Augmented reality-based navigation for use in neurosurgical procedures

Unmet Need

Over 200 million surgical procedures are performed each year globally and at least 4000 surgical errors occur each year in the United States. These preventable errors contribute to a significant number of surgical complications accounting for about 50% of all adverse events and up to 13% of all hospital deaths. In many instances, surgical procedures require physicians to interact with anatomical features that are hidden from view which increases the risk for surgical complications. These procedures pose a great challenge for physicians. For instance, ventricular catheter placement is arguably one of the most common and important lifesaving procedures in the neurologic intensive care unit. However, inadvertent placement into brain tissue leading to complications such as hemorrhaging occurs in 10–40% of cases. In some circumstances, such as brain tumors, cases may even be deemed inoperable due to the difficulty in reaching the region of interest without damaging surrounding healthy tissue. Therefore, there is a great need for technology that would improve the accuracy and precision of surgical procedures and reduce complications for patients.

Technology

Duke researchers have developed the augmented reality navigation system for use in medical procedures. They have designed a software that creates a 3D model of the ventricular system using a brain CT scan of a patient. This holographic model can subsequently be manipulated using the Microsoft HoloLens, an augmented-reality headset. The software places the ventricular model directly over the patient’s head so that when looking through the headset, the holographic ventricles appear in the precise location as they are in the patient. The system can also track the location of medical tools such as a catheter by generating a hologram of the catheter and superimposing this image on a physical catheter. As an additional navigation aid, the software displays arrows and intended trajectory lines to help guide the catheter from the skull through the brain tissue to the preselected target within the brain. This technology can assist medical professionals to find the precise anatomical location...
of interest that would usually be difficult or not possible to visualize by sight and enable surgery of previously inoperable cases by helping to locate safe surgical corridors. This device will serve as an effective, low-cost image-guided surgery system in comparison to intraoperative CT and MRI scanners.

Other Applications

This augmented reality navigation system has potential applications beyond neurosurgery including placement of central lines, percutaneous biopsies, CT or ultrasound-guided procedures, chest tube placement, and catheter placements. Furthermore, this technology can be used to training medical professionals for procedures in which they lack experience.

Advantages

- Allows for visualization of anatomical features that are hidden from view during operation to improve accuracy and reduce adverse surgical outcomes.
- Cost-effective alternative to expensive image-guided surgery systems such as intraoperative CT and MRI scanners.
- Has been realized as a functional prototype.

Publications

- App-assisted external ventricular drain insertion (Journal of neurosurgery, 2016)
- Brain surgery may get a bit easier, with augmented reality (Duke Today, 2016)
- Duke neurosurgeons test HoloLens as an AR assist on tricky procedures (Techcrunch, 2016)
- Duke hopes HoloLens will assist with tricky brain surgeries (Engadget, 2016)
- How Doctors Are Testing the Microsoft HoloLens for Brain Surgery (INC, 2016)
- Patent (16/484,444)