Eye Surgery Robot Mount

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Background

Certain types of retinal surgeries, including subretinal injection of stem cells and other therapies, have the potential to improve vision but are nearly impossible for surgeons to perform because of the extreme degree of precision required. A tele-operated surgical robot has been developed by Dr. Jake Abbott’s group that can make very precise movements on the order of 1 micrometer and hold all existing disposable retinal-surgery instruments [1]. This is the most precise eye-surgery robot ever developed. By tele-operating the robot, the surgeon’s hand and its associated tremor, is removed from any direct contact with the instrument or the patient.

The muscles of the eye are immobilized, so movement of the eye in its orbit is not a concern. However a sedative, not general anesthesia, is given to the patient which allows for head movements due to breathing and snoring, as well as other voluntary movements. These head movements limit the ultimate precision that is currently achievable.

Objective

The goal of this project is to passively compensate for patient head movement by noninvasively mounting the robot to the patient’s head using a mask-like device. The hypothesis is that this solution will reduce relative movement of the robot with respect to the eye during head movements, compared to a scenario in which the robot is mounted to ground (e.g., mounted to the patient’s bed). It is important that the proposed solution does not interfere with the sterility and workflow of the surgery.

Sterilization

Sterilization was one of the key design constraints. During eye surgery, a surgical draping is laid over the patient. Everything above the surgical draping must be sterile and autoclavable. Items below the draping do not need to be sterile.

Testing

Optical motion tracking was used to track the relative motion between the mask and the skull, the mask and the ground, and the skull and the ground. Success of testing was quantified by showing the relative movement between the mask and the skull was less than that between the skull and the ground. The motion recorded was due to deep breathing.

Results

The maximum relative movement between the mask and skull was 0.281 mm. The maximum relative movement between the skull and ground was 1.14 mm. This represents a 75% improvement.

Future testing with a fully 3D metal sintered mask will need to be ran using optical coherence tomography (OCT).