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Sonic interaction design: case studies from the Medialogy education

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Abstract.
In this paper, we share our experience with students' projects undertaken during the Spring Semester 2007 of the Medialogy education at Aalborg University in Copenhagen. We describe different projects which combine problem based learning with interaction and sound design.

1 Introduction

Medialogy is an education which was established at Aalborg University in Denmark in 2002. The main aim of Medialogy is to combine technology and creativity in the design, implementation and evaluation of interactive media products.

As part of the Medialogy education, the problem based learning (PBL) approach is adopted [3], in which students spend the first half of a semester following courses, and the second half solving a problem through a project.

In this paper, we introduce different projects implemented during the Spring semester 2007 in the 4th Semester of the Bachelor Medialogy education at Aalborg University in Copenhagen. Three sub-themes for projects were suggested: sound in games, alternative musical instruments and sound in products. Students were divided in 8 groups of 5-6 people each. The projects implemented by the students covered all these three categories.

The theme of this semester was Interaction design. Students were asked to find problems related to the design of a physical interface embedded with sensors, with auditory feedback, and evaluated using usability techniques.

2 Interaction design

In the pedagogical system developed at Aalborg University, each semester has a theme. Such theme is supported by several courses, known as project supporting courses (abbreviated as PE courses in danish). All students, working in groups, develop along the semester a project which is related to the theme and uses knowledge and experience obtained following the courses.

In this particular case, the theme of the semester was Interaction Design. Students learned how to design and build new interfaces embedded with sensors. At the end of the semester, they built physical objects which could be touched, squeezed, moved around, and which sent information of such actions to the computer. Students also acquired skills in sound design and how to program sound effects. Moreover, they learned about design principles, usability studies and evaluation techniques for interaction design.

The courses described in the following section are the PE courses supporting the project.

3 Description of the courses

3.1 Measurement of user experience

Measurement of user experience is a 2 ECTS course. The main goal of the course is to persuade students that probability of developing really useful products highly increases by involving all stakeholders into the design process as early as possible, even at the idea stage. [5] is used as a textbook for this course, as it fully advocates the main goal of the course. But, somehow students tend to believe that usability testing could be done only at fairly advanced prototypes however, in order to show them the opposite, an example from praxis is used. [2] describes how professionals from a major mobile-phone company (Nokia) are using paper-prototypes for testing a new WAP-phone. That article is used as additional course material. The students are encouraged to perform different usability procedures and testing several times during the project work.

3.2 Physical Interface Design

The Physical Interface Design course is a 1 ECTS course. The course provides the students with knowledge about design principles regarding physical interfaces and physical computing. It is also the aim of the course to connect the other courses of the semester in a meaningful way demonstrating their importance on a more global scale.

During the course the students are presented with design fundamentals that apply to everyday physical interfaces (telephone, coffee machine, bottle opener, etc.) using Donald Norman's *The Design of Everyday Things* [4] as main reference.

Extending these fundamentals the students are furthermore presented with the advantages and additional challenges provided by the integration of new media and the new interaction capabilities, entailed by this integration.

Everything is taught from a user centred point of view. During the course the students are presented with related projects from the real world of physical computing showing where the design is successful or has failed. During the last lecture the students create their first physical interface using a kit of simple sensors and materials provided to them.[1] They produce a video explaining their decisions and present their creation.

3.3 Audio design

Audio design is a 3 ECTS course which introduces students to the concept of digital sound manipulation and synthesis in real-time. As a prerequisite, students have basic knowledge of auditory perception, but have generally no previous experience with sound design and sound synthesis. The class is divided into a theoretical part in which concepts of sound design are taught, and an hands on part in which the theories are implemented in the real-time environment Max/MSP.[2]

The course starts by introducing the concept of digital audio (sampling and quantization) and sound effects in time domain such as loop, delay, echo, flanger, chorus, etc. Then the concept of a digital filter is introduced, and different filters such as low-pass, high-pass, band-pass and comb filter are presented.

In the second part of the course, sound synthesis is taught, and the advantages of creating sounds from scratch as opposed to manipulating existing recordings is discussed. Different synthesis techniques such as additive, subtractive, modulation synthesis (ring modulation, amplitude modulation and frequency modulation), as well as granular synthesis are introduced. For each technique, examples are illustrated of its use in interactive applications such as game and digital arts. Moreover, exercises allow the students to experiment on their own on the technique.

Given the difficulty of finding an appropriate textbook for the course, the instructor decided to write her own lecture notes.[3] This proved to be rather beneficial for the students.

Creating sounds from scratch which are aesthetically pleasing is a rather complex task, especially for unexperienced students. As it will be discussed during the description of the projects, some students were quite successful in achieving this goal, and rather proud of their result. Others preferred to work on existing samples and manipulate them according to their needs.

