‘ensemble’: Playing with Sensors and Sound

Kristina Andersen
STEIM
19 Achtergracht, 1017 WL Amsterdam, NL
kristina@tinything.com

ABSTRACT
This paper presents a set of sensor driven sonic prototypes and the workshops in which they are played with by children in games of dressing up. Seven garments are fitted with wireless sensors that control sound samples and their modifiers in real time. The aim of the project is to capture the children’s emerging understanding of the sensors as they explore and play and in the longer term inform the use of analog sensing in touchable interfaces. The system is described and observations from the first workshops are reported. The paper concludes with a short discussion and conclusions regarding both the system itself and the methods used.

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Interaction, children, sensors, sound control, prototyping.

ACM Classification Keywords
H.5.5 Sound and Music Computing: Methodologies and techniques.

INTRODUCTION
‘ensemble’ is an interaction design project conceived and built with inspiration from the world of MIDI controllers and electronic musical instruments. It aims to explore the merger of objects with electronic sensing as a way to inform the use of embedded sensors in the design of tangible sonic objects and musical controllers.

Objects augmented with electronic sensing capabilities require us to develop new intuitions or ‘naïve‘ understandings about both the resulting hybrid object and the specific affordances of the sensor itself. This naïve understanding can be seen as an extrapolation of Hayes’ ‘naive physics’ which refers to people’s knowledge of the everyday world [5]. ‘ensemble’ is a speculative project attempting to capture these emerging understandings by making sensors available to children in everyday objects and observing how they spontaneously explore and interpret them.

For this purpose a workshop environment was set up, where children can play with a set of seven wearable wireless sound controllers made up of seven garments fitted with light-sensors, accelerometers, pressure-sensors, linear expansion (pull), sonar (distance) and tilt. The garments are investigated though play by small groups of children. The workshops are focused on pre-school children as their understanding of the world is still being developed and they accept and learn new causalities quickly.

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RESEARCH GOALS AND RELATED WORK
‘ensemble’ builds on previous work on creating physical interfaces to sound. The ‘Boxology!’ project by Kieran Ferris and Liam Bannon consists of a series of cardboard boxes that act as big tangible interfaces to meta-control a music mix. The cardboard boxes are moved around in space to control sample triggering and mixing of a predefined piece of music [2]. Another example is the ‘Squeezables’ project by Gil Weinberg and Seum-Lim Gan which allows the players to control the actual parameters of the sound like amplitude, pitch and volume and compose and play new sounds and music by squeezing fabric balls [4]. ‘ensemble’ is related to these projects in its focus to explore tangible interaction in the context sonic manipulation. Our garments however are not designed as finished interfaces but rather as investigative tools and the workshops are meant to be enjoyable in their own right as well as generate data. Another difference is the use of everyday objects that already occupy a specific role and metaphor to the children as opposed to the more culturally generic balls or cardboard boxes. By making the sensors available to children in playful interfaces the aim of ‘ensemble’ is to explore the causal relationship between actions and sounds and capture the children’s intuitions about sensor control and use. These observations could then in turn inspire new ways of using and placing sensors in touchable interfaces.

SETUP AND DESIGN CONSIDERATIONS
The workshops are based on the metaphor of ‘dressing up’. This is done to lower the learning curve of the devices and allow the children to enter onto the experience as experts. They already know how to dress up and the metaphor is intended to act as a scaffold for the experience.

The system consists of seven garments including a dress, a hat, an umbrella, a bag, a pair of suspenders and two suit jackets. The clothes used are 'readymade' second hand garments. The overall look of the garments is deliberately low tech and there are no recognizable computers on view.

The garments are chosen and designed to provoke reflective thought. This is done by following three elements identified by Sedighian and Klawe [7]: representation, interaction protocol, and feedback

- The sensors are represented by the garments in such a way that the garments act as larger scale image of the function of the sensor.
- The physical attributes of the garments are used as clues to the interaction protocol in order to provide a tangible interface to the sensors.
- The feedback consists of a tight link between physical manipulation of the garments and immediate sonic response. There is no perceivable lag between the garments and the sonic response.

