

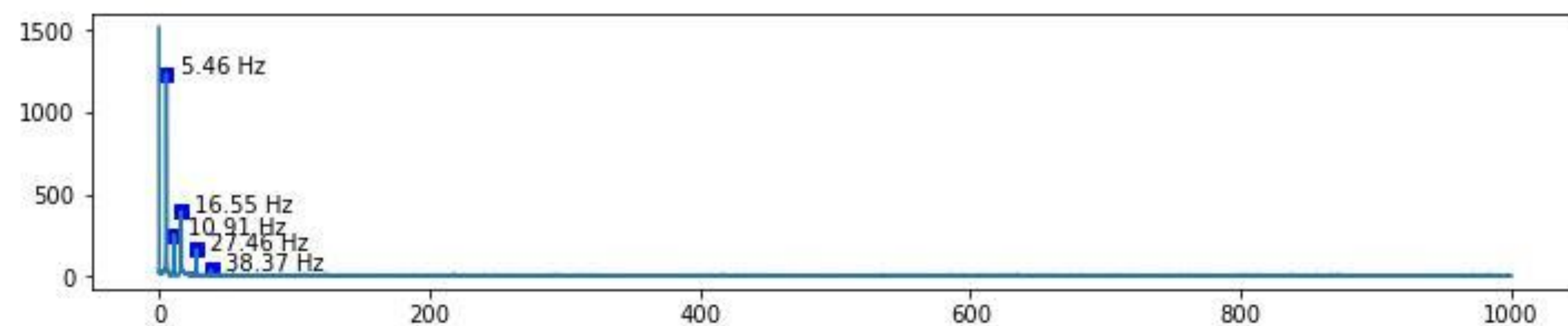
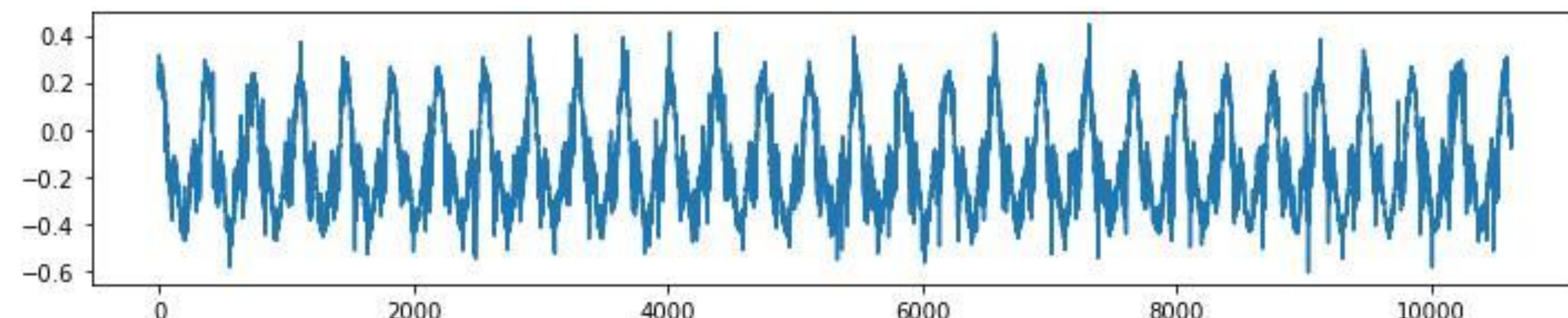
