AWESOME SOUND DESIGN TOOL: A WEB BASED UTILITY THAT INVITES END USERS INTO THE AUDIO DESIGN PROCESS

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ABSTRACT

Previous auditory display research has shown how fundamental aspects of an auditory signal may influence perception and impact the emotional state of the listener. However, a challenge for designers is how to find signals that correspond to user situations and make sense within a user context. In this article we present a web based application called AWESOME Sound Design Tool; a tool that invites users to take part in the design process of auditory signals. The basic idea is to give users control over some aspects of the auditory stimuli and encourage them to manipulate the sound with a specific user scenario in mind. The software may help developers working with applied design to find more appropriate sounds for user situations. It might also help researchers to better understand correlations between the properties of a sound and characteristics of a user situation. A pilot study has been conducted in which car drivers designed warning signals for critical traffic situations. The pilot study illustrated how the tool could be useful for applied audio design.

1. INTRODUCTION

Brief auditory signals that guide attention and support actions may be an attractive means of communication in various types of user environments, not least in safety-critical and visually demanding situations such as driving. Previous auditory display research has shown how fundamental aspects of sound can influence perception. For instance, a number of studies on auditory warning signals have addressed correlations between sound properties and perceived urgency [1, 2]. In recent years there has been a growing interest in research to examine how sounds in user environments may evoke emotional responses and how that in turn may impact performance [3].

In a typical scientific experiment some aspect of the stimuli is manipulated and presented to a participant who listens and reacts. This kind of study may give developers and designers some idea of which aspects of an auditory signal that are important to consider when designing signals for a particular situation. However, a challenge for the designers is how to find sounds that correspond to user situations and make sense within a whole user context. One way to find more appropriate signals might be to invite experienced users to give their opinions on a number of design suggestions. However, users that have little or no experience in sound design do not necessarily feel comfortable judging sounds and suggesting modifications on such a detailed level. A more beneficial strategy might be to give users some control over parameters of the sound and encourage them to modify the signal with some user scenario in mind. This kind of input from experienced users might help developers to better understand the correlations between properties of an auditory signal and characteristics of a user situation.

2. THE DESIGN TOOL

In the project AWESOME (Audio Workplace Simulation Machine) the Interactive Institute Sonic Studio is developing a series of tools to help and facilitate the work of designers of various types of sounding user environments. The AWESOME Sound Design Tool shares some of the fundamental ideas with REMUPP (RElations between MUsical parameters and Perceived Properties); an application which has been developed and evaluated within the area of music pedagogy [4,5]. Like REMUPP the idea with the present design tool is to make participants respond to an experience using the medium of sound itself, without having to translate it to other modes of expression. Another similarity between the applications is the possibility to save and export judgements for statistical analysis.

The REMUPP interface allows participants to change the musical expression in real time, by manipulation of musical parameters such as tempo, rhythm and articulation [4]. It has been used as a tool for studying how musical narrative functions are being experienced and used [5]. The AWESOME Sound Design Tool is designed to allow developers to find correlations between various types of sound parameters and characteristics of specific user situations. The tool is a stand-alone application intended for both controlled experiments and remote evaluations over the web. While REMUPP was bound to the evaluation of musical parameters, the present design tool allows the evaluation of any type of properties or combinations of properties of a sound.

2.1 Implementation

The AWESOME Design Tool is a web-based client-server application. A schematic illustration of the system is presented in figure 1. The server side of the system is a database accessed via PHP that stores pre-made user situations and sound files supplied by the experimenter during a preparation phase. The database has four tables; Sessions, Examples, Trials and Sounds. Before a test begins the experimenter sets up a number of Examples, or situations, using an administrator interface. An Example contains a picture or movie, a text string explaining the situation and an optional audio file. An Example serves as a user situation that creates a context for the test subject to relate the proposed sound design to. The database table Sounds is used to store a matrix of audio files that constitutes the sound design space within which the subjects can manipulate the sound they are designing. The number of dimensions in the matrix corresponds to the number of sound parameters that are to be evaluated. In the present configuration of the tool each axis in the matrix has three positions and each position in the matrix holds one, unique audio file. In total this gives 3 x 3 x 3 = 27 audio files that define the available sound design space. Since the sound properties are not modulated by the system, but are pre-rendered mp3 files, any combinations of sound properties are possible and allowed by the system.

