Concept, Development and Design of Wearable Computing for Image-guided Neurosurgical Navigation

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Learning Objectives

To present the development and design of an innovative setup that not only ensures surgeon's attention no longer diverted from the field, but also enables surgeons to have direct intangible control of the intraoperative image display.

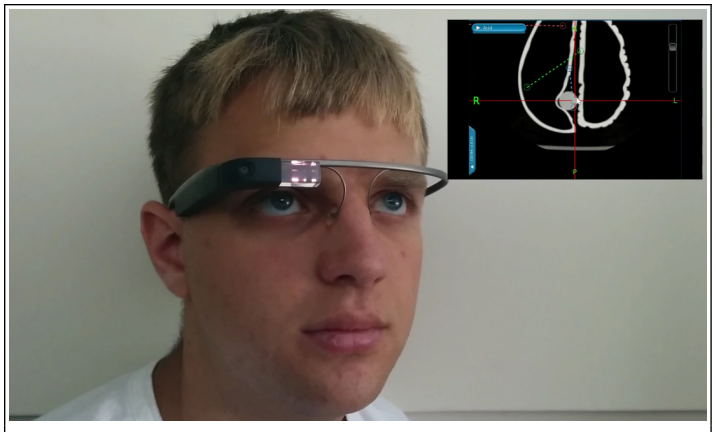

Figure 1: Preview of wearer's view

Introduction

Currently available image-guided neurosurgical systems (IGS) employ line of sight infra-red projectors, reflective trackers and high resolution monitors for display of multimodal data and images, requiring the surgeon to look away from the surgical field in order to confirm intra-operative progress. Such eye movement and lack of direct control over the display introduces a source of inefficiency and distraction for the surgeon, disrupting concentration and fluidity of delicate, technical movements. This study investigates wearable computing technologies to augment existing IGS by replacing remote visualization with a wearable, voice-controlled imaging device.

Methods

The original development is based on a commercially available near-to-eye monocular display (Google Glass) and a high performance video grabber (Epiphan).

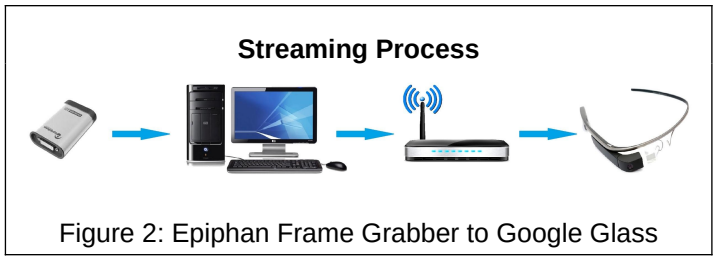

Figure 2: Epiphan Frame Grabber to Google Glass

The output video data of a surgical navigation system(Medtronic Navigation S7) is wirelessly streamed to the monocular display worn by the surgeon, thus making him/her the system interface. The screen of the navigation system can be remotely captured and dynamically projected to the surgeon's wearable device and is fully controlled using voice commands.

Results

The development kit was given to seven attending neurosurgeons or residents to use during the surgical procedure at Cooper University Hospital. Upon completion the procedure, they were asked to fill in the dedicated 9-item questionnaire.

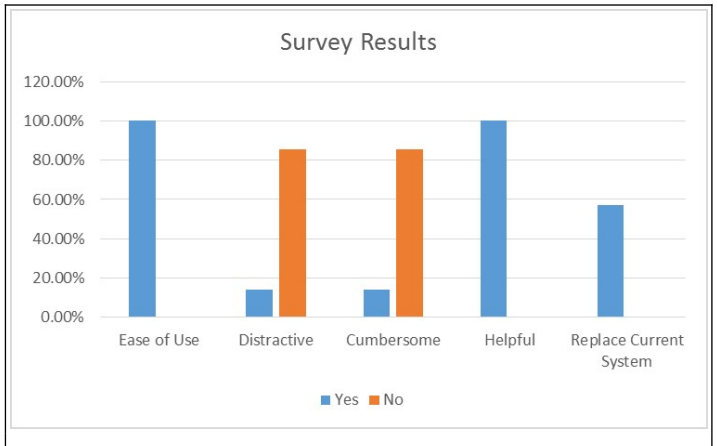

Figure 3: Initial Survey Results

Survey results showed that the system is easy to use and helpful. More than 80% of the neurosurgeons and residents who have tested the system in the operating room also reported that the system is not distractive or cumbersome.

The initial survey also showed a high interest in the new system as a replacement of the surgeons' existing surgical navigation systems.

Conclusions

By replacing the conventional method of navigation using a computer monitor, which withdraws focus from the surgical site, with a wearable device, the surgeon no longer needs to make unnecessary eye movement to view important visual information. The development has promising potential to be paired with any IGS to offer convince and safety for the surgeon and patients.

The first clinical trials showed that the system is simple, reliable and easily incorporated into the surgical environment. The distraction of using a conventional monitor, and the lack of any surgeon input has been eliminated by the wearable system.

Future Work

The future of this research will aim to further ease the navigation system for surgeons in operating room. Concerns from the surgeons will be addressed in the upcoming iterations.

A two-way straming implementation is currently in development, where the wearable device will stream a live video feed using the onboard peripherals to a computer. The computer will than process this data and interpolate information using preloaded DICOM images similar to the current method and stream it back to the wearable device, thus replacing the existing navigation system completely.