In Duet with Everyday Urban Settings: A User Study of Sonic City

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ABSTRACT
Sonic City is a wearable system enabling the use of the urban environment as an interface for real-time electronic music making, when walking through and interacting with a city. The device senses everyday interactions and surrounding contexts, and maps this information in real time to the sound processing of urban sounds. We conducted a short-term study with various participants using our prototype in everyday settings. This paper describes the course of the study and preliminary results in terms of how the participants used and experienced the system. These results showed that the city was perceived as the main performer but that the user improvised different tactics and ad hoc interventions to actively influence and participate in how the music was created.

Keywords
User study, new interface for musical expression, interactive music, wearable computing, mobility, context-awareness.

1. INTRODUCTION
Sonic City [2] is a new form of interactive music instrument where the urban environment is used as an interface, promoting the incorporation of everyday life settings and practices into personal forms of aesthetic expression. It enables users to create a personal real-time soundscape of electronic music by walking through and interacting with urban settings. Sonic City considers the user's path as a musical composition and her mobility through the shifting contexts of a city as a large scale musical gesture. We have previously designed and implemented a wearable prototype, where sensory information about the user's actions and about the context through which she walks are retrieved, combined, and mapped to the sound processing of urban sounds, resulting in music output through headphones. Musical control is designed to be a balance between user and environment influence. Sensory and bodily information are mapped on two levels. On a low level, discrete parameters (e.g. presence of metal, turns) and continuous parameters (e.g. light intensity, pollution) are respectively mapped to short musical events and spectral sound qualities. On a high level, combinations of action and context information (e.g. standing still at night) retrieved from low-level input, affect the structural composition of the music (for more details, see [2]).

Figure 1: Video-filming a Sonic City user in action

As a next step in this project, we wished to determine how people would actually use Sonic City in everyday settings. We therefore conducted a short-term user study with the prototype. This study partially served as an evaluation of our design choices in terms of enabling users to play the urban environment as a music instrument, but foremost helped us understanding characteristics of how people use Sonic City. Focusing on the latter aspect, this paper describes the process of the study and preliminary results based on feedback collected from users.

2. USER STUDY
We focused on investigating the following questions: would people consider Sonic City as an urban exploration tool, as a dynamic walkman, or as a music instrument through which they would actively use the city to produce music? Most importantly, how would users incorporate the urban environment, their everyday actions, and relationships to their surroundings, into their use of Sonic City?

The study therefore consisted in observing the interaction details of how a variety of participants used the prototype in one of their own everyday environment during a limited period of time, and in collecting their feedback about it.

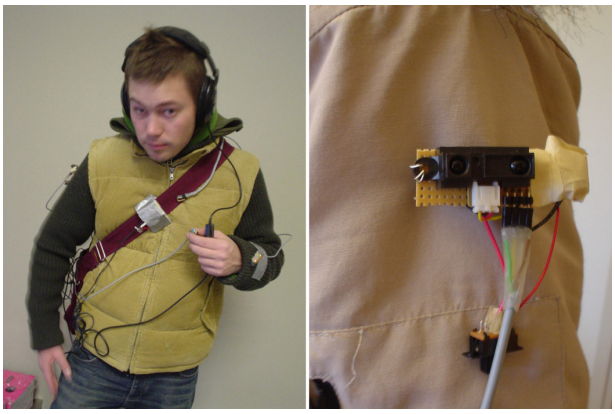

Figure 2: a) User wearing the Sonic City prototype; b) proximity IR-sensor on another user's arm

2.1 Participants

The study participants were chosen among people we met through everyday encounters. Getting a diverse (but not necessarily representative) sample of Göteborg's population was important to guarantee a variety of results and feedback. Therefore, user selection was based on how interesting their profiles would be for the study, as well as on their availability.