THE SYSTEM

The garments act as carriers both for the sensors and the wireless system. The sensors are separated by type and placed in the garments in such a way that the function of the sensor is conceptually supported by the form-factors of the garment. The dress has an accelerometer at the hem and is in itself an invitation to move and swirl. The hat houses two tilt switches perpendicular to each other reacting to any change in position from the horizontal plane. The suspenders hold two linear expansion sensors on each shoulder which are activated by pulling. The umbrella has a pressure sensor at its tip and can be activated as a button or by the umbrella being pressed into the floor. The handbag has two small light sensors reacting to the light-levels inside the bag. The suit jackets share a sonar that measures the distance between them. The sender sits in one jackets sleeve and the receiver sits in the sleeve of the other jacket.

Hardware

The garments are using modified and adapted game-pads as wireless signal carriers. Commercial wireless game-pads are affordable and useful for musical applications as both gaming and music share one crucial requirement: immediate feedback. Just like the gamer can accept no perceivable lag in response to an action, the success of a sound interface is dependant on very tight temporal link between interface actions and sound response. In this aspect 'ensemble' is building on previous work done on modifying game controllers and allow them to be changed into refined and sensitive instruments [11]. The game-pads are opened, the print taken out and the sensors are wired in. The sensors used are all analogue and returning gradual values. The game-pad communicates through radio to a receiver that plugs into the computer's USB port.

Mappings

'ensemble' runs on a single laptop using two pieces of software that translates USB-data from the game pads into distinct MIDI channels [6] and serves up sound samples while modifying them in real time [8]. Each sensor triggers a sound file (MIDI note on) while its MIDI data value controls the modification of the file. During the workshop the children experiment with sound sets of varying complexity and texture. The first set is cartoon-like and supports the metaphor of the garment (dress = swooshing noise). The samples in this initial sound set come from recorded human voices (singing, whistling, shouting etc) and the modifiers are conceptually simple: pitch and volume controls. The samples in the second sound set are based on recognisable field recordings (walking on gravel, birds, leaves crackling etc) and the modifiers are more complex than in the first set: scratching, panning, and layering. The final set is using samples of sound created in recursive computational processes and the modifiers are controlling much more complex parameters such as sample length, absolute region start and filtering.

WORKSHOP FORMAT

'ensemble' is played with up to seven children at a time and there is no audience. The majority of the children are aged four to five. The framework for the workshop is playful experimentation and fun is deliberately used as a driver to investigate the affordances of the garments as interfaces [1]. The children are playing independently. Paper and pens are available in the room and the children tend to spend the 45 minutes of the workshop alternating between drawing and playing. Drawing is integrated into the workshop as a method of collecting feedback from the children but also as a way of diversifying the experience and providing some relative silence in which some children can experiment with a particular garment and sound while others draw. During the workshop the children are video-recorded discretely and the drawings are photographed. The children are not interviewed formally, but will often volunteer explanations of their drawings. The choice to use drawings instead of interviews was done in order to maintain the child-driven feel of the experience. The groups of children are selected in various ways, from invited groups of school children to the audience of a children's theatre.

OBSERVATIONS

In the course of the first series of workshops some observations have been made in relation to each of the garment/sensor sets. These experiences point to areas that will be interesting to explore in further workshops and new setups. The following are some examples.

Scooping the light

The bag is an example of the children developing unpredicted interactions and high levels of control. Two light sensors are sewn into the bottom of the ladies bag with the game-pad 'hiding' in the internal pocket. The intended interaction was to operate it by opening and closing the bag. The bag is very rarely played in this way. Instead the children play in two ways: The first one is to turn the open bag towards the light source causing the sound to crescendo

Fig. 1: Bag and light

towards a high pitch. This can be done slowly and carefully as we see in fig. 1 or with a fast scooping motion. The other distinct way of playing is to make shadows with your fingers over the open and stationary bag. The distance between your hand and the bag determines the density of the shadow and thus the qualities of the 'notes' it produces. In this way it is possible to 'pick a specific note out of the air' above the bag with reasonable precision.

