Modal filtration without calculation of the modal model

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ABSTRACT

Modal filtration is a prominent tool in mechanical systems research. However, the application of modal filtration requires a prior calculation of the modal model consisting of a set of natural frequencies, modal damping coefficients, and mode shapes. Such a procedure can be costly and difficult to perform in practice.

In this work, an alternative approach is presented: modal filtration can be performed with perfect accuracy without knowledge of the modal model of the structure, provided only that natural frequencies and frequency response functions for all the sensors are known. In our approach, we take the frequency spectrum of the object in question and optimize from scratch spatial filters built with the same goal in mind as in standard modal filtration. An evolutionary algorithm is used to this end. Such a choice is dictated by the necessity to maintain the reliability of optimization in the presence of local minima. The fitness of individuals is assessed using a quality metric that weighs output frequencies according to their distance to the filtered natural frequency. The solution is presented using simulated and experimental data and enables filtration quality comparable with standard modal filtration based on a pre-calculated modal model.