Visual feedback mounted on surgical tool

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Background: In the operating room, feedback, such as instrument positioning guidance of surgical navigation systems is typically displayed on an external computer monitor (Figure 1). The surgeon's attention is usually focused on the tool and the surgical site, so the display is typically out of the direct line of sight. The objective of this work is to develop a simple visual feedback mechanism mounted on the surgical tool and thus always within direct line of sight, in order to alert the surgeon when it is necessary to look at the monitor for detailed navigation information.

Figure 1: OR layout in EM tracked electrosurgery [1].

Methods: The tool-mounted visual feedback mechanism was designed to be light-weight and compatible with electromagnetic (EM) tracking. Figure 2 shows the schematic of the proposed solution. The feedback device consists of a computer-controlled light source (RGB LED), which is programmed to flash and change color to get the surgeons attention. A variety of colors and flashing frequencies are explored to determine the most effective pattern. The light source is located 1-2m away from the patient and an optical fiber cable is used to transmit the light from this location to the tracked surgical device in order to reduce EM noise and avoid galvanic connection to the patient. A microcontroller (Arduino Uno, http://arduino.cc) communicates with the computer interface through a serial USB connection. We integrate the proposed visual feedback device in the SlicerIGT open source (www.SlicerIGT.org) surgical navigation system, in which tool tracking functions are implemented using the PLUS toolkit (www.plustoolkit.org) [1]. Our visual feedback device also uses the PLUS toolkit to communicate information from SlicerIGT to the microcontroller. The tool-mounted visual feedback device is first being applied in EM-navigated breast-conserving surgery [2] (Figure 1). The optical fiber bundle shares a 3D-printed mounting clamp with the EM tracking sensor, mounted on the distal end of the electrosurgery cauterizer and is placed inside a sterile transparent plastic bag. By varying the colour and flashing frequency of the LED, the surgeon is informed when surgical margins are changing and a severe warning is produced if the resection margin is violated.

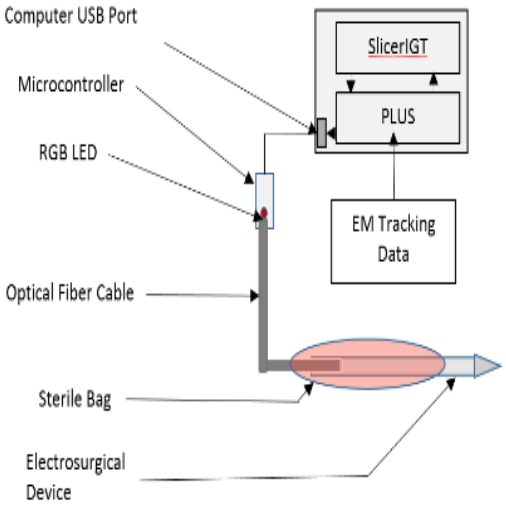

Figure 2: Schematic of Visual Feedback System

Conclusions: The tool-mounted visual feedback device has been designed and is currently being implemented and tested within the context of EM-navigated breast-conserving surgery. The device represents no risk to the patient and it can be promptly translated for clinical evaluation within our ongoing patient trial.

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