The invisible link

The suit-jackets require two children to work together as the sonars in the sleeves need to point at each other. The most common way children play is by holding the sleeves close to each other and then pushing their arms forward and backwards to maximise or minimise the distance. An alternative method is to turn the arm away to break and reconnect the sonar link. The invisible link between the two suits is conceptually hard to grasp. In one example this is seen as A (4 yrs) after having played the suits with another child tries to play by himself. We see him still wearing the jacket and carefully standing on the other unworn jacket while he moves his arm backwards and forwards. He has mapped the sound to his own movement and is very puzzled that this does not reproduce the sound.

The world is making sound now

The hat is an example of a garment that can be addressed as a discrete object/instrument or just worn translating the movements of the wearer into sound. From watching the children we see that the hat works as a percussive instrument when shaken whereas the intended slow movement produces a calm singing. In one example B (4 yrs) becomes very interested in turning the hat slowly or shaking it rapidly and producing sounds of very different quality. Afterwards he goes back to his own clothes and picks up first one shoe and then the other turning and shaking them in the apparent expectation that they will also produce sound. The possible passing conviction that the ability to make sound does not reside solely in our garments is reminiscent of Piaget's magical belief where the objects in the world are perceived to have their own tendencies and intentions [9].

DISCUSSION

Our observations indicate that by using familiar objects and activities like dressing up and making drawings the children enter into the experience with a confidence that supports them when the objects respond in unexpected manners. They appear to remain in control as they modify and develop their intuitions about 'how things work'. The garments/sensors are quickly redefined as sound controllers and the workshops become explorations of their affordances and capabilities rather that games of dressing up. As the garments are in effect functioning as very simple musical instruments it is possible to find some early indications as to their qualities as objects of interaction.

Mapping movement or addressing the object

Most of the garments can be used both as movement-to-sound interfaces and as instrument/object. It is a general observation that changing between these two modes also seems to require a mode shift in the mindset of the child. The dress is either being danced with or shaken but never danced with AND shaken and in a similar way the hat is either being just worn or moved deliberately. Even the garments that don't quite work in both modes can still be used as silent props: The bag is worn on the arm by a girl who is mainly concentrating on making sound with the dress and in another example a boy seems oblivious to the sounds the dress makes while he concentrates on the bag in the light. Technically the garments can be played in both modes simultaneously and it may be a consequence of their young age that the children seem reluctant to do so.

Where does the sound come from?

In the workshop there is little doubt that the sound comes from the two large speakers in the ceiling. At the same time a consistent feature of the drawings is the strict link between the sound and the object. The drawing of the bag in fig. 2 is made by C (7 yrs) who explained how the bag worked in the following way: "'Stuff' (crisscrossed lines) comes into the bag and then 'clown sparkles' (wavy lines) come out." In her drawing the bag remains the locus of the interaction and thus the bag is where 'the sparkles' are coming from. This could be seen as consistent with Piaget's

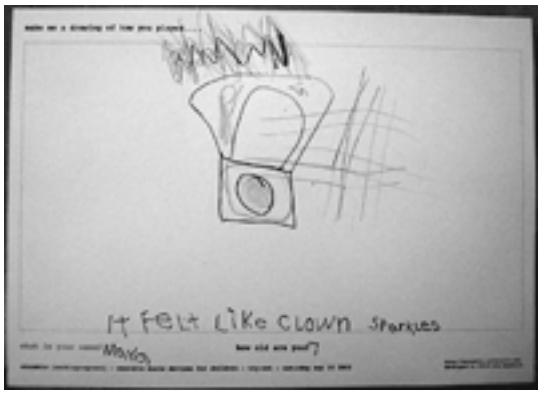

Fig. 2: It felt like clown sparkles…

experiments where one phenomenon can be perceived to have two totally different reasons. The young child is maintaining two simultaneous interaction models that are superposed and is not seen to mutually exclude each other [9]. The sound is caused and therefore coming from the bag and at the same time the sound is coming from the speakers in the ceiling.

