Magnetic Soft Robots

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Abstract

While human tissues are mostly soft, wet and bioactive; machines are commonly hard, dry and biologically inert. Bridging human-machine interfaces is of imminent importance in addressing grand challenges in health, security, sustainability and joy of living faced by our society in the 21st century. However, designing human-machine interfaces is extremely challenging, due to the fundamentally contradictory properties of human and machine. In this talk, we will highlight MIT SAMs Lab’s recent development of soft robots that can potentially perform various tasks inside human body. The soft robots are constructed by 3D printing of a new biocompatible magneto-active polymer into various structures. Our approach is based on direct ink writing of an elastomer composite containing ferromagnetic microparticles. By applying a magnetic field on the dispensing nozzle while printing, we make the particles reoriented along the applied field to impart patterned magnetic polarity to printed filaments. This method allows us to theoretically and experimentally program ferromagnetic domains in complex 3D-printed soft robots, enabling a set of unprecedented functions including crawling, jumping, grasping and releasing objects, and transforming among various 3D shapes controlled by applied magnetic fields. The actuation speed and power density of our 3D-printed soft robots with programmed ferromagnetic domains are orders of magnitude greater than existing 3D-printed active materials and structures. We will demonstrate a set of clinically relevant applications uniquely enabled by the 3D-printed magneto-active soft robots.

**Bio**

Xuanhe Zhao is a professor at MIT. The mission of [Zhao Lab](http://zhao.mit.edu/) is to advance science and technology on the interfaces between humans and machines for addressing grand societal challenges in health and sustainability with integrated expertise in mechanics, materials and biotechnology. A major focus of [Zhao Lab](http://zhao.mit.edu/)'s current research is the study and development of soft materials and devices for translational medicine and water treatment. For example, Zhao Lab’s invention of the hydrogel-elastomer tough hybrid is used in tissue phantoms for training doctors and researchers in medical imaging all over US.

Dr. Zhao is the recipient of the NSF CAREER Award, ONR Young Investigator Award, SES Young Investigator Medal, ASME Hughes Young Investigator Award, Adhesion Society’s Young Scientist Award, Materials Today Rising Star Award, and Web of Science Highly Cited Researcher. He held the Hunt Faculty Scholar at Duke University, and the d'Arbeloff Career Development Chair and Noyce Career Development Professorship at MIT.

