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14. ABSTRACT

A complete laser vibrometer system was purchased. This measurement system allows for a variety of enhanced data acquisition and analysis scenarios based on structural systems of interest to AFOSR.

15. SUBJECT TERMS

Vibration, dynamics, aeroelasticity

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Final Report
F49620-01-1-0252

AFOSR (DURIP) Program

Acquisition of a Point-to-point Laser Doppler Vibrometer Measurement System

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Summary

Measurements in dynamical systems provide the important data which is used to assess the accuracy of theoretical models and their improvement if necessary, provide monitoring information for damage detection including system aging, etc. Acquiring data from structural systems has traditionally been accomplished using strain gages or conventional accelerometers. However, with the rapidly improving processing capabilities of digital systems, (non-contacting) optically-based transducers are becoming an increasingly popular means of extracting data from experimental systems. The funded grant was used to acquire a state-of-the-art Laser Doppler Vibrometer system to measure the dynamic response of structural and aeroelastic systems of interest to the Air Force. The research program has successfully assessed the robustness of the measurement system in a variety of situations, and provides a strong resource for education of PhD candidates in sophisticated experimental measurements. A further use of this system has been directed toward lightweight inflatable structures, again an area of strong relevance to the research mission of the Air Force for space applications.

The Equipment Acquired:

The funding from this DURIP award was used to purchase the laser doppler point-to-point vibrometer manufactured by *Omitron* Corporation. This portable device has proved to be a very useful addition to the mechanics testing facilities of the Pratt School of Engineering at Duke Univeristy.

An important aspect of the complete measurement system is the *PULSE* data acquisition and analysis software developed by *Bruel and Kjaer*. This enables flexible and accurate measurements to be made, and subsequent signal processing capabilities allow rapid diagnostic testing, including system identification and FFT. Modal analysis capabilities have also been considerably enhanced by the use of *ME Scope*, a system packaged with the laser system.

This system has been used for the following structural systems:

- An Inflatable Structure – Some preliminary experimental work has been done on the dynamic response of slender, inflated structures. These have a potentially large range of application in space because of their relative light weight and would be suitable in the relatively benign conditions of space. The system shown in Figure 1 specimen tested in the nonlinear dynamics laboratory at Duke University. The natural frequencies and modes of vibration depend on material properties, internal pressure, etc. It is clear that with these types of lightweight structure it is crucial that the measuring device does not interfere with the system itself. Hence this is an ideal application for the laser doppler vibrometer.

Figure 1: An inflatable thin-film cylinder under test in the laboratory.

- A composite beam - Another application in which the laser vibrometer played an important role was in the situation shown in Figure 2. Here a composite structure is subject to damage (a loosening of the bolted connections) and the vibrometer is used to acquire modal damage which is then used to predict damage with a statistical measure of the dynamic response.

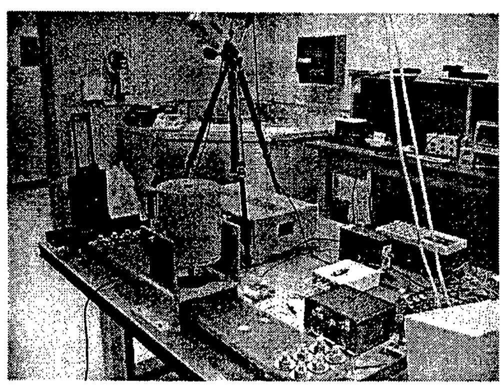

Figure 2: A composite beam subject to changing boundary conditions.

A number of other experimental systems will also benefit from the vibrometer. The system is very easy to use, portable, and the powerful software enables sophisticated experimental studies to be made.