Examination of Sensor Distribution Schemes for Vibration Estimation

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ABSTRACT

The general outset in vibration analysis is that a sensor distribution is optimal if the utility of the deployed system is maximized; with system referring to, for example, an identification system if the sensors are deployed to facilitate modal parameter estimation or a monitoring system if damage detection is the target. Regardless of the utility one seeks to maximize, explicit treatment of this is intractable, so the conventionally applied simplification is to, *a priori*, settle for the number of sensors to deploy and select a manageable cost function and then, accordingly, proceed by treating the task as a discrete optimization problem with the sensor positions as variables. While numerous studies have been presented in the context of system identification [1–3] and damage detection [4–6], few studies have addressed the sensor placement task for vibration estimation (also known as virtual sensing). Therefore, the present paper offers an examination of this by adapting three schemes—developed and widely used for optimal sensor placement in system identification—to estimate unmeasured vibrations from a limited number of output sensors. More specifically, we test the performance of the Effective Independence (EI) method [1], the Driving Point Residue (DPR) method [7], and the Kinetic Energy (KE) method [8] in the context of estimating unmeasured vibrations of a structural system of engineering interest.

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