Shift ‘n‘ Touch: Combining Wii Balance Board and Cubtile

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ABSTRACT
Combining input devices opens up new possibilities for interaction. We have investigated a Nintendo Wii Balance Board which allows foot input through weight-shifting together with an Immersion Cubtile which is a 3D multi-touch device. We have developed a framework that allows a mapping of inputs from both devices to output actions simulating keyboard strokes as well as mouse clicks and movements. Thus, with this setup, existing computer applications can be controlled. Exemplarily, a first-person shooter was used as a starting point for investigating this new device combination.

Author Keywords
Multi-touch; foot interaction; tangible user interface; input devices

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation – User Interfaces: Input devices and strategies, Prototyping

General Terms
Design; Experimentation.

INTRODUCTION
Combining different input devices creates new opportunities as well as problems for the interaction with virtual environments. In this paper, we introduce the combination of a Nintendo Wii Balance Board[1] and an Immersion Cubtile[2] to enable multimodal and complementary inputs – using feet and hands in this case. This allows the detection of single interactions to execute tasks in parallel, but also the creation of possibly complex input sequences involving both devices at the same time. The experimental setup is shown in Figure 1.

[1] `http://www.nintendo.com/consumer/downloads/wiiBalanceBoard.pdf`, last accessed: August 27th, 2012
[2] `http://www.cubtile.com`, last accessed: August 27th, 2012

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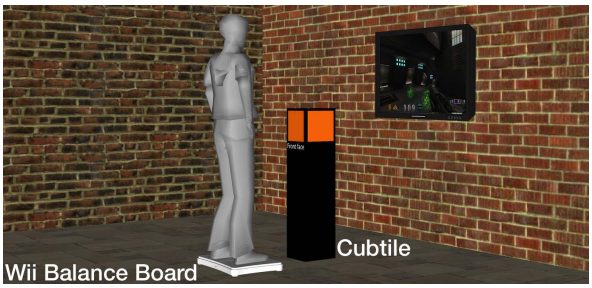


Figure 1: Experimental setup

To test the extended interaction possibilities, we used both devices to control the first-person shooter OpenArena[3] (based on Quake 3 Arena). The game is well-suited for a first investigation as it provides a virtual environment that can be explored and in which additional actions can be carried out e.g. changing a weapon or using an item.

RELATED WORK
The usage of the Wii Balance Board as an input device is not new. De Haan et al. [2] used it to interact with virtual objects and for navigation. Williams et al. [5] showed that solving a navigation task in a virtual environment using “Walking In Place” on such a device led to less turning errors compared to joystick interaction. In the study by Valkov et al. [4], participants had to travel through a virtual 3D city with a setup consisting of a stereoscopic wall and a Wii Balance Board in front of a small, upright standing multi-touch surface. The Wii Balance Board was used for steering and speed control via weight-shifting. A combination of hand, foot and eye gaze interactions was explored by Daiber et al. [1] for controlling a geographic information system. They used a Wii Balance Board for foot gestures, a multi-touch wall for hand gestures and an eye tracker to gather eye gaze information. To our knowledge, there has not yet been an investigation of a combination of a Wii Balance Board and a Cubtile.

INTERACTION DEVICES
The Wii Balance Board, equipped with four pressure sensors at its corners, provides a relatively low-priced possibility for the continuous computation of the user's weight shifting. The Cubtile is a 30 centimeters wide translucent cubic input device. It provides five multi-touch capable faces and thus defines a 3D volume. This allows for interactions in 3D space.

[3] `http://www.openarena.ws`, last accessed: August 27th, 2012

INTERACTION TECHNIQUES

According to Zhai [6], input interactions can be divided into "position controlled" and "rate controlled". In our case the former relates to interactions like touching or moving one or several fingers on one or more faces of the Cubtile directly corresponding to the controlled object. The latter maps the input (e.g. weight shifting on the Wii Balance Board) indirectly to a continuous movement of the object.

