Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M22-188P
Published: 2/24/2023

Inventors

Daniel Aukes

Dongting Li

Contact

Physical Sciences Team

Origami-Inspired Wearable Robot for Trunk Support

A variety of rigid exoskeletons have been developed for improving mobility over the decades. High forces and torques provided by those rigid exoskeletons assist the ankle, hip and/or knee, facilitating activities such as walking or lifting heavy objects. However, due to the complexity of the human musculoskeletal system, adjusting and aligning human and robot joints has proven difficult, increasing the metabolic cost of the wearer and the external energy expenditure of the attached system. Heavy, high-torque, and often non-backdriveable systems can also be a safety risk for the wearer when the control system fails or misalignments occur.

Recent innovations in soft robotic techniques have resulted in "exo-suit" style technology in which tendons routed through Bowden cables provide pulling forces across joints. While this has addressed many of the issues stemming from traditional exoskeleton designs, it has also resulted in increased forces across human joints, which can lead, over time, to damaging the user's joints through increased wear. Many wearable robotic systems employ active sensing and feedback control techniques to quickly respond to the wearer's motion and provide powered assistance both to assist the user as well as to offset the extra weight of the system itself. In many cases, the small control delays imposed by digital control techniques also add small but perceptible loads to the wearer that can over time lead to accelerated fatigue and reduced efficacy. Thus, there is a need for a wearable system to provide alternate loading pathways across joints, where a variety of capabilities can be enabled or disabled on demand based on the user's activity, and in which the trade-off between wearability and utility is made not through the use of active, timed, energy addition via powered joints, but by minimizing the weight of rigid systems, and by powering the system to change its state.

Researchers at Arizona State University have developed an origami-inspired wearable robotic device with embedded sensing capabilities as well as extensibility for connecting external sensors. This device can bridge the gap between rigid exoskeletons and soft exo-suits in a way that balances the compromises of both. The device can improve stability and reduce torques about the trunk of a wearer during obstacle avoidance.

Related publication: Origami-Inspired Wearable Robot for Trunk Support

Potential Applications:

- Mobility-assistive device – improve gait of a wearer during obstacle avoidance tasks
- Supportive device – provide trunk support for wearer

Benefits and Advantages:

- Light-weight, high-stiffness, and rapidly-manufacturable wearable device
- Low manufacturing cost to produce device
- Design can be adjusted to fit the individual wearer