Participatory workshops: everyday objects and sound metaphors

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Abstract. The Legos project aims at studying sound gesture relationship, and specifically, how sound can affect a sensory-motor learning process. During the project, two participatory workshops related to sonic interaction design have been organized. The aim of the workshops was to provide a framework to favor exchanges between members, first, to stimulate ideas related to the control of everyday objects using sound, and then, to create and experiment with new sonic augmented objects. The present article provides an overview of the two workshops in order to reveal how this framework can be use for the creation of new sonic objects. The first workshop focused on the analyze and the possible sonification of everyday objects. New scenarios of use were obtained and tested. The second workshop focused on sound metaphor, questioning the relationship between sound and gesture using the concept of basic actions and the work on the sound synthesis engines. During the two workshops, experiments using sensors and real-time synthesis were carried on a selection of case studies.

Keywords: Workshop, design, sound synthesis, interaction, rehabilitation

1 Introduction

The ANR project Legos[1] aims at systematically studying the coupling quality in gesture-sound systems over time. Three areas of application are under consideration in the project: the new digital musical interfaces DMI, rehabilitation and sonic interaction design SID.

Through these three areas, the sensorimotor learning is assessed by focusing on different levels: expressiveness and how the sound is controlled (DMI), quality of the gesture when guided by an audio feedback (Rehabilitation) and quality of the object manipulation by a user in an interactive context (SID).

The project is based on experimental approaches and frame of workshops, that are complementary, in order to generate interdisciplinary expertises in design, motor control, sound synthesis and cognitive sciences.

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[1] http://legos.ircam.fr

The aim of the project is to develop novel methodologies for the gestural interfaces design by analyzing and comparing the experimental results of the three mentioned areas.

1.1 Goals of the workshops

By organizing workshops, the goal was to provide a framework for brainstorming and experimentation. Another goal was to create case studies during workshops in order to frame the project for these three areas of applications. These workshops were organized with different members of the project. They had the second goal of providing an educational and methodological framework, on one hand, for the creation of new interactive sonic devices, and on the other hand, for the organization of future workshops[2]. Three workshops were scheduled corresponding respectively the three steps (Analysis, Conception and Validation) of a general sound approach introduced by the Ircam's Sound Perception and Design team. Thus the three workshops were :

1. Usage scenarios analysis. Scenario development of use of everyday objects incorporating a reflexion on sound design - June 2012.
2. Sound metaphor creation. Work on sound metaphors, questioning the relationship between sound and gesture, using the concept of basic actions and the work on the sound synthesis engines - October 2012.
3. Validation. Assessment of devices, working on a common framework for comparing the three different approaches (DMI, rehabilitation, SID) - to be achieved in 2013.

This article presents a summary of the workshops #1 and # 2 of 2012 which were held at IRCAM.

1.2 Theoretical backgrounds

The theoretical framework of these workshops stems from our participation to the European CLOSED project[3] and the COST Action SID Sonic Interaction Design [5]. Under these projects, different workshops ([4, 3, 15]) were organized and have helped to develop a framework, in the spirit of participatory workshops ([16]) to generate creative new ideas in interactive sound design context .

A methodology has been established to help designer generating new scenarios from everyday objects by analyzing them in terms of functionality, contexts of use, associated actions, and existing sounds. Participants are encouraged to hybridize different functionalities, associated actions and contexts of use taken from different everyday objects. The aim is to stimulate the creation of new scenarios of sonic interaction design. During these sessions, participants think together and share experiences during practical exercises.

[2] `http://hcsquared.eu/summer-school-2013/lectures-workshops`
[3] `http://closed.ircam.fr`

Practical exercises are diversified, inclunding "speed dating" [2] (generation of ideas in pairs on very short time regularly changing partners to stimulate), "bodystorming" [11] (play active situations with objects to test scenarios), or "sound drama" [7] (the scenarios are staged with objects using audio post production). This approach can be complemented by prototyping through sensors associated with microcontrollers (such as Arduino[4] or Modular Musical Objects [5]).

For our workshops, we used this framework by integrating the different skills of the project members: theoretical background on sound-gesture relationship, hardware and software for motion capture, different approaches to sound synthesis (physical modeling, synthesis based on acoustical descriptors, ...). These different skills gave us the opportunity to prototype the different ideas and to confront them. The aim is to evaluate these interactive sound devices in the three different fields of application (DMI, rehabilitation and SID). This will be the topic of the last workshop #3.