The study has involved 7 participants: 4 females and 3 males of various origins and activities. 2 participants have not yet completed the whole study process. Of the 5 who have, MK is a teenage high school student, FM a grandfather and second-hand shop owner, TR a robotic circus artist in her twenties studying art and technology, AS a grandmother and cultural worker, and DR a graffiti artist in his thirties co-owning a gallery. None of them consider themselves as musicians. They all use mixed types of transportation throughout the city: public transports (tramway, bus and ferry), BMX and regular bicycles, and of course walking. Their familiarity with the city varies from a couple of years in Göteborg (TR, DR) to decades (FM) to their whole life (AS, MK).

2.2 Methods

The methods employed in this study are partially based on a cognitive science-oriented proposal about evaluation methods for Sonic City [3]. As the methods focused specifically on altered way-finding behaviours and perception of environment from a cognitive perspective, we adapted and extended them to the study of performative aspects of the users' behaviours and experiences, in terms of musical interaction.

2.2.1 Cultural Probes: Insight Into Everyday Path

Cultural probes were introduced by Gaver et al. as a method for inspiring design by gathering information about a user's everyday life [1]. They are individual self-contained small packages handed-out to users that typically contain assignments, a still camera, a questionnaire and a map. In our case, we used cultural probes prior to the user testings, in order to gain insight into the users' everyday environments, the type of path they would take, and their perception of them. This also helped determining where the test sessions would be conducted, as they had to take place in the users' everyday environments.

2.2.2 Observations: Path & Behaviour During Use

In order to obtain information about real-time interactions in real-life settings rather than about the role of the system in people's life through e.g. diary types of documentation, we opted for a behaviourist approach: audiovisual documentation of the testing sessions, with video-filming of the users in action (see Figure 1) and audio recordings of the music. This enabled a close study of paths and behaviours during use.

2.2.3 Interviews: Direct User Feedback

The users' personal views of the sessions were obtained through in-depth semi-structured interviews. These interviews were mainly conducted right after each test, with some complementary questions after watching the videos. They were documented with audio recordings and transcribed for further analysis.

2.2.4 Video Analysis: In-Depth Interaction Study

Analysis of videos synchronised with corresponding music allowed us to get a deeper understanding of the details of interactions by linking interactions with musical results, and repeating playbacks. The videos were watched:

- *with each user*: collecting their own comments and analysis of the sessions as a post-use think-aloud technique, where their cognitive load were lighter than during use and they could concentrate on recalling the music making process;
- *without users*: by synchronising these comments with the videos, we could compare the users' feedback with an objective analysis of their behaviours while avoiding misunderstandings about their intentions.

2.3 Prototype Adaptation

Because the study would be performed in real-life settings, the prototype had to face some limitations and related adaptations. Main problems were short battery lifetime in cold winter temperatures limiting the length of each test, as well as the system not being proof against rain or other difficult weather conditions.

Sensors used during the tests were a microphone placed on the user's chest, a light intensity sensor on a shoulder, a metal detector a hand, a linear proximity IR-sensor on the opposite arm, a press-button in one hand, and an accelerometer on a leg (see Figure 2). In order to improve processing performance, the parameters pollution level and temperature were set to simulated default values, as they were rather stable in each testing setting. The accelerometer sensed stops, starts, and the starting user pace that determined the music tempo of a whole session. The user explicitly indicated turns by pressing the button. The real-time context recognition algorithms were also limited to determining contexts likely to change during a session. As for more general testing contexts that would remain constant (day vs. night, indoors vs. outdoors), different programs with specific compositional structures were used for each of them.

On a low level, sound level was mapped to the amount of rhythm layers, and light intensity to pitch. The metal detector played back the latest random samples of urban sounds recorded by the system. Samples could also be scratched with the proximity sensor. On a high level, enclosed environments had twice as fast tempo as open ones, loud contexts more intricate rhythms than silent ones, and bright contexts were more atmospheric than dark ones. Standing still muted most of the music except for a

metronome sound. Turning changed the patterns of the rhythm layers randomly.