CONCLUSION AND FUTURE WORK

The workshop conducted so far points towards two conclusions. The first concerns the suitability of the method itself. Using theatrical methods of make believe and dressing up as an emotional framework for the workshop has proven a useful way to scaffold the experience and aid the suspension of disbelief. The children show high levels of concentration and enthusiasm and the workshops have produced useful data in the form of video and drawings. 'ensemble' will be played and explored further but these early observations show some promise as to the viability of using this method to explore the perceived interfaces of sensors. It is however clear that the project would benefit from more sophisticated methods of capturing the experiences of the children. For this purpose input and collaborations with practitioners from for example psychology and movement analysis is sought.

The second conclusion is concerned with generating valid knowledge to inform the design of musical controllers. In it's investigative phase the project has inspired a rethinking of the way we use light sensors in particular. While the existing setup will be played to gather more data two possible future directions have been identified: Changes to the sound mapping setup and inviting children to be not just testers but co-developers of new more complex sonic objects.

The changes to the setup include reconfiguring the software to enable the different garments to manipulate each others sound. This would encourage the children to play together which as the name suggests is one of the original intentions of the project. It also opens the possibility of a more direct comparison with collaborative sound controllers like Squeezables [4]. Another change to the existing garment setup is to introduce wireless microphones that will allow the children to produce their own samples through the live sampling capabilities of the software [8]. This could eliminate some culturally specific aspects of the samples and provide an interesting addition to the system by allowing the children to fully control the sound. These changes will all be implemented and tested in further workshops.

The second goal will be to create hybrid objects that combine several types of sensors and thus make the possibilities for control wider by opening the possibility for the use of conditionals or chords in the sound control. In this stage the objects themselves will be designed and created with preschool children as fully involved co-developers as well as testers and players.

These initial experiences of the project are presented to the HCI community in the hope that it will provoke discussion not only about user-testing with children but more specifically about which methods we can use to capture data from out-of–the-lab experiments. The aim is to find new ways of using movement, drawing and investigative objects to help us enact and play our way to intuitive understandings that will inform 'ensemble' and other sensor driven projects.

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REFERENCES

1. Andersen, K., Jacobs, M., Polazzi, L. Playing Games in the Emotional Space Funology: from usability to enjoyment, Blythe, M.A., Overbeeke, K., Monk, A.F. and Wright, P.C. (ed.s) Dordrecht, the Netherlands: Kluwer, 2003.
2. Bannon, L., Ferris, K. ...a load of ould Boxology! Proc. DIS2002, London, UK
3. Druin, A. Cooperative Inquiry: Developing New Technologies for Children with Children. Proc. CHI '99 Pittsburgh PA USA
4. Gan, S. L., Weinberg, G. The Squeezables: Towards an Expressive and Interdependent Multi-player Musical Instrument. Computer Music Journal, 25:2, pp.37-45 (2001)
5. Hayes, P. The naive physics manifesto Systems in the Micro-Electronic Age, Michie, D. (ed) Edinburgh University Press, 1978.
6. JunXion, USB to MIDI software, http://www.steim.org/steim/junxion.html
7. Klawe, M., Sedighian, K. An Interface Strategy for Promoting Reflective Cognition in Children. CHI '96 Companion, Vancouver, BC Canada
8. LiSa, live sampling software, http://www.steim.org/steim/lisa.html
9. Piaget, J. The Child's Conception of Physical Causality, Transaction Publishers, New Jersey, 2001.
10. Saffo, P. Sensors: the next wave of innovation. Communications of the ACM, Volume 40 Issue 2 (1997)
11. STEIM,19 Achtergracht, 1017 WL Amsterdam, NL, www.steim.nl