



MECH 493 project: Developing VR Eye Tracking for Brain Injury Screening

Research Project Overview

Concussions, or mild traumatic brain injuries, typically result from excessive accelerations of the head. Concussion incidence is high in sports, recreation, falling, and automobile accidents. Current methods of concussion diagnostics are highly subjective and largely rely on patients to self-report their injuries. There is a need for more objective and quantitative injury screening and diagnosis methods. In past research, it has been found that sensorimotor deficits, such as the inability to maintain balance or stable eye gaze, are common after concussions. Sensitive and quantitative methods such as eye movement tracking [1][2] have been developed to quantify such sensorimotor deficits. In this project, we have been developing a virtual reality (VR) eye tracking system to quantify eye movement errors during smooth and saccadic eye motion and applying this system in a prospective ice hockey concussion study.

We are currently developing the VR eye tracking tests using the HTC Vive Pro Eye system [3] and the Pico Neo 2 Eye system. Each of these systems have eye cameras embedded into VR headsets to track eye movements as the user is navigating a virtual scene. Stimuli can be projected in the virtual scene and the accuracy of the eye gaze focusing on or tracking the stimuli can be quantified through eye tracking. Common test paradigms include smooth pursuit, where the user tracks a target that moves through a smooth trajectory; and saccades, where saccadic eye movements with the gaze jumping from one target to another are tracked. It is anticipated that concussion patients have amplified gaze errors.

References

- [1] Maruta, J., Suh, M., Niogi, S. N., Mukherjee, P. & Ghajar, J. Visual tracking synchronization as a metric for concussion screening. *J. Head Trauma Rehabil.* **25**, 293–305 (2010).
- [2] Murray, N. G. *et al.* Smooth Pursuit and Saccades after Sport-Related Concussion. *J. Neurotrauma* **37**, 340–346 (2020).
- [3] Imaoka, Yu, *et al.* "Assessing Saccadic Eye Movements With Head-Mounted Display Virtual Reality Technology." *Frontiers in Psychiatry* **11**, 922 (2020).

Research to be performed by the student

- Development of the virtual reality eye tracking tests through Unity.
- Laboratory and field eye tracking data collection involving human volunteers.
- Eye tracking signal processing and analysis.

Facilities and team:

Main lab location: ICICS Building, Room X015

Team: the undergraduate student will work with graduate students on this project, with direct guidance from Prof. Wu