Cobra: Flexible Displays for Mobile Gaming Scenarios

Zi Ye
Queen's University
Kingston, ON K7L 3N6 Canada
zi@acm.org

Hammad Khalid
Queen's University
Kingston, ON K7L 3N6 Canada
hammad.kd@gmail.com

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Abstract
We discuss Cobra, a handheld peripheral for computer games that applies flexible display design principles to provide a highly intuitive, mobile gaming experience. Cobra is a flexible cardboard interface that uses bends as input to the gaming device. Images are provided through projection with a shoulder-mounted pico projector. In this paper, we will present our prototype, the motives behind it, and its immediate applications.

Keywords
Organic User Interfaces, Mobile Gaming, Flexible Displays.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces---input devices and strategies, haptic I/O

Introduction
In today's game hardware industry, the primary research focus has shifted from maximizing graphical power to creating new, more natural methods of interaction for players. Nintendo's Wii Remote [1], Sony's PlayStation Eyetoy [2], and Microsoft's Project Natal [3] are examples of how new input hardware is changing the way games are being played.

However, these new solutions usually involve a stationary setup. As such, they are difficult to incorporate into handheld gaming consoles, and are typically designed specifically for desktop console scenarios. Both the Nintendo DS [4] and iPhone are example handheld game platforms that introduce more physical methods of interaction. However, one issue with the use of Wii interaction styles with handhelds is that the physical acceleration of the display itself affects the visibility of the image or game characters on display.

With this work, we aim to bring physical interactions to handhelds that rely on deformability of the display instead. An organic user interface is a user interface "with non-planar displays that actively or passively change shape via analog physical inputs" [5]. In this project, we envisioned a flexible, handheld surface that players could twist and bend in order to provide input without requiring fast movements or obstruction of the display. Although interfaces exist that rely on deformation for input, e.g. Paperwindows [6], Gummi [7] and Foldable Input Devices [8], these interface were not specifically designed within a gaming context.

Hardware Implementation

The Cobra prototype consists of a flexible display board on which a game is projected using a pico projector. The game is run on a netbook worn in a carrying bag (Fig 1). The decision to make Cobra a computer peripheral allows users to play games that leverage the power of laptops, while at the same time giving them the level of freedom provided by handhelds. Thus, it makes computer gaming more mobile, and makes mobile gaming more powerful. As Figure 1 shows, a regular

Figure 1. The prototype consists of a modified notebook carrying bag, a pico projector, and an input/display board.

notebook carrying bag conveniently houses the entire system. The central piece of hardware is the board (Fig 2). It serves as a display and an input device, and provides all communication between the player and the game. The board consists of two sheets of thin, flexible plastic on which an image is projected from a shoulder-worn pico projector. The board also houses three infrared LEDs. These are used to track the position of the board using a Wiimote camera mounted on top of the shoulder-mounted projector. Similar to Paperwindows [6], this information is used to target the projection more accurately as the user moves the board.

Sensing Deformation

The board's plastic is flexible to bend, but stiff enough to snap back into shape and not sag when held with one hand (Fig 2). Four bidirectional bend sensors and 2 pressure sensors controlled by an Arduino Bluetooth [9] control board sense the deformation of the board by the user (Fig 3).

Figure 2. The front side of the Cobra board.

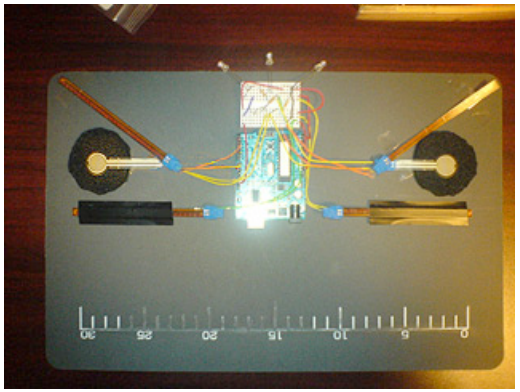

Figure 3. The board's internal circuitry.

When in use, any bending or pressure sensed is communicated wirelessly to the netbook. The current prototype detects bi-directional bending of two corners and two sides, and has two pressure-sensitive points on the back. The other half of the hardware consists of a pocket projector and a disassembled Wii Remote camera [1], joined together, and attached to the bag's shoulder strap. These are adjusted to rest on top of the shoulder and point roughly towards where the board will be held. The projector cable runs under the bag's strap, and into the netbook bag. The Wii Remote tracks the infrared LEDs on the board, and wirelessly communicates this data to the computer. The computer uses this data to determine the board's position and orientation relative to the player. The screen area of the game being played is transformed based on this data, and the projector projects this transformed image onto the board. Like Paper Windows [6], Cobra uses a combination of computer vision and projection for tracking and display. This frees the board from having to have its own display, and allows it to be wireless. Unlike Paper Windows, however, Cobra does not use machine vision to detect bending. Instead, Cobra uses embedded sensors like Gummi [7], providing reliable and responsive input.

