Visceral Interaction: there is more to the Perceptual User Interface than meets the eye

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Abstract. This paper introduces visceral interaction, which we believe complements the vision of Perceptual User Interfaces (PUI) in creating more natural and intuitive interfaces. We describe a study that highlights the importance of recruiting user's natural abilities in physical manipulation so long as devices possess key features of physicality, in this case the 'natural inverse' property. The device, a Cubicle, controls a media application, but the mapping between the device and its effects were deliberately manipulated. Despite a lack of understanding of the mappings, the participants were able to react appropriately to feedback by merely focusing on the visceral interaction.

Keywords: physical interaction, Cubicle, tangible interfaces, user experience

1 Introduction

Undoubtedly, our everyday interaction with everything in the real world requires perceptual and motor ability on our part in order for us to comprehend the world and for us to take any action towards that understanding. Turk and Robertson describe how Perceptual User Interfaces exploit these abilities:

> *PUIs are characterized by interaction techniques that combine an understanding of natural human capabilities (particularly communication, motor, cognitive, and perceptual skills) with computer I/O devices and machines perception and reasoning [5].*

However, the key characteristics of PUIs are largely focused on establishing human–computer interactions that more richly exploit inter-personal aspects of human abilities: the passive monitoring of posture, eye-gaze etc. combined with speech, gesture, etc. In contrast research on tangible interfaces is clearly building on human physical abilities.

The contrast between inter-personal communication and physical manipulation was also evident 20 years ago in the emergence of direct manipulation and the GUI interface! There are however significant differences between the syntactically rarified and heavily formalized command languages of pre-GUI interfaces and the rich perceptual nuances and tacit body language being interpreted by the PUI.

Strangely, in the early days of the GUI, Buxton argued strongly that physical devices used in graphical interactions should not be similarly reduced to abstract devices

for pointing, text input, and selection [2]. He used children's drawing toys to emphasise the subtle differences between, for example, using a joystick to draw as opposed to the multiple knobs of Etch-a-Sketch. However, whilst there is a line of research that has preserved his vision, the broad thrust of GUI practice has elided the differences between mouse, trackpad, or joystick and followed blindly the path of abstraction.

In this paper we want to re-emphasise the importance of the detailed physical aspects of devices and the way in which these can recruit our natural human abilities. We call this *visceral interaction*. This will be exemplified by a short study of the Cubicle, small cubic devices that have been proposed as a tangible input device [1, 4]. In the experiment we manipulate a system so that the visual affordances make mappings between device and effect more or less natural. That is, in Norman's terms, we manipulate the naturalness of the mapping [3]. However we deliberately preserve critical aspects of physical interaction. Despite the often complete breakdown in explicit understanding of the device–system mappings, the users were able to successfully complete task and moreover enjoy the experience.

2 Cubicle Experiment

The Cubicle experiment was designed to study the Cubicle's performance as an input device in terms of ease of calibration and manipulations, and also experience and user preference. Furthermore, a within subjects design was used in order to investigate to which type of mapping of control surface led to the best the calibration and manipulation performance, and also to examine whether this type in any way influences the playful experience.

We used a Cubicle application developed by Block et al., [1] intended as an input device for playfully changing between different TV-channels. In particular, the Cubicle was used to select movie trailers for Alien, Die Hard, James Bond, Love Actually, Lord of the Rings: return of the Kings and Matrix, from a screen by manipulating the cube. Table 1 shows the ways in which a user could manipulate the cube to control the TV image.

Table 1. Cubicle actions and the associated GUI output

Action	GUI output
Rotation	Display different movie trailers' images Full image of a movie trailer being displayed selects a movie trailer
No action (cube is placed on a table, or is held parallel to the ground)	Zoom out and play a movie trailer, provided that at that time the screen was showing just one side of the cube (one full image of movie theme)
Shake	Return to initial orientation (correct the calibration), or, zoom out the display if the application was playing a trailer (thus stop/pause the trailer)

The Cubicle itself constructed of wood with sides approximately 3 in (7.5 cm) (see Fig. 1). It was augmented with accelerometers hidden within the wooden case. The sides were numbered 1 to 6, but without any images if the movies or other indications of meaning. This meant that the mapping between the cubes movements and its digital effects could be 'soft' and reprogrammable. In order to help the user to understand the effects of the Cubicle, it also has an on-screen representation of itself. In this digital representation the sides each display a title image for the associated movie.

Fig. 1. Wooden Cubicle

The study to be semi-exploratory, hence the instructions given to the participants (Table 2) included some prescriptive tasks, but also space for exploration. Out of 14 participants, eight come from the Computing department, three from Psychology, one from Accounting Finance department and two participants were in their A-Levels. More than half our participants were men - 9 male, 5 female. Five participants have used alternative input devices, such as haptic gloves, and two of them have used the Cubicle interface before.

Participants were first given time to familiarize themselves with the Cubicle interface. The next two steps were to give participants the idea of selecting a movie trailer by carefully rotating the Cubicle. The rest of the instructions/tasks were carefully designed to observe how participants manipulate the Cubicle, i.e. the calibration (if any), expressions, as they selecting the requested movie trailers.

Nonetheless, because of the novel nature of the Cubicle and the limitations of the technology, we realized that these tasks were more likely to explore the limits of interaction rather than to provide solid quantitative data.

Participants were asked to complete four sets of test by using the same list of instructions. Each set represents a condition of numbered or unnumbered cube coupled with face- or top- aligned, in which its objective is to establish of the users with four different mapping conditions.

The order of these four sets was varied and partially balanced in order to measure and compensate for order effects.