2.4 Study Process

The first part of the evaluation consisted of testing the robustness of the prototype implementation. We started by performing a cognitive walkthrough, in which we tested different interaction options and usability issues ourselves. Then we staged the use of Sonic City during controlled experiments in urban settings, using a modular jacket designed specifically for this purpose. This helped calibrating the prototype and determining optimal sensor placement for the study [4].

Participant were each given a cultural probe for a few days, with instructions to only open it and proceed when taking a path they would have taken anyway. The probes contained the assignment of documenting a single everyday path with a digital still camera, taking pictures of obstacles, resources and what would catch their attention. Then, they would write down answers to both clear and ambiguous questions about their path, draw their own map of it, put stickers where the pictures had been taken, and locate themselves on a larger city map. One documented path lasted typically about 15 minutes.

The observations, interviews and video analysis phase reported here took place during a period of two weeks. Each test took between 5 and 20 minutes - depending on how long the prototype's batteries lasted in subzero winter temperatures - and in the area documented in the user's probe. The user was however free to decide path and actions within this area. In case of bad weather conditions combined with re-scheduling difficulties, a session would be conducted at the central train station, an indoor yet urban and dynamic environment. Test locations were:

- AS: the central train station on a week day morning,
- TR: an industrial area at night (see Figure 3.b),
- FM: a popular central area of the city on a week day morning (see Figure 3.a),
- DR: around a highly trafficked hill next to the harbour on a Sunday afternoon,
- MK: a central area of the city, characterised by its parks and dense population on a week day afternoon.

The interviews typically lasted about 15 minutes and were conducted right after each test in the same area but indoors. Questions asked focused on the user's sense of control, perception of the environment and of the music, actions taken and their motivations, ability to predict musical events, and on comparisons with the walkman and with music instruments. A total of 65 minutes of collected videos were synchronised with corresponding music recordings, followed by the users' spontaneous comments while watching their own videos and by an average of 5 minutes of complementary interviews.

3. PRELIMINARY RESULTS

3.1 User Experience and Behaviour

The following points describe patterns of experience and use obtained through the study, nuanced with individual results.

3.1.1 Nature and Quality of Experience

Using Sonic City turned out to be an enjoyable and interesting experience for most users, except for AS who felt uncomfortable about wearing a lot of equipment in public. Each session

Figure 3: User walking a) in a central street a day; b) in an industrial area at night

alternated between moments of discovery, system testing, relaxation, frustration, boredom, and excitement, sometimes back and forth. All users agreed on the system being very different from a walkman because the music dynamically reflected their surroundings, but also because they could not explicitly choose the sounds they were listening to. For the latter reason, Sonic City was not really considered as a music instrument either: it was something else. Two users expressed a wish for being able to fetch sounds from a bank of samples. DR suggested assigning sounds through specific gestures and TR remixing randomly picked MP3s.

3.1.2 Perception of Urban Environment

Most participants reported that their perception of their surroundings was enhanced when using Sonic City. Some felt more aware of details, of things that they had stopped paying attention to or never even noticed, and that were now emphasised by the system. The intensity with which the users and the system perceived an input was sometimes very different, causing occasional confusion. Users also commented on feeling more present and on being forced to be more involved in their environment, which contradicted our initial fears about isolation or traffic safety. Embarrassed by the visibility of the system, AS felt however socially isolated.

3.1.3 Musical Control

All users felt that the environment was what produced the music, not them. They felt able to participate and influence the music through choices of path (reaching different ambiences and interaction opportunities) and through localised bodily interaction, but since they could not control environmental events that had a stronger impact than their own actions (e.g. cars passing by), they did not feel much in control. This was however not necessarily a problem, as FM for example preferred being immersed in his surrounding than controlling how the music was made, two alternatives he considered incompatible. Many users had wishes and suggestions about implementation changes related to increasing their control over the experience. Some considered that they would certainly know how to manage the system if using it under a longer period of time. TR however pointed at the "scale" of the instrument that implied that one "would have to do a lot of exploring to (...) develop an ability to play", in comparison with a guitar, for example: "if you grab a guitar, you

can play it with your fingers in two minutes and see what it can do".

