 1 presents efficient algorithms for the solution of small-signal stability problems of large power systems (see Appendix). All these algorithms involve the solution of an equation of the general form:

$$\begin{bmatrix} J_A' & J_B \\ J_C & J_D \end{bmatrix} \cdot \underline{X} = \underline{b} \qquad (1)$$

where J_A' corresponds to the matrix block J_A of Figure 1 with some extra terms added to its diagonal. The characteristics of the Jacobian matrix shown in Figure 1 are described in the Appendix.

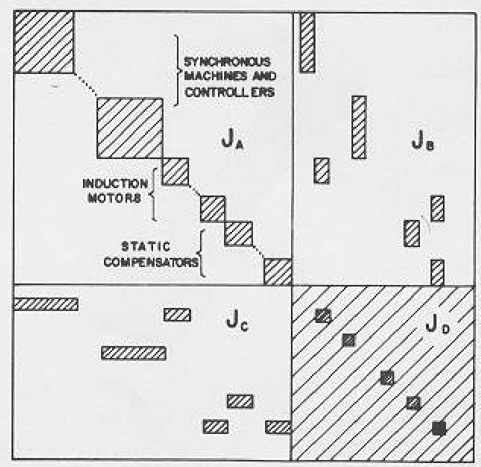

Figure 1 : The Power System Jacobian Matrix (The hatched blocks contain non-zero elements and have sparse structure)

Consider an interconnected system which is to be decomposed into two subsystems. By reordering the variables of equation (1) one obtains: