MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, September 21 2022 at 13:30, D. Dan and Betty Kahn Building, Auditorium 1.
Online: https://technion.zoom.us/j/95643861283

Auto-resonance driving schemes for Coriolis vibratory gyroscopes

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A gyro sensor is used to measure rotation rates. The operation of most commercial Micro-Electro-Mechanical-Systems (MEMS) gyroscopes is based on a vibrating structure and the Coriolis effect. The sensing of rotation rates is performed by measuring the modulation of a physical quantity, induced by the Coriolis force that acts on a vibrating mechanical element, which is fixed to a rotating system. These sensors are commonly known as Coriolis Vibratory Gyroscope (CVG) devices.

There are two prevalent types of CVG devices. The first type is an Amplitude Modulation (AM) gyro, which measures the variation in the amplitude of displacement and/or velocity of the vibrating element's motion, to sense the applied rotation rate. The second type is a Frequency Modulation (FM) gyro, which measures the variation in the motion frequency of the vibrating element, to sense the applied rotation rate. The main difference between the two types is the actuation scheme that drives the motion of the vibrating element.

In this work, Auto-Resonance (AR) driving for resonators is introduced. The principle of AR is a square wave driving force. A closed-loop feedback is used to ensure that the driving force is always in phase with the velocity of the motion, such that the driving force does not subtract power from the system. We analyze AR based actuation schemes to implement both AM and FM gyroscopes. The analysis is based on a Mass-Spring-Damper (MSD) model of the gyroscope and the derivation of the dynamic equations of motion. Approximated solutions of the equations of motion are derived using the harmonic balancing technique, and the validity of the approximation is tested by numerical simulations. The characteristics of the motion, as a function of the applied rotation rate, is observed and analyzed. The aim is to evaluate the possibility of using AR based actuation schemes, as an alternative method for operating AM and FM gyroscopes.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Matthew Suss.