Using mobile eye tracking for gaze- and head-contigent vision simulations

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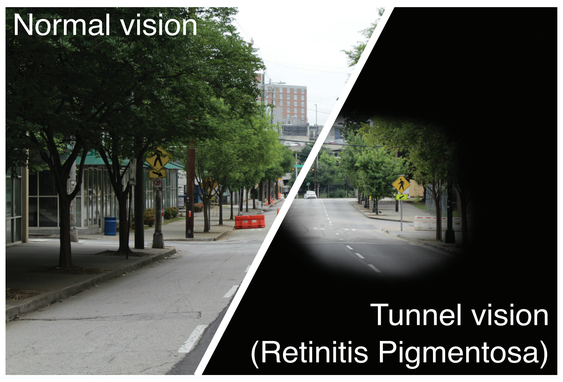
Purpose

How can we intuitively demonstrate the influence of visual impairments or retinal diseases on everyday life?

- Visualizations can give a basic understanding of visual impairments. However, single illustrations lack immersion.
- For students or patients and their relatives, an immersive, gaze-contingent demonstration could help with experiencing how visual impairments impact our perception.

Typical visualizations of visual impariements and eye pathologies



VR is a promising tool for vision simulations in research and demonstrations. However, in some situations VR headsets cause problems:

- Some individuals cannot use VR headsets or feel reluctant towards them.
- The user is isolated from the instructor or physician, which can cause insecurity.

Objective: Improvement of immersion and accessibility of visual demonstrators

Methods

Mobile eye tracking

PupilLabs Core is used for head and gaze tracking for a screen-based vision simulation running in Unity.

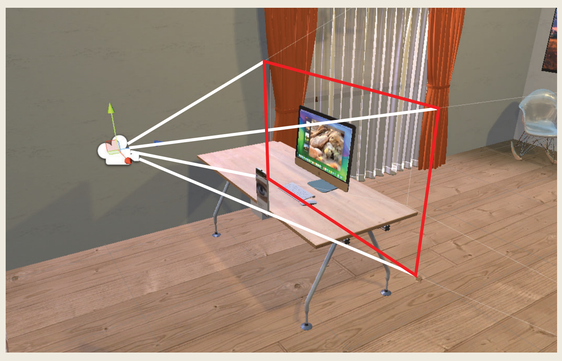
Fiducial markers are used to
- map gaze on the screen
- estimate head position

Head tracking

Head pose relative to the screen is estimated from the fiducial marker position in the eye tracker's scene camera.

Tracking quality could be improved using IMU or external trackers.

Off-axis projection



The camera position in the virtual world is updated in Unity by accessing the head position via PupilLabs network API.

The projection properties are adjusted for an off-axis projection, which simulates the view "through a window" into the virtual world.

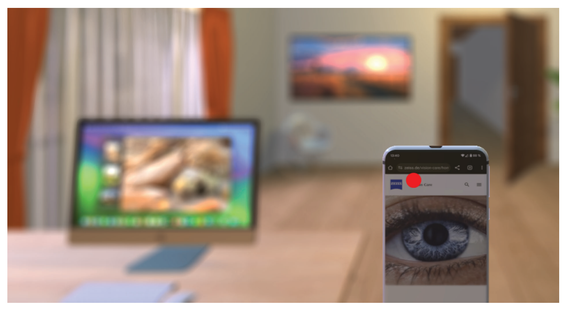
Gaze-contigent simulation

PupilLabs surface mapping is used to map gaze to the screen surface. In Unity, the gaze position is accessed via network API.

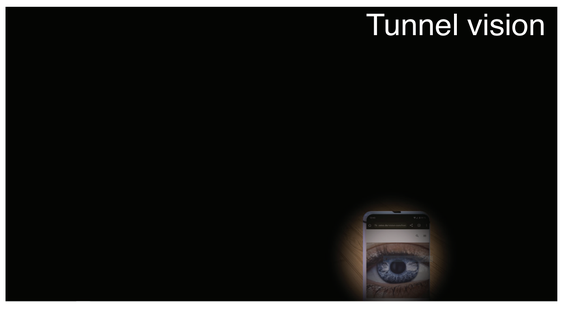
Screen coordinates are transformed to calculate 3D gaze direction in the virtual scene.

Results and Discussion

Simulation of gaze-contingent blur for demonstrating refractive errors



Simulation of central and peripheral visual field defects



Video demo:

Advantages of off-axis projection and gaze surface mapping for vision simulations:

- No complex VR or dome setup is necessary.
- Better suited for teaching or presenting to groups.
- User is not isolated but can still interact with the instructor.
- Existing VR gaze training could be more accessible for individuals who cannot use VR headsets.

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