Hidden touch: Passive touch output in tangible interfaces

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ABSTRACT

In this paper we explore passive touch as a means to give output in a tangible user interface. We present a new interaction style for giving secret information to digital tabletop game players through tangible play pieces that use passive touch.

Author Keywords

Tangible interaction, touch, play pieces.

ACM Classification Keywords

C.0 [**Computer Systems Organization**]: General – *hardware / software interfaces.* H.5.2 [**Information Interfaces and Presentation (e.g. HCI)**]: User Interfaces - *Haptic I/O, Input devices and strategies (e.g., mouse, touchscreen), User-centered design.*K.8.0 [**Personal Computing**]: General – *games*.

INTRODUCTION

The field of tangible interaction mostly focuses on how physical artifacts can give input into an interactive system. However, the original description by Ullmer and Ishii [14] states that the disctintion between representation and control should not exist, therefore both input and output should be provided at the same location.

In this position paper we want to explore the potential for tangible interaction to provide tactile stimulation on a prop that is simultaneously used as a tangible input means. We will show one small case study into using tactile stimulation to provide secret information to the user, which we call hidden touch.

RELATED NOTIONS

In this paper we will use the term *feedback* to include all kinds of information coming from an interaction, so also the feel of an artifact, which is not specifically designed to give information to the user. On the other hand *output* is used as a subset of feedback (and not as synonym), covering intentionally provided explicit information to the user.

In general we believe that in the field of tangible interaction there is room for exploring the tactile sense in the interaction. When we talk about tactile we mean the use of a body part to perceive something through the somatosensory system. This sensory system includes responses to touch, pain, body position and temperature. This is quite an extensive system, which can be subdivided in many ways, but a relevant one for this paper is Gibson's [5] distinction between *active* and *passive* touch. In the latter situation the user does not move his hand or finger, while during active touch he does. Both types of touch can be used in interaction with a tangible interface. E.g. active touch is when a user makes exploratory movements to feel a physical artifact, such as tapping, gliding and pressing (take a look at [13] for an overview of active touch movements that can be used in an interface). On the other hand with passive touch a user could just lay his hand on top of an artifact and the artifact could provide him with feedback, such as output through vibration.

In either case, we think that both active and passive touch raise interesting interaction opportunities within the field of tangible interaction. But output should be perceptible even without movements of the user, who might be unaware of output coming up, so we will focus on the exploration of passive touch for tangible interaction in this position paper.

RELATED WORK

Recently several studies have focused on tangible artifacts not only giving proprioceptive feedback (e.g. the feeling that you have moved an artifact), but giving output as well (e.g. intentionally provided explicit information for the user). This started with auditory and/or visual output, while later also physical output started to emerge, also called pushback tangibles [8], such as curlybot [4], the Weathergods bridge [1] and Topobo [12]. Another example is the Actuated Workbench [11], which moves pawns over a surface using electro-magnetic fields. However, the physical output of these examples is actually a form of visual feedback, since they do not aim to give direct tactile feedback.

Tactile and force feedback has been applied in for example interaction devices such as game controllers, 3D input devices, and computer mice (e.g., Logitech Wingman Force Feedback Mouse). However, the only tangible interfaces known to the authors that use both active and passive touch (in the sense that the user has to put his hand on top of the tangible artifact in order to feel the output) focus on human-human communication, also called social touch. For an excellent overview take a look at [7]. One relevant example is the inTouch [2], a personal communication system that two people can use across distances, where each device contains three rollers that you can move and the user at the other end of the virtually connected device can experience and interact with.

In this paper we focus on physical artifacts in the paradigm of tangible interaction, which give information to its user via the tactile senses in the user's hands. Note that of course there has been a lot of work done beyond this, including works that focus on the complete body, bodily interactions such as Larssen et al. [9] and on embodiment and phenomenology, such as Dourish [3].

HIDDEN TOUCH – CASE STUDY

For the case study described in this position paper, we focused on the context of a digital tabletop game with tangible interaction. We looked into how physical artifacts or play pieces can give output in a game. We distinguished three broad categories of information: 1 – personal information, such as the player's scores, collected items and status; 2 – game information, such as the level or time in a game; and 3 – the information about other players, e.g. position, relation to this player and strategy.

One recurring theme in all three categories was to provide the player with secret information, e.g. about other players or about the game. That sounded like a challenge and we decided to focus on giving players of a digital tabletop game information through their tangible play piece, which other players could not use. The type of secret information we focused on was directional information, e.g. give the player hints in which direction the invisible treasure is hidden in the game. We chose directional information because this does not require a new haptic language or creation of meaning (for an overview see [6]), since we wanted to focus on the creation of the artifact. During the game play the player will cover his artifact with one hand to either move it (as input in the game) or receive information (as output in the game). This leads us to explore the interactive possibilities of the tactile senses in tangible interaction, in particular passive touch.

For implementing this idea we looked at the types of passive touch that could be used, see Table 1.

Our application requires that the tactile output is invisible to other users. However, many of the listed output types are visible to others if they are not fully covered by the user's hand. Any means using externally moving elements, such as for example rotation, could be seen by other players if not covered completely by the player's hand.

