The Effect of Latency on Digital Vitreoretinal Surgery

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Purpose:
Different three-dimensional heads-up display visualization systems for vitreoretinal surgery have started to be used recently. Latency is one proposed disadvantage over the traditional optical microscope however to the best of our knowledge, there have not been any studies yet published studying the effect of latency on surgical performance in the setting of vitreoretinal surgery.

Methods:
Thirty participants conducted two tasks, suturing and peeling, on a 3 dimensional heads-up display at 4 levels of latency, 50 ms, 66 ms, 90 ms, and 120 ms. For each time trial, the task completion time was measured. In addition a 6 item questionnaire on usability of the system was administered for each time trial. The order of the level of latency was randomized and blinded to the participant.

Results:
In terms of surgical performance, for both the suture task and the peeling task, there was no statistical difference between completion times between a 50 ms latency and a 122 ms latency (p=1.000). This was also true when looking at the subgroups of participants who had VR training (p=1.000), and those who had VR training and regularly used 3D HUD (p=1.000).

Usability of the system was measured by a 6 item questionnaire. In the suturing task, usability dropped by 60% at 122 ms when compared to 50 ms (p<0.001). This drop was also found in all subgroups as well. However, there was no statistical difference at 66 and 90 ms. In the peeling task, usability only dropped 20% at 122 ms compared to 50 ms (p=0.12) and this was also true for all the subgroups. None of these differences were statistically significant. Indeed, usability was not found to be significantly different at any of the latency values for the peeling task.

Conclusions:
The results of this study suggest that latency, at the levels found in current models of 3D HUD, are below the threshold of negatively affecting performance for the majority of users and therefore challenge the belief that latency plays a key role in the difference felt between the optical microscope and 3D HUD.