Table 2. List of instructions

1.	Pick up the cube
2.	Play around with the cube, until you feel comfortable

3. Then, manipulate the cube in your hand(s) so that any three sides of the cube visible on the screen
4. From 3, make one of its side (left or right) visible on the screen
   Please tell instructor when you are done
5. Select Matrix trailer
6. Place the cube on the table
7. Watch the movie for a few seconds
8. Pick the cube up again
9. Select a different movie trailer
10. Then place the cube on the table, or make the cube parallel to the floor
11. Watch the trailer that you just selected for a few seconds
12. If you placed the cube on the table, pick the cube up again, or continue moving the cube
13. Now, resume the Matrix trailer
14. Place the cube on the table once you select this
15. You can now browse to any other trailers available if you are interested
    Please tell instructor once you finished

3 Visceral Interaction

We anticipated the act of calibration between the Cubicle in their hands with the virtual cube on the screen from the participants – but this was hardly occurred. Instead, what we observed was a similar pattern of manipulation act toward the Cubicle – participants heavily relied on *visceral interaction*. They more focused on the screen rather than on the physical device and responded appropriately to feedback.

Participants all followed the same general pattern. They commenced the first few steps of each condition with an attempt to establish a correct mapping between the physical and its effect on the screen. But this act didn't sustain very long. Together with the fact that the condition they were in was not disclosed, we could see the participants struggled when trying to cope or match their movement with the movement of the virtual cube on the screen, even with the numbered cube. And, even though on few occasions they were able to establish calibration, they were not able to maintain this and were clearly quite frustrated when they could not cope with the mappings. Eventually all the participants abandoned their attempts to calibrate and understand the cube mappings and then proceeded to successfully accomplish further steps. Over subsequent trials, independent of order of conditions, each participant's attempts to calibrate became progressively shorter. However, despite all this, they still managed to successfully complete tasks, and enjoyed it at the same time!

Figure 1below illustrates how much the participants enjoyed the whole experience of interacting with the Cubicle. General comfort and fun, are a lot higher compared to both physical and mental effort and frustration. And although we can see from the figure that the mental effort was rated higher than physical effort, this does not necessarily means that it has contradicted to what we've just described about visceral interaction. Most participants referred the mental effort attribute to their initial foray in establishing correct calibration or mapping of the physical movement of the cube in

their hand(s) with the virtual cube, whereby gradually in time they admitted less effort were required from the mental aspect.

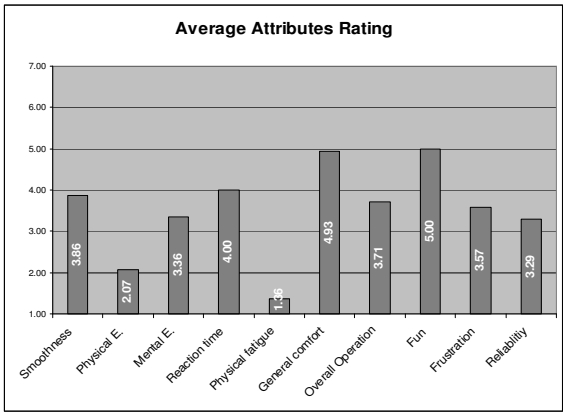

Fig. 1. Average property rating.

Why is it that despite failure to establish a mapping the participants were able to successfully and enjoyably manipulate the Cubicle? As previously mentioned in the introduction, we believe this is due to *visceral interaction*, the physical aspect of device which recruits our natural human abilities. In particular, the Cubicle had *natural inverses*. At any moment the participants did not how a physical rotation of the Cubicle would translate into rotations of the virtual cube. However, it was always true that the reverse of a particular rotation moved the cube in the opposite screen direction. This means that without explicit conscious deliberation 'errors' would be corrected in a sort of constant exploration of the momentary mapping. This is exactly like the interactions we have with physical objects in the real world.

From our observations, participants preferred not to dwell too much time on understanding the mapping, especially when their attempts never seem to make any differences. They, rather, remarkably, found it easier to manipulate the Cubicle by just paying attention to the visceral interaction. By doing so, the participants didn't need to plan their action; all they had to do was responded to feedback in a very direct perceptual–motor cycle with apparently little explicit cognitive understanding. Even though the mapping established was strange and ever changing, it was impressive to see how the mind and body works in unconsciously comprehending the physical and virtual movements in order to complete the tasks.

This 'carefree' and intuitive act definitely shaped their attitudes toward the Cubicle. We observed participants enjoyed their interaction with the Cubicle and this resulted to more playful, fun experience. Several of the participants commented on this,

"Good fun :-)"

"Great device, enjoyable experience (would like to use again!)"

These participants also spent a longer time watching the trailers.

4 More than Meets the Eye

Turk and Robertson characterise PUI as perceptive (rich sensing of users by computers), multimodal and multimedia interfaces, the integration of these would no doubt create more natural and intuitive interfaces [5]. We share the same vision, which is to seek and to achieve for more general and intuitive ways of interacting with technology. However, the broad thrust of perceptual user interfaces is towards rich capture of physical data and deep processing within the computer, whilst visceral interaction recruits deep-seated human abilities to manipulate physical objects.

From the Cubicle study, we have discovered that despite the 'failure' of calibrating the mapping of the physical cube with the virtual cube, participants still able to complete tasks, and enjoyed it! Normally in user interfaces a poor mapping between action and effect would be regarded as crucial [3], but visceral interaction has enabled participants to overcome the cognitive complexity of the 'impossible' mappings. The intuitiveness of natural inverses enabled successful task completion, and the participants had such fun!

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