State Estimation in Structural Systems with Uncertain Stiffness and Damping Matrices

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The paper considers the problem of state estimation in a linear MCK system when the prediction error derives from uncertainties in the damping and stiffness matrices of the nominal model. It is shown that the difference between the true and the state estimated by the nominal model satisfies a state space recurrence whose eigenvalues are identical to those of the nominal model and which is driven by the product of the error in the transition matrix and the true state. An observer gain is introduced and its structure is selected to ensure that, at each time station, the norm of each of the two terms that add up to give the state error is smaller than in the open loop operation. The gain is selected without imposing restrictions on the type of excitation or on the internal structure or norm of the errors in the stiffness and damping matrices. A numerical example including noise in the measurements and error in the mass matrix (items not contemplated in the derivation of the gain) suggests that the estimator can operate robustly in the presence of these additional sources of error.

Key words: State estimation, observers, model updating
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