Computationally efficient optimal sensor placement

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The topic of smart civil infrastructure has attracted significant attention. An important component of such structural systems is the network of sensors used to monitor the structure and deliver information about its current health status. The task of optimal sensor placement is not trivial due to the discrete, combinatorial nature of the problem. The brute force search is unfeasible for large structures, which calls for approximate and heuristic approaches. This problem has been investigated for several decades, beginning probably with the landmark 1978 paper of Shah [1]. A recent review can be found in [2].

The criteria typically used for assessing candidate placements are based either on Kammer's Effective Independence (EFI) and the Fisher Information Matrix (FIM) [3], and quantify the amount of information provided by sensors, or on covariance matrices obtained within the Kalman filtering procedure used to quantify the uncertainty of the unknown response of interest being estimated [4]. However ingenious, most of the proposed procedures are computationally costly in large-scale problems.

This talk will discuss two optimal placement methods that have been recently developed with the objective of computational efficiency [5, 6]. One of them is based on Kalman filter covariance matrices and has—instead of typically quadratic—a linear complexity in the number of potential sensor locations. The other method uses the technique of convex relaxation to represent the problem in a computationally tractable continuous form and speed up the solution procedure even further. The presented application examples will use models of bridge structures.

References

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