A Hybrid UKF-MGA Algorithm for Finite Element Model Updating of Historical Constructions

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Abstract

The finite element model (FE) updating is a calibration method that allows minimizing the discrepancies between the numerical and experimental modal parameters. As result, a more accurate FE model is obtained and the structural analysis can represent the real behaviour of the structure. However, it is a high computational cost process. To overcome this issue, alternative techniques have been developed. This study focuses on the use of the unscented Kalman filter (UKF), which is a local optimization algorithm based on statistical estimation of parameters taken into account the measurements. The dome of a real chapel is considered as benchmark structure. A FE model is updated applying two different algorithms: (i) the multi-objective genetic algorithm and (ii) a hybrid unscented Kalman filter-multi-objective genetic algorithm (UKF-MGA). Finally, a discussion of the results will be presented to compare the performance of both algorithms.

Keywords: model updating; historical constructions; unscented Kalman filter; multi-objective genetic algorithm.

1. Introduction

The structural assessment of historical constructions is an increasingly relevant issue. The most usual approach for the assessment of their structural behaviour is to design a mathematical model (e.g. finite element model). To build the Finite Element (FE) model, the material and geometrical properties are assumed and the boundary conditions implemented may not be the proper. These facts may involve large discrepancies between the numerical results obtained from these mathematical models and the experimental results obtained from field vibration tests. The model updating may be formulated as an optimization procedure where these discrepancies are minimized. Friswell *et al.* [1] introduced in 1995 the main techniques which may be employed for FE model updating. The procedure consists in selecting one or several physical parameters of the numerical model and changing theirs values iteratively. For each iteration, the differences between numerical and experimental results (usually modal parameters) are evaluated. In this manner, viewed from the optimization perspective, the parameter identification solved as an inverse problem can be considered as a general minimization problem.

https://doi.org/10.2749/guimaraes.2019.0029
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