2 Workshop #1: Usage scenarios of everyday objects

2.1 Introduction

This workshop was held at Ircam[6] in June 2012. The first day was dedicated to the generation of scenarios and the second day to the prototyping of these scenarios with augmented objects. This workshop had different aims: creating user cases of everyday objects augmented with sonic interaction than can be applied to digital musical instruments and to rehabilitation. The aim was to create experimental prototypes to explore how sound can change the interaction experience with everyday objects.

Before the workshop, participants were asked to bring one or two small objects. Objects had to be simply manipulated with one or two hands, in contact or not with another object or support and with a specific function and purpose. The first object had to give satisfaction to the user in terms of use. The second object at the opposite, had to be hard to use (hold and task to achieve).

The first day, we introduced to participants the different goals of the workshop. After this introduction, each participant have presented their objects, explaining their choice.

Grid for analyzing objects Participants were grouped in pairs to analyse the different objects using a grid:

[4] `http://www.arduino.cc/`

[5] `http://interlude.ircam.fr/`

[6] Participants: Sara Adhitya, Frédéric Bevilacqua, Eric Boyer, Florestan Gutierrez, Sylvain Hanneton, Olivier Houix, Jules Françoise, Nicolas Misdariis, Alexandre Panizzoli, Quentin Pyanet, Nicolas Rasamimanana, Agnès Roby-Brami, Patrick Susini, Isabelle Viaud-Delmon.

- Object description: form, size, material, grip.
- Use: context, primary and secondary functions.
- Action on the object: descriptions, interaction with a support or with an object.
- Experience with the object: positive and negative.

Then, we selected few objects to produce scenarios integrating sound. The second day, we have prototyped the selected scenarios with augmented objects, separating us into two groups of five participants. At the end of the day, each group presented their works.

2.2 Analysis and selection of the objects

Participants bring several objects following the instructions given to prepare the workshop. Each participant outlined the objects brought. This first round was also intended to involve participants in a participatory framework. These objects were varied: a screwdriver, wooden and plastic citrus presses, a tea infuser, a razor, an apple corer, a rechargeable lamp, keys, a squeegee, a spinning gyroscope with its launcher, matches, a spirit level, a saw, make-up, a sponge, a clothespin, an alarm clock, a lighter, a jam jar, a coffee plunger and a measuring tape. Some objects are difficult to use or manipulate or having a baffling design. Other objects are acceptable, often used in everyday context and elicit positive emotion during its use.

Participants were then placed in pairs in order to describe the selected objects using the analytical grid (section 2.1). We asked to highlight the negative and positive aspects of the objects both in terms of ergonomics, of design, of use and manipulation.

In the end, we focused on the negatives aspects highlighted by the participants. For example, the jam jar is difficult to open and catch, the regular movements of the spinning gyroscope are difficult to master, and the spirit level requires delicate settings with always a visual feedback no always easy to observe.

After this step, participants selected objects to generate scenarios focusing on use problems. Thus the different problems or specificities encountered were organized when using objects to sample our selection . These categories are: problems of grasping, problems of coordination or adjustment of the action, problems of design, manual or bimanual manipulation, manipulation without visual feedback or not, signage problem without interaction, reversed tool (for example, pressing the infuser tea to open it). The selected objects and the associated problems or specificities are:

- The jam jar and the measuring tape (Bimanual manipulation)
- The spinning gyroscope, the sponge and the squeegee (Adjustment of the action)
- The rechargeable lamp (Signage problem of the charge level)
- The spirit level (Need visual feedback)

2.3 Development of the scenarios

Participants, we have worked in parallel into two groups. While one group worked on objects for 30 minutes to provide usage scenarios, the other group proceeded in the same way on other objects. Then the two groups inverted objects and continued for 30 minutes in the same way their brainstorming. The participants used simple ways to illustrate their scenarios (gestures, vocalizations, paper - pencil, ...). In a second phase, the two groups met in the same room and shared scenarios. The participants presented their ideas that were analyzed and discussed. The principal ideas concerning the four objects are summarized. A selection of scenarios are presented here.

The jam jar One group have proposed the sonification of the closing sound of the jam jar in order to be optimal, i.e. not too strong or not too loose. This idea was related to the work done by Rocchesso et al. [13, 14] on the moka pot[7]. An other proposition was the use of two beating sounds, like the tuning of a guitar, to prevent strong closing. Other ideas were related to the way of giving a relationship between the container and contents.

