ABSTRACT

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ABSTRACT

This dissertation is devoted to the study of two important problems arising in vibration analysis and control of structures modeled by a system of matrix second-order differential equations: the state estimation and the finite-element model updating problems.

The state estimation problem of a second-order control system is solved via its associated descriptor system (generalized state-space model). A new theory is developed using generalized Sylvester-observer equation and then three new algorithms for solving this equation are proposed. These new algorithms generalize the existing algorithms for the Sylvester-observer equation for standard state-space systems. Indeed, a new block algorithm for the standard Sylvester-observer equation, generalizing a well-known algorithm due to Van Dooren, is also proposed. These algorithms, which are rich in BLAS-3 computations, are tested on some benchmark problems using high-performance software libraries LAPACK and SLICOT.

The finite-element model updating problem, although is of significant industrial importance, has not yet been solved satisfactorily. A new solution to the problem in the undamped symmetric positive semidefinite case is proposed in this dissertation. The new algorithm works with a set of incomplete measured data and, unlike other existing algorithms, does not require model reduction. An extension of the algorithm to the damped case is also made and possible solutions are suggested. These new algorithms for model updating are based on a set of new orthogonality relations between the eigenvectors of a symmetric positive semidefinite quadratic pencil. These new orthogonality relations, which are also derived in this dissertation, generalize the

existing ones for the symmetric positive definite model and are also of independent interest.

Finally, a solution to the eigenvalue embedding problem, which is a special case of the finite-element model updating problem, is proposed in case the model is symmetric positive semidefinite and the eigenvalues to be updated are real, generalizing earlier results in the symmetric definite case.

The new results in this dissertation, besides being useful contributions to the literature of linear and numerical linear algebra and vibration engineering, are expected to impact a wide variety of industries, including automotive and aerospace.