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3D digital image correlation methods for full-field vibration measurement

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ABSTRACT

In the area of modal test/analysis/correlation, significant effort has been expended over the past twenty years in order to make reduced models and to expand test data for correlation and eventual updating of the finite element models. This has been restricted by vibration measurements which are traditionally limited to the location of relatively few applied sensors. Advances in computers and digital imaging technology have allowed 3D digital image correlation (DIC) methods to measure the shape and deformation of a vibrating structure. This technique allows for full-field measurement of structural response, thus providing a wealth of simultaneous test data. This paper presents some preliminary results for the test/analysis/correlation of data measured using the DIC approach along with traditional accelerometers and a scanning laser vibrometer for comparison to a finite element model. The results indicate that all three approaches correlated well with the finite element model and provide validation for the DIC approach for full-field vibration measurement. Some of the advantages and limitations of the technique are presented and discussed.

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1. Introduction and motivation

There has been a significant amount of effort expended in the development of test and analysis tools for the correlation and updating of analytical models used for structural dynamic predictions over the past twenty years. In that time, many model reduction methods [1–5] have been developed for correlation to determine the adequacy/accuracy of the models developed. In addition, there have been many approaches developed to provide expansion of measured mode shapes [1–5] necessary for the updating methodologies employed to refine models. Model reduction and expansion has been the "Achilles Heel" in the overall process. The severe mismatch between the relatively few measured degrees of freedom (DOF) for the test data when compared to the finite element model has been a roadblock to the efficient and effective correlation and updating of these analytical models.

Over the past two decades, there has been a tremendous growth in the models developed, whereas the corresponding test data has not grown at such a fast pace. In the 1980s, the number of measurements made might be as high as 100 triaxial measurement points, while the model may have been as large as 200,000 DOF. At that time, this mismatch was a significant hurdle that needed to be addressed. Many reduction/expansion algorithms were developed to provide the best possible matching between these data sets. Today, the number of measurement points may have only grown to as high as 450 triaxial measurement points, whereas the finite element model has grown to well over a million DOF in many

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