Automated Characterization of Hemispheric Resonator Gyroscopes
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Executive Summary
The process of characterizing the vibrational modes of Hemispheric Resonator Gyroscopes (HRGs), such as finding the principal axis of elasticity and damping, is time-intensive and requires manual input. To reduce human involvement, we have developed a method of tracing the inner rim of the HRG with a measurement laser utilizing an image recognition machine learning algorithm. Automated controls collect the data for the trial, reducing the manual involvement to setting up the run.

Context
- Looking for Axes of Elasticity
- Wineglass Modes of Vibration

Characterization Process
- Mount (accomplishes analysis)
  - Clamp to avoid damaging granite base
  - Mount stays out of the way of the existing modules
  - Avoids catastrophic vibrations
  - Bracket accommodated loads exceeding a Safety Factor of 10+

Computer Vision/ML
- MATLAB Image and Video Labeler Toolboxes
- Rim is not perfectly circular and varies with each HRG, causing traditional image processing techniques to fail short
- Machine Learning (ML) approach builds in greater tolerance for variation

Design Process
- Automatic resonator characterization and tuning setup
- Characterization setup
- 3 axis movable stage
- Ablation setup
- Image processing
- Lock in amplifier
- Laser controller
- Laser Doppler Vibrometer
- Pass electronic pack
- Camera
- Vibration control & measurement

Future Work
Further work on this project will include integrating the characterization with laser ablation and FLICE stages. This will enable the automation of both the characterization and tuning phases of HRG manufacturing.

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