Tablet interface for 3D interaction

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Introduction

Virtual Reality (VR) platforms worldwide use a variety of interfaces, without uniformity. In general, these interfaces (hardware and software) are specific to a given platform. This lack of any given standard limits the interoperability between platforms.

Various visualization systems

Today, one can find a vast number of metaphors and peripherals for 6 dof manipulations of objects within a virtual environment (e.g. data gloves, wands, haptic devices). However, most of these are designed for a given application and/or VR system.

Classical interaction devices

Quite a number of studies have already investigated the use of tactile surfaces for 3D objects manipulation. Most of the time, manipulation is done via a tactile surface that is simultaneously The display screen. Other solutions have already been tested, in which the graphics rendering is spatially dissociated from the control interface itself. However, those interfaces are always fixed in space.

Our tentative solution take this concept one step further, since the control interface can be freely oriented in 3D space and geometrically connected to the manipulated object.

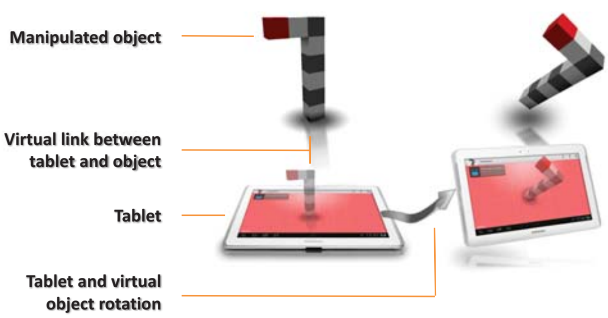
Development framework

We focused on the usage of a Samsung Galaxy tab 7.0 plus® under Android® 3.2 operating system. This tablet offers a 7 inches screen and is suitable for prolonged use, weighing less than 350 g. A smartphone interface is currently in test). For the visualization part, we used the Unity 3D® 4.0 graphics engine. This interaction is meant to be possible in any VR system, from a simple screen on a laptop computer to a complete multi-surface immersive system.

Methodology

> Rotations

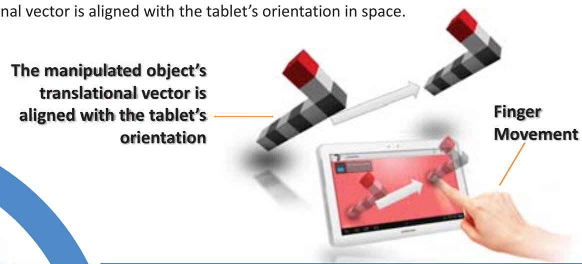
In order to enable the user to orient the manipulated object, we made use of the tablet's integrated orientation captors. The tablet's 3D orientation is then directly applied to the object's orientation, using the "virtual hand" metaphor, with a 1:1 correspondence. This method favors intuitive manipulation of the object. At any moment, the user can activate and de-activate the connection between the tablet's orientation and the manipulated object's rotations by double-tapping on the tablet.



Methodology

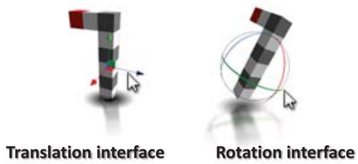
> Translations

As concerns translations, we did not want to use a tracking system (for compatibility between VR systems). As a consequence, we could not determine the current 3D position of the tablet. We circumvented this problem by developing a metaphor based on the displacement of the users' finger on the tablet surface. The manipulated object's translational vector is aligned with the tablet's orientation in space.



Experimental study

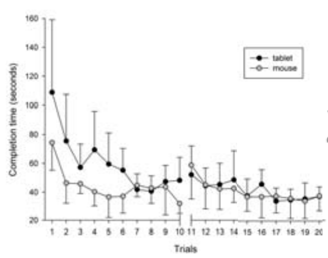
We present the results of a pilot "docking" experimental study, in which we compared the performance of participants when using the tablet interface, as compared to a classical mouse interface.



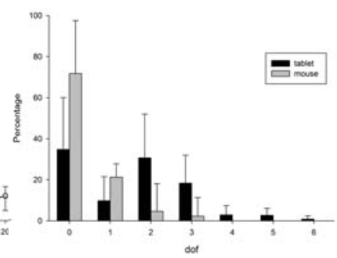
Participants used the tablet and the mouse interface successively, in a balanced order. For each interface, they successively realized 10 trials with a first configuration then 10 trials with a different configuration (to test for transfer effects of learning)

We measured completion time (the time required to have the manipulated objet in coincidence with the target object. We also computed an instantaneous indicator of the number of degrees of freedom (dof) used by the participants. As a primary indicator, we computed, for each trial, the percentage of time spent using between 0 (no displacement) and 6 degrees of freedom (dof).

Completion time



Coordinated degrees of freedom



Statistical analysis (ANOVA) revealed a clear learning effect, comparable between interfaces. The main difference was that, between trials 10 and 11 (change of configuration), **completion time significantly rose with the mouse interface, which was not the case with the tablet interface**. This result suggests that transfer of learning occured with the tablet, more than with the mouse.

For the 7 dof presented, differences were significant (for the first 4 dofs) between the tablet and the mouse. With the tablet, participants spent less time motionless (0 dof), less time manipulating one dof, more time manipulating 2 and 3 dofs, as compared to the mouse interface.

Conclusion

These results suggest that the tablet interface has real potentials for3D manipulation. Moreover, we observed trials in which participants used 4 to 6 degrees of freedom meaning that they were able to rotate and displace the manipulated object simultaneously. This was impossible anyway with the mouse, since rotational and translational movements were dissociated on the interface. Further analyses are required, to understand more precisely the coordinated use of multiple degrees of freedom, when using a tablet interface.

Acknowledgements

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