Damage Detection via Lagrange Multipliers from Least-Squares Adjustment

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Abstract

Continuous monitoring of structural designs throughout their lifetime is a significant task and subject of a multitude of research activities. From the aspect of sustainability extending the service life of existing structures is of incalculable value, regarding both financial considerations as well as the preservation of infrastructure facilities and historical monuments. Despite all the success of projects for structural maintenance and restoration, the question of how to detect even minor emerging damages at an early stage has not been answered in a satisfactory manner yet.

This contribution introduces a new method for damage detection and structural monitoring which is based on an integrated evaluation of measurements obtained from multiple sensors using the method of least squares. The main focus does not lie on the evaluation of modal parameters of structures, but rather on the analysis of deformations while taking into consideration an appropriate mechanical model. Introducing such mechanical conditions into the functional model of least squares adjustment enables the possibility to analyse the related Lagrange Multipliers (LM) which are reflecting the disagreement between the observed structure and applied mechanical model. This novel approach for damage analysis of structures will be demonstrated by a numerical example.