The spirit level The general idea was to enable the "reading" without visual feedback in the case of the user is not in front of the spirit level. The sound can give the necessary information about the direction of the inclination. The natural metaphor of the rain stick was proposed, in reference to the sound installation "GrainStick - 2.0" from Pierre Jodlowski[8]. A possible extension was the hybridization between the spirit level and the measuring tape (rattle sound for giving information about the measured distance).

The spinning gyroscope The participants struggled to run the spinning gyroscope. Its use is not particularly intuitive when starting for the rotation of the spinning. Two proposals have been made for its use: for relaxation and meditation like the Chinese health balls without launching top and for triggering different sound worlds depending on the type of movement. The other group studied the manual mechanism to launch the spinning gyroscope. They noted two main movements: the movement of the wrist in order to move the launcher and the rotational movement of the spinning gyroscope on its axis. The movement of the launcher could be two points instrumented to retrieve information on the move. Two different sounds may be associated with wrist and spinning gyroscope. The idea is to phase these two parameters for the gesture and action when they are optimal.

The squeegee Analyzing the use of the squeegee sheet glass, various control parameters are listed: the inclination of the head of the squeegee, the normal

[7] `http://vimeo.com/898836`
[8] `http://brahms.ircam.fr/works/work/27276/`

pressure on the surface, the path and the flow velocity. These parameters can also be similar to the use of a razor. Another track is to explore the sonification of the error in the control of the squeegee (the following parameters) rather than the whole gesture. For example if we consider the pressure on the surface, too much pressure may be associated with a violin sound squeaky. The object does not present special problems of manipulation, but the goal of sonification in this case is to be aware of the movement.

Summary During this step, participants have created scenarios for these objects by integrating a reflection on the use of sound to improve or expand their uses. Following the discussion about the different scenarios and discussions, we selected two objects (The squeegee and the spinning gyroscope) to deal with the scenarios in depth and make them interactive.

2.4 Propotypes

Two groups were formed to work specifically on scenarios using the spinning gyroscope and the squeegee window. The goal is to prototype the scenarios by instrumenting these objects using sensors associated with sound synthesis softwares.

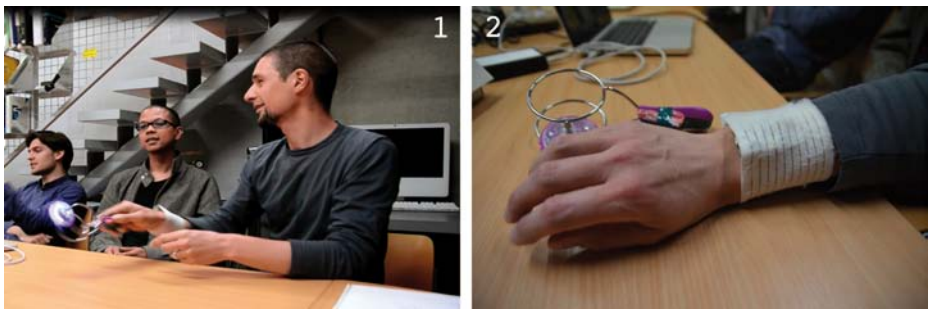

Fig. 1. Working group on the spinning gyroscope. Participants instrumented the launcher and the wrist of the user (4) using sensors MO[12] to sonify the movement.

The augmented spinning top At first, the participants made comments to understand what was the best movement involving a minimum of effort. The optimal motion is to make a small dry tilting of the spinning top to begin the rotation mechanism. This movement gives energy to the spinning, allowing a first cycle and the rotation. They observed that participants who were unable to produce a rotational movement, produced more erratic movements of the wrist. An imagined solution is to optimize the gesture by sonyfing two parameters: the movement of the wrist (with a fixed angle), and the frequency of the spinning top

due to its frequency rotation. The group was able to demonstrate a prototype of the spinning top accompanied by sensors placed on the wrist and the spinning top (see Figure 1). When the user plays with the spinning top, he/she received a sound return on his/her gesture, the sound became more "rough" when the movement deviated from the optimal movement. An extension of this work, could be the sonification of the phase difference between the movement of the wrist and the spinning top rotation so that the user can correct his/her gesture.

