Design of an Evaluation Study for 3D Input Devices

Tobias Nowack[1], Peter Kurtz[1], Stefan Lutherdt[2], Torsten Gramsch[1], Martin Gerlach[1], Gunnar Sievers[1], Beate Schlütter[1]

Technische Universität Ilmenau, Faculty of Mechanical Engineering
[1]Department of Ergonomics,
[2]Department of Biomechatronics
Max-Planck-Ring 12, D-98693 Ilmenau
+ 49 3677 69 2460, + 49 3677 69 1280
peter.kurtz@tu-ilmenau.de, www.tu-ilmenau.de/awi

1. INTRODUCTION

For more than twenty years a number of new PC-based input devices displace old fashioned tools in the everyday life of an engineer. For example in the 1980's a technical designer worked with a drawing board or graphic tablet. Currently you will find a workstation with a mouse and one or more three-dimensional input devices.
In the 1990's the development of 3D input devices was dominated by the "European Space Agency" (ESA). In the following years the devices were also made available to the free market. This growing market raise the question: Which 3D interface is the best for which task because different interaction devices are needed for purposes in medicine, CAD, automotive or aeronautics.
A comparison of several 3D interfaces will show that their designers did not think about their ergonomic aspects. Thereby a longer use of some 3D input devices results in a feeling of discomfort.

2. A NEW EVALUATION CONCEPT FOR 3D DEVICES

[Krauss 03] found that it is necessary to have quantitative measurable attributes of the handling of 2D pointing devices. In all window-based software systems are known two mouse operations called *"Click"* or *"Drag & Drop"*. These operations Krauss had been used to develope of two exercises for 2D devices. An additional developed third exercise was *"Draw"* a line. He proposed to measure the rate of use, errors during the operational time and the positioning accuracy with these three exercises.
These three measurable attributes are just as interesting for 3D input interfaces as for 2D pointing devices. But not all mouse operations are operable with 3D interfaces, e.g. the *"Click"*-operation.
Another problem is the non-interchangeability of the 3D input devices because they are strictly designed to fulfil the needs of special tasks. For example it is difficult to play a flight simulation with a CADMan as well as to control a cad-software with a joystick.
The 3D input devices could be divided into three classes:

1. line-based (for example PHANTOM from SensAble Technologies, Inc.)
2. angle-based (for example a Joystick)
3. force-based (for example CADMan from 3D connexion).

The properties of these three device classes combined with their different mental models will expect different results of the tests.
The skills of the experimentees are the last clincher. They have to discern the 3D room without any assistants. Even the measurable attribute of positioning speed between start and

target positions depends on the visible skills. The time between moving from start position and reaching the target position will be divided into two parts, the time of detecting these positions and the time of moving the box between them by using the tested input device.

The evaluation should be done by two persons. The first is playing the evaluation games with the device which will be tested. The second person is logging the visible sings of the first person's behaviour. After finishing the games, the first person has to fill out a questionnaire.
Based on the idea of the *"Click"* and the *"Drag & Drop"* task developed by [Krauss 03] for 2D input devices the first two tasks of the evaluation game had been created. In these tasks are measured the positioning accuracy with and without barriers. A box should be placed in a 3D space. During the first game the box should be moved on the direct line between the start and target position. For the second game the shortest distance between these positions have to be found, but there is a pyramid like shown in fig. 1 blocking the straight way to the target position. The software writes a log file with distance and deviation from this straight line. This log file can be analysed with common statistic tools.

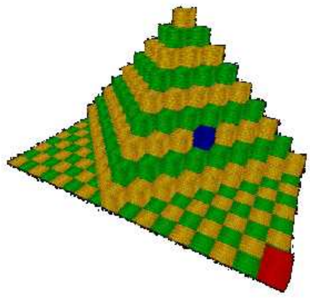

Figure 1: A snapshot of the second evaluation game

The third game was designed on the base of the mental model of flying. With that game the course accuracy of the input devices will be checked (equal to *"Draw"* test by [Krauss 03]). The programme shows a tunnel with a random course. The user has to move a ball without touching the wall for a specified period. In the background data for evaluation are written to a log file. These logged parameters are the number of bounces "ball – wall", the timestamp of the bounces and the distance "centre of ball – centre of tunnel".

3. FURTHER WORKS

The department of Ergonomics has developed a line based 3D input device called *"Haptor"* [Gramsch 05]. The main advantage of this device is the ergonomically designed hand position, which will be proved. The questions for the *Haptor* evaluations will be:

- Does the Haptor fulfil the expectations?
- Are the advantages of the Haptor able to prove?
- For which task model is the Haptor most suitable?

To answer these questions the *Haptor* will be integrated in the first evaluation study soon.

REFERENCES

[Gramsch 05] T. Gramsch, P. Kurtz, T. Nowack, G. Sievers, User oriented control panel design of precision measuring machines at the example of nanopositioning and nanomeasuring machines (NPM-Machines), in L. Urbas, C. Steffens, State recognition and System design workshop (6. Berliner Werkstatt Mensch-Maschine-Systeme), VDI Verlag GmbH, 2005, pp 207-210.

[Krauß 03] L. Krauss, Development and Evaluation of a methodology to examination of interaction devices for machine and process control systems with graphical interfaces, VDI Verlag GmbH, 2003.