Autonomy of Origami-inspired Transformable Systems in Space Operations

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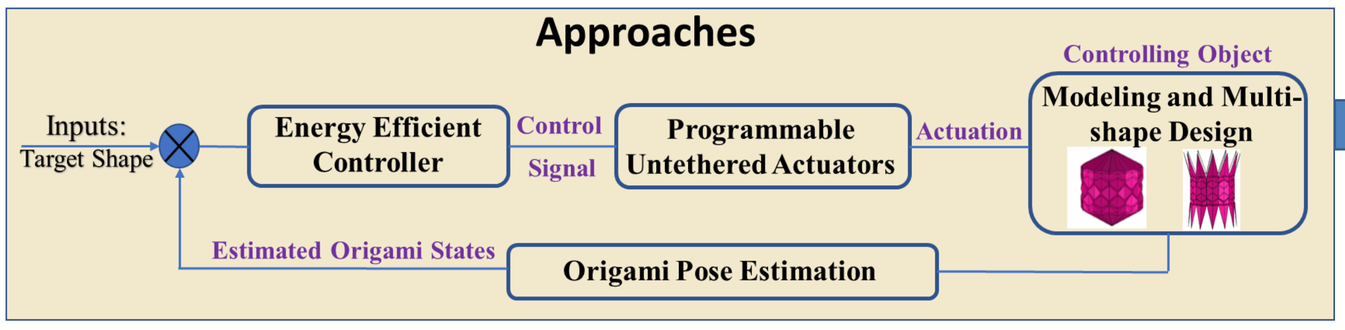
https://engineering.purdue.edu/AOL/research/cps

Goal: Enable high-performance Autonomous Deformation Maneuvering in space operations via core CPS technologies



Challenges:

- How to achieve high degree-of-freedom to augment the origami deformation capability
- How to generate real-time deformation control commands to guarantee controllability, reachability, and energy efficiency
- How to physically realize the actuation to precisely match the computed deformation control commands

Solution:

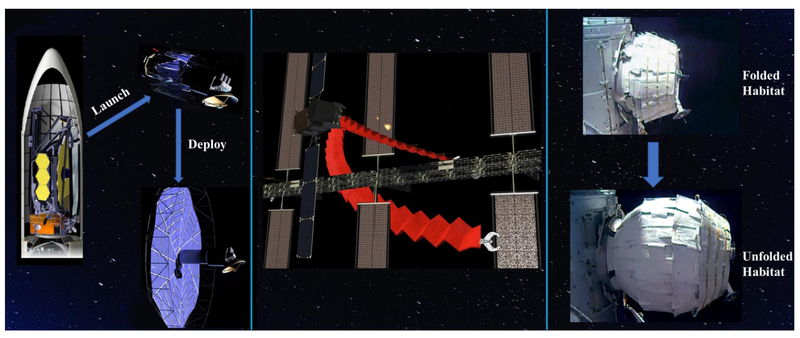
- A network-based approach for modeling and design of multi-shape origami structures
- Integrated sensing and control strategy with guaranteed controllability, reachability, and energy efficiency
- Autonomous actuation via optimally designed energy-efficient actuators

Scientific Impact:

- The methods developed for optimization based design and learning-enabled energy-efficient control can be applied to design and control of general multiagent systems
- The automation of the origami deformation process facilitates the manufacturing and commercialization of origami-inspired structures in robotics, architecture, medical devices, space instruments, etc.
- In-orbit manufacturable origami systems
- Uniform transformation control approach for all origami patterns
- The integrative research contributes to a theoretical and experimental platform to advance the autonomy of origami system operations in challenging environments.

Broader Impact

- The project has long-term industrial and economy impacts, especially for the proliferated satellite markets marketplace



Education and Outreach

- New graduate-level courses "Networked Dynamic Systems", "Optimization based Data Mining", and "Soft Robotics"
- Summer undergraduate interns and "OrigaRobot Olympics" at UW, undergraduate milestone project for foldable solar panels at Purdue
- K-12 outreach event at Purdue and Stanford cross-campus summer undergraduate research fellowship

Potential Impact

Frequent use of autonomous origami structures with guaranteed control properties and energy efficiency will contribute to:

- Promoted growth of smart material market
- Great saving of workforce and improvement of safety factor during deformation operations

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