Multi-Degrees-of-freedom hinge joints on miniature tubes for steerable medical devices and its applications

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Technology description

Overview

With the proliferation of successful minimally invasive surgical techniques, comes the challenge of shrinking the size of surgical instruments further to develop a new set of medical devices that improve the performance of current clinical procedures or create new ones. Several technologies have been developed to minimize surgical instruments, consisting primarily of either flexure-based planar joints or ball joints. Both of these types pose a challenge for the precise and dextrous tip control of miniature medical devices. In the former case, the limited degree-of-freedom reduces the device capability, while the latter necessitates precise alignment of subcomponents and assembly, increasing manufacturing costs and limiting further miniaturization. It is highly desired to develop a sophisticated fabrication method of joints with more natural kinematics and higher maneuverability (requiring minimal space to turn or orient).

Technology

The disclosed technology introduces laser machined, multi-degree-of-freedom hinge joints embedded on tubes as a means to realize such miniature instruments without the need for any assembly. A method for the design and fabrication has been developed, mathematically modeled, and extensively tested in the lab. The process of embedding hinge joints on a tube is accomplished using the generated G-code to implement a computer-aided-manufacturing process.

Application area

A set of new medical devices (patents filed) were created using the disclosed technology:
Robotic In Vivo Manufacturing of Sustainable Drug Delivery Patch Using Non-Thermal Plasma Technology
Miniature robotic delivery platform for less-invasive medical applications

Miniature endoscopic ear surgery tool with a reconfigurable distal head
Biorobotics Smart design,
materials, processing, and advanced micro-manufacturing
Development of innovative biomedical devices

Advantages

There is no need for assembly.
Multi-degree-of-freedom motion is possible when appropriately arranged.
An inner channel can be preserved for matter exchange.
Fatigue is reduced because subcomponents are not required to undergo significant bending.
The joints can be controlled more intuitively and precisely because the end effector basically pivots about the hinge joints.

Institution

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