Software Implementation

We used a simple Arduino program to send the sensor data from the Arduino Bluetooth to the computer. Computer games interface with the Cobra through a C++ library. The library reads the sensor data from the board, as well as the tracking data from the Wii Remote, processes the data, and provides the game with an abstracted representation of the board's current state. The game can then fire events and transform the screen image accordingly. These features can be turned on or off, so that the game can still be played in a traditional fashion without the Cobra. For testing, we wrote a few small 3D demos with OGRE [10].

Physical Interaction Styles

Digital inputs, such as buttons, restrict the human body's entire range of motions to just two possible states. Analog inputs, on the other hand, capture ranges of movement, and allow for better expressiveness. Because Cobra has many analog inputs, there are many possible gestures at the game developer's disposal. This gives rise to brand new, original game mechanics, designed to be intuitive to the player. These interaction styles are not necessarily pre-defined, but are rather defined by the user through his or her physical interaction with the board.

For example, grabbing hold of a corner of the board, bending it back, and releasing it can be used to shoot an arrow, cast a fishing line, or swing a golf club. The player is also able to gauge and adjust the power that goes into these actions, because the board's stiffness and other physical properties provide haptic feedback. An intuitive control mapping should create the closest match possible between the game world and the real world based on a physical metaphor. For example, an appropriate mapping for a driving game might require the user to bend the board left and right in order to steer the vehicle, while using the pressure points as the gas and brake pedals. A first-person shooter might take advantage of the spatial relationship between the board and the player for navigational controls. By combining the high degree of freedom and passive haptic feedback provided by the board with appropriate control mappings, developers can create physically engaging games.

Usability

Since most netbook users carry their computers around in a bag anyway, users only needs to carry the board , Wiimote circuitry and pico projector. When not in use, the board fits nicely in the bag with the computer, since it is thin, light, and has dimensions similar to those of the computer. When the user wants to play a game, he or she takes the board out of the bag, and presses both pressure points simultaneously to start the game selector. The user can then scroll through the list of games by bending, and start a game by pressing the primary pressure point.

Figure 4. A Cobra player in action.

While playing, the user is free to move around in the real world. The tracker only acquires the board's position and orientation relative to the user, so the user's actual position and orientation in the real world do not affect the game. Because the projected image is transformed to follow and fit the board, objects and people in the user's vicinity are not be affected by the

Figure 5. Sample game projected on Cobra board.

projection. This makes Cobra private and non-invasive, unlike other projection-based interfaces, such as Wear Ur World / Sixth Sense [11]. When the user lowers the board or moves it out of the way, it leaves the projector's light cone, and the entire projected image disappears, thus saving battery power. When the player wants to stop playing, he or she simply puts the board back into the bag.

Conclusion

We presented Cobra, a flexible cardboard interface that uses bends as input to a mobile gaming device. Images are provided through projection with a shoulder-mounted pico projector. While the focus here is on gaming, a peripheral like Cobra could just as easily be used to watch movies, manipulate 3D objects, or mix audio. There are numerous domains which would benefit from a flexible, mobile display interface.

References

[1] Nintendo Wii. http://nintendo.com/wii.

[2] Sony PlayStation Eye. http://us.playstation.com/PS3/Accessories/SCPH-98047.

[3] Microsoft Project Natal http://xbox.com/en-ca/live/projectnatal.

[4] Nintendo DS. http://nintendo.com/ds.

[5] Vertegaal, R. and I. Poupyrev. Organic User Interfaces: Introduction to Special Issue. *Communications of the ACM, 2008*. 51(6): p. 26-30.

[6] Holman, D., Vertegaal, R., Altosaar, M., Troje, N., and Johns, D. (2005) Paper windows: interaction techniques for digital paper. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '05. ACM Press.

[7] Schwesig, C., Poupyrev, I., Mori, E. Gummi: a bendable computer. *Proc. CHI 2004*, ACM Press (2004), 263-270.

[8] Gallant, D., A. Seniuk, R. Vertegaal. Towards more paper-like input: flexible input devices for foldable interaction styles. *Proceedings of the 21st annual ACM symposium on User interface software and technology*, (Monterey, CA, 2008).

[9] Arduino BT Circuit Board. http://arduino.cc/en/Main/ArduinoBoardBluetooth.

[10] Open Graphics Rendering Engine. http://ogre3d.org.

[11] Mistry, P., Maes, P., Chang, L. WUW - Wear Ur World - A Wearable Gestural Interface. In *CHI '09 extended abstracts on Human factors in computing systems,* (Boston, USA, 2009).