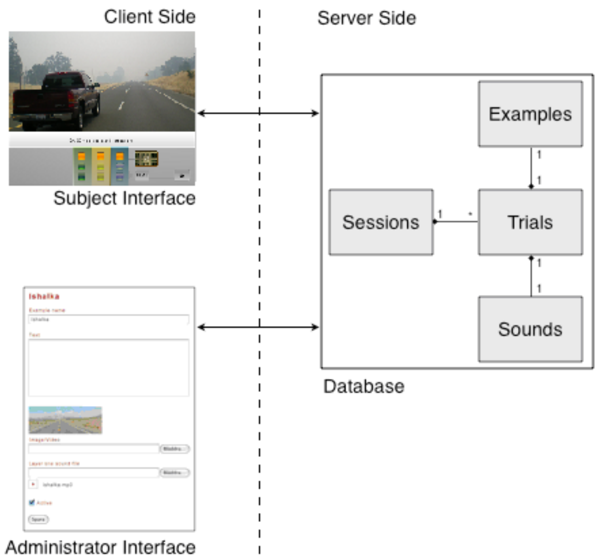

Figure 1: *Schematic overview of the system.*

The client side has been developed using Macromedia Flash and has two interfaces. The first interface is for administration used by the developer or researcher to prepare tests sessions and to extract data from previous test sessions. The second interface is used by test subjects to judge situations and manipulate parameters of the sound. This interface is presented in figure 2. Since the system uses pre recorded files subjects are not really manipulating the sounds. However, the intention is to give users the impression of manipulation through the design of the interface. The user context and situation is represented on the screen by an image or video and a text string. The auditory stimulus is manipulated using radio buttons organised in columns placed in the lower part of the screen. Each column represents a unique sound parameter that can be manipulated separately in three steps or levels. When the user clicks on a radio button in one of the columns, the sound corresponding to the present button configuration is played automatically. The participant can also play the current configuration using the Play button. Clicking the OK button advances the user to the next user situation. The order of situations and the default configuration of the radio buttons are randomised by the application.

Figure 2: *The interface used by participants to judge situations and manipulate sounds.*

2.1. Analysis of data

The data generated by the subjects are stored in the database for future analysis. By using the administrator interface the designer can export data from the database in a file format recognised by commonly used statistical softare such as SPSS, SYSTAT and Mircosoft Excel.

3. PILOT STUDY

Evaluation of the AWESOME Design Tool is conducted as part of a collaboration project between Interactive Institute, Scania CV AB and Luleå University of Technology. The present work addresses how audio design can meet the requirements of effective Intelligent Transport System (ITS) communication in heavy vehicles.

Utilising the AWESOME Sound Design Tool might be a beneficial strategy to find appropriate warning signals for specific traffic situations. One aspect may be to find signals that express the urgency or importance of a driving situation. Previous studies have suggested how different parameters in sound may affect perceived urgency. But can we expect to see reliable and apparent tendencies in how drivers select sounds using the tool?

One aim of the pilot study was to get some first indication of whether the tool can be appropriate to use in applied warning design. The study also aimed at finding potential usability issues that can be avoided in future evaluations and versions of the tool. The following main questions were addressed in the usability study.

- Do the users intuitively understand the interaction model?
- Do the drivers feel comfortable judging auditory stimuli using the medium of sound?
- Do the drivers feel satisfied or restricted by the design space, and how should it be extended or complemented in future studies and evaluations?

3.1. Method

41 drivers, 23 males and 18 females, between the ages of 25 and 65 (mean 36.5) participated. None of the drivers had any

previous experience of the tool. All drivers had self-reported normal hearing.

The interface was presented on a Macintosh MacBook 2.0 GHz laptop (Apple Inc., CA, USA) The sounds were played to participants at a comfortable listening level through a pair of KOSS Porta Pro headphones (Koss Corporation, WI, USA).

An illustration of the design space is presented in figure 3. The drivers were allowed to manipulate three parameters of the sound; number of tones per time unit (A), harmonic complexity (B) and register (C). The first bar in each parameter (A-C) illustrates the low level, in that parameter. The second bar illustrates the medium level and the third bar illustrates the high level.

