M3SoRo - Mobility and Morphing using Modular Soft Robots

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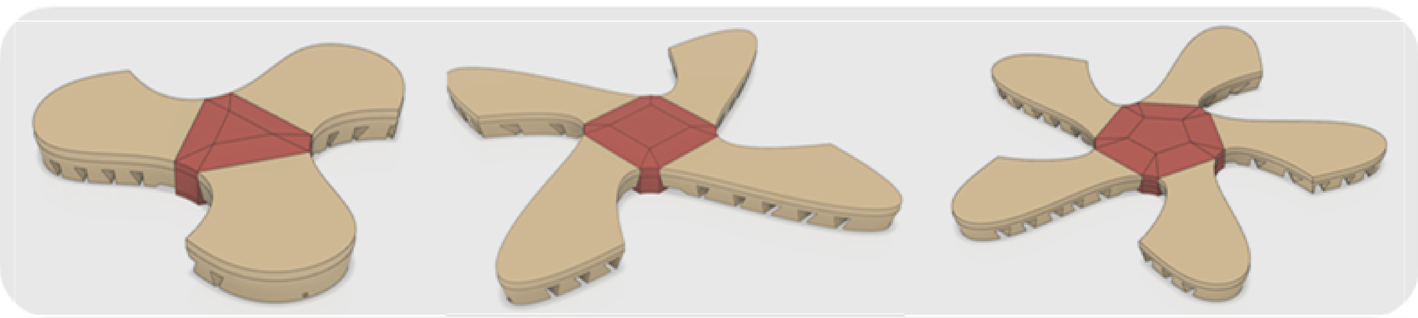
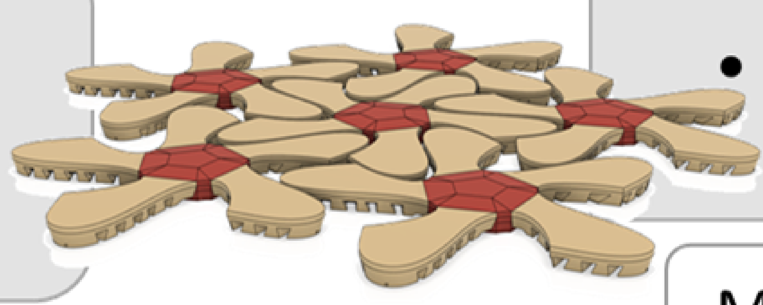
Multi-limb reconfigurable MSoRos



Enhanced Versatility

- Assemble and disassemble
- Ability to alter dimensions
- Conform to surfaces for increasing area of contact

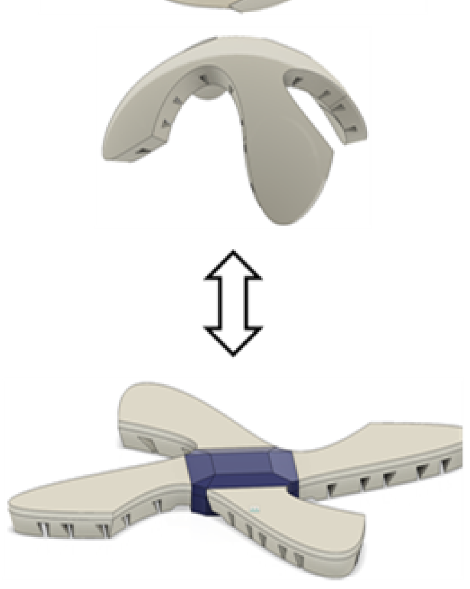


Improved Robustness

- Repetitive, inter-changeable
- Impact resistant
- Inert to environmental changes (e.g., PDMS)

Lower costs

- Costs low due to large scale production
- Single-unit cost low –silicone polymer robot bodies



Research Objectives

Learning mobility (locomotion) principles

- **Discretization** captures factors dominating robot-environment interaction
- Infer '**reduced model**' and mobility principles using dominant interactions

Morphology and design of reconfigurable modules

- **Limb topology design, mechano-geometric docking** using platonic & Archimedean solids
- **Stiffness mismatch** between soft boy and rigid-flexible actuators (e.g., motor-tendons)

Environment-centric control and adaptation

- **Metamorphosis** between rolling-ball (3D), sheet (2D) or snake-like rod (1D)
- **Environment learning** through data-driven database construction and gait optimization

Challenges

- *Hardware.* Actuator-SoRo integration, on-board electronics and inter-modular docking
- *Control.* 'Environment-centric' using motion primitives and ILP optimization problem
- *Morphing* of multiple modules with different design primitive (3,4 or 5 limbs)
- *Application-specific.* complex, adverse (heat-cold) environments, economic cost

Scientific Impact

- *Mobility principles for complex environments*. Reduced order models (ROMs) learn factors that dominate robot-environment interaction
- *Open-source untethered MSoRos.* These will enhance versatility, robustness and cost-effectiveness of traditional robots
- *Environment awareness and reconfiguration*. Task specific morphing of collective MSoRos

Technology Impact

Promising solution where terrain is unknown and unstructured.

MSoRos swarms have potential applications to the fields of disaster relief (search & rescue operations), space exploration and precision agriculture.

Education Impact

Soft robots easy to disseminate as safe to operate. Encourage students toward STEM, robotics.

Excite young minds. Connect illustrations of Transformers, Big Hero 6 with real-life morphing soft robots.

Research Impact

Understanding locomotion in unknown, unstructured environments.

Hybrid control models. 'Environment-centric' exploratory learning with 'model-centric' knowledge.

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