Magnetically Steerable, Soft-Bodied Continuum Robots

Technology #21435

Applications

This invention is a magnetically steerable, small-scale, soft-bodied continuum robot that has diverse medical applications in minimally invasive procedures, such as cerebrovascular and endovascular neurosurgical procedures.

Problem Addressed

Robotic systems present a novel strategy for remotely controlled, minimally invasive surgical procedures, such as stroke intervention. However, conventional robots are comprised of a series of rigid links, joints, and actuators; this composition limits their mobility and is unsuitable for navigating through narrow and complex systems such as the cerebrovascular anatomy to reach target lesions. Continuum robots, in contrast, are built with flexible materials, and they can achieve complex motion through their ability to bend upon deformation. It should be noted that existing continuum robots still contain some rigid components and are limited to millimeter scales due to miniaturization challenges of conventional actuation mechanisms. This invention is a submillimeter-scale, soft-bodied continuum robot capable of steering and navigating through complex and constrained environments upon remote actuation by externally applied magnetic fields.

Technology

This invention is a ferromagnetic soft-bodied continuum robot that can be fabricated by 3D printing of thermoplastic polymers and silicone-based ferromagnetic composites. The robot is composed of a soft polymer matrix containing ferromagnetic particles, which enable magnetic actuation of the robot when external magnetic fields are applied. This composition facilitates remote omnidirectional steering and navigation of the robot through a desired path, such as the neurovascular system. To reduce friction while the robot navigates through complex and constrained environments, the surface of the robot can be coated with a thin layer of hydrophilic polymers for lubrication. To expand the robot’s medical applications, various functional cores can be incorporated inside of the soft composite matrix. For example, one or a bundle of optical fibers can be included to enable imaging, illumination, or laser delivery.

Advantages

- Submillimeter-scale of robot is optimal for minimally invasive procedures
- Better steerability than conventional robots due to exclusion of rigid components
- Ferromagnetic particles allow robot to be steered remotely
- Incorporation of various functional cores allows for diverse surgical functions
- Teleoperable to enable remote surgery in rural areas with limited access to hospitals

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Intellectual Property

IP Type: Pending PCT Application

IP Title: Magnetically sterable continuum robotic guidewires for neurovascular applications

IP Type: Pending US Patent Application

IP Title: Magnetically sterable continuum robotic guidewires for neurovascular applications

Categories For This Invention:

Medical Devices
Surgical
Therapeutic (Medical Devices)
Robotics
Life Sciences
Clinical Applications
Neurology
Other (Clinical Applications)
Imaging
Instrumentation
Therapeutics

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Publications:

Ferromagnetic Soft Continuum Robots
Science Robotics
August 28, 2019, 4(33), eaax7329
Hard-Magnetic Elastica
Journal of the Mechanics and Physics of Solids
September 2020, 104045

External Links:

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Image Gallery:

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