FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Evaluation of the Recognition Distances of Safety Signs in VR Considering Vision Impairments

Masterstudium:
Visual Computing

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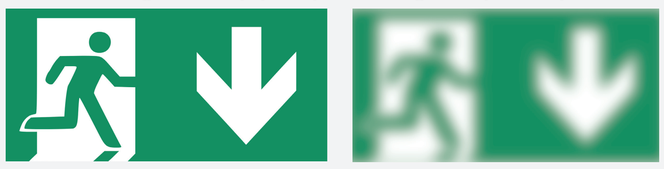
Motivation

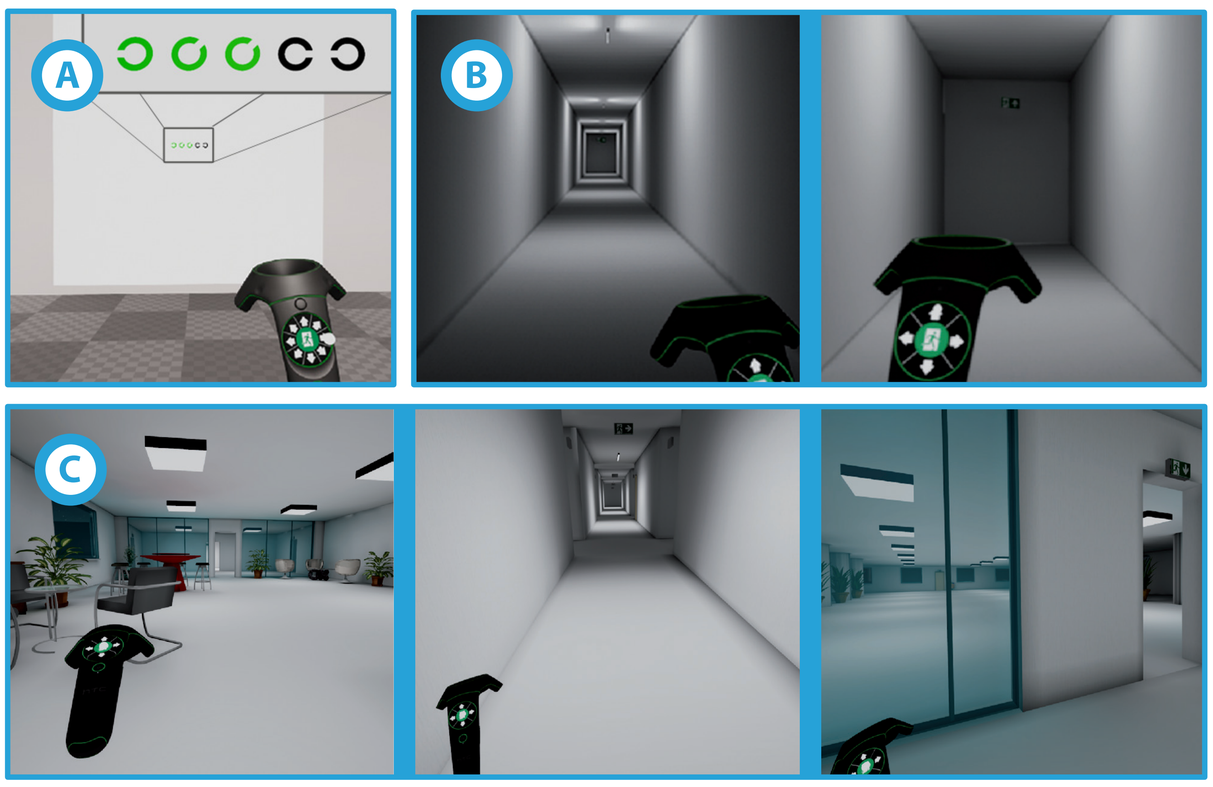
Escape route safety signs are positioned by a lighting designer. The safety signs need to be legible along the whole escape route. There are standards that specify how to achieve this. However, these specifications do not provide considerations concerning people suffering from vision impairments.
In particular, persons that are at high risk to suffer from vision impairments, such as elderly people in retirement homes, require a guidance system that takes these factors into account. Age-related eye diseases are a main cause of vision impairment for elderly people, with the most common symptom being the loss of visual acuity.

Problem Statement

To evaluate existing standards concerning vision impairments, the influence of visual acuity on the ability to recognize safety signs has to be evaluated. A user study to determine this influence is difficult to carry out in the real world as visual acuity is seldom experienced as an isolated symptom and finding an appropriate group of participants is thus difficult.



A safety sign (ISO 7010) and the impairing effect of reduced visual acuity.



Simulation of Vision Impairments

We simulate the effect of reduced visual acuity in VR. This simulation serves as the basis for our user study on the influence of visual acuity on the maximum recognition distances (MRDs) of safety signs.

(A) Using our new methodology, we conducted a user study with participants calibrated to the same level of visual acuity. This is achieved by using test subjects with normal or corrected vision and simulating the impairment in VR. We calibrate the visual acuity via a standardized medical test (ISO 8596) per user in VR.

(B) In a first experiment, participants have to approach the sign and report the sign's direction as soon as they think they can recognize it correctly. The distance for correct inputs is recorded and serves as basis for the determination of the MRD.