Figure 3: *Illustration of the predefined design space used in the pilot study. A. Number of tones per time unit. B. Harmonic complexity. C. Register.*

Five driving situations were selected for the study. Two of the situations were assumed to be perceived as very urgent by drivers. In one situation (*child*), a young girl was running in front of the vehicle. In the other urgent situation (*car*) another car in oncoming traffic was driving towards the own vehicle. Two selected situations were assumed to be perceived as less urgent by drivers. In one situation (*school bus*), a school bus was parked behind a road crest. In the other situation (*cyclists*) a number of cyclists were standing in fog on top of a road crest. The final situation (*speed camera*) was not directly related to traffic safety. In this situation the driver was approaching a speed camera. The images used to represent the traffic situations were all taken from the drivers' position.

Instructions presented on the screen introduced participants to the design task. Neither the sound parameters nor the characteristics of the traffic situations were revealed in the instructions. By clicking a button the drivers continued to the first driving situation. The five situations were presented to the participants in random order. The experimenter was present during the test but participants were not allowed to ask any questions unless they got stuck. After the last situation the drivers were given a questioner containing 15 statements related to the usability questions addressed in the study. They were also allowed to write freely about any issues experienced and suggest improvements.

3.2. Key findings

3.2.1. Appropriateness of the method

Complete data was collected from all 41 participants. Figure 2-4 shows the distributions of driver choices in the sound parameters. For the most urgent situations (*car* and *child*) a majority of the drivers preferred the high level in all three parameters. It was assumed that drivers would perceive the *speed camera* situation as the least urgent situation. This situation showed opposite patterns in all three sound parameters compared to the two most urgent situations. The other two situations, *school bus* and *cyclists,* tended to have rather even distributions with a small peak in either the low or medium levels of the parameters. The distribution patters are not surprising. Based on previous research on sound parameters and urgency it was reasonable to believe that drivers would associate more urgent situations with a high register, more tones per time unit and a higher level of harmonic complexity. The clear tendencies seen in the results indicate that the drivers were able to actively manipulate the sounds to make them correspond to the driving situations.

About 80 % of the drivers choose the high level of harmonic complexity in the most urgent situations. This indicates that the predefined design space may not have been adequate for such urgent situations. In the questioner two drivers explicitly stated they were not able to design signals that sounded urgent enough for the *child* and *car* situations. It is reasonable that many drivers would have selected sounds with a higher level of "sonic urgency" if that had been possible.

