הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, September 10, 2026 at 14:00-14:30, Lady Davis Building, Auditorium 250

Experimental investigation of a planar robotic swimmer with a passive elastic joint

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This research presents an experimental investigation of a planar robotic swimmer with a passive elastic joint. Bio-inspired robotic swimmers have been widely studied as a means of understanding aquatic locomotion and developing efficient underwater robotic systems. Previous studies investigated fully actuated inertia-driven three-link and five-link robotic swimmers, as well as a three-link swimmer incorporating one actuated and one passive joint. However, the experimental results and underlying mechanisms of passive-joint locomotion have not been thoroughly documented in the literature. Furthermore, a mathematical model and numerical simulations developed within our research group produced results that contradicted theoretical predictions, motivating the need for a renewed experimental study.

To better understand the mechanics governing propulsion in such systems, a floating three-link robotic swimmer was designed and constructed using 3D-printed components. The robot consists of three elliptical links connected by an actuated joint driven by a servo motor and a passive elastic joint whose motion is determined by a torsional spring, hydrodynamic forces, and the robot's dynamics. Experiments were conducted in an indoor swimming pool, where the actuated joint was driven by sinusoidal control inputs with varying frequencies and amplitudes.

Motion data were collected using an OptiTrack motion capture system. Key performance metrics included the passive joint amplitude, the advancement of the central link per stroke cycle, and the phase difference between the actuated and passive joints. The collected data were processed and analysed in MATLAB.

The experimental results revealed a strong relationship between swimming performance and the phase difference between the joints. In particular, a change in the direction of advancement was observed upon varying the actuation frequency, influenced by specific combinations of phase difference and passive joint amplitude. These findings provide new insights into the role of passive elasticity in robotic swimming and contribute to the validation and refinement of existing theoretical and numerical models.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Prof. Sefi Givli