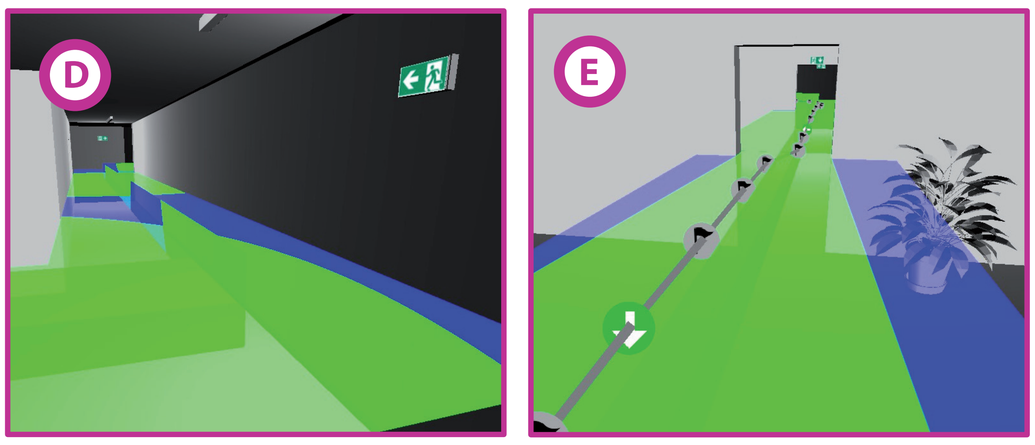
(C) In a second experiment, participants freely navigate through a building and have to find an emergency exit, while again reporting recognition distances for signs along the escape route.

Design Evaluation Tool

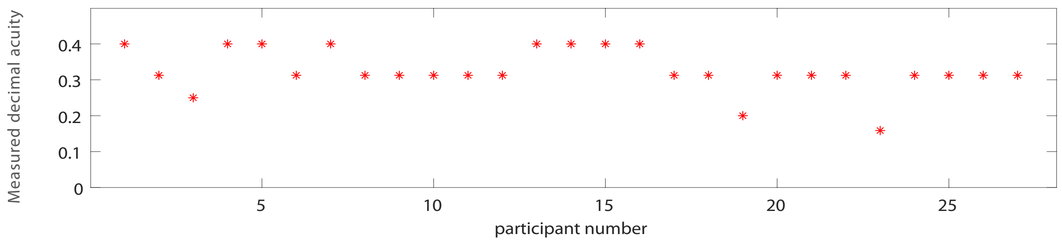
We provide lighting designers with a tool to check their designs considering MRDs to investigate problematic areas along an escape route.

(D) We adapt the shadow-mapping algorithm to the computation of the visible area inside a safety sign's MRD. The signs' visibility and MRDs are visualized parallel to the building's floor map and along the escape route.

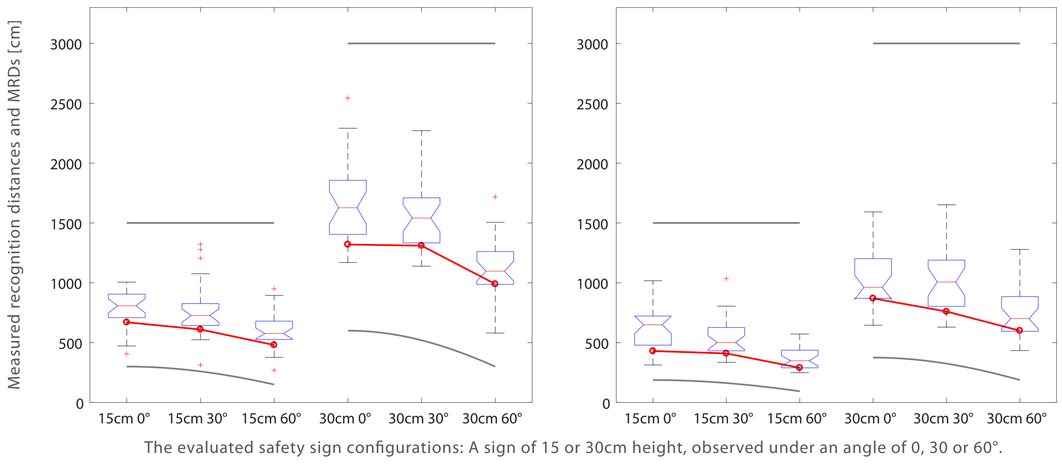
(E) Our design evaluation tool enables the visualization of our user study data, i.e. a participant's path and the positions from which the signs were recognized.



(F)



(G) **Recognition distances and MRDs for 0.2 decimal acuity (left) & 0.125 decimal acuity (right)**
The gray lines show the MRDs suggested by the standards EN 1838 (top) & ISO 3864-1 (bottom).



The evaluated safety sign configurations: A sign of 15 or 30cm height, observed under an angle of 0, 30 or 60°.

Results and Conclusion

This thesis provides a more realistic simulation of the reduction of visual acuity than previously achieved by calibrating the severity of this symptom in VR. The experienced visual acuity can be calibrated to any acuity value and accounts for the user's actual visual acuity.

(F) Using our novel methodology, we determined the impact of the HTC Vive's HMD on the visual acuity achievable in VR. None of the participants could achieve a visual acuity better than 0.4 decimal acuity. This corresponds to a considerable vision impairment.

(G) We determined the recognition distances for safety signs, observed under two different levels of visual acuity.

We conclude that the existing standards fail to correctly estimate the MRDs that result from the recognition distances we determined: EN 1838 overestimates the MRDs, which results in an incomplete coverage of the escape route. ISO 3864-1 underestimates the MRDs, requiring more safety signs and thus increasing costs.

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