

Dual Cursor Interaction Techniques

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Abstract

I present mouse-based, symmetric, bimanual interaction techniques as a solution to both the lack of spatial input and the lack of natural interaction techniques for direct manipulation in desktop interfaces. I outline the techniques I have implemented and tested thus far and the techniques and interfaces yet to be developed as part of my doctoral thesis.

Keywords: dual cursors, bimanual interaction, symmetric interaction, two-handed input, mice

1. RESEARCH PROBLEM

There are two separate, but related, problems that I am attempting to address in my doctoral research. The first problem is the shortage of spatial input in typical computer applications, which leads to the constant need to switch modes. Because there is only one spatial input device (usually a mouse or track pointer), direct manipulation of objects is limited to simple geometric transformations, such as translate or scale. This leads to the second, related, problem, which is the lack of natural interaction techniques. While in real life we are able to move and turn objects in a single motion, this natural interaction is absent in interfaces. Thus, manipulation of objects in our interfaces is not as direct as it could be. While many two-handed, or bimanual, interaction techniques have been studied and have demonstrated performance improvements, current computer systems are still limited to a single spatial input device. This may be partially due to the use of specialized devices in much of the previous bimanual interaction research and partially due to the difficulty of getting two separate spatial input streams into an application.

2. PROPOSED SOLUTIONS

I propose the use of standard, inexpensive, USB mice as spatial input devices for two-handed interaction. I have created a C/C++ library for Linux, called symPut, which allows applications to get two separate input streams (both spatial and actuator input) from two USB mice.

The majority of bimanual interaction techniques described in the HCI literature follow the guidelines set out by Guiard in his paper on the Kinematic Chain model of asymmetric interaction [1]. Such interfaces involve splitting work unevenly between two input devices, with the non-dominant hand setting the frame of reference in which the dominant hand works, and the dominant hand performing the more difficult, or detailed work. I propose an alternative, *mixed*, approach to two-handed interaction, in which *symmetric* interaction techniques complement asymmetric interaction techniques. Symmetric interaction can be characterized by the two hands working together on a common task at similar levels of spatial and temporal detail. Certain tasks in direct manipulation interfaces will likely work better with a symmetric dual-input technique than with an asymmetric dual-input technique. Combining both types of dual-input techniques, in addition to single input techniques where appropriate, is likely to generate significant performance benefits in an application interface.

3. METHODOLOGY

I have used symPut to create a dual-mouse 2-D drawing program, called symDraw, which serves as the basic testbed for the interaction techniques I design. The interface of symDraw is completely symmetric, meaning that any single-mouse action can be performed by either mouse, asymmetric interactions can be performed in either direction (ie. either hand can play the dominant role) and some interactions are symmetric, requiring both hands to work together. Putting the symmetric techniques together inside of a

single application allows me to investigate how the symmetric techniques interact with both single-mouse and asymmetric techniques. An interesting benefit of this symmetric design is that the interface is perfectly accessible across the handedness spectrum, without requiring any software or hardware configuration for left-handed users.

My methodology follows a typical software engineering life-cycle, minus the requirements analysis. I think of a way in which symmetric input might be useful in an interface, and then design, implement, pilot test, refine and experimentally validate the technique. I run my experiments on non-computer-science students, and use a repeated-measures design. Some experiments consist of a single session, while others are longitudinal and require repeat sessions.

4. CURRENT RESULTS

I have completed the implementation and validation of three symmetric interaction techniques. The first is a symmetric steering technique, in which two mice attach to the corners of a 2-D shape and ‘drive’ the shape around the screen, effectively translating and scaling the shape simultaneously [4]. The second technique is an image alignment technique, in which images or other objects can be simultaneously scaled, translated and rotated [3]. These first two techniques were also implemented in Kurtenbach’s T3 system, but were never described in detail or experimentally validated [2]. The third technique is symSpline, a symmetric spline manipulation tool in which the user selects an edit point on the spline and the user’s cursors warp to the ends of the tangent to the editing point. Moving the cursors around the screen translates, scales and rotates the tangent, which allows the spline to be manipulated in a variety of ways with a single gesture.

The common thread linking all three of these techniques together is the lack of mode-switching required by the symmetric interaction technique, and the fact that the two hands are working together on a unified task. Experiments on the first two techniques showed positive, statistically significant, results. For example, the symmetric technique was 87% faster than the single mouse technique in the image alignment experiment. The symSpline experiment also generated positive results, which will be submitted for publication in 2005.

5. FUTURE WORK

I am currently working on a symmetric interaction technique for document panning, zooming and rotating. In addition, I am planning a prototype window management system which will combine single-mouse, dual-mouse asymmetric and dual-mouse symmetric interaction techniques for operations such as window manipulation, inter-application copy-paste, and icon manipulation. This prototype is aimed at demonstrating how dual cursors can operate at a system-wide level, in addition to operating on application-specific tasks. Overall, I hope to develop an understanding of, and present in my thesis an explanation of, the broader contributions of my work in various areas: interaction techniques for direct manipulation tasks, cognitive load associated with bimanual interactions, and parallelism in bimanual interactions.

6. CONTRIBUTIONS

I hope to show that there exist tasks that naturally lend themselves to symmetric, bimanual interaction and propose guidelines for when symmetric interaction is appropriate. Although the benefits of bimanual interaction techniques have been studied extensively, current computers still use a single spatial input device. By combining commodity USB devices with bimanual interaction techniques that perform well, I hope to make the dual-mouse and dual-cursor desktop common-place.

Bibliography

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