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Untethered Knit Fabric Soft Continuum Robotic Module with Embedded Fabric Sensing

Background

With interest in soft robotics on the rise, there have been extensive studies on soft materials, actuation, control, sensing, and even soft pneumatic pumps and valves. Soft robotic systems have the advantages of being lightweight, highly compliant, articulate, and inherently safe for interactions with human body and environment. Soft continuum robots are popular in manufacturing and surgical tasks as well as activities of daily living (ADL). Such robots feature various types of soft actuation mechanisms, including cable-driven systems, pneumatic artificial muscles (PAMs), and inflatable actuators.

However, previous developments have been confined to a fixed setting because of the tethered pneumatic source and pose sensing using a motion capture system. In order to develop compact soft robots that are more versatile, modular, and deployable, the bulkiness of the pneumatics must be addressed, as well as optimization of actuator proprioception and tactile feedback.

Invention Description

Researchers at Arizona State University have developed a continuum, lightweight, multi-degree of freedom (DOF) soft robotic module made of high-stretch knit fabric. Inspired by muscular hydrostats found in elephant trunks, the module is highly articulated and robust. In addition to being able to bend in 3D space, the soft continuum robotic module can also vertically extend and twist along its central axis. This work also integrates a thin, flexible, and conductive fabric stretch sensor to provide pose information for motion tracking. An on-board electropneumatic system has also been developed. The resulting innovation would therefore enable creation of safe human-robot interfaces that are both modular and suitable for complex tasks.

Potential Applications

- Manipulation assistance for daily living tasks

- Surgical and manufacturing robotics
- Soft robotic systems

Benefits and Advantages

- Compact and lightweight
- Capable of bending in 3D space, twisting, and extension
- Motion tracking aided by embedded fabric stretch sensor
- Actuator manufacturing involve low-cost and rapid techniques

Related publication (link): Towards an Untethered Knit Fabric Soft Continuum Robotic Module with Embedded Fabric Sensing

Research Homepage of Professor Wenlong Zhang