# Abstract

One of the goals in the ophthalmic and vision sciences is to come up with new, easy and sensitive tools to screen for the presence of eye disorders. However, even the latest tools have certain shortcomings in some ophthalmic areas. In this thesis, I focus on two such areas: perimetry and 3D motion perception (3DMP). Even as standard automated perimetry (SAP) to chart the visual field is laborious, requires manual responding and cannot be employed in all patient groups, current clinical depth tests are static in nature and are not reflective of the perceived dynamic 3D world. Therefore, I use eye-tracking and virtual reality (VR) to develop new frameworks to address these issues.

First, I introduce the concept of using eye movements in a continuous tracking paradigm as a natural alternative to the traditional psychophysics used by SAP to screen for the presence of visual field defects. Previously through gaze-contingent simulations of scotomas, it has been shown that there is a direct relationship between visual field loss and the spatio-temporal properties (STP) of eye movements. Here, I show that these properties are altered in patients with glaucomatous and neuro-ophthalmological visual field defects in a specific and measurable way such that the paradigm can be used as a complementary approach to SAP for rapid screening. I find that these properties are stable across control cohorts of two ethnicities.

The thesis then turns towards the creation of a VR-based framework for portable screening of visual field defects. Here, I first illustrate the creation of the modified framework in VR with built-in eye tracking. Next, I describe the procedure to extract the STP of eye movements of two clinical groups - patients with glaucomatous and neuro-ophthalmic visual field defects and healthy controls in this VR setting. Subsequently, I compare the performance of the VR framework to that of the screen-based eye tracker setup in terms of separation of the clinical groups. I find that the two frameworks perform similarly even though the latter framework is considered to be research-grade. I also show that patients prefer this adapted VR version of the framework across all dimensions of user experience over the less portable screen-based eye tracker version and the standard SAP.

In the latter part of the thesis, I extend this framework to the detection and continuous evaluation of 3DMP in a VR environment with built-in eye tracking. I briefly describe how eye movements and their associated extra-retinal binocular cues can be used to measure 3DMP. Through experiments on visually healthy volunteers, I illustrate that the framework agrees well with prior retino-centric 3DMP studies. Lastly, I show that the measurement of 3DMP is reasonably robust in the presence of systematic and variable errors in the VR eye-tracking data.

In summary, these frameworks pave the way to not only create effective and intuitive screening tools for ophthalmologists and vision scientists but also advance our understanding of oculomotor behavior in relevant clinical and healthy populations.