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Titolo: Surgical Tactile Tools - SurTacT (Cod. Progetto: P20229WPKX)

Abstract: The sense of touch is fundamental in surgery. It provides information about the clinical condition of a tissue, and feedback for controlling surgical gestures. The use of sophisticated minimally invasive surgery (MIS) techniques has limited the interaction of the surgeons via their own hands with the tissue to intervene on: in the last decades the introduction of laparoscopic, endoscopic, microsurgery and robotic surgery reduced invasiveness but also the possibility of hand palpation. Despite the clinical evidence on the effectiveness and added value of such new surgical technologies, their lack of tactile interaction is a limiting factor that the SurTacT project aims at overcoming.

The role of tactile information concerns sensing, for example, the pressure necessary to incise a tissue or to tighten the knot of a suture or the palpation of an anatomical structure. Traditionally, tactile information is received by the own hand of the operator or through the surgical instrument. In fact, palpation using hands has always been a prominent part of the objective examination, allowing the physician to determine the location of pathological conditions that escape sight. In addition, it also provides information about extension, consistency and pain of hidden pathologies. Each tissue has its own tactile peculiarities as well as each procedure requires specific tool-tissue interaction. Errors in a surgical procedure due to the lack of tactile information or inadequate tool-tissue interaction forces are common and, therefore, acquiring this kind of knowledge is paramount to enhance surgical performance and education.

The goal of the SurTacT project is to design, develop, and validate a new generation of surgical tools, empowered with an artificial sense of touch for the operator. The instrument will embed force and temperature sensors and will provide the operator with real-time haptic feedback on his/her body. The location of the feedback will be identified through a biomechanical study of surgical gestures.

These innovations on surgical tools will be achieved via new sensing technologies, such as Fiber Bragg Grating (FBG) and Rayleigh backscattering (RBS)-based optical fibers, that would enable distributed measurements of strain and temperature through their integration with 3D printing methods directly within the surgical tools, without wiring overhead. Finite Element Methods (FEM) and Artificial Intelligence (AI) will foster the optimization of the positioning of the sensors within the surgical tools and their calibration prior to the experimental validation. Within SurTacT, those novel tools will provide feedback through a haptic interface while palpating realistic tissue phantoms and anatomical models. The sensorization of surgical tools, if deployed in clinical scenarios in the project follow-up, would further allow to build references for the tactile properties of the tissues or the surgical gestures, which are currently not available.

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