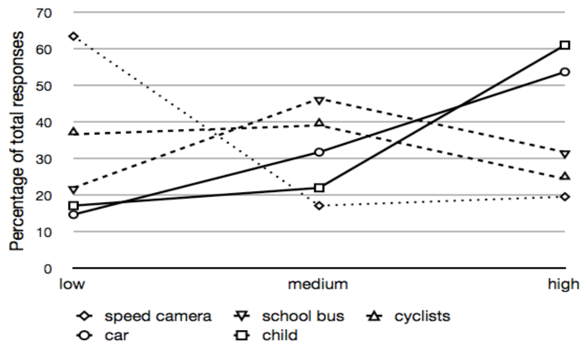

Figure 4: *Selections for the parameter "number of tones per time unit".*

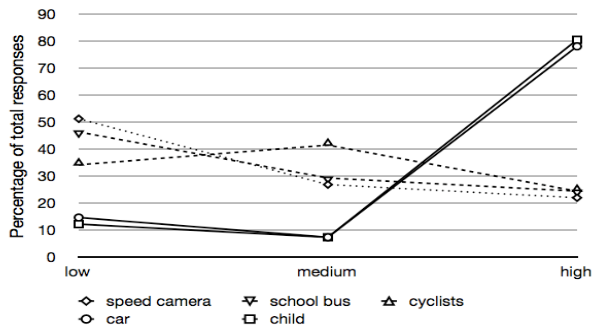

Figure 5: *Selections for the parameter "harmonic complexity".*

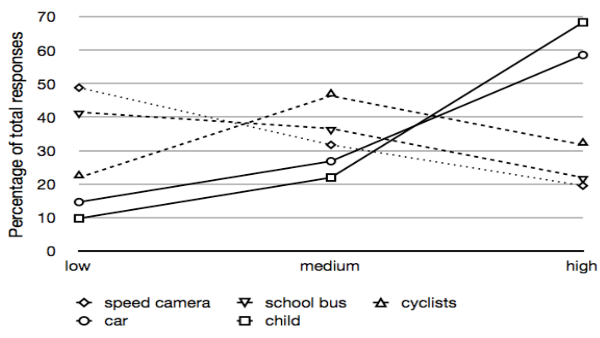

Figure 6: *Selections for the parameter "register".*

3.2.2. *Usability*

In general, most of the participants found the interface easy to use. Some drivers experienced difficulties in the very first traffic situation. 6 of the 40 drivers stated that they did not understand directly how to change the shape of the sound using the interface. 3 drivers got stuck in the first example and had to ask the experimenter for assistance. One of the drivers suggested that a practice example at the beginning of the test would have been helpful.

The results of the questioner showed that the drivers were comfortable expressing themselves using sound. They seemed to like the interactive and nonverbal concept. Almost all the drivers answered that they would prefer using the tool compared to expressing themselves verbally. They also answered that it is appropriate for them to design warning signals. 4 drivers wrote that they would have preferred the possibility to go back and change previous designs. The current version of the tool does not have such a feature. In the present study the idea was to collect spontaneous opinions from drivers. Although, in other types of studies it may be preferable if subjects are allowed to compare situations and designs.

Most of the comments about the design space were related to the musical timbre used for the sounds. 11 drivers wrote that they felt restricted by the sound of string instruments. Also, as mentioned previously, some drivers found it impossible to design sounds for the most urgent situations. Selecting parameters and levels within parameters that suits the design task may be one of the mayor challenges for developers intending to use the tool.

4. DISCUSSION

The AWESOME Sound Design tool is a web-based application that allows participants to respond to an experience using the medium of sound itself, without having to translate it to other modes of expression. The interface allows experienced users to take part in a design process but without requiring any prior experience in sound design. The software utilises pre-rendered .mp3 files that can be easily exchanged by the experimenter depending on the type of study or parameters of the sound that are to be investigated.

Auditory display research has to a large extent been focusing on advantages and disadvantages of different sound types such as earcons and auditory icons. However, in recent years a more semiotic approach to the design of non-speech sounds has been proposed [6, 7]. Mustonen [7] pointed out that the same sound could be listened to with different outcomes in different situations and orientations. When listening to interface elements we may intuitively recognise familiar parts from the sound and construct the meaning from their relation to the situation. The design tool brings together users' experience of a context and their perception of auditory stimulus within the context. A better understanding of these correlations might allow designers to find more meaningful auditory signals for specific contexts and situations.

The pilot study illustrated how the tool could be useful for applied auditory design. The participants found the interface easy to use and they felt comfortable using the tool to design warning signals for traffic situations.

Defining a suitable design space can be a challenging task for designers and researchers intending to use the tool. The pilot study used a rather arbitrary defined design space and many drivers felt restricted by the possibilities offered. It is likely that developers would like to offer end users a more extensive design space with more parameters and/or steps within parameters. However, as the space grows, so does the number of sound files needed. 4 parameters with 3 steps instead of 3 three parameters with 3 steps requires 81 files instead of 27.

The tool may be useful to gather opinions from various types of end users. Depending on the type of study, it might be of importance to keep in mind that subjective opinions not nessesarily lead to a more sucessful design. It can therefore be a good idea to validate the results, for instance in an controlled experiment monitoring user behaviour and performance. In a forthcoming evaluation the design tool will be involved in a simulator study at the Swedish National Road and Transport Research Institute. In this study a number of warning signals produced with help of experienced truck drivers and the design tool will be evaluated in simulated driving.

The design tool can easily be used both in controlled experiments and remote studies using the web. Remote studies may involve a decreased level of control which is problematic for scientific studies. However, it might be an effective way to gather opinions from a large number of end users, or users with different cultural backgrounds. Future evaluations of the tool should address the use of the design tool for remote studies.

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