SMU | Lyle School of Engineering

Mechanical Engineering
Master's Thesis Defense:

A Microresonator-Based Laser Doppler Velocity Sensor For Interplanetary Atmospheric Re-Entry

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Abstract:

A laser velocity sensor concept based on optical microresonators is presented and the application to spacecraft atmospheric entry is explored. The concept is based on the measurement of Doppler shift of back-scattered laser light. Specifically, the Doppler shift is detected by observing the whispering gallery optical modes (WGM) of a dielectric microresonator excited by the back scattered light from particulates and gas molecules. The microresonator replaces the typical Fabry-Perot interferometer and CCD camera system, thereby significantly reducing the size and weight of the overall detection system. This thesis presents proof-of-concept results for this measurement approach. The Doppler shift of a tunable narrow line laser scattered from the edge of a rotating disk is measured using a $\sim 500\mu m$ diameter silica sphere as a microresonator. Different coupling modes (fiber-based and free-space) are explored and different resonator tuning methods (piezo-modulated and wavelength-modulated) are discussed. Results indicate that such a detection scheme is possible, although improvements to signal processing may be required for measurements in a gas. An improved signal processing algorithm is introduced and discussed.