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Hand Navigator: Experimenting hand navigation in desktop virtual reality

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Abstract

This demonstration provides experimentation on several versions of the Hand Navigator, a peripheral device allowing to control a virtual hand with fine dexterity. Our devices, as easy to hold and to release as a mouse, integrate various small sensors enabling the simultaneous control of a large number of degrees of freedom. Our demonstration invites users to experience new ways of interaction with virtual environments through relevant examples of manipulation tasks such as playing with deformable objects.

Categories and Subject Descriptors (according to ACM CCS): B.4.2 [Input/Output and Data Communications]: Input/Output Devices—Channels and controllers

1. Introduction

Manipulating virtual objects with our hands is a great challenge for the virtual reality community. Several solutions have been proposed, such as data gloves or vision capture systems. Their main drawbacks are: (i) they need a calibration, which is generally time-consuming, (ii) they do not integrate tactile feedback.

One solution for the second point is to implement systems with haptics perception (also referred as active feedback). However, the complexity of the system and its cost increase.

Another solution is to implement passive feedback using a proxy (e.g. a sponge) to fool the proprioceptive senses of the user [LCK*00]. This solution is cheap with an improvement compared to the device without feedback [Ins01].

Our solution relies on passive feedback to provide a device especially fitted to hands-on interaction.

2. Objectives

Our goal is to develop a device that allows a user to control a virtual hand in a virtual space with his real hand, using a large number of degrees of freedom to achieve fine dexterity motions, while sensing passive feedback. Our device should also be cheap, calibration free and ready to use.

We also want to address ergonomics issues on the device to allow complex movements without generating tiredness for the user. Well chosen sensors must be integrated on the device to achieve a good control of the virtual fingers.

Finally, to integrate our device easily in various applications, a good interface must be implemented, with a well modeled hand and interactions for visual feedback.

3. Existing version and related issues

A first version of the Hand Navigator, called V2, has been described in [KPBC08] and patented. The motion of the virtual hand was controlled using a SpaceNavigator (`http://www.3dconnexion.com`), enhanced with petals and two force sensors for each finger to get passive feedback (see figure 1). This device was cheap and very easy to integrate in a desktop environment. It was however difficult to use and raised two main issues: (i) ergonomics of the physical device and (ii) realization of tasks.

3.1. Ergonomics of the physical device

With the V2 prototype, the user faced tiredness as he had to put his hand in an uncomfortable posture. Other issues included a bad interaction of the sensors with the user's nails, a bad force distribution on the device and the presence of a threshold in the force sensors, leading to an interference

Figure 1: *From left to right: the V2 prototype with petals and force sensors, the V3c prototype with trackballs and the V3b prototype with a touchpad and trackballs.*

between the force the user applies to move the fingers and the one the user applies on the SpaceNavigator to move the hand. Thus, the shape of the device and sensor's technologies, especially their mechanical properties, are important elements to be considered.

3.2. Realization of tasks

To achieve fine dexterity, specific controls must be implemented that can be velocity-based or position-based. Velocity control was implemented for the V2 prototype, as a task can then be interrupted and re-started anytime. However, there was no limitation on the virtual hand and the virtual camera was not fixed in the virtual hand's frame, thus the user quickly lost the position reference between the virtual and the real hands. Visual feedback and types of control are thus important elements to improve.

4. Designing new devices

Several prototypes were designed considering the issues described above. We conducted a deep analysis of different sensors technologies. Many different types of sensors were tested with different types of control. We succeeded in integrating various sensors in our devices. In this demonstration, we show two prototypes called respectively V3c and V3b (see figure 1). These two prototypes are coupled with the SpaceNavigator. The V3c integrates a touchpad for the fingers and a trackball for the thumb, whereas the V3b integrates only trackballs. These devices do not require large forces that could interfere with the motion of the hand.

In order to improve dexterity in manipulation tasks, we analysed different possible shapes for the devices, leading to a mouse-shaped design. This shape allows modularity with different types of sensors, and an easy integration in different applications.

We also implemented a C++ API, allowing a user to quickly interface the Hand Navigator with any application.

5. Demonstration

We propose in our demonstration to perform several manipulation tasks using the Hand Navigator. Users are invited to experience new ways of interaction with virtual worlds, through manipulations of deformable objects such as playing with gum animals or making virtual sculpture with clay (see figure 2). Users will sense passive feedback when contacting objects, allowing them to achieve complex manipulation tasks with fine dexterity.

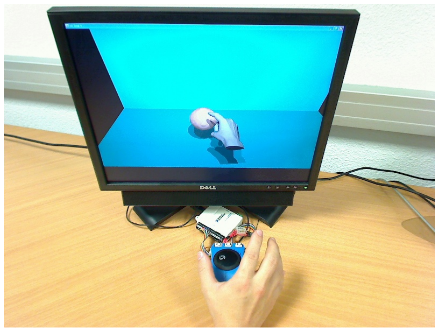

Figure 2: *Virtual sculpture using the V3c prototype.*

6. Extensions

We expect our device to be used in several applications, such as physical simulations, interactive shape manipulation and telemanipulation. In physical simulations, our device could increase the sensation of immersion in virtual worlds. Shape modeling could be made very naturally thanks to hands-on interaction. Lastly, handicaped persons could use our device to control a robotic arm helping them to grasp an object.

References

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