Large-Scale Interaction with a Sound Installation as a Design Tool

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ABSTRACT

In this paper we present an installation done in collaboration with Volvo Cars® for the international motor shows in Geneva, New York, and Shanghai during spring 2017. To envision and produce a *future car sound* for silent vehicles, users were given high-level control of a sophisticated synthesizer through playing with an attainable and inviting "color book"-inspired interface. The synthesizer algorithm was designed to dynamically create a rich mix of looped sounds that could blend with a sonic background scenery that had ecoacoustic validity, and that could metaphorically align with the visual elements. The installation ran faultlessly for around thirty days and with tens of thousands recorded sessions.

Figure 1: Volvo sound studio installation for Geneva International Motor Show. Welcome screen with three sceneries: In each, the user "paints" the car sound design in a color-book style interaction.

CCS CONCEPTS

• **Applied computing** → **Sound and music computing**; • **Human-centered computing** → **Auditory feedback**; *Touch screens*; *Activity centered design*;

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87th Geneva International Motor Show™

Dates	March 9–19	
Visitors	700.000	
www.gims.swiss		

New York International Auto Show™

Dates	March 30–April 8	
Visitors	1.000.000	
autoshowny.com		

Auto Shanghai™ 2017

Dates	April 21–28	
Visitors	1.000.000	
autoshanghai.auto-fairs.com		

Sidebar 1: The Volvo sound studio installation was featured in three international motor expositions in 2017. Promotional material (official logos) available at respective website.

Figure 2: The main exposition hall, Geneva International Motor Show 2017. Promotional photo: https://www.gims.swiss/en/photos/atmosphere-2017-11208

KEYWORDS

Sound design; car sounds; audio-visual; sound installation; sound interaction

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INTRODUCTION AND BACKGROUND

We present an interactive tool for sound design of future electric cars, called “Volvo sound studio” (Figure 1). The finished installation has been exhibited at three international motor shows during spring 2017 with a total estimated visitor count of 2.7 million people (see Sidebar 1); data analysis from many thousands of sessions are currently being conducted. In this paper, the focus is on describing the system and sound design, and thus we present no results from analyses. With such a big audience in three continents, we faced a very diversified user group. With that in mind we wanted to explore how an intuitive and easy-to-use interface that, without requiring prior knowledge of sound design, could provide for enough creative freedom and control to generate passable car sound compositions.

Electric and hybrid cars drive silently, and silent cars potentially jeopardize the safety of pedestrians [1]. These challenges are met by new international regulations and laws. The UN directs implementation of an “Acoustic Vehicle Alerting System” (AVAS) in quiet cars [3]. While the AVAS is accurately defined in terms of sound levels in frequency bands, the sound design is not restricted, and manufacturers are allowed to provide alternative sounds selectable by the individual driver. In contrast, US laws dictate that AVAS should be identical for each make and model, and not user selectable [8].

With regards to the still indecisive AVAS regulations, alert sounds will be an increasingly important area for car manufacturers in their strategic branding, design and production. How the sound design process should be devised is still an open question which has got recent attention from academics, artists and industry alike (see for instance [4, 7, 10–12]).

At the world’s largest motor shows, the manufacturer brands and affiliated industries fight hard for the visitors attention (see photo in Sidebar 1). In the presented “sound studio” project in collaboration with Volvo Cars®, we had the following specifications and expectations in creating an interactive attraction for the company’s pavilion:

— The installation must be attractive.
— The installation must adhere to the company’s current visual and sonic branding.
— It must be possible for visitors to achieve a satisfactory result within around 30 seconds.
— The sound design must not contravene the company’s core values; Safety, Quality and Environment.

Research Challenge

1. Will an installation with instant high-level control of combined audio parameters yield similar sound designs as a carefully operated user interface with low-level control of single parameters?

2a. How are measured differences in sound design accounted for by external factors, e.g. geographical location, time of day, and visitor crowdedness?

2b. How are measured differences in sound design accounted for by interface factors, e.g. indicated car speed, color choices, sound material, and presented scenery?

Sidebar 2: Main research questions for the project.

Hardware and software

Windows® Surface Studio PixelSense™ 28” touch display, Windows 10 OS, www.microsoft.com/surface/devices/surface-studio
Bowers & Wilkins® P9 Signature, over-ear headphones, www.bowers-wilkins.net/Headphones/Wired-Headphones/P9.html
AudioQuest® DragonFly red, 32 bit ESS 9016 DAC and headphone amplifier, www.audioquest.com/dragonfly-series
Pure Data, 0.47-1, real-time programming environment for audio, puredata.info
GEM, 0.93.3 with Pd-extended 0.43.4, graphics environment for multimedia, https://puredata.info/downloads/gem

Sidebar 3: Overview of the technical set-up and system components.

