EMBODIED INTERACTION DESIGN IN ENGINEERING EDUCATION USING ASUS XTION PRO

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ABSTRACT

How does a design of emerging embodied technologies, such as *Asus Xtion Pro,* enrich the HCI learning processes in Engineering Education? The fifth semester engineering students used the motion sensing input device, *Asus Xtion Pro* (similar to *Microsoft's Kinect*), for the design of an embodied interaction tool for children. They designed a gesture-based painting tool, and the users painted in different colours using pencils in different sizes. The prototype was tested on school children from the third grade. The platform was interesting as a design tool because it appealed to full body interaction. During the test, they experienced that hand gestures, full body interaction and playfulness often were linked. The digital design process enriched the HCI learning processes, and the students successfully developed their own prototypes. The students reflected on HCI and design issues based on real embodied prototypes. In other words, the students learned by designing and reflecting.

KEYWORDS

HCI and Design Education, Interaction, Engineering Education, Learning, Embodiment.

1. INTRODUCTION

How does a design of emerging embodied technologies, such as *Asus Xtion Pro,* enrich the HCI learning processes in Engineering Education? Embodiment integrates how having a body affects interaction design (Pfeifer, 2007). Last autumn, my fifth semester engineering students used the motion sensing input device, *Asus Xtion Pro* (similar to *Microsoft's Kinect*), for the design of embodied interaction tools for children. The platform was interesting as a design tool because it appealed to full body interaction.

The design was part of a course in physical interaction design where the students explored other interactive platforms than PCs and tablets. The students developed a painting application where the end users painted in ten different colours by waving one of their hands.

Basically, we have three types of technological platforms for physical and embodied interaction: Touch and Tangibles, Interactive Wearables and Interactive Surroundings. In actual designs, the platforms might be integrated. 1) Touch and Tangibles are devices such as smartphones, tablets and interactive cubes (Majgaard, 2011; Sharp, 2007; Dourish, 2004). Dourich denotes embodiement as a kind of participative status that combines physical and symbolic interaction (Dourich, 2004:207). 2) Interactive Wearables are technology attached to the body, such as google glasses, gps watches, heart-rate monitors, interactive clothes, accelerometers etc. 3) Interactive Surroundings are Sensor Networks such as camera tracking and hands-free speech recognition and motion sensor devices such as Microsoft Kinect or Asus Xtion Pro. The motion sensor device introduces a natural form of interaction (Melgar, 2012; Willaroman et al, 2011). And exploration of this type of interaction in HCI courses can become very instructive. Kinect or Asus Xtion can provide activities that aid in the study of natural user interaction that would otherwise be unavailable. Willaroman et al suggest learning activities such as: (1) "Study how cognitive principles, affordance, and feedback should influence the design of Kinect controlled interfaces in desktop computers;" (2) "Design and implement for a specific application domain – such as web browsing;" (3) "As an emerging technology, exploring how Kinect or Asus Xtion can help advance the field of gesture-based, natural user interaction;"

(4) “Test and analyze whether usability and user-experience requirements can be met with the current capabilities of the Kinect-enabled user interfaces.” In our course, the students designed, implemented, and user-tested a specific application.

In this study, we want to investigate the relationship between emerging technologies, natural interaction, and learning activities. Our teaching and learning perspectives are based on exploratory and reflective learning. This is supported theoretically by Schön (1983), Papert, (1993) and Bateson (2000). The students basically learn while they are exploring and designing new prototypes. In the classroom and in project work the students reflect on their design ideas, concepts, programming, target groups, and test results. Active participation and reflection is the core of learning (Bateson, 2000; Wenger, 1998). The overall question explored in this paper is:

How does a design of emerging embodied technologies, such as Asus Xtion Pro, enrich the HCI learning processes in Engineering Education?

First we describe the study and research method. Then we describe the motion device, the designed painting prototype, and the user test. The HCI learning loops are illustrated focusing on the interplay between the students and children in real-life situations. Finally, we summarize and conclude.

2. STUDY AND METHOD

The students were fifth semester students from the engineering programme, *Learning and Experience Technology*. *Learning and Experience Technology* is a 3 plus 2 years IT Engineering Program. The overall learning goal of the course was to design interactive tools for play and learning. The designs should be based on other media than traditional PCs. Each student did an individual programming assignment and participated in team-oriented project work. As a part of the project work, the students conducted field observations of the target group and they also tested the interactive prototype on the target group. In order to get started on the technological platform, the students read and did exercises from the book, *Arduino and Kinect Projects* by Melgar and Diez (2012).

The research method used in this study is based on Design-based Research and Action Research (Majgaard, 2011; van den Akker 2006; Lewin, 1946). Design-based Research is a branch of educational research that uses the iterative design of educational interventions to exemplify and develop theories of learning. Action Research brings a change in the behaviour of the target group into focus and allows emerging goals. Experiments and critical reflections are the core of the research method, allowing learning from and through practice. The interventions take places in the target group’s natural surroundings e.g. in the classroom.

