Continuous sonic interaction in books for children

Amalia de Götzen
Dept. of Computer Sciences
University of Verona
Verona, Italy +++ MEDIALOGY COPENHAGEN
degotzen@sci.univr.it

Davide Rocchesso
Dept, of Computer Sciences
University of Verona
Verona, Italy
davide.rocchesso@univr.it

Abstract

We present the prototype of a new digitally augmented book for children, using sensors to allow continuous user interaction and to generate (not just play back*) sounds in real time. This, in turn, will allow the user to intuitively modify and control the sound generation process, and engagement will certainly be boosted.*

1. Introduction

Current commercial interactive books for children are very often similar to conventional colored stories with the addition of some pre-recorded sounds which can be triggered by the reader. The limitations of these books are evident: the sounds available are limited in number and diversity and they are played using a discrete control (typically a button). This means that sounds are irritating rather than being a stimulus to interact with the toy-book or allowing for learning by interaction.

Pull-the-tab and lift-the-flap books play a central role in the education and entertainment of most children all over the world. Most of these books is inherently cross-cultural and highly relevant in diverse social contexts. For instance, Lucy Cousins, the acclaimed creator of Maisy (Pina in Italy), has currently more than twelve million books in print in many different languages. Through these books, small children learn to name objects and characters, they understand the relations between objects, and develop a sense of causality by direct manipulation [9] [2]and feedback. The importance of sound as a powerful medium has been largely recognized, up to the point that there are books on the market that reproduce prerecorded sounds upon pushing certain buttons or touching certain areas. However, such triggered sounds are extremely unnatural, repetitive, and annoying. The key for a successful exploitation of sounds in books is to have models that respond continuously to continuous action, just in the same way as the children do when manipulating rattles or other physical sounding objects. In other words, books have to become an embodied interface [8] in all respects, including sound.

2. The state of the art

In the nineties, the introduction of the *e-book* was supposed to trigger a revolution similar to that of CDs versus vinyl recordings. Many companies tried to produce hardware and software devoted to digital reading: an important example is the Gemstar GEB 2150 [10], which was a portable e-book reader. Unfortunately, in 2003 Gemstar had to stop the development and production of its products (Softbook, Nuvomedia, GEB, etc.). The main problem that was immediately apparent in this commercial flop (beyond the enthusiastic expectations [10]) was that researchers thought to identify the book object with just one informative medium: its text. Such an electronic book cannot win when compared with the traditional book: the thickness of a book, the possibility of quickly browsing its pages, etc. are all important features. Some experiments about the rendering of such features have been carried out [7, 6, 15].

Focusing on augmented books for children, it is worthwhile to mention the work done by researchers of the Xerox PARC (Palo Alto Research Center) Laboratories. In the SIT (Sound-Image-Text) book prototype [3] the idea was to use sensors in order to use the reader hands' speed as control parameter for some sounds effects. Listen Reader [4] is the natural prosecution of the SIT Book project: while in the SIT Book the sounds effects are used to create a soundscape for the narrative content, here the sound part is a foreground element in itself, conveying information about what the child is reading. Gestures are used to control the sound synthesis, and the electronic part is completely hidden to enhance the naturalness of the interaction.

In recent years, the European project "The Sounding Object"[1] was entirely devoted to the design, development, and

[1] http://www.soundobject.org

evaluation of sound models based on a cartoon description of physical phenomena. In these models the salient features of sounding objects are represented by variables whose interpretation is straightforward because based on physical properties. As a result, the models can be easily embedded into artefacts and their variables coupled with sensors without the need of complex mapping strategies.

Pop-up and lift-the-flap books for children were indicated as ideal applications for sounding objects [14], as interaction with these books is direct, physical, and essentially continuous. Even though a few interactive plates were prototyped and demonstrated, in-depth exploitation of continuous interactive sounds in children books remains to be done.

2.1. Physical models and continuous interaction

Studies has been done using physical modelling with continuous auditory feedback [12, 13]: continuous sound feedback can emphasize causality. The main purpose of these works was to introduce interactive cartoon models of everyday sound scenarios with a new control approach through audio-visual-tangible systems. The idea is that human interaction in the world is essentially continuous, while the majority of sounds that right now are used in computer environments are unnatural or repetitive (e.g. triggered samples). A few practical examples of that interaction have been elaborated by the SOb project developing rolling sound models based on physical models of impact [11]:

- *the invisiball*: a thimble acts as the sender and the receiving antenna is placed under a 3D elastic surface. Finger position in the 3D space is detected in real-time and it is used by the algorithm controlling the rolling movement of a ball;

- *the ballancer*: the user has to balance a ball by tilting a rectilinear track. Feedback is provided by the modeled sound of the ball rolling over the surface of the track along with a tactile-visual response.