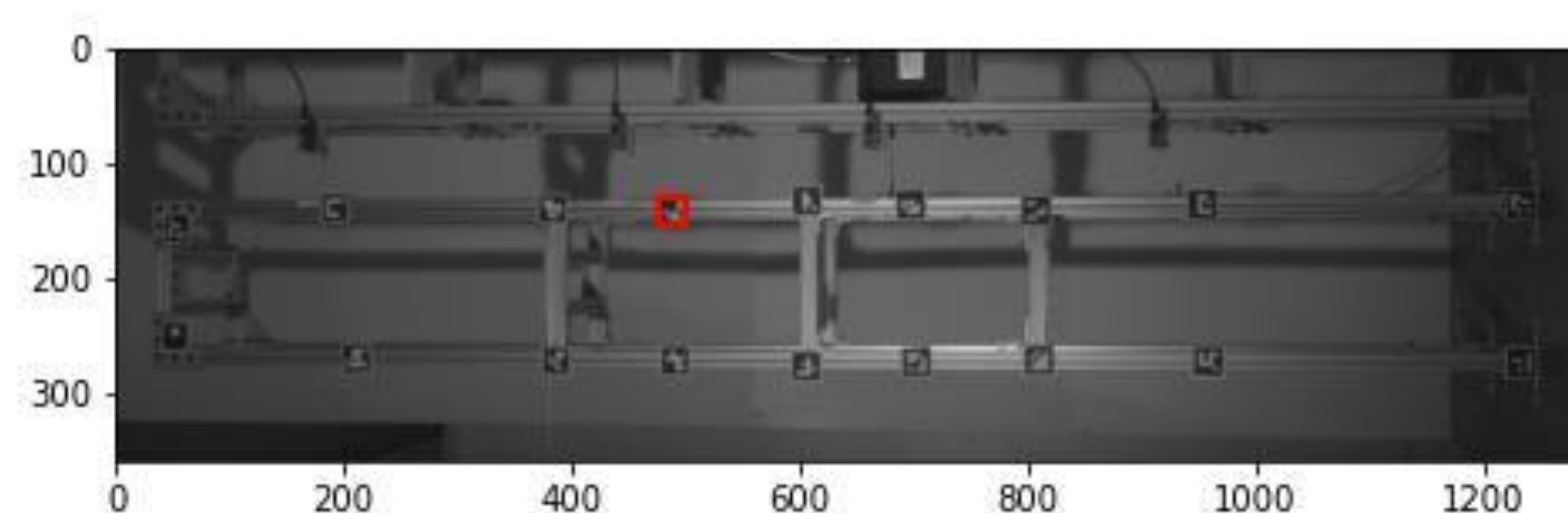
STRUCTURAL HEALTH MONITORING USING MOTION MAGNIFICATION



