# Geometric deformation for reducing optic flow and cybersickness dose value in VR


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## Abstract

Virtual reality (VR) technologies are widespread and have found strong applications in multiple domains. However, the fear to experience motion sickness is still an important barrier for new VR users. Instead of moving physically, VR users experience virtual locomotion but their vestibular systems do not sense the self-motion that are visually induced by immersive displays. Previous solutions actively reduce user's field-of-view or limit their navigation. In this poster, we propose a less disruptive approach that temporarily deforms geometrically the virtual environment according to user navigation. Two deformation methods have been prototyped and tested. The first one reduces the perceived optic flow which is the main cause of the visually induced motion sickness. The second one encourages users to adopt smoother trajectories and reduce the cybersickness dose value (CSDV). Both methods have the potential to be applied generically.


## Scene deformation for reducing optic flow

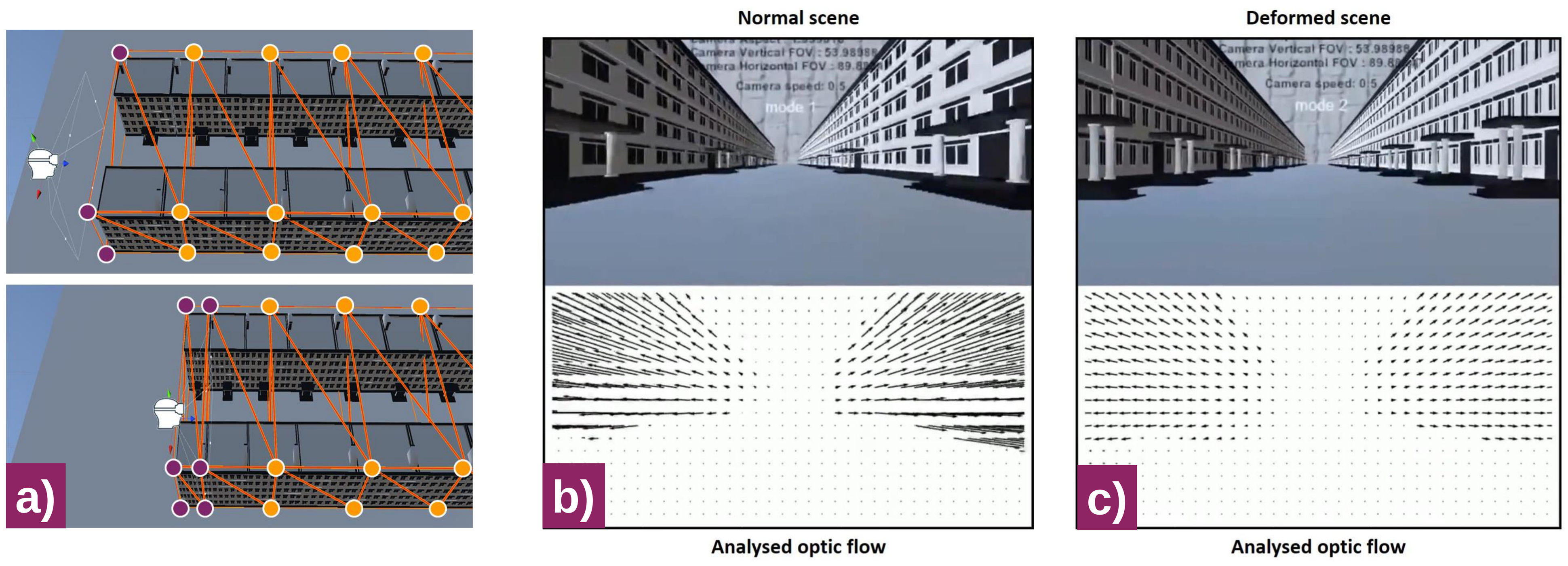

Figure 1:Scene deformation (a) and Optic flow comparison (b-c)

In order to reduce the visually induced self motion the virtual scene is deformed through a regular grid containing control points [SP86]. The control points seen in the peripheral field of view (FOV) (purple points) are moved in the navigation direction so that the building is deformed (fig1.a) [LC19]. The optic flow [JFR04] has been analyzed on the rendered images for both normal and deformed scene (fig1.b&c). Scene deformation can significantly reduce the peripheral optic flow in the visualized images ($p<0.001$, paired t-test) without changing the optic flow at central view.

