NUS Graduate School for Integrative Sciences and Engineering
Research Project Write-up

Title of Project : Bio-inspired Flexible Robotic System for Minimally Invasive Surgery

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Short Description

Robotic assisted minimally invasive surgery (MIS) is believed to the next revolution in surgery as MIS greatly reduces the trauma, pain, post-operative discomfort, and length of hospital stay associated with open surgery. However, the potential of Robotic assisted MIS is hampered by the rigid instruments, such as those used in the Da Vinci System, which limit the dexterity and pose risk of tissue collision and trauma within the operative field. Flexible instruments have to be developed to address these issues.

The objective of this research is to develop the next generation of flexible surgical robots. One fundamental part is flexible mechanisms, which should have large reachable workspace and provide dexterous manipulation inside the body. We believe nature has offered great examples of flexible instruments that are highly dexterous and powerful, such as the body of snakes and trunk of elephants. Inspired by nature, we will develop a family of biomimetic highly flexible instruments, which offer much higher dexterity and larger workspace with excellent controllability than existing flexible instruments.

Together with surgeons from NUHS, we have developed and tested a bio-inspired flexible mechanism for surgical robotic arms. The mechanism comprises of a flexible backbone, a set of controlling tendons and a constraint. The length and the angulation of the bending section of the mechanism are both controllable. A proof-of-concept instrument has been developed and cardiac surgery test on animal models demonstrated the superior performance of the technology.

The key focus of this research will be on the novel mechanism design with tendon as well as smart materials, modeling, sensing and control of the flexible arms, instrument shape and force sensing and tracking, master slave system design with haptic feedback, animal and clinical testing and validation.

Students with strong Mechanical and Mechatronics background and entrepreneurial interest are encouraged to join this promising research which can bring both academic and commercial payoff.

Keywords:

Minimally Invasive Surgery, Bio-inspired Robotics, Tendon or Cable Drive Robots, Master-slave manipulator, Medical Device.