Dexterous Robotic Wrist and Gripper for Extreme Precision Micro-surgical Maneuvers in Confined Spaces

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Summary

This invention presents a robotic wrist and gripper that operate with three independent degrees of freedom (yaw, pitch and roll) for increased dexterity in minimally invasive surgical procedures. This is the smallest robotic wrist of its kind, and due to its size and unparalleled dexterity, this wrist enables complex surgical maneuvers for minimally invasive procedures in highly confined spaces. Examples of surgical areas benefiting from use of this wrist include natural orifice surgery, single port access surgery, and minimally invasive surgery. In particular, the proposed wrist allows for very high precision roll about the longitudinal axis of the gripper while overcoming problems of run-out motion typically encountered in existing wrists. Thus this wrist is particularly suitable for extreme precision maneuvers for micro-surgery in confined spaces.

Addressed Need

- Many surgical sub-tasks such as passing a circular needle in confined spaces require localized orientation dexterity at the gripper. In particular, rotation about the longitudinal axis of the gripper is needed for facilitating passing circular needles in highly confined spaces.
- Existing surgical wrists do not offer three degrees of freedom wrists in a small package while allowing for independent control of roll about the longitudinal axis of the gripper. Instead, the motion of several joints are coordinated to achieve orientation dexterity. Perfect coordination to achieve very precise rotation about the longitudinal axis of the gripper is very difficult to achieve. Hence existing systems have difficulty achieving very high precision roll about the gripper's longitudinal axis.
- There are miniature surgical "wrists" capable of providing dexterity at the end of instruments used in minimally invasive procedures, but they are limited by the inability to roll about the primary axis as an independent degree of freedom

Technology Description

This revolutionary robotic joint greatly expands the capabilities of minimally invasive surgical tools by providing the dexterity to operate efficiently in tight spaces. The joint's dexterity comes from its ability to operate with three completely independent degrees of freedom: pitch, yaw, and rotation about its primary axis. The joint is especially suited for use with continuum robots during minimally invasive surgical procedures but has the potential to improve almost any tool, robotic or not, used in confined spaces.

Commercial Applications

Minimally invasive surgery is currently a $35 billion industry that is slated to grow by about 7% each year. Almost all minimally invasive tools and procedures would benefit from the advantages provided by this technology.

Unique Properties

- This is the smallest robotic joint of its kind
- The size and increased dexterity offered by this robotic wrist and gripper greatly expands the tasks that could be performed by a minimally invasive surgical robot or device
- This surgical wrist operates with three independent degrees of freedom, increasing the precision and dexterity with which it can operate in confined spaces

Intellectual Property Status

- Issued US Patent: US 9,687,303
- Issued US continuation: US 10,500,002
- Published Paper: IEEE/ASME Transaction on Mechatronics (Vol.18, Issue 5, Oct. 2013)
- Nautilus Magazine: Team's tiny robot called medical science 'breakthrough'

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