Contact Detection and Localization in Continuum Robots

VANDERBILT UNIVERSITY
CTTC Center for Technology Transfer & Commercialization

Summary

This technology expands the capabilities of continuum robots with a system and method that enables them to detect instances of contact and to estimate the position of the contact. This framework allows the motion of the robot to be constrained so as to ensure the robot doesn't damage itself, another robot arm, or surrounding environments. Applications for this technology include enhanced safe telemanipulation for multi-arm continuum robots in surgery, micro-assembly in confined spaces, and exploration in unknown environments.

Challenges in Robotics and Surgery

Minimally invasive procedures are usually performed using several tools and surgical ports; with several tools operating in such a small space, there are potential hazards associated with the tools running into each other, especially in a robotic procedure. To safely navigate uncertain surgical environments, a robot must be able to detect instances in which it contacts surrounding tissue or other surgical tools. There are previous works on contact detection, but these methods provide no information about the location of contact.

Commercial Applications

Robotic systems have shown exciting potential in their ability to perform minimally invasive surgical procedures with more precision than a human surgeon alone. Continuum robots are able to expand this potential by providing dexterous access along tortuous, long anatomical paths to deeper anatomy. This technology further expands the potential of these continuum robots by allowing them to operate deep inside unstructured environments through significant reduction of the possibility of damaging any tissue or surgical tool. The system can support applications in the area of natural orifice transluminal surgery, trans-anal surgery, and many other minimally invasive procedures. The system and methods also have industrial applications including the assembly of small parts inside electronic guide tubes, assembly in cluttered environments such as in car dashboards, exploration of sewage pipes, precise archeological procedures, and search and rescue exploration.

Technology Description

The framework enables an actively compliant continuum robot to detect an instance of contact and to localize that contact during a procedure. The system compares theoretical and actual positions of the continuum robot to identify a collision, and upon identifying contact, the robot can immediately move to relieve contact and ensure that no damage is done to the robot or surrounding environment. In surgical contexts, these contact methods also guide the continuum robot in safely bracing against the anatomy to increase precision and stability during a procedure, significantly broadening the complexity of procedures that can be performed by robotic surgical systems.

Technology Features

- Allows for both detection and localization of contact without perceptible delay
- Can be safely and rapidly deployed into unstructured environments
- Enables the continuum robot to safely brace itself against the anatomy while increasing the stiffness and accuracy at the tool tip, ensuring that the tissue it contacts isn't damaged

Intellectual Property Status

- US Patent Issued: US9333650
- Publication: IEEE Transactions on Robotics (Vol. 28, Issue 2, pgs. 291-302), Collision Detection Video Example

CTTC CONTACT:
Ashok Choudhury, Ph.D.
(615) 322-2503
ashoik.choudhury@vanderbilt.edu

INVENTORS:
Nabil Simaan, Ph.D.
Professor of Mechanical Engineering and Otolaryngology
http://arma.vuse.vanderbilt.edu/

VU REFERENCE: VU12072

Visit **http://cttc.co/technologies** for available Vanderbilt technologies for partnering