As such, the sound composer interface and sound aesthetics should attend to the artistic perspective as well as the practical. The interface had to be very intuitive and require as little learning as possible in order for the users to interact immediately. The graphic aspects of the interface were mainly to act as a support for designing the sounds, without demanding too much attention and stealing focus from listening to the sounds. The graphical interface should also afford a clear start and ending of the sound design process so as to know when the sound could be considered finished.

In addition, we identified a few characteristics of the environment:

— The exhibition space is very noisy, and audio should be played using noise-isolating headphones.
— Visitors might carry belongings, and all interaction should be single-handed, unpracticed gestures.
— Visitors will gather around the screen, so interaction should be clear, self-explanatory and inviting.
— For practical reasons we can only collect interaction data, and no other user information.

While work and prototypes with similarity to the described system have been done elsewhere, these were not actively identified, considered nor evaluated, and will consequently neither be reported here. However, we were certainly aware of and inspired by works such as [2, 5, 6, 9]. The sound design was not expected to be in accordance with the previously mentioned regulations for alert systems for silent vehicles, nor to be perceptually optimized; the object was mainly to provide for entertainment (to the public). Practical design decisions were taken with advice and recommendations from company representatives with experience from auto fairs, and grounded on novelty and attractiveness.

The project was allowed to provide us with research data, and thus aims to answer our current research questions in sound design and interaction (see Sidebar 2). These concern generally the sound designing *process* more than the applied area of vehicle sounds. In this paper, focus is on the technical aspects of our installation. These include sound design through image manipulation, real-time audio processing, the large-scale settings, and challenges of the working environment. The installation was to be implemented with Windows Surface computers and Bowers & Wilkins over-ear headphones. Audio and graphics were programmed in Pure Data and GEM (see Sidebar 3).

DESIGN AND IMPLEMENTATION

While we artistically could have envisaged both more complex graphics and audio manipulations in our work, the context did not favor this. Directed by the conditions described above, we implemented a color-book interface, where the user could “paint” the sound design. This approach solicited high-level control of sound parameters instead of accurate adjustments, and provided visual cues to a start and finished stage. Even with a simplistic interface, we ambitioned to create rich and dynamic sounds. Three *sceneries* were introduced: 1) a school area, 2) a country road, and 3) a city center (Fig. 1).

The sound material included one set *soundscape* for each of the sceneries, and five selectable *constituent sounds* used for the interactive composer. We avoided intentional cross-modal couplings

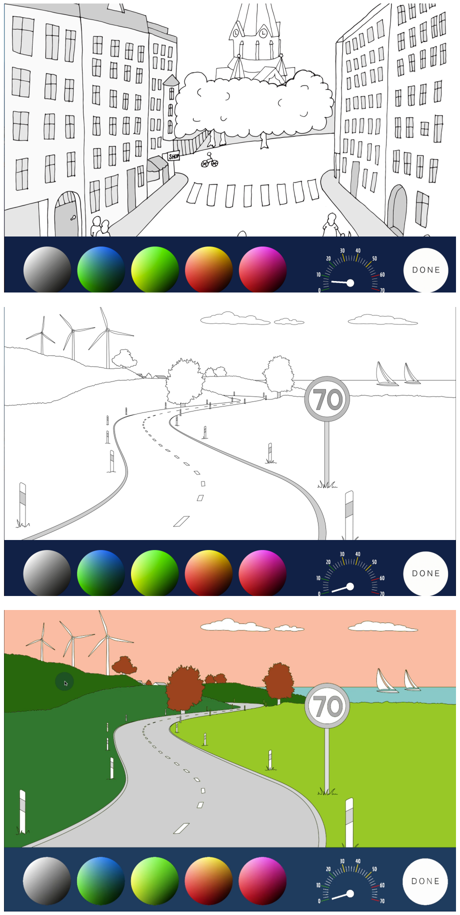

Figure 3: The city center and country road sceneries with empty canvasses and a finished painting. Users were not instructed to color the image in any particular way, and the produced sound did not reward realistic choices.

such as mapping color to frequency or emotion. The soundscapes were played in the background and acted as subdued auditory representations of the sceneries to enhance the sensation of immersion and provide ecoacoustic validity.

Designing the soundscapes

The soundscapes were designed through mixing recordings of nature sounds and urban environments. They were three and a half minutes long and played in a seamless loop.

City center scenery soundscape A mix of field recordings of two cities recorded at different locations early in the morning, a recording from a busy pedestrian street, and a church bell.
Country road scenery soundscape A mix of field recordings of breaking waves, seagulls, cars driving at a distance on the countryside, and soft wind on a field.
School road scenery soundscape A mix of field recordings from a playground, a quiet urban environment, and a parking lot outside a shopping mall.

Designing the constituent sounds

Five constituent sounds were designed to be used as building blocks for the composer. These were five seconds long and could be looped at any point without notable glitches. Three of them were contextually connected to sceneries through resemblance to the soundscapes, as we were interested to see if participants also would use these consistently.

When designing the constituent sounds, the intention was to produce sounds that could easily be combined with each other to form a composite whole and be gratifying even in repeated, longer listening. The users could combine different sounds or even multiple layers of the same sound, and apply audio filtering to this combination. The sounds are presented below with provisional labels.

