Chapter 3
Developing 3D Freehand Gesture-Based Interaction Methods for Virtual Walkthroughs: Using an Iterative Approach

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ABSTRACT
Gesture-based 3D interaction has been considered a relevant research topic as it has a natural application in several scenarios. Yet, it presents several challenges due to its novelty and consequential lack of systematic development methodologies, as well as to inherent usability related problems. Moreover, it is not always obvious which are the most adequate and intuitive gestures, and users may use a variety of different gestures to perform similar actions. This chapter describes how spatial freehand gesture based navigation methods were developed to be used in virtual walkthroughs meant to be experienced in large displays using a depth sensor for gesture tracking. Several iterations of design, implementation, user tests, and controlled experiments performed as formative and summative evaluation to improve, validate, and compare the methods are presented and discussed.

INTRODUCTION
Gesture-based 3D interaction has been considered a challenging and relevant research topic due to its natural application to gaming, Virtual and Augmented Reality applications (Ni, 2011; Hürst et al., 2013; Billinghurst et al., 2014), and in other scenarios (Garber, 2013), as well as to the prospective alternatives.

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it has brought to the interactivity with the ever more pervasive public large displays (Bowman, 2014). However, this interaction paradigm presents several usability challenges, as the lack of feedback, and problems related to fatigue. Moreover, which are the “best” gestures are not always obvious, and users may use a variety of gestures to perform similar actions (Wobbrock et al., 2009). On the other hand, the relative novelty of these methods results in a lack of systematic methodologies to develop this type of interaction.

We have been developing an interactive system, located at the entrance hall of our Department, including a large public display and a depth sensor, meant to run applications that might support various Department activities, such as providing relevant information to passersby, or experiencing demos and walkthroughs for visitors (Dias et al., 2014). In this scope we have been developing several 3D spatial freehand gesture-based interaction methods envisaging an application in virtual walkthroughs following a user-centered iterative approach. This approach allowed a progressive refinement of the interaction methods based on several rounds of design, implementation and tests with users. According to our experience, performing more than one round of user tests is fundamental as these tests allow the development team better understand the strengths and limitations of both the methods, and also the experimental protocol of the tests in their current versions. Much of this insight is obtained based on observation and feedback from participants. Furthermore, participants often bring a fresh view suggesting improvements that might not occur to the team.

In this chapter we present a brief review concerning the topic of gesture-based 3D interaction.

We focus mainly on the type of gestures used, and describe how we developed and evaluated navigation methods, based on a depth sensor (Kinect) for spatial freehand gesture tracking, to be used in virtual walkthroughs. The results of several rounds of user tests and controlled experiments performed as formative and summative evaluation to improve, validate and compare the methods are presented and discussed, and conclusions are drawn.

BACKGROUND

The use of gestures in human-computer interaction can be traced back to Sketchpad, developed in the sixties by Ivan Sutherland, as it used an early form of stroke-based gestures using a light pen on a display. After this first attempt, gestures have gained popularity as a means of realizing novel interaction methods, and several devices have been developed to support this possibility. Namely, manipulating virtual objects using natural hand gestures in virtual environments was made possible in the eighties through instrumented gloves (Fisher et al., 1986). In the nineties, a vision-based system (Freeman & Weissman, 1995) demonstrated a viable solution for more natural device-free gestural interfaces, and later other approaches have been used, as for instance the ones described in Boussemart et al. (2004), Malik et al. (2005), Karam (2006), and Wachs et al (2011); yet, only the recent advent of affordable depth cameras truly gave an essential momentum to the spatial freehand paradigm of gesture-based user interfaces.

Besides eliminating the need for an input device, spatial freehand gestures have several advantages as an interaction method: they are natural to humans who constantly use them to communicate and control objects in the real world from infancy, and may underpin powerful interactions due to hands’ multiple degrees of freedom, promising ease of access and naturalness also due to the absence of constrains imposed by wearable devices (Wachs et al., 2011; Ni, 2011, Ren et al. 2013b; Jankowski & Hachet, 2015).