These examples of interaction have demonstrated that everyday sounds can be very useful because of the familiar control metaphor: no explanation nor learning is necessary [5]. Moreover, it is clear that the continuous audio feedback affects the quality of the interaction and that the user makes continuous use of the information provided by sounds to adopt a more precise behavior: the continuously varying sound of a car engine tells us when we have to shift gears.

In this perspective sound is the key for paradigmatic shifts in consumer products. In the same way as spatial audio has become the characterizing ingredient for home theatres (as opposed to traditional TV-sets), continuous interactive sounds will become the skeleton of electronically-augmented children books of the future. The book-prototype is designed as a set of scenarios where narration develops through sonic narratives, and where exploration is stimulated through continuous interaction and auditory feedback. Through the development of the book, the class of models of sounding objects has been deeply used and verified[2]. The physical models of impacts and friction have been used to synthesize a variety of sounds: the steps of a walking character, the noise of a fly, the engine of a motor bike, and the sound of an inflatable ball.

3. Scenarios Design

Beginning with the sound models available from the Sounding Object project, it has been studied how to integrate and combine them into an engaging tale. The first step was to create demonstration examples of interaction using different kinds of sensors and algorithms. During this phase the most effective interactions (i.e. easier to learn and most natural) have been chosen, and several different scenarios were prepared with the goal of integrating them in a common story. The scenarios use embedded sensors, which are connected to a central control unit. Data is sent to the main computer using UDP messages through a local network from sensors and the sound part is synthesized using custom designed Pure Data (PD)[3] patches. These PD patches implement a set of physical models of everyday sounds such as friction, impacts, bubbles, etc. and the data coming from sensors is used to control the sound object model in real time. In the following subsections we describe some scenarios which have been investigated.

3.1. Steps

The *steps* scenario shows a rural landscape with a road; an embedded slider allows the user to move the main character along the road, and all movement data are sent to the computer, where the velocity of the caracther is calculated and a sound of footsteps is synthesized in real-time. The timing, distance, and force of the sound of each step is modified as a function of the control velocity. Fig. 1 shows a preliminary sketch, while fig. 2 shows the final prototype with the embodied sensor.

3.2. The fly

The *fly* scenario shows our main character in front of a piece of cake, but she is quite annoyed by a fly which is moving near her food. An embedded magnetic sensor allows the user to move the fly away from the food, and all

[2] http://www.soundobject.org/articles.html

[3] http://www.pure-data.info

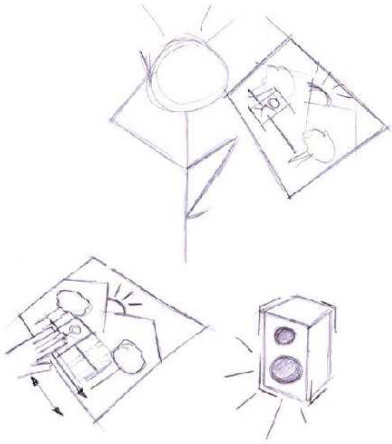

Figure 1. The user is looking at the scene, identifies the moving part and tries to move the character generating sound

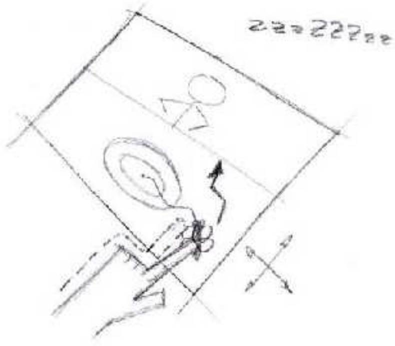

Figure 3. The moving part here is a black small thing, the user will identified the fly, as soon as he will try to move it and he will hear the synthesized sound

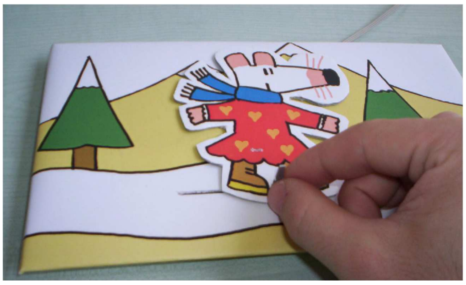

Figure 2. Interaction through slider: the footsteps scenario prototype

Figure 4. Interaction through a magnet: the fly scenario prototype

movement data are sent to the computer where the sound of a fly is synthesized in real-time according to the user gestures. A friction sound model has been used to synthesize the fly [1]: the distance of the fly and its speed are modified as a function of three parameters: the gain, the dynamic friction and the static friction factors, each of them controlled by the sensor position. Fig. 3 shows the scenario design, while fig 4 shows the final prototype with the embodied sensor.

