Enabling Technology for Safe Robot-assisted Retinal Surgery

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Abstract

Retinal microsurgery is one of the most technically challenging surgical disciplines. Surgeons need to operate on very small, delicate eye tissue under the magnification of a surgical microscope. The challenges are tremendous, just to list a few of these challenges: human natural hand tremor is larger than the eye tissue thickness; surgeons need to coordinate the motion of two tools with geometric constraints; surgeons struggle to protect healthy tissue when eliminating diseased tissue (when performing microsurgery without “force feedback” sensor signaling or any other similar types of computerized surgery navigation tools). In prior work studies, we overcame hand tremors through the development of steady-hand manipulators for retinal microsurgery. The robot controller senses forces exerted by the operator / surgeon on the tool and uses this information, in various control modes, to provide smooth, tremor-free, precise positional control, and force scaling, resulting in improved surgical instrument functionality. Microsurgical instruments, with multi-functional sensing capabilities, have also been developed to “feel what the surgeon cannot feel”. Strategic next steps mandate integration of the emerging tool’s superior “force sensing” ability with strategic automated tool responses. Using sclera force information, a new robot control framework could generate useful robot behaviors to enhance safety by providing real time intuitive feedback to surgeons. This talk will reveal the last developments conserning the technology for safe robotic assistance in retinal surgery.