Real Time Mesh Editing with Virtual Tools in an Immersive Virtual Environment

Benedikt Reschberger
Ludwig Maximilian University of Munich
reschberger@cip.ifi.lmu.de

Wolfgang Höhl
Ludwig Maximilian University of Munich
hoehl@cip.ifi.lmu.de

ABSTRACT

In this work interactions with virtual tools in an immersive virtual environment are designed and implemented. Of particular interest are the effects of different interactions on the usability and the question how affordance and fidelity of a virtual object are connected. For this purpose the application "CarpentryVR" was developed, in which the user is able to work with virtual wood by using different tools (measure tape, pencil, saw, glue, hammer, and nails). In this way users are able to create their own virtual objects.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; *Activity centered design*; • **Computing methodologies** → *Mesh models*;

KEYWORDS

Virtual reality; Immsersive Virtual Reality; Interaction; Affordance; Mesh Manipulation in Virtual Reality

1 PROBLEM PRESENTATION

In digital, virtual environments interactions are often designed like their real world, analog counterparts. Complex interactions, including multiple levels or being performed over a longer period of time, quickly impose vast challenges, in terms of development and usability. A realistic modeling of interactions is as costly to compute as it is to implement. However, exactly this degree of realism is crucial for the user to understand an interaction offered by a tool or object and directly affects the effectiveness the user can gain with a virtual tool. Furthermore, objects that behave differently than expected can lead to a decrease in immersion and presence for the user.

Past work mainly focuses either on different kinds of input forms for immersive virtual environment or general interaction types, like selection or basic object operations. McMahan et al. have shown how different levels of fidelity for display and input affect user performance in a virtual reality game. [McMahan et al. 2012]

Bowman et al. define three general groups of interactions: movement, selection, and manipulation of objects. Building on this idea formalized test methods are developed to evaluate the effectiveness of single interaction techniques and creating a taxonomy of interaction techniques in immersive virtual environments. [Bowman and Hodges 1999]

In comparison little attention has been directed onto complex interactions with virtual tools processing other virtual objects in realtime. Furthermore, no research which is known to us examines the connection between an object affordance and the interaction fidelity of the object. However, the issue was identified and addressed by Blom in 2010. [Blom 2010]

2 RESEARCH METHOD

Based on the proof-of-concept simulation "CarpentryVR" a user study with 12 participants has been conducted. The users were given the task to cut wood with four saws, corresponding to four different interaction types. The interaction types are composed of two important interaction properties. First, the corresponding fidelity of the interaction: the specific motion the user has to perform to achieve a certain corresponding action of the virtual tool. And second, the available freedom in interaction space, where the user is able to perform the interaction. Crucial factors of interactions with virtual tools are to be identified. What happens if the interaction with an objects is different from what the user expects? Should interactions with virtual tools be designed as realistic as possible and what repercussions on the user experience are to be expected when the degree of realism of such interactions is reduced?

3 SOLUTION AND RESULTS

We present the retrieved results, which indicate, that a high degree of realism is not necessary for a good user experience. Often, high fidelity interactions can be simplified to achieve greater performance with an almost equal user satisfaction. Furthermore, we observed a negative impact on the user experience by a constrained interaction space. Our data shows a negative correlation between degree of realism of an interaction and variance in the user experience, indicating that non-realistic interactions should be further explained to the user.

Comprehensive research in this area is vital for making virtual reality available to an extended audience. In particular the affordance and user expectations in immersive virtual environments are important aspects of future research. The technology is still new for many users and further improvements in terms of acceptance, intuition and presence need to be achieved for the eventual success of immersive virtual environments.

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