3.4 Sensors Technology

Sensors Technology is a 3 ECTS course, divided in 15 lectures. As work with sensors implies work with electronics, the course introduces electronics, with special perspective on sensors, and their utilization in context of user interaction with rich media software applications.

This stated coverage of the course content, can sometimes span several semesters and different courses in traditional bachelor electronic engineering studies. To manage to fit all these discussion areas in a meaningful manner in a single semester course, the course is organized as follows. It starts with a brief discussion of the concepts involved in interfacing software and hardware (including data acquisition hardware), and continues with a brief review of atomic theory, including the concept of free electron, and electric properties of matter. Elementary electrostatics is introduced, on a microscopic scale, as a basis for understanding voltage - and extended to the context of conductive materials, and Ohm's law on a macroscopic scale. This leads to a brief overview of circuit theory, where elementary analysis techniques are introduced, from which the voltage divider is central (as being both relatively easy to analyze, and being applicable with a number of off-the-shelf sensors). At the same point, a hydraulic analogy to electric circuits is introduced, as a tool to simplify the discussion of the different electronic elements.

The circuit theory stays mostly on the level of DC analysis with resistors. From that point on, an introduction to the capacitor, diode, and transistor are given, as elementary electronic elements. The main discussion focuses upon their role in an electric circuit, and a corresponding hydraulic analogy; several elementary circuits are provided for each element, along with analysis. Using linear approximations as models (where possible, say for the diode and the transistor) allows that the analysis stays within the linear domain,

[1] Teleo Starter Kit, two potentiometers, one button, one strain gauge. Implemented using Max/MSP.

[2] www.cycling74.com

[3] Available online at: http://www.media.aau.dk/~sts/ad/

and remains simple. In addition, sensor variants of each element are discussed.

The course concludes with discussion of the operational amplifier as a circuit element, as well as a brief overview of available, more complex sensors (like IR distance detectors), which provide relatively simple electric interfaces. During the course duration, in-class demonstrations (during lectures) and lab exercises (after lectures) are held, where the students solder and measure the circuits discussed in class - which provides the elementary experience with circuit assembly and soldering, prerequisite to the application of sensor technology in the semester projects.

Given the difficulty of finding an appropriate textbook for the course, the instructor decided to compile his own lecture notes, as well as produce several visualisation applets.[4] Since this was also a need for the audio design class, it seems like a suitable textbook covering topics related to the Audio mostly conference is needed.

Students also learn how to interface different sensors to the Teleo starting kit[5] and the Arduino board.[6]

4 Description of projects

According to the pedagogical model developed at Aalborg University, all projects start with the formulation of an initial problem. Through the development of a product, students can address the problem, and evaluate if it has been solved from a human centered perspective. It is therefore important for the students not only to be able to develop and application, but also to put it in a context and properly assess the validity of their solution.

Students were allowed to choose the problem statement they wanted to address. The only limitation imposed was the need for the application to be interactive, to contain an alternative sensorial input and auditory feedback, and to be evaluated according to the techniques learnt in the Measurement of user experience course.

To delimit the choices, three themes were offered:

Three groups worked on sound in games: the first group built an alternative physical interface to a ball game, which was implemented in the form of a squeezable ball with pressure sensors and accelerometers. The second group designed a game in which players were asked to interact at a certain tempo, while the third group designed a game in which players were wearing a physical interface capturing jumping. Concerning the theme of alternative musical instruments, one group designed a ”soundgrabber”, i.e., an interface in which sounds could be moved around in space and thrown away with physically meaningful gestures. A second group designed a new interface to enhance singers’ performances. Concerning the last category (sound in products), one group designed a wobble board enhanced with sensors, in order to be able to control a game with auditory feedback for enhancing the experience of reabilitation. Other groups examined how new forms of interaction and auditory feedback can improve ordering services in a bar or helping reducing the use of electric appliances for reducing global warming.

4.1 Beat-bandit

This group explored the possibility of designing audiovisual games in which audio is an intrinsic part of the gameplay, and investigated if a physical interface can make the user more engaged in the sensation of audio.

To achieve this goal, they designed a game called Beat-bandit, in which the player is asked to shoot some targets following a beat, in a similar fashion as done in the game Rez for Playstation 2 by Sega (2002), but with the aim of designing a less abstract game environment.

The controller designed to play the game was a plastic gun enhanced with IR sensors. The sensors technology adopted showed some lack of precision, which prevented proper testing of the complete setup.

16 subjects tested the game and completed a questionnaire. Figure 1 shows a test subject while trying the beat bandit game with a traditional mouse and keyboard interface versus the gun interface. Overall, the test subjects enjoyed the fact that they were supposed to follow a beat, but had difficulties in understanding properly the rules of the game and which rhythm they were supposed to adjust to.

Figure 1: Subjects testing the beat bandit game.

