Gummi: User Interface for Deformable Computers

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ABSTRACT

We show interaction possibilities and a graphical user interface for deformable, mobile devices. WIMP (windows, icons, mouse, pointer) interfaces are not practical on mobile devices. Gummi explores an alternative interaction technique based on bending of a handheld device.

KEYWORDS

Handheld devices, GUI, embodied interfaces

INTRODUCTION

While WIMP user interfaces allow reasonably efficient interaction with computers in a desktop environment, they are difficult to use on small, handheld devices. As devices and screens become smaller, pointing and clicking on small interface elements becomes increasingly difficult. Furthermore, external input devices such as pens are easily misplaced and there is less space available for mechanical controllers, such as buttons and dials.

To address these problems, we envision a handheld device without buttons, pen or WIMP-based touch screen interface. It would consist of several layers of flexible electronic components with a flexible display on the top, electronic circuits in the middle, a touch-sensitive panel on the bottom and an embedded sensor measuring physical bending of the device (Fig. 1). The resulting device would be extremely thin, flexible and have no mechanical parts. Users would interact with this device by physically deforming it and by touching the sensor on the back (Fig. 1). Creating such a deformable computer may seem a very remote possibility. However, recent rapid advances in flexible electronics make such a device feasible in the relatively near future. Indeed a full color, high-resolution, 0.2mm thick flexible organic display has been very recently demonstrated [7]. Such new generation organic flexible displays were one of the motivations for this project.

In this paper we present Gummi: a prototype of our deformable computer and a novel graphical user interface designed specifically for such devices. Gummi focuses on alternatives to WIMP interaction and facilitates a wide range of interaction tasks by only a combination of one-dimensional bending and 2D position control in an easy to use, practical and enjoyable interface.

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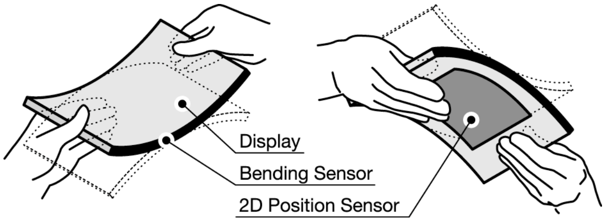

Figure 1: Gummi device and interaction

RELATED WORK

The limitations of WIMP interfaces have motivated researchers to develop extensions or alternatives to existing interfaces for mobile devices [e.g. 1, 5]. Of these previous efforts, embodied interfaces are the most relevant to Gummi. They suggest the augmentation of handheld devices with a variety of sensors to allow users to interact with the device by physically manipulating it in their hands [2, 3, 4]. Embodied interfaces, however, were mostly designed as extensions to WIMP interfaces for specific tasks, such as browsing lists [3, 4]. We are not aware of any attempts to design a unique interaction style that is driven by embodied interaction and that would allow users to accomplish a wide range of interaction tasks. Designing such an interaction style is the goal of the Gummi project.

DEVICE PROTOTYPE

We designed and implemented a device prototype that closely simulates essential properties of the deformable computer discussed above (Fig. 2). As flexible electronic components were not available to us, we used a rigid TFT color display mounted on a flexible base. A conventional USB touchpad was mounted on the bottom of the base. Continuous bending data was obtained from two resistive pressure sensors attached to opposing sides of the prototype. The flexible base is rigid enough to return to a flat state when no force is applied.

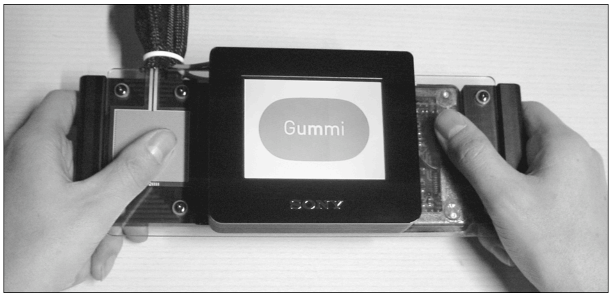

Figure 2: Current Gummi prototype

INTERACTING WITH GUMMI

As shown in Figure 1, all interaction with Gummi is based on simultaneous bending of the device and controlling 2D position on its back. We found that this does not complicate the interaction – Zhai [6] showed that humans can effectively control both position and force at the same time. In a familiar example, we can easily control 2D position and pressure of a pen when writing. We try to use these natural human abilities in Gummi.

Interaction vocabulary

Gummi interaction combines single-point 2D position control from the touch panel with continuous 1D two-directional input from the bending sensor. Figure 3 illustrates the interpretation of bending data:

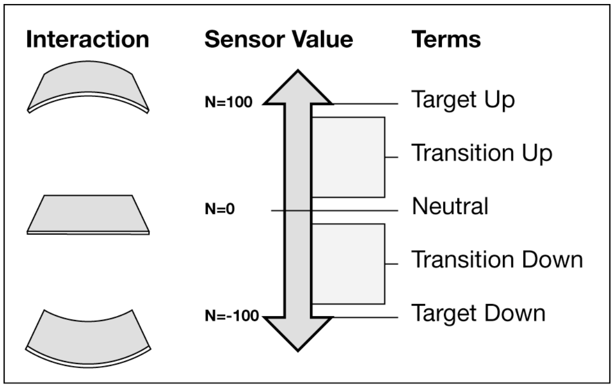

Figure 3: Vocabulary of bending interaction

Starting from a neutral position, users can bend the device either up or down. In both directions of bending, sensor data is interpreted first as continuous analog control (*Transition Up* and *Transition Down*) and then, when a certain amount of force is applied, as a discrete switch (*Target Up* and *Target Down*). The device returns to a neutral position when no force is applied.

Gummi user interface tasks

Interpreting the sensor data as presented above makes it possible to complete a wide variety of interaction tasks by only bending the device and using 2D position control. *Selection*, for example, is combined with scrolling: The 2D position sensor is used to scroll content in one or two dimensions. Actionable items (e.g. links) are selected according to their position on the screen. For example, the item that is closest to the center of the screen is highlighted. The user can then *trigger* the selected action (or *open* the selected content) by bending the device further to Target Down. Transition Down provides a *preview* of the selected action or content, as well as visual feedback of the state of the device (Fig. 4). We use Target Up to exit a mode or to close content – this is functionally similar to a “Back” button in a web browser. Altogether these allow for easy navigation of hierarchical menus and hypertext content.

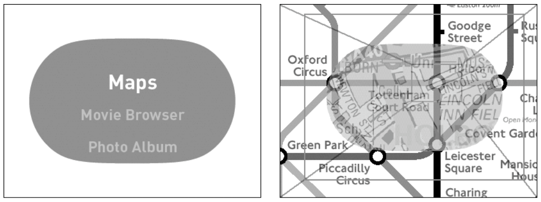

Figure 4: Gummi GUI screens – menu and maps

Users can control the amount of bending very accurately. The Gummi GUI contains intuitive bending controls for tasks that exploit this fact, such as zooming in and out of a map, controlling the playback speed of media files and controlling the composition of image layers (such as a street map overlaid with an arial photograph). These continuous control functions are easy to use and make it possible to present more information on the small screen of a handheld device without having to add buttons or additional menu hierarchies.

CONCLUSION

The prototype shows promising possibilities for a generic, embodied interface for mobile devices. Especially the continuous control properties of the bending interaction allow types of functionality that would not be possible in a WIMP interface. We are planning to build a new prototype incorporating a flexible display and better bending sensor.

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