הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, November 29 2023 at 13:30, D. Dan and Betty Kahn Building, Room 217.
Online: https://technion.zoom.us/j/97655827861

Control and unusual dynamics of a Spherical robot with inertial actuation

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Presented is a hemispherical robot that progresses in a non-reciprocal oscillatory motion generated by an inertial actuator that is tuned to the natural oscillation period of the device. Using an onboard accelerometer, the inertial actuator is moved at some phase relative to the periodic oscillations, thereby efficiently turning gravitational potential energy into kinetic energy and vice versa. With this actuation, the robot traces an evolving curve with average progress perpendicular to the inertial actuator's local curve's motion.

An experimental implementation made use of a hemispherical robot, actuated by changing the center of mass of the system, which is able to move in a predetermined manner. The system is driven in open and closed-loop control to achieve autonomous motion and has shown some capability to move in a complex trajectory given the correct control signals.

To verify the relationship between the actuation forces and the robot oscillations, a series of measurements were held, in which the 3D motion of selected points on the robot, as well as reaction forces from a pressure plate, were carried out. The dynamic model was utilized to reconstruct the actuation forces of the inertial mass.

On top of an Analytical model for the system, an extensive simulation model, which is built using the Simscape Multibody environment enables us to choose the state variables and design the control system. Various Autoresonance schemes that automatically synchronize the actuator to the natural motions of the robot are realized in simulation and experiment.

The experimental test rig is compared to the simulations and shows a similar behavior in both the simulation and experiments run in the open loop case. Closed-loop control can overcome friction and surface irregularities.
The actuation method does not suffer from singularities exhibited by gimbaled systems and, as the robot is underactuated, cost-efficient, therefore suitable for satellite orientation control and smart buoys.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Matthew Suss.