

An Evaluation of Multiple Pointing Input Systems

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Abstract: Multiple Pointing Input System(MPIS) allows concurrent manipulation of multiple pointing devices, and is targeted as a generic input system. This paper reports on an experimental evaluation on our MPIS prototype system. The system allows concurrent manipulation of multiple pointing devices. The experiment has subjects sort 8 objects on the screen in displayed order. We found that concurrent manipulation with more than 2 devices was less effective. In addition, we found that the difference between the result of generic devices and specialized devices was small.

Keywords: Input Device, Multiple Pointing Device, Two-handed Interaction

1 Introduction

Multiple pointing Input System(MPIS)(Fukuchi & Matsuoka, 2000) allows manipulation of multiple pointing devices on a GUI system so that the user can control multiple graphical objects on the screen. There are many objects potentially concurrently controllable in a usual GUI application. For example, an audio mixing panel has multiple sliders for volume control of each audio source, and the user can control each slider independently. A real audio mixing console that has physically controllable sliders permits concurrent manipulation of such sliders, while a mixing console GUI on an **Single Pointing Input System(SPIS)** allows only single manipulation of one slider.

Our design goal of MPIS is for it to be a generic input device, and as such the user would employ MPIS for a variety of applications for desktop or mobile environments. We constructed a prototype system of MPIS based on video image capturing, and studied whether MPIS would be effective as a general input scheme.

2 Prototype System

We constructed a prototype MPIS that employs video image capturing, allowing concurrent manipulations of 8 devices. The user manipulates those devices on an input surface. The position pointed to by each device is indicated by a pointer on the screen.

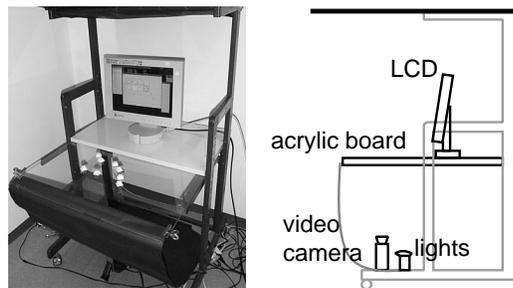


Figure 1: The appearance of the prototype system

Figure 1 shows the structure of the prototype system. It is based on a standard desk, whose top surface is replaced with a clear acrylic board. Each device has a different colored felt cloth on its bottom surface, and they are manipulated on the acrylic board. Their bottom surfaces are captured from the video camera placed below the board, and the position of devices are calculated by real-time processing of the captured images. Pixels whose color

is registered as device colors are filtered and detected. The position of each device is the average coordinate of all the pixels. On the prototype system we achieved 30 scans per second.

Each device has no buttons or other interaction parts, providing only their positional information. However, pseudo-clicking action can be performed by lifting the object, where the camera will detect the change in the size of the bottom surface.

3 Experiment

An experiment was run to investigate efficiency of MPIS against SPIS for concurrent user interactions. The experimental application is a sorting task that represents common drag-and-drop operation found in desktop applications. Figure 2 shows a snapshot of the experimental application.

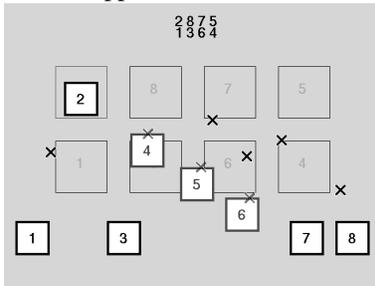


Figure 2: snapshot

The task was run on three input types: SPIS with a generic device, MPIS with generic devices, and MPIS with specific devices. On the system using generic devices, pointers are displayed on the screen (cross cursors seen in Figure 2). When the subject touches a card with the pointer, the card is bound to the device that correspond to the pointer. Then the card is moved by the device directly. When the card is moved into the designated square the binding is automatically released, and the card is affixed the square. When the card is moved into a wrong square, the card is not detached and the binding is maintained. This operation is identical for both SPIS and MPIS with generic devices. For MPIS with specific devices, each card is attached to a specific device, and the detachment operation is disabled.

3.1 Subjects

Seven subjects participated in this experiment. Two were senior University undergraduates, and five were graduate students. All had sufficient experience of GUI operations with mouse. The subjects were given explanations of the prototype system and had training time of about 2 minutes, manipulation of multiple devices in particular.

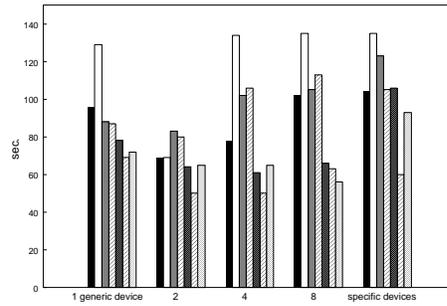


Figure 3: The results from each subject (time)

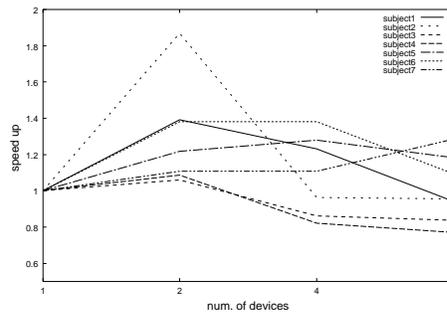


Figure 4: The result from each subject (speed up)

3.2 Results

Figure 3 and 4 shows the results. On the average, using more than four devices was not effective for the task, but this tendency did not apply for all subjects. The subjects 5,6,7 were well experienced subjects, and for those individuals, the time to complete the task the time continued to decrease along with growing number of devices, in particular with four or eight devices.

From the experiment we hypothesize the two properties: One is that the efficiency of concurrent control on MPIS is low when multiple objects are controlled independently. The constraint on the locomotive aspects of human hands could limit various independent control of the devices.

The other is the physical conflict between physical devices, practically unavoidable in a physical device system. Also we had initially speculated that using specific devices could be advantageous over using generic devices due to the costs of attachment operation for generic devices, it turned out that the conflicts affected to the efficiency strongly for both systems, actually making them less efficient compared to SPIS systems for our experiment.

References

Fukuchi, K. & Matsuoka, S. (2000), "Implementation of Multiple Pointing Input System", *IPSJ SIG notes* 2000(61), 15–21.