Configuration and manipulation of soft robotics for on-orbit servicing

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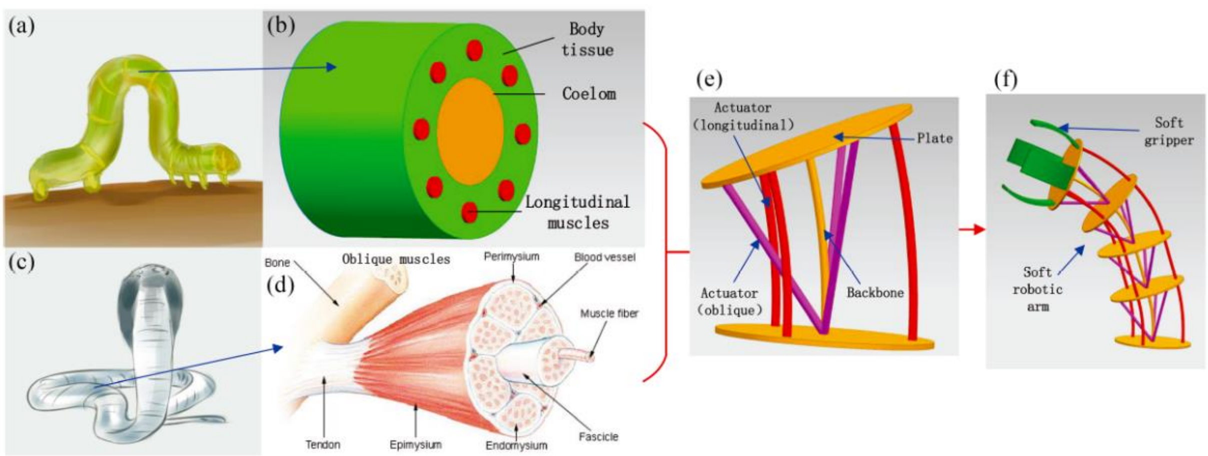


The hybrid structure of the space soft robot for OOS. Credit: ©Science China Press

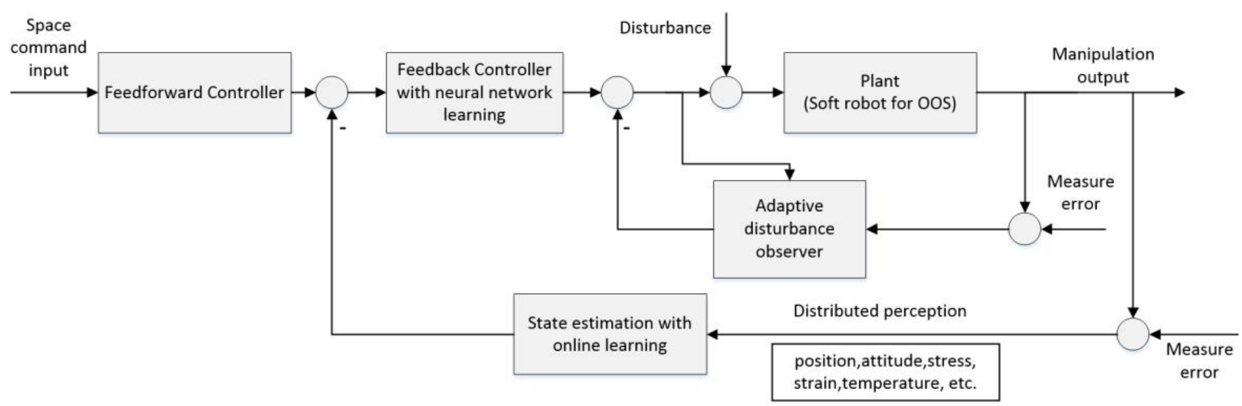
Traditional rigid-bodied robots are stiff, with few degrees of freedom, placing limits on many applications. Recently, more engineers are learning from the soft flexibility properties of living beings to advance bionic soft robotics. The main characteristics of soft robots are flexibility, deformability and energy-absorbtion.

With respect to on-orbit servicing (OOS), soft robots have promising characteristics: (1) Flexibility (many degrees of freedom)—soft robots can adapt to the unstructured space environment. (2)

Deformability—soft robots can perform multiple tasks, which can lighten the payload of spacecraft. (3) Energy-absorbing characteristics—soft robots can improve safety and reliability when robots interact with targets or even humans. A recent paper published in *SCIENCE CHINA Information Sciences* reviews the status and development of soft robotics and proposes a conceptual design of configuration and manipulation of a space-based soft robot.

Soft robots are notable for their configuration and manipulation. The paper mainly surveys soft robotic arms, soft grippers, earthworm-like robots, caterpillar-like robots, and multi-limb robots. For example, most soft robotic arms are inspired by elephant trunks or octopus arms. The robots can roll up or operate targets flexibly. However, manipulation of soft robots is difficult. The actuation and control of soft robots cannot be addressed by traditional methods. Novel actuation is required to realize the complex motion of these novel configurations. The paper describes actuation via electroactive polymers (EAPs), cable actuation, shape memory alloy (SMA) actuation and fluidic actuation. Control problems for soft robots are much more challenging, and most current studies use a sequence of motion commands to control them. To increase the automation level of soft robots, novel control schemes need to be developed.

This paper proposes a conceptual design of configuration and manipulation of a space soft robot according to the application requirements of OOS. The robot is composed of a space soft robotic arm and a space soft gripper. Inspired by the biologic body of inchworms and snakes, the soft robotic arm combines flexibility and stiffness. The space soft gripper mimics the prolegs of an inchworm to catch targets. With respect to space soft manipulation, distributed perception and brain-inspired control offer a high performance control system for the space soft robot. Similar to living beings, sensors are embedded in the robot to obtain the inner states of the robot and the information of outer environment. Neural networks connect the sensing signals and the control signals to enable the robot to complete various missions automatically. The hybrid structure of the space soft robot is shown in Fig. 1 and the block diagram of the potential manipulation system of space soft robot is shown in Fig. 2.



The block diagram of the manipulation system of the space soft robot for OOS. Credit: ©Science China Press

More information: Zhongliang Jing et al, An overview of the configuration and manipulation of soft robotics for on-orbit servicing, *Science China Information Sciences* (2017). DOI: 10.1007/s11432-016-9033-0

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