[4] Available online at http://media.aau.dk/∼sd/st/
[5] makingthings.com
[6] www.arduino.cc/

4.2 Game mechanics' effect on score

In this project, students addressed the statement formulated in [1], claiming that in games that use sound effectively, an expert player's score is lower with the audio turned off that it is when the audio is turned on.

The group was interested in extending this statement and investigating the effect of using an alternate controller together with sound effects and see if this increased the player's score. To achieve this goal, an alternative controller shaped as a hand-held ball was designed, embedded with four pressure sensors and one accelerometer, as shown in Figure 2. Such controller was inspired by the Squeezables developed at the MIT Media Lab [6].

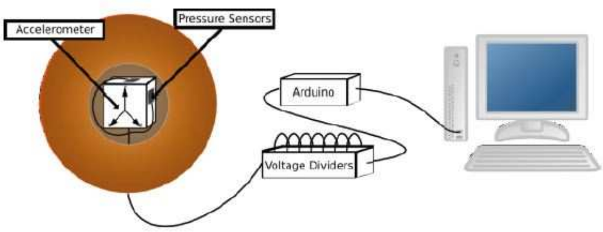

Figure 2: The controller designed to test the game mechanics' effect on score.

The game was tested with novice and expert players (in this case the developers of the game). Results show that novice players had a hard time adjusting to the new controller, while expert players performed slightly better while using the novel controller compared to the traditional keyboard.

The effect of audio on the player 's performance was also tested, and proved to give no conclusive increase when playing with or without sound, both in the expert and novice tests.

4.3 "SSS" - Jumping 2D platform game

This group started with looking for means to increase the physical activity of players during game playing. The resulting product is a traditional 2D game, implemented in Adobe Flash, where the user interacts through a handheld button device, and a couple of FSR sensors fitted on the users shoes. The user can control the game avatar by physically jumping and crouching. The project report, besides game design, discusses traditional 2D platform games, as well as problems of perspective of the user and immersion; audio design of game sounds using FM and granular synthesis; and problems of sensor implementation, fitting, and interfacing.

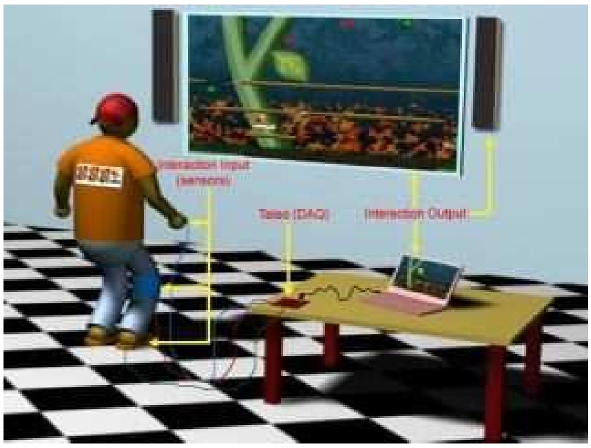

Figure 3: A setup diagram of "SSS" jumping 2D platform game.

4.4 Sound grabber

The main idea behind the sound installation called Soundgrabber is to understand if it is possible to touch a sound by grabbing it from a bucket and positioning in different locations. As can be seen in Figure 4, the Sound grabber is a physical interface designed as a semi-circle, enhanced with four cones. At the bottom of each cone a speaker is placed. Each cone is embedded with light sensor, which allow to detect the distance of objects from the cone itself. The user interacts with the Sound grabber using a glove embedded with a bend sensor. By bending the hand inside a bucket, users are able to grab a sound, listen to it (thanks to the speaker embedded inside the glove) and release it in one of the bucket.

The Soundgrabber was publicly demonstrated at the Sound Days event in Copenhagen in June 2007. Sound experts and naive visitors tried the installation, and provided enthusiastic feedback. Figure 4 shows a visitor at the event.

4.5 Singer interface

The idea of this project was to empower a singer to manipulate her own voice in real time, while singing on the stage. The singer should use a handheld device, in a form of a short stick. The device should, by help of two dual-axis accelerometers, be able to measure 3-dimensional acceleration of singers hands moving during the performance.

Depending on direction of acceleration (up/down, left/right or front/back), different filters could be activated and would modulate the voice. Implemented effects were: delay, flanger and tremolo. The group

Figure 4: The sound grabber at Sound Days.

