6DOF Input Device Usability Test in a CAD Task

Martin Sundin, Josef Weiss
IWF, IHA
Swiss Federal Institute of Technology Zürich
Tannenstrasse 3
CH-8092 Zürich
Switzerland
+41 1 632 24 14
sundin@iwf.bepr.ethz.ch

Gunilla Sundin
KTH, Royal Institute of Technology
College of Engineering
Fiskartorpsv 15A
S-100 44 Stockholm
Sweden
+46 8 790 95 45
gsn@admin.kth.se

ABSTRACT

A usability test was performed with two six degrees of freedom (6DOF) desktop input devices in a CAD assembly task: one elastic position control device and one stiff elastic velocity control device. Position control was preferred by the subjects for precise adjustments of the viewpoint, for rotations and zooming. Velocity control was preferred especially for long virtual object translations.

Keywords

6DOF input device, computer aided design, input device control order

INTRODUCTION

The use of 3D computer visualisation have increased with the explosive development of computer graphics. Wide spread applications include *computer aided design* (*CAD*), *computer graphics art tools*, and *scientific data visualisation.* These applications generate a need for 3D human computer interaction and accordingly a number of 3D input devices have been developed. Zhai [5] compared an elastic input device with an isometric input device, both in velocity control mode. He concluded that the elastic controller was better in terms of completion time and learning for a docking task. In recent years there has been an increased use of 6DOF input devices in CAD following the trend from 2D- to 3D-tools in engineering. The 6DOF device is typically used by the non dominant hand for non precision tasks as a complement to keyboard and mouse. It allows the user to turn, pan, and zoom the virtual model, which enhances the 3D understanding and helps controlling the optimal viewpoint. In our usability test an assembly task supported by mathematical constraints was performed with two different 6DOF devices: SpaceBall [1], a stiff elastic input device, and SpaceCat [2][3], an elastic input device. The SpaceBall workspace is limited to approximately ±3mm, in which case the velocity control is preferable [5]. SpaceCat allows for a work space of approximately ±10mm, which is sufficient to provide position control. The test was performed with experienced SpaceBall users to find out whether the introduction of a new input device would significantly change the task solving time.

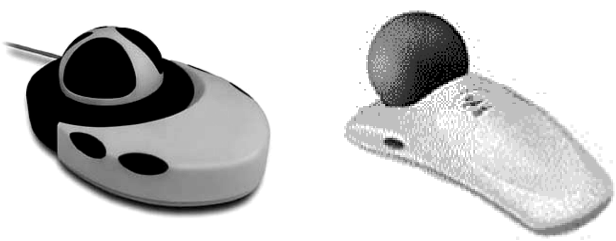

Figure 1: *SpaceCat and SpaceBall 3003 FLX*

THE USABILITY TEST

A video recorded experiment was performed with SpaceCat and SpaceBall 3003 FLX [4]. The experiment was performed on a Digital Alpha-Station 400-MHz under Unix 4.0A with the Unigraphics CAD system Version 13. The SpaceBall was connected to the CAD-system through the preinstalled plug-in whereas the SpaceCat used a new plug-in especially developed for the usability test. The experiments were recorded on video with two cameras according to figure 2.

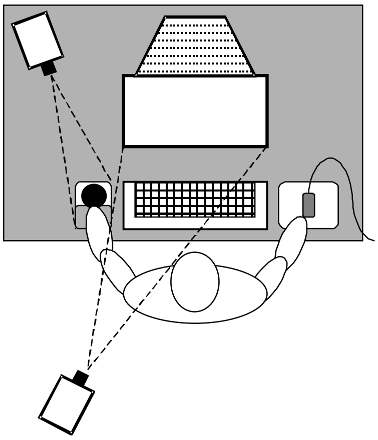

Figure 2: *Experiment set-up*

12 men (average and standard deviation age was 27 ± 6 years, 3 were left handed and 9 were right handed) who all had at least half a year experience with the SpaceBall performed an assembly task supported by mathematical constraints, i.e. the 6DOF input device was used simply to change the viewpoint, making it possible to select the surfaces to be connected with the conventional mouse. This specific CAD task was chosen because it contains a comparatively high amount of 6DOF interaction. Thus no precision work was performed with the 6DOF input device, which was handled with the subjects' non dominant hand. All subjects were aquatinted with this specific task. The subjects were told to keep their normal work pace and that the execution time had no importance in the test. The participating subjects always began with velocity control and then repeated the task with position control. The experiment was assessed on the following criteria: task solving time, spoken comments, and the number and kind of unintended manipulations.

RESULTS

The recordings of seven subjects could not be used for time measuring purposes because they fundamentally changed their strategy on how to solve the problem. Unigraphics allows functions to be entered via mouse or keyboard and furthermore allows different kinds of object representation. The five subjects sticking to the same strategy needed 179s ± 34s with velocity control and 161s ± 16s with position control to solve the task, i.e. no significant differences in terms of completion time were measured. No unwanted manipulations were registered in position or velocity control mode. According to all subjects, position control was easy to learn, reliable and intuitive. Furthermore, when zooming on details the image was easier to maintain with position control. Generally the subjects thought rotations were better handled using position control whereas the translations were better handled using velocity control, especially long virtual object translations which demanded a range of clutching actions in position control mode.

CONCLUSION

The control order or the kind of input device does not play a major role when solving a CAD assembly task supported by mathematical constraints. The users could quickly learn the new position control input device sufficiently for this task. The comments of the subjects reveal major differences however. Position control has its strength in precise control of an object whereas velocity control is good for long object translations. An optimal 6DOF input device should accordingly be capable of both position and velocity control. To achieve this SpaceCat is the better candidate: due to its' greater workspace it is applicable to both velocity- and position control. In future research the combination of position and velocity control will be investigated. Furthermore a comparison between the devices is planned in a precision task.

REFERENCES

1. www.labtec.com
2. www.smart-device.com
3. Sundin, M. (1999) Produktentwicklung am Beispiel „Virtual Gripper". *Optimierung der Produkt- und Processentwicklung.* Zürich: VDF-Verlag
4. Weiss, J. (1999) *Feinmotorische Koordination von Hand und Fingerbewegungen bei der manuellen Mensch-Computer Interaktion.* PhD thesis, Swiss Federal Institute of Technology Zürich
5. Zhai, S. (1995) *Human Performance in Six Degree of Freedom Input Control* PhD thesis, University of Toronto