Looking at 3D User Interfaces

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Abstract
In this position paper for the ACM CHI 2012 Workshop on "*The 3rd Dimension of CHI (3DCHI): Touching and Designing 3D User Interfaces*", we describe our vision on how the interaction with virtual 3D interfaces may benefit from integrating gaze input. On the one hand, 3D UIs can profit by diagnostic eye tracking studies on how users perceive presented content. On the other hand, the consideration of a user's gaze as a supporting input channel may provide a more immersed and natural user experience with virtual 3D environments.

Author Keywords
3D interaction; gaze-supported interaction; perceptual user interfaces

Introduction and Background
Our eye vision represents an important channel for perceiving our environment. In addition, our gaze direction can convey what we currently attend to, for example, looking at somebody while addressing this person in a conversation. Using our eyes for interacting with digital systems is particularly appealing, because gaze provides a fast and natural input channel also for virtual three-dimensional (3D) environments [3, 4, 16]. However, until now research on gaze-based interaction has mainly focused on traditional desktop settings often trying to substitute mouse input via gaze (e.g., [10]).

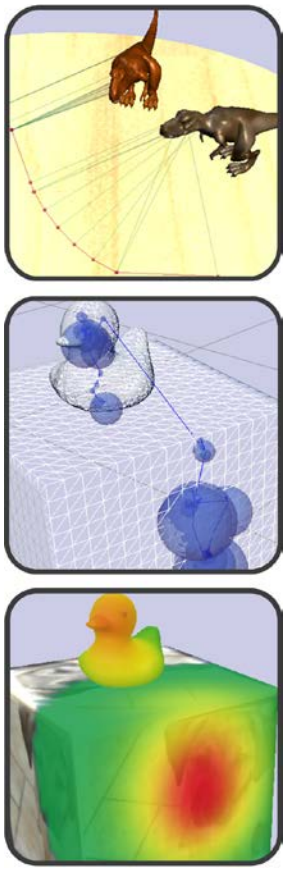

Figure 1. Advanced gaze visualizations for virtual 3D environments [14, 15] based on common scanpath and heatmap representations.

There is an increasing importance of 3D virtual environments (VEs), because they are used in various application areas, such as 3D gaming, virtual interactive training, scientific 3D visualizations, as well as social networking environments (e.g., Second Life). Nevertheless, using eye tracking for such applications is still rather limited.

The contribution of eye tracking to enhance 3D UIs is two-fold. On the one hand, diagnostic eye tracking studies investigating how virtual 3D scenes are visually perceived by users can help in advancing existing 3D UIs. In this respect, enhanced techniques for interactive visual gaze analysis for 3D VEs were presented by Stellmach et al. [14, 15] (cf. Figure 1). On the other hand, there is a high potential for directly using gaze to interact with 3D VEs. So far, the development of gaze-based interaction techniques has been hindered by a lack of low-cost, reliable, and convenient eye trackers. However, eye tracking devices become more and more affordable, because video-based systems only require (near-) infrared light sources and cameras. In addition, the systems develop into more lightweight and more comfortable setups (e.g., [1, 8]). This provides a great potential for the integration of gaze input in a professional or even everyday application context.

Considering this trend towards more ubiquitous eye tracking systems, we assume that gaze can be incorporated for the interaction in various user contexts in the near future (e.g., [2]). Especially the role of a user's gaze in *supporting* other input modalities shows a particular high potential based on our previous research (e.g., see [11, 13]). As for example depicted in Figure 2, a combination of gaze input with a

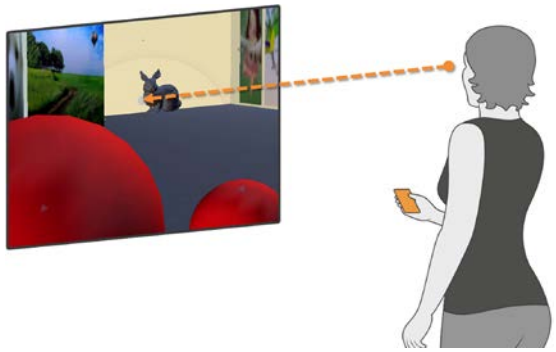

Figure 2. Visionary application of gaze-supported steering and selection in virtual 3D environments (e.g., [12, 13]).

handheld to interact with virtual 3D scenes shown on a distant display may provide a natural and yet efficient interaction. However, in contrast to *gaze-only* input (e.g., [6, 7, 10]), gaze-supported interaction has not been thoroughly investigated up to now. To motivate further research in this emerging field, we describe several application areas for gaze-supported interaction with 3D UIs in the following.

Designing the Future

Virtual 3D models are employed in various application areas nowadays, for example, product design and automotive industry. The developed models are usually discussed in the course of different design phases. In this context, collaborators may benefit from attentive displays (see e.g., [17]). For example, visualizing a conversational partner's gaze position may provide others with context information about what this person is currently talking about and may reduce misunderstandings. Furthermore, information about a user's visual attention can also be used for more

natural depth-of-field visualizations especially with respect to stereoscopic displays [5].

Play the Game

Considering a user's eye or head direction can lead to a more natural exploration of virtual 3D scenes. Players of digital games are a large user group for which gaze-directed steering may allow a more immersed user experience [9]. In this context, Istance et al. [7] describe different approaches for steering with the eyes, for example, in *World of Warcraft*. More advanced gaze-based steering UIs are described by Stellmach and Dachselt [12] indicating the potential for efficient and yet user-friendly steering using the eyes. Furthermore, a more natural avatar behavior could be achieved in games by indicating what a player currently looks at. Other fundamental 3D interaction tasks, such as object selection and manipulation, can also benefit from gaze input (see e.g., [13]).

Touch away

Various scientific 3D visualizations, such as geological or medical data, can also benefit from additional gaze input. For the exploration of such extensive 3D visualizations, large-sized distant displays are often used. To explore virtual 3D environments on a distant display in a natural and yet efficient way, a combination of remote touch input on a handheld device with information about a user's visual attention has proved beneficial (see e.g., [11, 13]). Thereby, gaze suggests and touch confirms. Further considerations may include gaze-adapted depth-of-field and focus-and-context techniques. Additional investigations are required on other suitable input and output combinations that can benefit from gaze input.

Conclusion

To summarize, 3D user interfaces can greatly benefit from a better integration of a user's visual attention. A more natural perception-based interaction with virtual 3D contexts may enhance the user experience and may even improve task efficiency under certain conditions. We put a particular high interest in the role of our gaze as a supporting input modality in concert with other interaction modalities. To unleash the full potential of gaze-supported interaction for 3D UIs, further investigations of suitable input and output combinations, target groups, and application contexts are required.

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