"The harmonic sound" A pad created by resonating and reverberating fragments of a church bell and a minor chord. Contextually connected to the *city center soundscape*.
"The rolling sound" Filtering and delaying a minor 7^{th} chord using a recording of waves to trigger the delay channel for an organic rhythm. Contextually connected to the *country road soundscape*.
"The school bell sound" A recording of wind chimes first compressed then resonated, reverberated and amplitude modulated to tremolate. Contextually connected to the *school road soundscape*.
"The motor sound" A recording of a Volvo V60 internal combustion engine filtered through a high pass filter, and moderately distorted to accentuate the engine sound.
"The sci-fi sound" Oscillating a single tone which then is reverberated, and further flanged and resonated. The combination of a low drone and high buzzing created sensations of movement, and sounded futuristic and dissimilar to both conventional car sounds and the soundscapes.

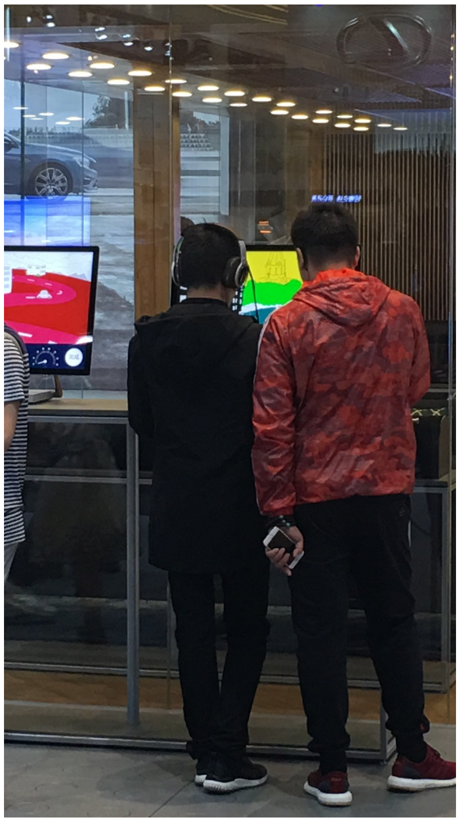

Figure 4: A user engaging in the Volvo sound studio, coloring the sky of the city scenery yellow. The users wore noise-isolating headphones. Photo by Vesa Marin.

Graphics and interaction

All screen interaction was single finger, and multi-touch was disabled. A demo video was played after a period of no registered activity. First, the visitor was presented a “coloring book” with the three mentioned sceneries. After selecting one, the user could choose a color from five different palettes and apply it to any of the areas in the drawing (Fig. 3). Each palette was assigned to a different constituent sound from the above, and the different chromatic nuances corresponded to different parameters of a sonic filter. While selecting a color in the palette, the real-time changing of the sound was heard.

When an area had been filled, the full composition was played. The user could repeat this action until satisfied. A “speedometer” could control playback speed variations on the full composition. The user could press a “done” button which opened a final window with an option of sharing the sonic/graphic data anonymously. After this last screen, the installation returns to the first window for a new scene selection; there were no limit on number of allowed iterations with each scene.

Sound synthesis

Applying color to an area started a looped playback of the mapped designed sound. To produce dynamic sounds, each triggered area initiated three simultaneous loops of short and various lengths. Loop boundaries were set each time using a pseudo-random function: the first played from somewhere in the first half of the recording, the second from the middle part, and the third from the last part. It is practically impossible to replicate a combination of loops. Each trio of loops was processed with a predetermined audio effect: either a pitch-shifted delay, sweeping a voltage-controlled bandpass filter, a modulating phaser, or a time-varied delay line. The color palette controlled the effect parameters.

Each of the six areas of the painting thus had three unique, processed loops, and the full composition had 18 simultaneous loops. Stereo panning was applied to match the graphics. The speedometer changed overall pitch and looping speed of the whole composition, but to avoid trite effects, the changes were not linear, and pitch and speed did not covary.

RESULTS AND FUTURE WORK

The concept of composing complex sounds from simple interaction worked very well and the technical platform was satisfactory. Interaction with the installation proved to be intuitive and fast in terms of required time per user (see Fig. 4). The installations ran faultlessly at the different venues for approximately 30 days without supervision or maintenance. Collected data are currently being processed for analysis.

Pure Data and GEM were appropriate for the task, but the workload was initially high for the computer. The load was reduced using the new `clone` and `switch` functions in Pure Data, and through smaller image files in GEM.

Future development plans include to make a tablet version, and to test the sound design interaction in other settings. The presented version of the Volvo Sound Studio was however aimed at the auto shows during spring 2017, and are not planned to be modified.

To approach the research questions, further controlled experiments will be done. In particular, we are interested to compare sound designs from the presented interface with sound designs resulting from a low-level control interface where the users can manipulate all parameters accurately, with no surrounding distractions, and with no time restraints.

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