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INTRODUCTION

Structural health monitoring and assessment are critical areas of research for civil and aerospace applications. To address any rapid degradation in structural integrity, it is imperative to monitor and note changes in the structure's behavior at regular time intervals. The current state-of-the-art requires many sensors and spending extensive amounts of time processing data when assessing the health of a structure. One proven method of detecting damage is observing the change in mode shapes and natural frequencies overtime. Optical technologies have been demonstrated to accurately detect the dynamic properties of a structure. The novel aspect is determining how to interpret those changes, and how to relate this to damage location and potential severity. The sensitivities of the optical techniques to various degrees of damage and excitation needs to be determined to accurately interpret the results.



Caption: Displacement and frequency results using motion magnification.

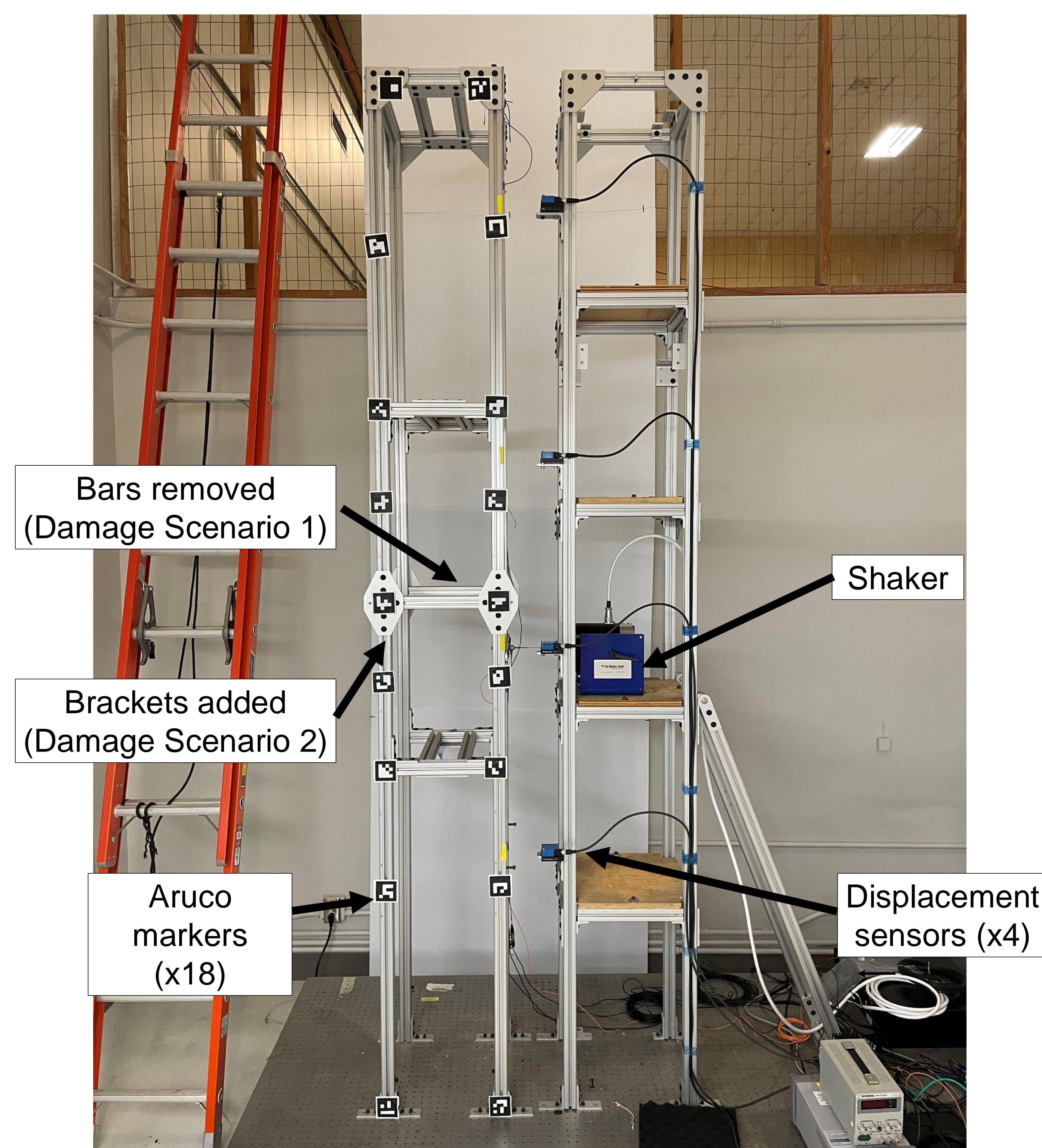
The long-term goal: Develop long-term structural health monitoring methods for Moon and Mars structures by utilizing image processing of short video clips to provide a targeted inspection plan to an autonomous robot/human and reduce the number of sensors on a structure

The near-term goal/project objective: Determine if motion magnification can quantitatively measure changes in mode shape and frequency by performing a vibration test on a 10-ft tower and simulating different "damage" scenarios

ALIGNMENT

Gap 930, focusing on the autonomous inspection aspect, but can aid in the maintenance and repair as well.

APPROACH



Caption: Left tower is the test tower, the right tower is the rigid tower.

- Perform a vibration test of a 10-ft truss tower and determine the undamaged dynamic characteristics using MSFC's in-house image processing code.
- Different types of "damage" will be inflicted in various locations.
 - Baseline includes all members in the image except for the brackets
 - Bars removed from center of tower
 - Brackets added to joints in center of tower
- Use standard-rate cameras and highspeed cameras (purchased with EV TE funds)
- Process data and quantify changes in mode shapes for frequencies up to 200 Hz

RELATED REFERENCES

1. Stewart, Eric Colby, and Justin G. Chen. "Motion Magnification to Visualize the Modes of Space Structures." *Spacecraft and Launch Vehicle Dynamics and Environments Workshop*. 2021.
2. Sarrafi, Aral, et al. "Vibration-based damage detection in wind turbine blades using Phase-based Motion Estimation and motion magnification." *Journal of Sound and vibration* 421 (2018): 300-318.