3.3. Motor

The *motor* scenario shows the main character in front of a motor bike: she wants to ride the motor bike! A rotation sensor (a potentiometer) is embedded in the motor bike, the user can just rotate it as if it was in a motor bike. According to their movements the synthesized sound of the motor bike informs the user that he can control the acceleration of it. In this example a sampled sound file is also used: when the user starts to rotate the sensor he will hear the motor starter as an initial prompt. In this scenario an impact model has been used: the rotation of the sensor controls the number of impacts and so the frequency perceived. Fig. 5 shows the scenario design, while fig 6 shows the final prototype with the embodied sensor.

3.4. Inflating the ball

The last scenario shows the main character inflating a ball. Here a pressure sensor is used as interface: the user discovers that he has just to press the small sensor to inflate the ball. The synthesized sound is generated using a friction model: each time the user will press the sensor a higher frequency will be synthesized till the a fixed maximum value when the ball will burst. Fig. 7 shows the scenario design, while fig 8 shows the final prototype with the embodied sensor.

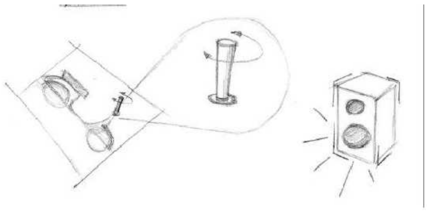

Figure 5. The rotating sensor placed in the motor bike will be used to change the acceleration

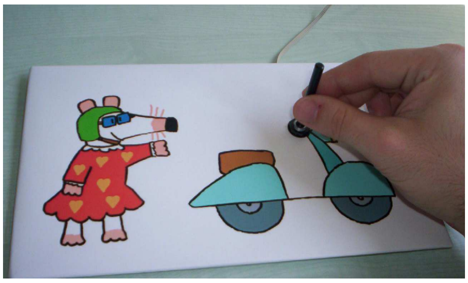

Figure 6. Interaction through a potentiometer: the motor bike prototype

4. Conclusions

The final outcome of this work will be a lift-the-flap scenario for a book for children, augmented by sounds that respond continuously and consistently to control gestures. The sample scenarios[4] shown in this paper demonstrate the effectiveness of sound as an engaging form of feedback, and the feasibility of real-time physics-based models of everyday sounds in embedded systems. The work will now concentrate on real-world tests with children that will enhance the playability/usability of the book. Another aspect which will be developed is the embedding and the sophistication of the technologies used.

As a concluding remark, we highlight the fact that all four scenarios here presented have been implemented by using only two sound models (impact and friction) even though the four sounds are remarkably different from each other. Even though one may expect that friction sounds are appropriate for insects [1], the use of a friction model for the aeolian sound of blowing into a ball is by no means obvious. This may be considered an example of extreme cartoonification (pretty much like dressing a mouse with a skirt) and it is the overall design, context, and control that give consistency and credibility to the scene.

[4] http://www.scienze.univr.it/documenti//Tesi/allegato/bookvideo.avi

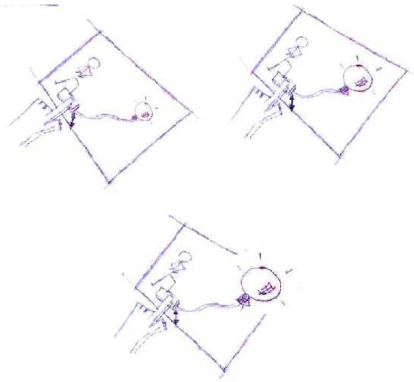

Figure 7. In the ball scenario the user have to discover how to blow, what kind of gesture is required: the interaction is intentionally quite natural and intuitive

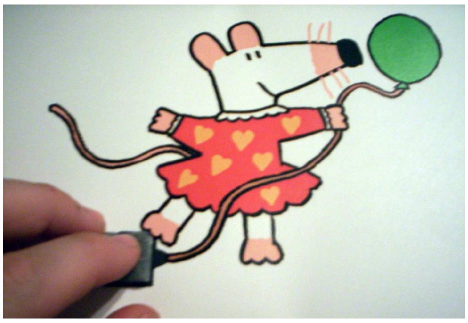

Figure 8. Interaction through a pressure sensor: the ball prototype

Authorship

The conception and realization of an early prototype of a sound-augmented book were carried on by the second author as part of the Sounding Object project[5]. Later on, students Damiano Battaglia (Univ. of Verona) and Josep Villadomat Arro (Univ. Pompeu Fabra, Barcelona, visiting Verona in 2004) realized the sketches that are described in this paper as part of graduation projects, under the guidance of the authors. At the moment, the first author is pursuing her PhD on fundamental issues in sound-mediated interaction, such as causality and Fitts' Law, and she is looking at children books as a possible application scenario.

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