3. TECHNOLOGICAL PLATFORM

Asus Xtion Pro is a motion sensing input device for Windows PCs, see the figure 1 (a) below. Asus Xtion Pro (no RGB camera) and Xtion Pro Live (RGB camera) were released in 2012. The Asus Xtion Pro was based on an infrared camera that enables users to control and interact with the computer without the need to touch a game controller. The interaction takes place through a natural interaction using the body and hand gestures. A similar product on the marked is the Microsoft Kinect and they compete with the Wii Remote and Eye Toy.

Figure 1. (a)The open platform Asus Xtion Pro (Asus, 2013); (b) IR Projected light on a blank surface; (c) 3D image based on IR information

Asus Xtion makes use of an infrared camera for recording the movements of the user and the recordings are based on variations in depth. The camera has two lenses: one lens projecting an infrared grid, see the figure 1(b) above; the second lens captures and creates a 3D image, see figure 1(c). The closer, the object is to the IR camera, the whiter is the image. The Asus Xtion connects by USB to a PC. The software development kit is called OPEN NI (2013) and it offers methods for skeleton tracking, hand-point tracking, and gesture recognition. The programming was done in programming environment *Processing* and is based on simple Java-like syntax.

4. THE PAINTING APPLICATION AND THE USER TESTS

The painting application was the result of the project work. The graphical part of the interactive painting prototype was divided into two equal parts, see figure 2 below. The left side showed the user's painting and the right side showed the representation of the infrared 3D image. An invisible colour pencil was attached to one hand. The pencil was displaced from the centre of the palm to the fingertips. This worked intuitively correct. The registration of the user's hand was done by waving in front of the camera. To control painting functions, an Arduino board with three buttons was used: (1) One switched cyclically between 10 different colours; (2) The second deleted everything that was painted on the screen; (3) The third switched between five different pencils.

Figure 2. Testing the interactive drawing prototype (the star is subsequently made more colourful)

The test was conducted in the students' classroom. The testers were four school children from the third grade about 9 years old, see figure 2 above. The test description is based on quotes from the students' test log and the oral examination: "the girls were excited about the test and the program...". They tried to paint Harry Potter, stars, dogs etc., and they learned quickly how to use the programme", wrote the students. The programme had some bugs, e.g. the hand recognition deadlocked. The students wrote: "When the program went into a deadlock, the children helped each other and restarted the programme." The students observed that the girls took their own playing activity into the testing process: "They took turns to paint and they started to dance and sing while they were waiting. They could see their own IR image while they danced and this made it more interesting". After the test, the students made a short interview. They asked the children what they liked about the programme, and what could be done differently. They got the following suggestions: use the feet as a pencil instead of hands; draw on top of another picture; eraser; undo button; more colour options; insert squares, circles, triangles, etc. The children found it annoying that they had to wave so much to start drawing. And they found the infrared camera was more fun than a normal camera. And they would like the students to develop structured gaming elements, e.g. a competition to draw a human or an animal and receive points.

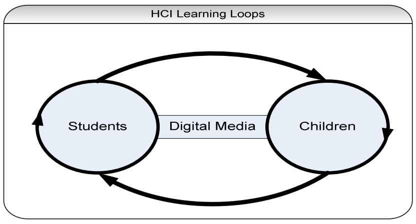

Figure 3. HCI Learning Loops

The above figure 3 illustrates the students' and children's learning loops. First, the students' learning process took place during the iterative design process illustrated in the left cycle. The cycle on the right side illustrates the children's playful learning process. The cycles are learning loops of action and reflections (Schön, 1983). The digital media were developed and understood in interplay between students and children. The media constituted a community of practice (Wenger, 1998). Secondly, the students learned while they watched the media in use. The arrows between the students' and children's learning cycles illustrate the dialogue, instructions and feedback that took place. Altogether, the figure illustrates learning processes in real-life situations.

5. SUMMARY AND CONCLUSION

In this paper, we explored how a design of emerging embodied technologies, such as Asus Xtion, can enrich the HCI learning processes in engineering education.

The motion device, Asus Xtion, is very promising for exploratory design of gesture-based and full-body interaction. The available software package made it possible for the students to design interactive prototypes. In the beginning they had all kinds of practical installation problems, but soon they were all up and running. There were some ongoing usability issues with hand recognition.

All the students managed individually programming of the device, one of the students made a traditional pong game, another combined a music video and the user's body as a skeleton; a third drew circles, and a fourth used the hand as a computer mouse.

The project work resulted in a painting application prototype. The users used their hands for painting and they painted in different colours and used pencils in different sizes. The prototype was tested by four school children from the third grade. The students got a lot of useful feedback from the testers. The feedback fell into three categories: (1) *Usability issues* such as deadlock situations and the hand recognition problem. (2) *Creative ideas* e.g. painting using feet instead of hands. (3) *Unexpected playful use*. The girls danced and sang while they were taking turns. If the painting application was to be developed further, there are exciting possibilities for full-body interaction, participatory interaction, and creative interaction.

All together, the motion device, Asus Xtion, enriched the HCI learning processes in the classroom. The students successfully developed their own embodied prototypes, and during the test, they experienced that the full-body interaction and playfulness were linked. The students reflected on HCI and design issues based on real embodied prototypes.

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