Google Glass as a Display Device during Ultrasound-Guided Procedures

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Background

Wearable computing is a fast growing field of electronics that aims to merge technology into everyday life. This includes optical head-mounted displays, such as Google Glass, which can be worn as a pair of spectacles allowing images and contextual information about the environment to be overlaid on a user’s field-of-view. There is great potential for well-designed and supported wearable devices to enhance our ability to interact with the world in an intuitive and practical way. While there is a vast frontier for everyday consumer applications, in the medical field there is a growing interest for such devices to help medical providers enhance patient care. In fact, there have been an increasing number of surgical studies evaluating the use of wearable media in the operating room whereby imaging information can be directly overlaid on the patient (1, 2).

Case Presentation

The development of a universally applicable system to wirelessly stream medical images in real time to a wearable display would be invaluable in advancing the field of interventional radiology. This would allow operators to keep both their hands and the imaging data in the same field of view. From the perspective of a naïve operator, this could theoretically allow for a more intuitive learning experience allowing better control of an ultrasound probe, catheters, or other wires. From the perspective of more experienced operators, this can help during more ergonomically difficult cases (eg. percutaneous nephrostomy management or placement in a contracted paraplegic patient) where it may not be possible to position a traditional display ideally. This would allow the operator to be more comfortable with their body and hand positioning without the increased burden of keeping images in an accessible field of view.

Outcome

Google Glass is a small computer running a modified version of the Android operating system which is worn like a pair of eyeglasses that projects images directly into the user’s retina. In order to take advantage of this device in the interventional suite, we developed a prototype video capture system that captures analog images from an ultrasound machine using a USB-capture device connected to a Raspberry-Pi 2 (Open-ELEC 5.0.8). An open source live-stream server (ffmpeg 2.6.1) is hosted on the Raspberry-Pi 2 which broadcasts over a local WiFi network over TCP/IP. In order to view the images, we modified an open source android application (Exoplayer) to run on the Google Glass device and connect to the hosted streaming server to view the images. Utilizing this device, several users were able to successfully gain intravenous access in a phantom training device using ultrasound guidance. Our system allowed for <600ms of delay between image display on the ultrasound machine monitor versus display on the Google Glass device (figure 1).
In preliminary use of our device, we discovered several hardware problems that limit the current clinical feasibility of Google Glass. Given the processing requirements of displaying live-streaming video, extensive use of the device resulted in overheating which triggered a processor throttling safety mechanism that decreased the processing power and subsequently heat generation at the cost of increased delayed in image display. We compensated for this by decreasing the video quality and frame-rate.

Similarly, given the demanding workload on the display device, battery life suffered during use, limiting continuous device use to a maximum of forty-five minutes before requiring another charge. While the device could function while wired to either a USB port or power outlet, this would restrict operator flexibility when using the device.

As the technology currently stands, battery and processor restrictions would not be conducive to application in clinical settings. Future iterations of the device would require faster and more energy efficient processors or a better designed heat sink as well as improved battery capacity.

Using similar technology, a study was performed by Wu et al. in 2014 using Google Glass as a display device during ultrasound-guided central venous access (3). They randomized users with variable ultrasound-guided procedural experience into a group that utilized a traditional display and a group that used Google Glass as the display device. Their results demonstrated technical success by all users at the cost of increased procedure time. We believe these results were particularly limited by their system’s high latency rate which they quoted as “around 1 s”.

The field of optical head mounted displays is still in its infancy and Google Glass provides the first consumer grade device which was widely available for purchase. Since its release, there has been in increase in similar devices which are becoming increasingly available for testing by the public and potential developers. While
initial attempts at commanding the technology for medical use has been limited, a true future exists for this technology in medicine. Continued participation of the medical field in the development of these technologies is necessary to achieve continued expansion and relevant clinical application.

References


Keywords

Mobile, Wearables, Ultrasound, Image-guided Procedures, Interventional Radiology