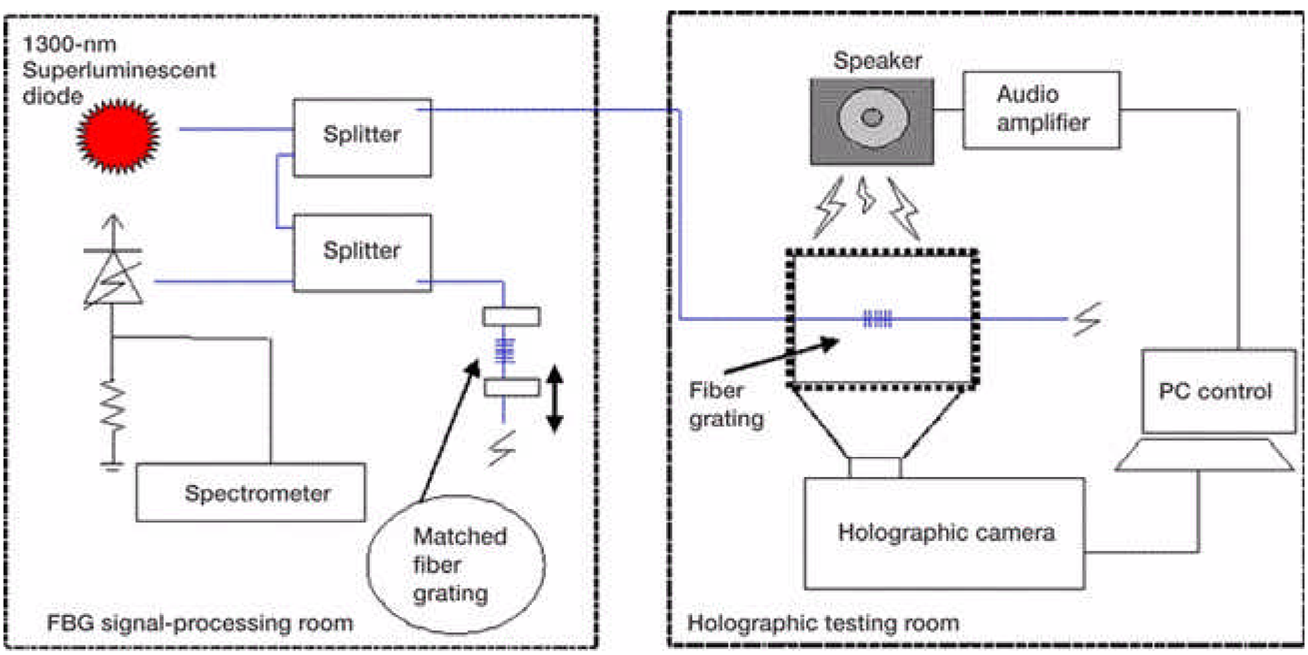
# Fiber-Optic Bragg Gratings and Optical Holography Compared as Vibration Detectors

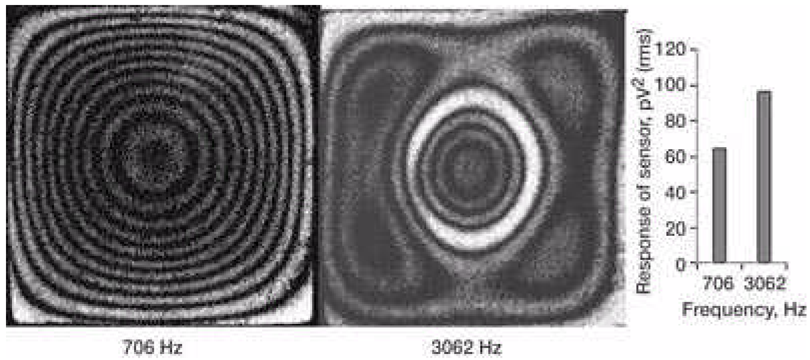
The NASA Glenn Research Center is interested in determining structural damage in engine components during flight to evaluate the health of aerospace propulsion systems. On the ground, we can use holography to detect structural damage by examining the characteristic mode shapes and frequencies of vibrating objects. We are studying the feasibility of using embedded fiber Bragg gratings (FBGs) to accomplish this goal in a flight-worthy system, by using the minimal intrusion and high sensitivity afforded by fiber optics. We have recently compared holographically imaged modes of vibrating plates with the corresponding dynamic strains detected by embedded FBGs.

We constructed an experimental setup for studying the responses of FBGs to dynamic excitations. One of the plates was made of a polymer matrix composite (PMC) with an FBG embedded in it, and the other one was made of copper with surface-mounted FBGs. The instrumented plates were mounted and vibrated, and time-averaged holography was used to measure their surface displacements. Simultaneously, the signals from the FBGs were detected and sent via fiber-optic cable to a quiet location about 20 m away for interrogation.



*Test configuration showing FBG data processing and holographic testing equipment.*

The preceding figure shows the test configuration used for the PMC plate. Experimental results are shown in the following figure. The FBG was embedded in the middle of the PMC plates, roughly within the center circular fringe in each of the interferograms shown in the following figure. Two resonant excitation frequencies were used: 706 and 3062 Hz. The plot in the following figure shows a larger FBG signal at the higher frequency; this is because the plate bends more at higher order resonant modes, causing higher strain. This contrasts to the smaller displacements characteristic of higher frequencies, which are measured by holographic techniques.




*Experimental results: Left: Holographic image of the 706-Hz resonant mode of the PMC plate. Center: Holographic image of the 3062-kHz resonant mode of the PMC plate. Right: Graph comparing the response of the embedded fiber sensor for two resonant frequencies.*

# References


1. Lekki, John, et al.: Evaluation of Mechanical Modal Characteristics Using Optical Techniques. NASA/TM--2002-211678, 2002.



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