SYSSON: A Systematic Procedure to Develop Sonifications

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Abstract
The goal of this thesis is to design, develop and evaluate a 'User-Centered Design' approach to sonification. Eighteen climate scientists volunteered for requirements-gathering interviews. The results showed that climate scientists are heavily depending on visual display in their data analysis workflows. An audio interface shall enrich their perceptualization possibilities, based on the language metaphors derived from the interviews.

Author Keywords
Sonification; User-Centered Design; Audio Interface

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces; H.5.1 [Information Interfaces and

Background and Related Work
Auditory interfaces have not been explored in the HCI field as much as other interfaces (e.g. graphical interfaces). Furthermore many years of experience in HCI has helped disciplines that use it to design and create new design processes and apply them to similar problems when necessary [4]. This form of reinvention of design is explored by Steven Barrass [2] in his sonification design patterns. Design patterns are first introduced in the field of architecture and then got

expanded in many other designing disciplines. Alexander et al. [1]Later patterns are introduced to HCI. Borchers [3] has claimed that HCI is closer to architecture than software engineering and therefore design patterns are very suitable for this field. In the auditory field design patterns are not very common yet. Frauenberger [5] analyzed 23 proceedings of ICAD 2007 on four themes: design process, guidance, rationale, and evaluation. He describes that all papers introduce the application domain, but contextual information is not playing a role in the design process. After the in-depth view on design issues, he looks at the field of design in sonification from HCI community's point of view using an online survey. The results of this research show that the design process for auditory display is mostly unstructured and it provides limited support to reuse the design knowledge created. Another issue is that methodologies and existing guidance in audio domain are often tied to a specific context and reusing them is only possible within the restricted context[6].

The main tool for scientists to analyze data has been visualization in the last century. With the growth of information technology the amount of data available to be explored and observed has expanded. A central concern has been, missing on discovery of hidden information available in such huge amount of data. A set of exploratory data analysis methods has been formed to work on this challenge, which is typically based on graphical display. Although the most common output has been visual rendering of data, sonic displays have been explored as a complimentary tool. One of the challenging scopes for graphing has been multivariate data where sonification could be a great help. The fundamental difference in physiology of human ears and human eyes make the auditory and visual modalities be used for very different purposes. [9] Using auditory display in sonification has been explored in various domains e.g. real time monitoring of multiple data dimensions such as stock market analysis[8], EEG signals [7], and physics [10]. The advantage of using sound in such domains is because these types of signals are bound to time, and naturally since sound is also bound to time, expansions and contractions in time can be understood by sonifying. Climate science data have a similar characteristic, as they are usually time related.

Context, Motivation, and Statement of Thesis

User centered design methods have been evolved and integrated into many design processes to optimize them around how users can, want, and need to use the product instead of forcing the users to change their behavior to adapt to the product. Researching how to give attention to the users' behavior in each stage of the design and development and understanding how the users' learning curve looks like is a substantial part of this thesis. How could user centered design process improve sonification? What are some design patterns suitable for the domain of audio and sonification? In addition to functionality and usability, pleasure is also a central goal in designing products and applications. Users want something more than just usable: they want products that bring not only functional benefits but also emotional ones. Designing aesthetically appealing interfaces is about understanding the users and respecting humans diversity. How to design aesthetically appealing sonic interfaces without missing on usability and functionality?

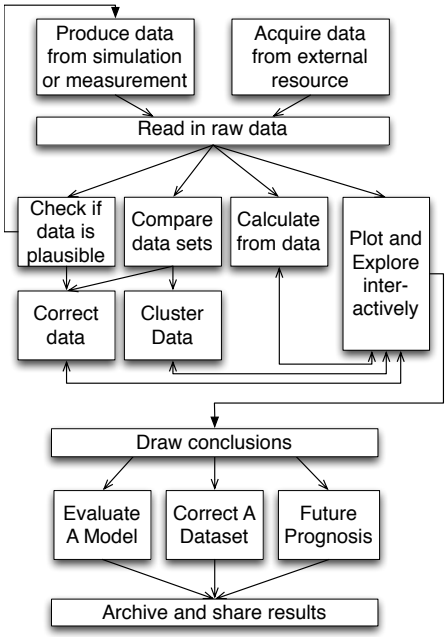

Figure 1. A workflow summarizing the data analysis task of the users.

Research Goals and Methods

There are two predesign experiments designed so far in detail; one of which has already been conducted using contextual interviews and focus groups. 18 climate scientists who are all members of Wegener Center for Climate and Global Change are interviewed and observed. The first experiment consisted of two sections:

- Contextual Inquiry: Is a field study where an observer and an interviewer visited actual users (climate scientists) in their workplace to analyze their work habits, activities, flows, and environmental factors while analyzing data.

- Focus groups: Participants belong to three different research groups. Each user group participated in a facilitated discussion where they share ideas and opinions on their work. Focus groups were conducted to observe more specific information about the communication between the experts within a group. Participants brought their own task results and were asked to briefly present and discuss them with the other members of the group.

All interviews were audio recorded and transcribed and are analyzed for their language and metaphorical content. Task analysis and evaluation of the first round of experiments are ongoing and will deliver results on the following questions: Information about the work environment of the climate scientists, including soft- and hardware and their expertise with it. Information about their work flow i.e., typical tasks in data analysis and which steps are part of the exploration process. An assessment of the language content that climate scientists use (a) towards non-experts and (b) within expert communication, with a special focus on metaphors that are useful as sound equivalent. An analysis of visualizations used by climate scientists, including their shortcomings.

Work Flow Analysis: Fig. 1 shows a common workflow summarizing the data analysis process in all of the three user groups. They acquire data from external research institutions or they simulate data themselves. Filtering, scaling, calculating specific parameters out of the raw data is necessary for the next steps of analysis. Metadata is extracted from the datasets or datasets are corrected in case of error or missing data. Then the metadata is used in the analysis to check characteristics in the dataset or to evaluate/compare various models. The central process in the workflow of the users is to plot and explore the data visually and interactively. This is where an audio interface could assist scientists to explore data from other perspectives using sonification. The commonalities in each step (Data gathering, Data Analysis, Drawing Results) of the users actions will help to define features of the audio interface.

Dissertation Status and Expected Contributions

We gathered data about the workflow of the climate scientists analyzing data. Furthermore we investigated user goals and their language metaphors to map them to sonic metaphors. The next steps are building a sound space and mapping sounds to climate metaphors for the auditory display in an iterative approach to create a pattern for analyzing data using sonification.

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