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Soft and Stiffness-controllable Robotics Solutions for Minimally Invasive Surgery: The STIFF-FLOP Approach

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Description:

Soft and Stiffness-controllable Robotics Solutions for Minimally Invasive Surgery presents the results of a research project, funded by European Commission, STIFF-FLOP: STIFFness controllable Flexible and Learn-able manipulator for surgical Operations.

In Minimally Invasive Surgery (MIS), tools go through narrow openings and manipulate soft organs that can move, deform, or change stiffness. There are limitations on modern laparoscopic and robot-assisted surgical systems due to restricted access through Trocar ports, lack of haptic feedback, and difficulties with rigid robot tools operating inside a confined space filled with organs. Also, many control algorithms suffer from stability problems in the presence of unexpected conditions. Yet biological "manipulators", like the octopus arm can manipulate objects while controlling the stiffness of selected body parts and being inherently compliant when interacting with objects. STIFF-FLOP robot is an innovative soft robotic arm that can squeeze through a standard MIS, reconfigure itself and stiffen by hydrostatic actuation to perform compliant force control tasks while facing unexpected situations.

Technical topics discussed in the book include:

- Soft actuators
- Continuum soft manipulators
- Control, kinematics and navigation of continuum manipulators
- Optical sensors for force, torque, and curvature
- Haptic feedback and human interface for surgical systems
- Validation of soft stiffness controllable robots

Keywords: Soft Robots, Surgical Robots, Medical Robots, Continuum manipulators, Soft actuators, Tactile and Force Sensing, Bending Sensors, Control of continuum manipulators, Haptic feedback, Surgical human interface, Benchmarking of surgical robots.