VIBRATION-BASED STRUCTURAL DAMAGE DETECTION FOR CERAMIC COMPOSITE STRUCTURES

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OBJECTIVES

- Develop global and local damage detection in ceramic composite hybrid structures using vibration NDI (Nondestructive Inspection) techniques.
- Correlate between material properties and vibration data by system identifications.
- Integrate sensors and remote DAQ (Data Acquisition) to automate NDI technique.

MOTIVATIONS

- The potential for life-safety benefits and economic benefits cold be obtained by moving from time-based maintenance to condition-based maintenance and on-line SHM (Structure Health Monitoring).

ACKNOWLEDGEMENTS

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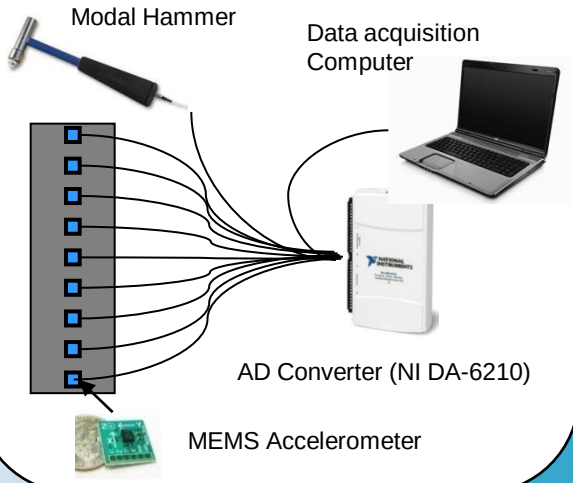
SDD PROCESS

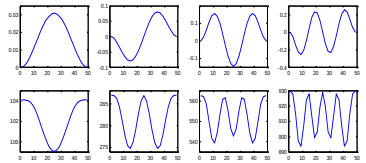
- Operational evaluation
  Define the damage to be detected and begin to answer questions regarding implementation issues for a structural damage detection system.
- Data acquisition
  Define the sensing hardware and the data to be used in the feature extraction process.
- Feature extraction
  Identify damage-related features from measured data.
- Feature discrimination
  Classify damage-related features into damaged or undamaged category.

DAMAGE DETECTION SYSTEM



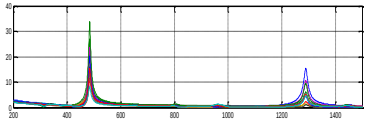
INFLUENCE OF DAMAGE ON NATURAL FREQUENCIES (1)

- Steel beam with free boundary condition, Length 1m, Young's modulus 210Gpa.
- Damage area 0.042m, Young's modulus: 105Gpa

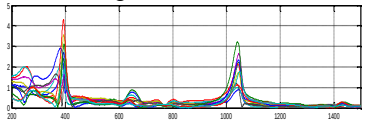


INFLUENCE OF DAMAGE ON FRF

FRF of undamaged structure

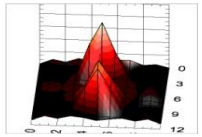


FRF of damaged structure

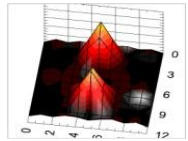


SIDER RESULTS

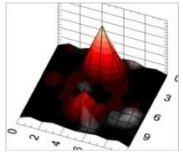
Sensor I, hitting I



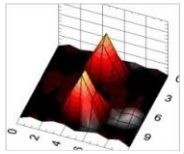
Sensor I, hitting II



Sensor II, hitting I



Sensor II, hitting II



CONCLUSIONS

- Significant variation on natural frequencies, damping ratios, FRFs, and ODSs happen when damage occurs in ceramic composite hybrid structures.
- The value of variation is not only sensitive to the damage level but also the position of input and/or output of FRFs and the curvatures of modal shapes.

FUTURE WORKS

- Damage detection for more complex structures.
- On-line SHM methods development for ceramic composite hybrid structures.