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Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING SEMINAR

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"Dynamic Scaling and Control of Flexible Foldable Structures"

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Hosted by: Prof. Alon Wolf

Origami engineering has rapidly evolved, offering a powerful framework for designing a variety of systems including metamaterials, robots, waveguides, and space structures. The inherent kinematics of folded structures provide unique advantages, such as multiple states, compact stowing, and tunable stiffness. To leverage these capabilities, it is crucial to obtain an accurate model of the structure's dynamics - most notably vibration mode shapes, natural frequencies, and damping ratios of the final configuration. This challenge intensifies in large-scale flexible structures, such as the Caltech Space Solar Power Project (SSPP), since large deflections can lead to efficiency loss, damage, or stability loss. However, these structures often cannot be tested at full scale prior to deployment, and numerical simulations may overlook key components, such as the correct damping mechanisms. To solve such problems, classical similitude methods such as dimensional analysis (DA) have been applied to different mechanical systems, such as swimming robots, shaft rotors, and wind turbines. However, DA is limited to full similitude, which is inapplicable in our case, since parameters such as shell thickness and the stiffness matrix cannot be experimentally scaled.

To address these challenges, I propose a data driven similitude method that exploits multiple down scaled experiments to overcome distortion due to partial similitude. In addition, to account for the inherent uncertainty in ultralight foldable structures, this method is extended into a Bayesian-inference-based statistical similitude model, which allows for uncertainty quantification in the acquired scaling law. The model is constructed from simulated data and updated based on experimental measurements, enabling statistical model updating of the scaling model. Finally, I present a stiffness switching damping mechanism that leverages boundary condition induced change in natural frequency in deployable structures to actively suppress vibrations.

Dr. Eyal Baruch is a Postdoctoral Scholar in the Space Structures Laboratory at Caltech, conducting research as part of the Space Solar Power Project (SSPP). He earned his Bachelor's degree from Tel Aviv University, and his Master's and PhD degrees from the Technion.

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