Minimizing Motion Sickness Effects in Virtual Reality through Adapted Navigation Control Mechanisms

Keywords
Motion sickness, Virtual Reality, Visual Attention, Navigation Control, Locomotion, Human Behaviour

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Context
Navigation is a key component for any virtual reality application as it enables users to modify their viewpoint in order to explore, search or maneuver in the virtual environment **[Bowman17]**. In most VR systems, navigation is usually achieved through indirect navigation techniques. These techniques enable the control of the viewpoint through additional input devices (e.g. joystick). Although such techniques are efficient in nature, they are susceptible to generate motion sickness (a.k.a. VR sickness, cybersickness) which is a major undesired outcome in immersive virtual reality experiences [**Fernandes16**]. A number of studies have shown that the main cause is due to conflicting sensory information involving visual, vestibular and proprioceptive channels **[Stanney1998]**. In addition, potential factors that have been studied for motion sickness in virtual environments (cybersickness) are diverse, from task-related factors (e.g. navigation control, navigation speed or the visual display). Furthermore, motion sickness can appear at different grades and different exposure times according to users individual differences.

Objectives
The objective of this internship is two-fold, first, the creation of novel navigation techniques which better match the control mechanisms involved during human locomotion, and second, the use of visual optical flow analysis to assess them.

The feeling of being in control of the system (e.g. navigation) is known to have a positive impact on motion sickness symptoms [**Stanney1998**]. If the user has no control over the system (e.g. automatic navigation) unexpected conflicts (the user is not able to predict the motion) will occur between different sensory inputs. In this situation, the participant is more likely to experience motion sickness. Thus, we aim to investigate whether motion sickness can be reduced if we better match the control mechanisms involved during human locomotion. In particular, a hierarchical top-down control was shown in human locomotion: head anticipates the body reorientation in the horizontal plane [**Hicheur2007**, **Sreenivasa2008**]. The goal will be to integrate such top-down control mechanism in indirect navigation techniques.

In a second step, optical flow analysis [**Argelaguet2016**] will be introduced to assess the quality of the proposed navigation techniques. Optical flow analysis can be applied in order to assess vection (visually induced self-motion illusion) which is one of the major factors for cybersickness [**Hettinger1992**]. We also envision to introduce the optical flow analysis directly in the navigation control loop.

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