HIDDEN TOUCH – ARTIFACT DESIGN

For our case study we decided to explore the options of vibration as output, implemented in such a way that it could not be seen by others when actuated: the Hidden Touch was born. We have applied a number of design iterations to investigate the communicative possibilities of this modality, using different locations (spatial) and different rhythms (temporal).

Output type	Feasibility
Temperature changes	Slow
Little electric shocks	Annoying
Texture changes	Difficult to implement
Rotations	Has potential
Massages	Has potential
Vibrations	Has potential
Little pin-pricks	Has potential

Table 1. A first list of ideas to implement touch output in a tangible play piece in order to provide secret information.

The input to our artifact comes from a display in a digital tabletop; therefore we came up with the idea to work with light sensors in the bottom of the artifact that would turn the vibrating motors on and off. The top of the artifact would then vibrate in the player's hand.

We started by creating working prototypes (all measuring about 3 x 3 x 3cm) in order to test whether giving directional information with different vibrating motors in one artifact would work. The first prototype (see Figure 1) consisted of two light dependent resistors (LDRs) on the bottom and two small vibrating motors (KE2 682) on top of a small cube of foam. For testing we put the artifact on a laptop screen folded horizontally and displaying an image as can be seen in Figure 2. We played a flash movie in which the white squares turned on and off, which was sensed by the light sensors and turned on the vibrating motors. The principle worked. However, the vibrating motors made too much noise and even if only one motor was on the complete object vibrated, not resulting in useful directional information.

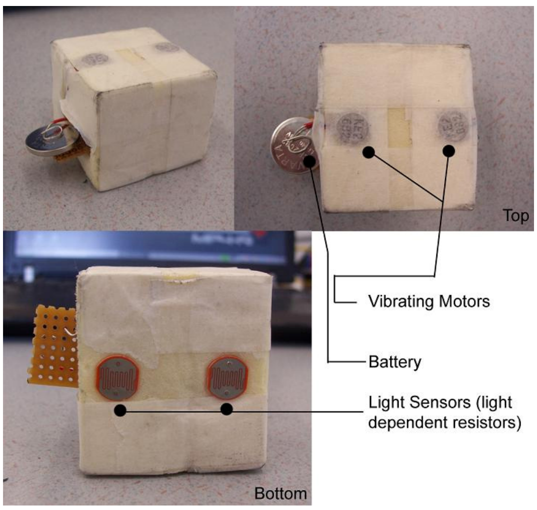

Figure 1. First iteration of Hidden Touch working prototypes.

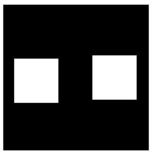

Figure 2. A test screen showing the black outline of the prototype and white squares at the location of the LDRs.

In the second prototype we added a piece of carpet on the bottom of the artifact to muffle the sound of the motors. This worked and had the advantage that the artifacts could not scratch the screen anymore. The carpet was also used internally in the artifact in between the two vibrating motors to isolate the vibrations. However, this did not help enough to identify the directional information.

The third prototype (see Figure 3) contained four LDRs in order to make a distinction between the four directions a play piece could be moved in the game and by combining two adjacent motors 8 directions in total could be communicated. Again carpet was used but did not isolate the directional vibrations sufficiently.

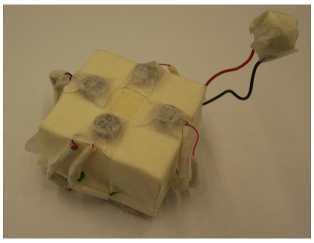

Figure 3. The third prototype with 4 LDRs and an external battery (top right).

For the fourth prototype we decided to not put the vibrating motors in the artifact, but on extensions protruding from the artifact. Unfortunately, the extrusions were created of a material that was not flexible enough, since it made the whole artifact vibrate again. Therefore in the fifth prototype (see Figure 4) we used the wires that connected the motors with the LDRs and the battery. Some extra wires were used to strengthen the construction and this worked. Using the screen animations, similar to the ones in Figure 2, we could feel the vibrations giving us clear directional information.

Figure 4. The fifth prototype's bottom (left) and top (right). During a game the player covers the top with his hand.

In Figure 5 you can see a 3D-image created of the final design of the artifact, taken into account the antennas, the LDRs and the size and shape fitting a digital tabletop game.

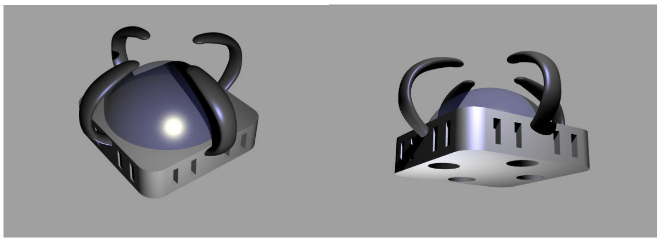

Figure 5. Rendered 3D images of the final design of the Hidden Touch.

DISCUSSION AND CONCLUSION

This preliminary work showed the first explorations of tactile stimulation in tangible interaction, in particular passive touch using vibration feedback. We have demonstrated that even this one type of, rather straightforward, passive-touch based artifact could create a new gaming experience with interesting potential. Apart from vibration feedback we think it is worthwhile to explore other types of tactile stimulation in tangible interaction, and study their communicative abilities in more detail.

ACKNOWLEDGEMENTS

We thank Sriram Subramanian and the User Experiences group of Philips Research for their input and support.

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