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Case ID:M22-090P^
Published: 10/12/2022

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Pinched Tubes for Reconfigurable Robots

-Background

When a soft tube is pinched, its stiffness is lowered at the pinching location, making it possible to buckle the tube at the pinch location. This phenomenon can be stimulated through the use of mechanical interference and vacuum, tendon-based pulling forces, or by pushing out a hinge from the inside. Once pinched, a hinge is formed that is of lower stiffness than the original tubular shape. This "joint" can then be used as a traditional robotic joint by rotating it via external forces or connected actuators. Through proper selection of materials, the tubular shape (and associated higher stiffness) can be restored when the pinching forces and any external loads are removed.

Invention Description

Researchers at Arizona State University have developed a novel method of pinching a soft tube in different ways and using the resulting virtual hinge for the creation of mechanisms on demand. This method can be used to create soft robotic arms with different kinematics on demand.

Controlling the pinch location and angle permits the hinge location and orientation to be controlled, enabling a changeable kinematic structure that can be reconfigured as a function of the pinching forces. This method has been demonstrated using tendons, internal pressure, and an active robotic mechanism that travels inside a hollow tube to create joints on demand. Using the effects of nonlinear compliance, a single tube can be reconfigured into a robotic arm of various configurations on demand and return to its original shape when complete.

Potential Applications

- Soft robotic arms
  - Climbing robots for conducting inspections or maintenance work
  - Biomimetic devices for physical rehabilitation
  - Replacement for missing limbs

Benefits & Advantages

- On-demand configuration of joints
- Different mechanisms can be created from one base element
- Original tubular shape is restored once the forces are removed
- Ability to select orientation of resulting hinge

Related Publication: Vacuum induced tube pinching enables reconfigurable flexure joints with controllable bend axis and stiffness

Related Publication: Reconfigurable Soft Flexure Hinges via Pinched Tubes