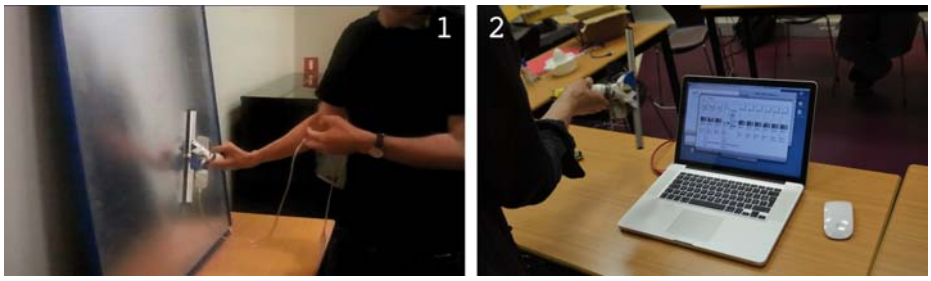

Fig. 2. Working group on the squeegee window. Participants instrumented the squeegee using sensors MO[12] (2), and have tested different movements (1) and different sound engines to sonify movement.

The augmented squeegee First, participants observed the window cleaning techniques to understand the different movements. By testing themselves this technique on a surface (see Figure 2), the sequence could be broken down into a succession of repetitive actions (linear trajectory followed by a rapid rotation to change direction). A first observation was done: it is difficult to keep a fluid gesture during the successions of the linear path followed by the rotation and that this requires training.

To better understand the various successive actions, the idea was to sonify the different parameters such as the angle of the squeegee, the pressure exerted on the surface, and the rotation. The idea is to make fluid changes of direction and regular trajectories. The augmented squeegee with sensors should control a sound synthesis software that suggests an optimal trajectory and movement with a sound metaphor.

For example, considering the angle of the squeegee, if the user kept the race too close to the surface, a sound like "wind" or "white noise" indicates that the squeegee do not adhere enough on the surface, otherwise, a grating sound is produced. And finally between these two non-optimal situations (angles too low or too high), the right movement is sonified with the metaphor of finger sliding on a glass. Different type of sounds were tested: earcons or auditory icons [9] and vocalizations. The first tests suggested that vocalizations associated with

the GESTURE FOLLOWER[9] allowed, in a first approach, to sonify easly the gestures being closest to the movement.

2.5 Summary

During this first workshop, we have proposed a methodology to help participants brainstorming and generating new scenarios from everyday objects.

Participants have analyzed everyday objects in terms of use, function and form. Instead of hybridizing news functionalities and associated actions, we have focused on use problems and selected a few objects to brainstorm on use scenarios. Participants have used different approaches to illustrate their scenarios: vocalizations, bodystorming and sound drama. The last part of the workshop was the work on prototypes. We selected two user cases and built augmented objects with sensors and sound synthesis to test our scenarios. During this workshop we did not specially work on the relation between sound and action, this is the topic of the next workshop. This workflow is a part of a very useful frame to link theoretical background and user cases that we help us to develop experimental studies in the three areas.

3 Workshop #2: Sound metaphors

3.1 Introduction

The objective of this second workshop was to study the sound gesture relationship. A first proposition was to work on the decomposition of the movement with basic gestures. The second one was to work on the type of relationship between gesture and sound production. We also wanted to do further work on the synthesis engines (sound synthesis, physical models of behavior). This workshop was held at Ircam[10] in October 2012. A video summarized this workshop[11].

3.2 Basic gestures and sound-gesture relationship

Basic gestures The analysis of a complex action into elementary actions is derived from work done in the CLOSED project[12]. The aim of these studies was to break down the basic tasks of daily life, especially in the kitchen and to see if they were associated to a sound resulting, or not, from the actions. We completed this analysis [6] to extend this framework by integrating the results of studies that analyze the manual gesture. For example, studies [10, 17] have

[9] `http://imtr.ircam.fr/imtr/Gesture_Follower`

[10] Participants: Sara Adhitya, Frédéric Bevilacqua, Eric Boyer, Jules Françoise, Sylvain Hanneton, Olivier Houix, Fivos Maniatakos, Nicolas Misdariis, Robert Piechaud, Nicolas Rasamimanana, Agnès Roby-Brami , Norbet Schnell, Patrick Susini, Isabelle Viaud-Delmon

[11] `https://www.youtube.com/watch?v=GGKcTk95kDc`

[12] `http://actionanalysis.wikispaces.com/`

proposed a taxonomy of manual gesture differentiates a gesture requiring power and another requiring precision. We felt that this approach could help structure our thinking.