## Scene deformation for reducing CSDV

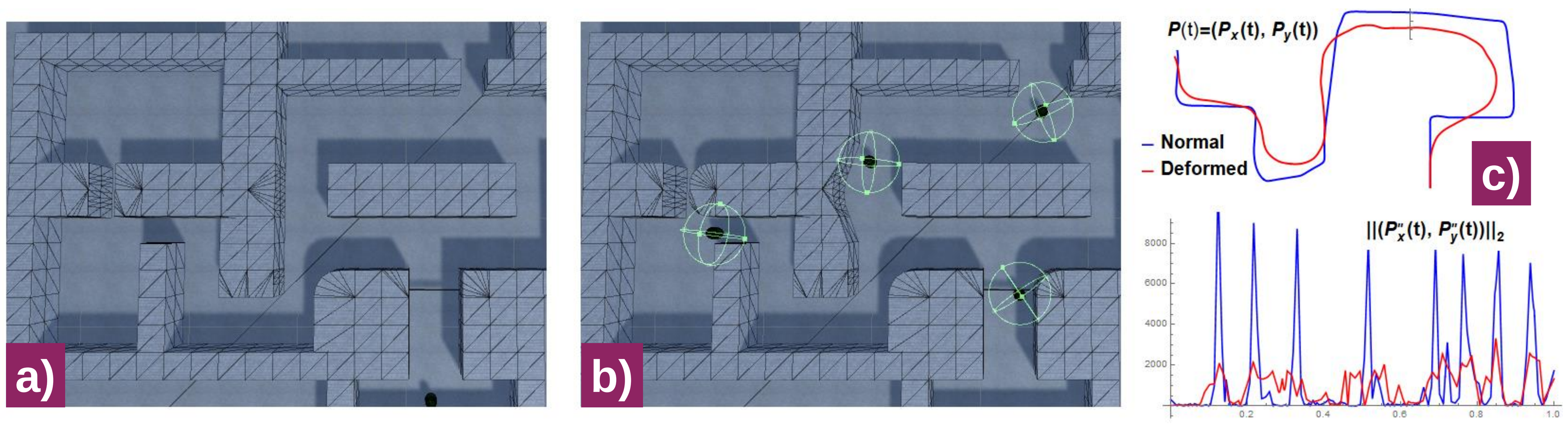

Figure 2: Initial scene (a), deformed scene (b) and navigation trajectories interpolation and second deviation (c)

In order to reduce the CSDV [So99] that is related to the acceleration and exposure time during navigation the virtual environment is deformed according to the location of the user. The initial experimental scene (fig2.a) has been deformed according to the user positon (fig2.b). Cubic polynomial curves are computed on experimented navigation trajectories and the second derivatives are used to compute the CSDV (fig2.c). The ratio of CSDV in deformed scene to normal scene is 0.49

## Conclusion

This poster reports the use of geometric deformation of the scene to reduce motion sickness in VR. Two deformation approaches have been implemented and analyzed. The first approach significantly reduces the optic flow perceived in the rendered images. The second approach encourages users to realize smoother navigation trajectories leading to 50% reduction in cybersickness dose value (CSDV). These investigations confirm the effectiveness of the geometric deformation on motion sickness in VR. In the future the first deformation approach will be updated to account for rotational movements. Both methods can be implemented in a generic way through a deformation engine. The challenge is to determine levels of deformation. Future work to upgrade CSDV to a predictive model for estimating the optimal deformation parameters are desirable.

## Bibliography


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