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Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering
is pleased to announce the following seminar:

Soft and Strong Robots

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Wednesday, 17 February 2021 at 14:00
Via Google Meet

Host Academic: Dr Shuhei Miyashita, ACSE

Abstract

Remarkable progress has been made in robotics research with the recent development of bio-inspired soft actuation. However, developing a lifelike robotic device (e.g., actuator) that is both strong and compliant remains a long-standing challenge in engineering. To address this issue, we use a combination of soft and rigid materials and to leverage the physical interactions between fluids and solid matter. We proposed a novel architecture for fluid-driven origami-inspired artificial muscles (FOAMs). These artificial muscles require only a compressible rigid "skeleton", a flexible thin "skin", and a fluid medium. The interactions of the three components enable the artificial muscles to contract over 90% of their initial lengths, generate stresses of 600 kPa, and produce peak power densities over 2 kW/kg. A simple linear FOAM actuator can lift objects 1,000 times its own weight. Our "soft and strong" artificial muscles can be rapidly fabricated using various materials, and they can also be designed to achieve multiaxial and sequential motions. These performances are all equal to, or in excess of, natural muscles. Based on the FOAM concept, we further proposed a new actuator architecture, named the "tension piston". In contrast to 300-year-old conventional pistons, the fluid-pressure-induced tension forces in the flexible membrane play a primary role in the system, rather than compressive forces on the internal surfaces of the piston. Our experimental results indicate that the tension piston can produce substantially greater force (more than three times), higher power, and higher energy efficiency (more than 40% improvement at low pressures) compared to a conventional piston.

Biography

Dr. Shuguang Li is a postdoctoral research associate at the John A. Paulson School of Engineering and Applied Sciences (SEAS) at Harvard University. He is also affiliated with the Computer Science and Artificial Intelligence Laboratory (CSAIL) at the Massachusetts Institute of Technology (MIT). Dr. Li received his Ph.D. degree in Mechanical and Aerospace Engineering at Northwestern Polytechnical University (Xi'an, China) in 2013. He has also studied in the Sibley School of Mechanical and Aerospace Engineering at Cornell University as a visiting Ph.D. student and a postdoctoral fellow. Dr. Li is currently working on projects related to reconfigurable robotics, soft robotics, and origami robotics. His recent studies have been highlighted in and covered by hundreds of news outlets, including BBC, Wired Magazine, Discovery News, Scientific American, Forbes, Huffington Post, Associated Press, Science Friday, MIT Technology Review, CNN, NPR, etc..