Sound-gesture relationship We introduced different type of relationship between gesture and sound production:

- Arbitrary relation: a noise parameter varies as a function of arbitrarily gesture, such an object was manipulated upwardly increases its roughness;
- Metaphorical relation: when a user pump faster and faster a device, a virtual sound rattling is repeated more quickly (it uses the metaphor of a spinning top) [8].

We asked the participants to think about these two types of sound-gesture relationship applied to basic gestures using synthesis technics (vocalizations, Foley or programs).

3.3 Sound-gesture relationship

Each participant presented an example of sound-gesture relationship based on elementary actions. This presentation has shown that exercise could be difficult, for example to imagine the metaphorical relation. Some participants have given examples of case studies related to an object rather than elementary gestures. Nevertheless, all participants attempted to answer it by providing reflection and proposals. Participants gave examples like:

- Arbitrary relation: the cinematic of a ping pong is sonifyed with simple oscillators depending on the different directions. This example can be related to the artistic performance of Robert Rauschenberg "open scores"[13] in 1966. An other example: when there is no movement, there is silence. when the gesture is amplified a noise becoming a granular texture sonify the amplitude of the movement. Accidental gesture (with snap) is associated with a percussive sound. This example is inspired by "light music" of Thierry de Mey[14].
- Metaphorical relation: when a spirit level is inclined, the movement is related to bubble sound. A torsional movement could be associated with a liquid sound when wringing cloth. And a last example: when a drawer is opened, a sound world unfolds, giving also information on its contents.

After these discussions, we defined three case studies that challenge different type of feedbacks (about the position, about the movement).

[13] http://www.fondation-langlois.org/html/f/page.php?NumPage=642
[14] http://brahms.ircam.fr/works/work/27276/

3.4 Development of the case studies

The participants were separated into three groups to work specifically on these three case studies. We did not use the user cases developed during the first workshop to stimulate new ideas and to diversify the scenarios. We will select the best scenarios after the workshops that can be applied in three application areas. At the end of the day, each group gave a demonstration of its augmented object.

The sonic level The idea developed in the "sonic level" is to sonify the angle relative to the horizontal axis using a virtual orchestra (an accordion and drums). Thus, when the level is flat, the orchestra plays all the instruments (drums, accordion) and the angle with the horizontal plane increases, the orchestra gradually goes out of sync and only plays the accordion.

The eRhombe A physical model of interaction was developed, producing no sound at the moment. Indeed, the objective is to first model the behavior of a virtual rhombus which is driven by the rotation of a physical sensor (gyroscope). The user rotates the sensor (MO) and must be consistent with the model when the virtual rhombus starts running and running. The next step is to sonify the virtual rhombus with an abstract or metaphorical relationship.

The augmented ping pong To begin, participants wanted to sonify the position and the acceleration of the racket for the gestures "forehand" and "backhand". They encountered difficulties of motion capture, eg to distinguish "forehand" and "backhand". The sounds used in the demonstration were based on the principles of classical sound synthesis. This work have been extended after the workshop with a functional prototype and presented to ping pong player [1].

4 Summary and perspectives

The workshop # 1 was very challenging, participants appreciated this framework highly developed in the design community but little use in our respective disciplines. Participants were able to identify issues related to objects found in the remaining part of LEGOS project and proposed answers in the form of prototype augmented objects.

At that time, we did not test different approaches of sound synthesis to refine the sound design of the interactive objects. For example, we have not been able to fully exploit the expressive possibilities of sound synthesis by physical modeling. It was difficult to be closer to the movement. An approach of the sound synthesis by physical modeling needs a fine setting to make audible the different gestures.

This work will be continued in order to test hypotheses about the role of sound feedback in sensory-motor learning and the type of sound (metaphorical, abstract).

For the workshop # 2, the use of sound metaphors to sonify gesture showed that beyond the issue of choosing the type of sound, it is paramount to make audible the information associated with different actions that composed the movement. And the development of interaction model as an intermediate structure between the motion capture and sound synthesis engine seems a very promising work.

These workshops have been beneficial for the LEGOS project because we developed different prototypes to test experimental situations, always questioning the three fields: sonic interaction design, rehabilitation and digital musical interfaces. These workshops also helped to generate more theoretical questions, especially regarding the distinction between sound metaphor and interaction metaphor, and the question of expertise has been the focus of discussions.

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