Improving List Selection Performance with Pressure-Sensitivity on a Scroll Ring

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ABSTRACT
We propose supplementing the scroll ring with pressure-sensitivity to improve selection performance especially for post-desktop and mobile systems. To show the usefulness of pressure-sensitivity, we have designed and evaluated a first software prototype, based on pen input. The results of this preliminary study indicate a potential for a substantial increase in selection task performance and high user acceptance.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. – Input devices.

General terms: Design

Keywords: Scroll wheel, pressure, input device

INTRODUCTION
The scroll ring is a highly efficient and intuitive input device, commonly used in mobile devices such as the Apple iPod, and with good reason: According to [5] it is significantly faster than a scroll zone or a mouse wheel. When designing a scroll ring for list selection, however, there is a trade-off between precision and speed: the faster the scroll movement is mapped to cursor movement, the less precise the selection will be. Since a typical selection task is comprised of multiple sub-movements, starting with a rough approximation and ending in precise selection, there is no optimum for this trade-off.

A common way of countering this effect is the use of acceleration: fast finger movement is mapped to even faster cursor movement, while slow finger movement is mapped to even slower cursor movement.

In this poster, we consider an alternative approach using pressure instead of speed to adjust the mapping between finger and cursor movement. We present a first prototype, based on pen-tablet input, and its evaluation, which yielded promising results. As a next step, we plan to conduct a general user study on actual hardware prototypes.

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Figure 1. Scroll ring from the Apple iPod.

RELATED WORK
Previous work by [4] investigated the use of pressure-sensitive sliders, called Zliders, on a pen-tablet. Even though they also proposed a Zliding Wheel, they concentrated on the pen-table interface: their design and study was based on scaling and zooming in design-centered applications, explicitly leveraging the properties of pen input. We, on the other hand, aim at improving general list selection using a physical scroll ring.

Other studies about pressure-sensitivity for input devices similarly concentrated on pen- or mouse input, and none considered circular interfaces. [6] used pressure on pen-tablets to improve precise selection and scrolling by adjusting the distance and velocity of the movement. [2] augmented the common mouse with pressure sensors to allow mode switching, scaling, or pressure menus while working on a desktop computer. [1] proposed the use of small pressure-sensitive pads as a new input device for interactive systems. They used pressure to "pop-through" different modes of interaction.

Since the use of a pen has great influence on the interaction with a system, the presented software prototype delivers only preliminary results. To realize a more elaborate hardware prototype, pressure-sensitive touch sensors are required. For this matter we are collaborating with IEE Lusense[1], who are using their force sensing resistor technology to develop appropriate sensors. An alternative could be frustrated total internal reflection technology to measure pressure on a touch surface[2].

[1] http://www.iee.lu/content.php?rub=m2_2

[2] http://www.cs.nyu.edu/~jhan/ftirsense

PROTOTYPE

The prototype was realized on a MacBook laptop computer extended with a pressure-sensitive pen display. The interface shows a touch ring similar to Apple's iPod with a clickable button in its center. The scroll ring (Fig. 1) controls a table displayed on top to avoid occlusion by the hands.

EXPERIMENT

Setup

We have evaluated the prototype with five volunteers. Each participant was asked to select 30 random entries from a list of 1000 by navigating to them with the scroll ring and confirming with a click of the center button. Besides a reference scenario, where pressure had no impact on the speed, we tested two setups: (1) linear and (2) quadratic mapping of pressure to speed with more pressure resulting in slower navigation. After each selection, the list was reset to its first position.

We also considered using more pressure for faster cursor movement but discarded this approach after initial user tests. Our participants commented that it felt unnatural and required more effort than the presented method.

Results

All of our test users preferred one of the pressure-sensitive setups to the reference setup. The preference between linear and quadratic mapping differed greatly between all individuals. Completion times were on average 9% faster for the linear mapping and 19% faster for the quadratic mapping. Remarkably, all participants performed better in at least one of the pressure-sensitive methods than the reference. Figure 2 shows an overview of the results.

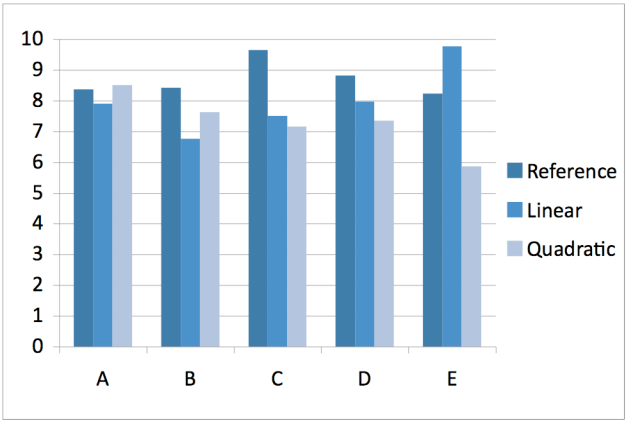

Figure 2. Completion times in seconds per user

We also wanted to confirm that the participants made appropriate use of the pen pressure during selection. Figure 3 shows a typical trace of pressure and angle change over time. As expected, the participant started with relatively low pressure to narrow down on the target, and then increased pressure for finer selection with several corrections. This was confirmed by the participants' feedback, as they considered the mapping natural.

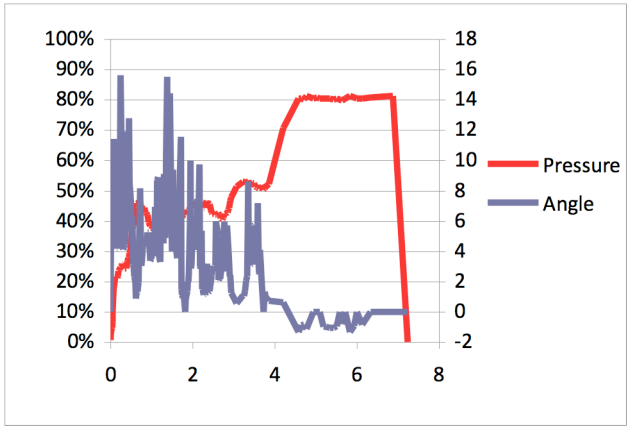

Figure 3. Trace of pressure (left axis) and angle change (right axis) over time for one example run.

CONCLUSION AND OUTLOOK

We have designed and evaluated a software prototype for selection tasks on a pressure-sensitive scroll ring. The results of our study indicate the potential for a substantial increase in selection performance and high user acceptance.

As a next step, we want to design a hardware prototype and evaluate the proposed method in a larger user study, to be able to present more fundamental results and encourage researchers to consider the pressure-sensitive scroll ring as a valuable input device for post-desktop or mobile devices.

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