IMPLEMENTATION

Both interaction devices are connected to a computer running the application to interact with. The Wii Balance Board is connected via Bluetooth using WiimoteLib[4]. The Cubtile uses a FireWire and a USB connection and is addressed via its API. We have developed a framework that provides a mapping possibility of user input (both foot and hand gestures) to mouse and keyboard actions. We check the interactions on each of the five Cubtile faces separately and differentiate them into single touches, multi touches and movements (in x and / or y direction). For the user's weight shifting on the Wii Balance Board, we have defined eight possible directions (N, NW, W, SW, S, SE, E, NE) as well as a neutral position.

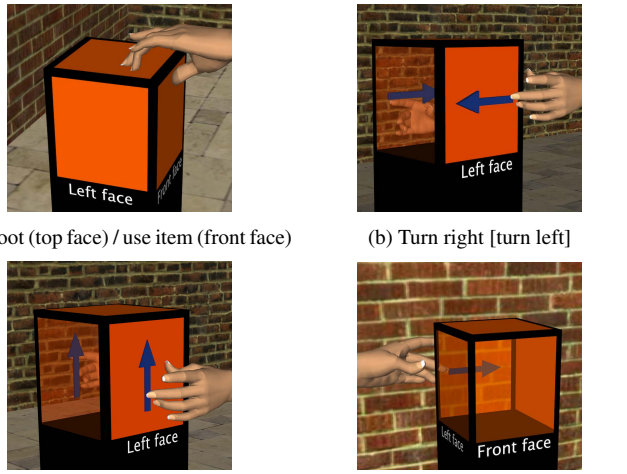
Our framework allows to define a mapping from one or more input interactions to one or more output actions. An example would be the mapping of a weight shifting towards North to a press of key 'w'. Another would be the movement of two fingers on opposing faces in opposite directions to simulate a mouse movement.

INFORMAL STUDY

To test our framework, we conducted an informal pilot study with four participants playing the first-person shooter OpenArena which is usually controlled by mouse and keyboard. Each participant stood on the Wii Balance Board, in front of the Cubtile, directly facing the display (see Figure 1). As the focus was not on winning the game but getting a feeling for the new interaction possibilities, the game difficulty was set to an easy level. The Wii Balance Board was used for moving the ingame character. The Cubtile's main purpose was to act as a replacement for the mouse (looking around and shooting) but additional actions were also possible e.g. using an item. The possible interactions are shown in Figure 2. We observed the participants during the study and afterwards discussed their impressions with them.

No participant had prior experience with the given setup. Nobody had severe problems to navigate through the virtual environment although it was unfamiliar. One participant mentioned that interacting with the backward face was not comfortable because of the Cubtile's size. Despite the easy difficulty level of the game, we made the obversation that it was hard to attack the non-player characters as the fast gameplay calls for rapid and often changing movements with both hands. These aspects should be kept in mind when designing the input/output mappings. Nonetheless, we assume that exploring a virtual environment in general (i.e. without the need for fast interactions) is feasible with this approach.

[4] `http://www.brianpeek.com/page/wiimotelib.aspx`, last accessed: August 27th, 2012



(a) Shoot (top face) / use item (front face)
(b) Turn right [turn left]
(c) Look up [look down]
(d) Next weapon [previous weapon]

Figure 2: Cubtile's interaction mappings in the pilot study. Actions in brackets can be achieved by counter motion.

None of the participants complained about problems with losing their body balance while executing the proposed interactions. Although we only made some informal observations that do not allow to draw definitive conclusions, we think that further investigation of this approach would be worthwhile.

FUTURE WORK

The next step should be to conduct a user study within the current setup to gain more reliable results, espescially in comparison to other existing devices. Due to the flexible input/output mapping approach in our framework, it is even possible to investigate different domains apart from first-person shooters. A problem already identified by de la Rivière et al. [3] is to find meaningful combinations of input interactions. Our presented work can be used to further investigate this issue. Similar to [1], the use of an eye tracker as an additional input device can further extend the set of possible interactions.

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