Sensor-Virrig - A Balance Cushion as Controller

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ABSTRACT
We introduce the extension of a standard balance cushion with sensors that capture all possible movements of the person situated on it. Several different basic activities can easily be distinguished. Thus, the cushion can be used as an input device emulating, e.g., mouse movements and clicks as well as providing an additional degree of freedom (rotation). Possible applications include but are not restricted to educational purposes especially for younger children. It is expected that physical interaction helps to increase fun, social familiarization and long-term learning results.

Author Keywords
ubiquitous computing, input device, sensors, cursor, mouse, game controller, fun, playful computing

ACM Classification Keywords
H.5.2 User Interfaces, B.4.2 Input/Output Devices, I.3.6 Methodology and Techniques, H.1.2 User/Machine Systems

INTRODUCTION
The experience when interacting with a system is strongly related to the input and output devices that are used. The physical properties of an input device have significant implications on the way it can be used and on the applications that are supported. With the introduction of graphical user interfaces and the mouse as input device new applications became feasible and new forms of interaction emerged ([1]).

In ubiquitous computing research new interfaces have been developed to enable specific forms of interaction. Examples are the TUISTER ([2] - a device for navigating menus and the Rope-Interfaces ([3]) - a UI for physically moving up and down. More complex interfaces, such as the Exertion Interface ([4]) for remote collaborative physical games, are designed to create a specific experience. These interfaces have in common that sensors are needed to capture the user's actions. The use of sensors in UIs is a major UI research topic, see [5].

In our work we investigate how embedding of sensors in common objects can make these objects interaction devices. Here we report on work where we equipped a piece of furniture with several types of sensors. This allows using the cushion as a control for a variety of applications. A design goal is ease of use and playful experience without lengthy training or introduction. Further issues are that users should be able to explore the input device and that the object can be seamlessly embedded into the environment.

In the remainder of this short paper we present the *Virrig* balance cushion. We first concentrate on the sensors and technology embedded. Then potential applications and our further plans are discussed.

PHYSICAL AND PLAYFUL INTERACTION
To create a physical and playful interaction we need to find ways to engage the user with the interaction device. We looked for a device that can be purposefully manipulated as a control in the digital world but still keeps a valuable non-digital function for the user. Furniture and furniture accessories offer a wide range of options for creating such devices.

For our experiments we chose the *IKEA/PS Virrig*® balance cushion, see Figure 1(a)). It is a flat cushion mounted on a robust uneven surface allowing it to be rotated and tilted in all directions. It is very flexible in use as the user can sit, crouch or stand on it. In the non-digital form it can be used as a cushion to sit on or as a toy to practice balancing. The cushion has a clear affordance, it is engaging and people know instantly what they could do with it based on the physicality.

The digital device that we developed does not change the affordance or the physicality of the cushion. From the outside it remains the same. The technical implementation is hidden inside and is not obvious to someone just seeing the device. The cushion is very robust and this property was not changed by including the technology. Users still can sit and stand on the cushion.

(a) The cushion ...

(b) ... and a user.

Figure 1. The IKEA Virrig Balance Cushion.

SENSING TECHNOLOGY

For our experiment we focused on the use of technology that could be included at very little cost. We used the Smart-Its prototyping platform ([6]) as the basis for processing and wireless communication. A sensor board, specifically designed for the cushion, is connected to the Smart-Its.

The following sensors are used to acquire information about the state of the cushion and the user movements.

- Four ball switches detecting tilting movements. It is indicated by the sensors if the cushion is out of balance. If more precise tilt recognition were required, an accelerometer could be used instead.
- An electronic compass detecting changes in rotational orientation. We can use this sensor to get the absolute orientation or the change in orientation.
- A pressure sensor detecting whether or not someone is using the cushion; to some extent position and weight of the user can be determined.

Figure 2 shows the opened cushion. The Smart-Its board including the wireless communication, the ball sensors, the compass and the power supply are located in the base of the cushion. The pressure sensor is mounted on top of the base, directly under the cushion. As size and weight are not an issue, we included four rechargeable batteries to maximize the run-time of the system. Depending on the mode of operation the device can run several hundred hours on a set of batteries, assuring the applicability for long-term user studies.

The data from the cushion is wirelessly transmitted and received by a Smart-Its base station that is connected to a PC. This PC reads the data from serial line and provides access for applications to the data read by HTTP. This drastically simplifies access to the data for application developers. The cushion appears as a web server that delivers a dynamic page based on its state.

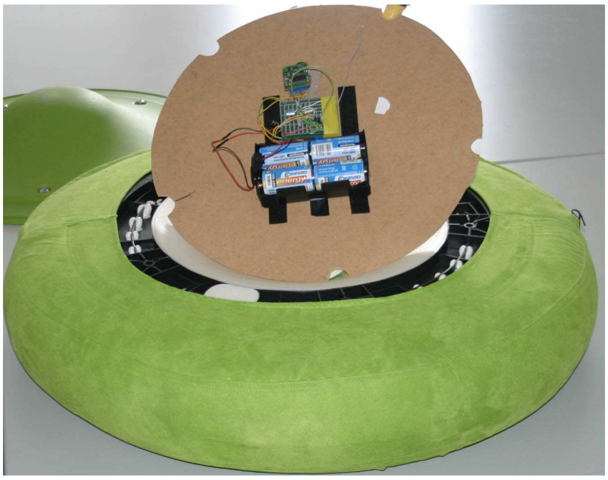

Figure 2. The open Virrig with internal components.

TOWARDS A USER INTERFACE

So far we have developed the sensing technology and connected it wirelessly to a backend infrastructure as described above. The degrees of freedom of the cushion are reflected in the following parameters. The input provided with the current version includes the orientation (0-360), the tilt state (in balance or tilted in one of eight directions, according to the state of one or two adjacent ball switches), and the pressure applied to the cushion (0-1024, where 0 means that it is not used and 1024 that someone very heavy is sitting or standing at the centre of the cushion). The controller resistance for rotation and tilt, as sensed by the compass and ball switches, is isotonic. The controller resistance for the pressure sensor is elastic. Depending on the transfer functions used, position or rate control can be implemented (see [7]).

To use the cushion with standard applications, these inputs can be mapped to conventional controls, such as cursor, joystick, and mouse movements. Alternatively the inputs can be translated into application specific control parameters.

In our initial tests we connected applications - that mainly visualize the state of the cushion - via HTTP. These were implemented in PHP and Flash MX 2004.

Currently we are investigating which applications can potentially be supported and what applications are fun with this specific device. We particularly look into the domain of learning and edutainment. One assumption we would like to have validated is that physical engagement with the controller will enhance the experience and eventually the learning success. For this we plan to run a user study with children. The device should be used as a controller to learning software (e.g. selecting answers in a multiple choice questionnaire answers).

CONCLUSION

In this paper we showed a piece furniture accessory that we have equipped with a set of sensors to detect user interaction. It integrates seamlessly into the environment and serves as an input device. Our favored field of application is the area of edutainment. We anticipate that users will be able to draw from both entertainment and physical challenge, thus enhancing the learning experience. A prototype has been built and user studies are planned as the next step.

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