Laserpointer-Interaction between Art and Science

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ABSTRACT

We employ Laserpointer-Interaction as an intuitive, direct and flexible interaction concept particularly for large, high-resolution displays which enforce physical navigation. We therefore demonstrate general applicability and suitability by applying Laserpointer-Interaction to a wide range of domains – from scientific applications and formal experiments to artistic installations for the broad public.

Author Keywords

Laserpointer-Interaction, pointing device, tapping test, large high-resolution display, artistic installation.

ACM Classification Keywords

H5.2. Information interfaces and presentation: Input devices and strategies; B4.2. Input / Output Devices.

MOTIVATION

In recent years, large, high-resolution displays (LHRD) have been increasingly used in scientific, industrial and artistic domains since they are capable of visualizing a large amount of very detailed information at a glance. Due to the fact that these displays match or even exceed the capabilities of the human visual system in terms of resolution or field of view, physical navigation (moving eye, head, body) is highly required to perceive all of the pixels and to take full advantage of these displays [5]. Although various studies have shown that increased physical navigation leads to less virtual navigation (zooming, panning, sliding) and thus to an improved user performance (overview in [1]), manual control with input devices cannot be replaced. Even though all information could be visualized at a glance, users want to manipulate or annotate data or explore related information (e.g. details-on-demand) directly, instantly and right on the spot. However, conventional input devices such as mouse and keyboard restrict users' mobility by requiring a stable surface on which to operate and thus impede fluid interaction. Wireless air mice or presentation aids with an additional joystick offer more mobility, but perform substantially worse compared to a traditional mouse [3]. They are also less suitable for supporting handwritten annotations and sketches due to their relative mode of interaction.

IUI'08, January 13-16, 2008, Maspalomas, Gran Canaria, Spain.
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LASERPOINTER-INTERACTION

We propose Laserpointer-Interaction as a flexible, direct and position-independent input technique particularly for LHRDs, which enforce physical navigation. In contrast to previous research [2], we concentrate especially on satisfying the requirements of usage with LHRDs with regard to accuracy, speed, and mobility. In order to assess these aspects we employed our solution in diverse environments, application domains and evaluations. Basically, a laserpointer is used to control the virtual cursor by visually tracking the laser reflection on the screen with one or more video cameras. Due to the low-divergence laser beam users have full flexibility to interact directly in front of the display or from distant positions. Laserpointers allow a very direct and intuitive manner of interaction by reason of similarity to the human pointing gesture. As absolute device, users can simply point to interesting information on the screen and the cursor is right where they expect it – at the intersection between device and display. Using a relative device like a mouse on LHRDs, clutching or similar time-intensive techniques are needed to entirely cross the whole display. Using a laserpointer this is just a matter of angle variation.

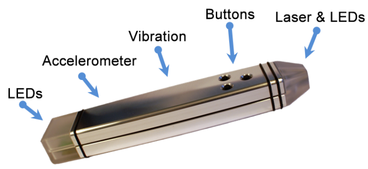

Figure 1: Laserpointer with actuators, accelerometer, multi-color LEDs for visual and vibrator for tactile feedback.

For our application domains we developed a custom-build laserpointer with three buttons as actuators and an embedded ZigBee module for wireless data transfer (Fig. 1). Although status changes are normally visualized on the display, we provide additional feedback for the user directly at the device. Therefore, multicolor LEDs are installed at both ends of the laserpointer and an integrated vibrator can be activated for tactile stimulation. For presentation situations in which speakers are mainly facing the audience and absolute pointing is therefore not feasible we integrated an accelerometer which allows recognition of simple gestures independent from visual tracking. The laserpointer emits invisible infrared light (785nm) with a very low intensity (0.55mW), which is hard to track but allows absolute safe usage even in public spaces. Further advantages of the invisible light are that no displayed information is occluded by the laser reflection and that the user does not realize the jittering caused by the natural human hand tremor. In order to support smooth movements as well as precise hovering, we employed an intelligent jitter compensation which dynamically adjusts a multi-model Kalman filter to current user behavior. Moreover, the system prevents user failures by changing pointer position depending on user action and system state. Applying Laserpointer-Interaction on LHRDs requires particularly high accuracy and interaction speed. We achieve this by using an array of 3-4 color cameras with a resolution of 1600x1200px and effective frame rates between 90-120fps. After an initial calibration our tracking library allows sub-pixel accurate localization within a processing time of less than 10ms. Thus the user gets instant feedback to his movement and is able to react immediately.

APPLICATION DOMAINS

We applied our Laserpointer-Interaction to diverse application domains to test its versatility and flexibility and also to provide a platform for qualitative and quantitative user studies. In an initial feasibility study we performed some basic pointing and selection tasks by moving bubbles (Flash application) at the Powerwall in Konstanz (5.20x2.15m, 4640x1920px). We also achieved general cross-application support enabling users to navigate in conventional applications (e.g. Google Earth), to manage presentations, to manipulate scientific visualizations or even to control the entire WIMP environment on the 221" Powerwall (Fig. 2b). For a comparative evaluation study we combined our Laserpointer-Interaction with an evaluation environment which gathered the entire interaction data while providing unidirectional and multidirectional tapping tests to participants (Fig. 2a). Besides scientific areas we also applied our system in an artistic domain and thereby presented it to the broad public. The Laserpointer-Interaction was part of the artistic installation »Globorama«, which opened the PanoramaFestival [4] at the ZKM | Center for Art and Media in Karlsruhe and was open to the public from 29/09/07 to 28/10/07. Surrounded by 360°-satellite images of the earth (Fig. 2c), visitors explored the entire globe with the laserpointer and submerged at selected points in georeferenced panoramic photographs (Fig. 2d) or webcams of the respective location. The visitor was able to physically move inside the 360° panoramic screen (8m in diameter, 8192x928px) while dynamically controlling zooming and panning by pointing to interesting areas and pressing the navigation button. Whenever the user crossed a selectable icon representing georeferenced information, the laserpointer vibrated for 200ms and thus provided tactile stimulation. Visual feedback was given by the integrated LEDs which changed their color according to the current button status.

Figure 2: Unidirectional tapping test (a) and Google Earth at the 221"Powerwall (b), artistic installation »Globorama« (c,d).

EVALUATION

Even without introduction, visitors of Globorama mostly stated in questionnaires and interviews that the laserpointer was easy to use and allowed fast and precise pointing. Also more than 80% of the 73 persons who filled out our questionnaire moved around inside the display and benefited from mobility. We also conducted a comparative evaluation study with 16 participants on the Powerwall comparing a conventional mouse and our laserpointer by means of a unidirectional tapping test (ISO 9241-9). The measured performance advantage of the mouse (13%) appears marginal considering the intuitive and direct mode of interaction in using the laserpointer and the flexibility gained by its use (see [2] for more details).

CONCLUSION

We presented Laserpointer-Interaction as a beneficial input device for diverse areas, applications and tasks. It can replace traditional pointing devices especially if large, high-resolution displays are used and thus mobility is essential.

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