3.1.4 Engagement in Experience

How the system worked and what it highlighted in the environment influenced how the users perceived the city, what they noticed and therefore how they used it. Enhanced experience of the environment and low amount of perceived control stimulated the users into engaging more into the experience, actively seeking interaction opportunities to influence the music (especially when it felt monotonous). Examples of such behaviours are MK searching for people to pass-by, AS walking towards a construction site a second time to experience a louder context than the first time, or FM drastically deviating his path a few seconds to get closer to a wall. On a couple of occasions, a sensor (metal detector or proximity sensor) would stop working momentarily, which pushed the user to try as hard as possible to get it to work, until he/she would give up about it, even when it had started working again.

3.1.5 Predictability and Variations of the Music

After having used the system for a few minutes, most users could predict that something was going to happen in the music based on noticed input, but not necessarily what and how. Sometimes, they could not figure out from where a musical event originated. Some users mentally linked music and environmental details in a highly subjective and personal way (e.g. rhythm patterns with stripes on the ground), even if they were aware that the connection was not real. AS, who walked in a very dynamic environment, often perceived the variations of the music as surprising. Others experienced it as monotonous when not much was happening around them, such as TR who described the music as "one very long song". DR expressed a wish for stronger variations in the music in certain contexts that he experienced as almost silent, but most of the time perceived the music as rich and "very good": "Time to hit the dance floor!"

3.1.6 Levels of Interaction

The interactions in which the users engaged were on the level of the global path and of local interactions. Both levels were managed in an ad hoc, rather improvised way. Paths were most often planned in advance by the users but were sometimes randomly or intentionally modified during the course of a session in order to look for more interesting contexts and test how they would sound (e.g. a noisy construction site for AS, a dark corner next to an electricity chamber for DR). The users looked around themselves to seek local interactions opportunities, which they also found by accident (e.g. metallic objects). Some had favourite inputs, such as human voices for MK or noisy traffic for FM.

The users actively directed sensors with their body. In order to produce input, they often got closer to fixed artefacts at hand such as metal or walls. They also turned their body and thus the sensors towards or against diffused sources of input in order to amplify respectively shadow them, thus modulating the city's input. DR turned his back on traffic to reduce the impact of the sound level for example. When it happened unintentionally, such as when TR's head cast a shadow over the light sensor while walking under a street lamp, this interference was perceived as odd.

3.2 Interpretation of Results

The study showed that mobility could indeed become a musical interaction between a user and her urban environment, enhancing her perception of and engagement with these everyday settings. Paths can be considered as a score articulated by ad hoc local bodily interactions. The study also opened the question of how to improvise and adapt one's musical interaction when confronted to a lack of control due to unpredictable and uncontrollable factors encountered in urban environments: the city was perceived to be more in control of this interaction than the user; however, she was able to actively influence how the music was created through different tactics - such as modifying paths, and through situated interventions - such as modulating urban input with body posture f.ex., all of them related to how the system was designed, what it highlighted and thus how it encouraged her to act. Design implications based on these results are however beyond the scope of this paper, which focused on user experience and behaviour.

4. CONCLUSION AND FUTURE WORK

Conducting a user study of Sonic City enables us to gain a grounded insight into how mobility in everyday urban environments would be used to create music in real time. Future work includes further and more detailed analysis of the user data gathered during the study, in order to sketch a general model of the use of Sonic City, and deriving design implications to apply to the next iteration of the prototype. Long-term user studies about the integration of such a system in a user's lifestyle would require a more robust hardware.

5. ACKNOWLEDGMENTS

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