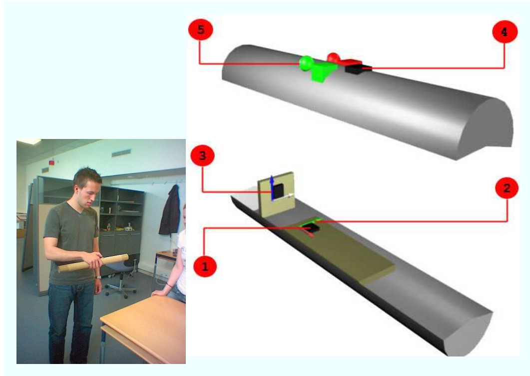

Figure 5: A fellow student testing the device (left) and Cross-section image of the Control Device 1) Sensor 2) X-axis of Horizontal sensor 3) X-axis of Vertical sensor 4) Button 5) LED- diode

worked with a singer and performer, and tested a prototype with her. Based on her experiments with the device, the group concluded that significantly more work is needed before they might produce a useful device. Although in technical sense mapping between performers motions and sound filters works correctly, there is a huge issue how to make this mapping natural, in a sense that a desired effect is achieved during stage-performance, and it feels natural for a singer.

This was yet another example of an ambitious project, where the students did not succeed to leverage the whole potential of the technology they had in hands, and where usability issues were greater than technical matters.

4.6 "BarZar" Bar Ordering System

This group started by thinking of ways to improve the efficiency of the process of ordering drinks at a bar. The resulting product is a system, consisting of a screen, PC and corresponding button sensors, to be fitted on each bar table for the customers, and one fitted at the bar for the bartender. The software is implemented in Adobe Flash, PHP and a database backend, and both an administration and a user interface are demonstrated. The project report, besides application design, discusses other systems of similar kind; how a typical auditory environment in a bar is taken into account in design of application sounds; and problems of sensor implementation, fitting, and interfacing.

4.7 Wobble active

This is an example of apparently modest, but overall very well executed project. A wobble board is a device for ankle rehabilitation after an injury. It is documented that exercising on a wobble-board is a very efficient way to rehabilitate ankles, both after sport injury or after any other kind of ankle injury. The issue is that the wobble-board training is quite boring, and patients tend to neglect it, as soon as they stop feeling physical pain although prolonged exercises are critical for successful rehabilitation. The students group had an idea to use a wobble board as an input device for a computer game, as they assumed that playing games would increase motivation of doing otherwise boring exercises. They cooperated with a physiotherapist during the project, trying to develop a simple arcade games that would encourage proper exercising. The main idea is that with a help of 4 bending sensors it is possible to measure inclination of the board in space, and to map those inclination into mouse movements on 2D screen. The group also implemented a very interesting way of clicking in the game, by keeping the position constant over a certain field for a certain amount of time. Combining with left/right and up/down motion, the wobble active board this way can perform all functions of a computer mouse. Moreover, as it is well known that balancing is much more difficult task with eyes closed, the group made experiments with sound feedback lower and calmer sounds for equilibrium states, and more loud sounds when the position of the wobble board is approaching undesirable states. The group made a functional prototype together with two tested games, the physiotherapist they have been working with has shown lots of appreciation for their work, and they are now looking for other possibilities in using this project.

Figure 6: A scenario of use of "BarZar" bar ordering system.

Figure 7: Top view. 2: Side view. 3: WobbleActive in action. 4: The underside.

4.8 AntiC02

The main idea of this project is to design a prototype of a home-system which will inform the users that their energy consumption is too high. For example, one of the cases when the system should react is when the window is open, and the radiator under the window is on. The energy is clearly wasted at that point. Measures could easily be done with several touch and temperature sensors, so that part of the project was not a big challenge. The main challenge is: what the nature of the feedback should be? If the message appears on some screen, it can easily be ignored. Sound comes as a natural choice but sound feedback has an inherent drawback if it is too obstructive or unpleasant, people tend to simply turn it off. Thus the group was trying to find informative, but not unpleasant or disturbing sounds and, finally, after a serial of user-testing, has settled to mimicking sounds from nature wind, raging from breeze to severe wind, and waterfall sound. Interesting, but not sufficiently finished part of the group work was testing different synthesized sounds with potential users, in order to figure out the most both informative and pleasant sound for the purpose of the system. The group also designed an appearance of a screen-saver and background of a touch-screen to be used with their system. The design idea was that clean and calm appearance should indicate that everything is as it should be, and rough, cluttered background indicates that something is going wrong within the system. However, a real product would require significantly more testing on likeability and unobtrusiveness of the system, as several one-hour tests could hardy prove that the system will not be previewed as obtrusive on prolonged daily use. This is an example of an ambitious and well-thought, but fairly poorly executed project.

5 Conclusion and discussion

In this paper, we introduced different projects performed by Medialogy students at Aalborg University in Copenhagen during the Spring semester 2007.

We find that the PBL approach helps students structuring their project work, facilitating them in the formulation an initial problem, which is then solved by designing an interface embedded with sensors tested using standard usability techniques.

A disadvantage is the fact that to acquire so many skills in a single semester is a quite demanding task, both from the students' and teachers' perspective.

As mentioned in the previous section, the scope and quality of the different projects largely varied among the different groups. However, all groups showed the ability to work problem based, and design novel input devices connected to auditory feedback.

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