Designing with Auditory Icons: How Well Do We Identify Auditory Cues?

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ABSTRACT

Despite the increased use of auditory icons in computer interfaces, a methodology for designing with auditory icons has not been demonstrated. This methodology should be based on factors which commonly affect the usability of auditory icons in computer interfaces. One step in this methodology is determining how well people can identify auditory cues. In the first of a series of experiments, subjects were asked to describe a collection of short everyday sounds. The content and accuracy of their identifications offers guidelines for the use of auditory cues.

KEYWORDS: Auditory Interfaces, Auditory Icons, Design Methodology, Audio, User Interfaces

INTRODUCTION

Over the past few years, there has been an increased interest in building auditory interfaces. Auditory interfaces are useful in a number of situations including portable computers with small displays, screenreaders for the blind, and situations where the user's visual attention is directed elsewhere or overwhelmed with too much visual information[1]. Many of these interfaces use *auditory icons* to convey symbolic information in the interface in the same way that graphical icons are used in visual interfaces.

Auditory icons are based on the concept of everyday listening which contends that people describe sounds in terms of the objects and events which caused the sounds, not in psychoacoustic or musical terms. Like their graphical couterparts, the purpose of auditory icons is to remind the user of an object or concept in the everyday world.

The use of auditory icons has already been demonstrated in a number of systems. The SonicFinder[2] first utilized auditory icons for objects (the Macintosh trash can sounded like a metal trash can), actions (copying sounded like pouring liquid) and attributes of objects (the frequency of a file icon was related to its size). Mercator, which provides access to graphical interfaces for people who are blind, uses auditory icons to replace standard graphical icons[3]. For example, a toggle button sounds like an chain-pull light switch, which conveys the notion of a two-state control. Editable text fields sound like old-fashioned typewriters, while non-editable text fields sound like laser printers. Many other interfaces for simulating physics environments[2], monitoring surgery patients, drawing programs, supervising satellite ground control, monitoring background computer activity [1] and others have been built using auditory icons.

In short, a number of interesting and useful interfaces employing auditory icons have been constructed. But, excepting usability testing, these interfaces have been constructed on an ad hoc basis. Currently, there are few guidelines for the use of auditory icons. Likewise, a methodology for designing auditory icons does not exist. This short paper describes work in progress to demonstrate a design methodology for selection, use and evaluation of auditory icons. Factors which affect the usability of auditory icons are identified, and a design methodology corresponding to these factors is described. One step in this methodology is determining how well people identify typical auditory icons. The paper details a series of experiments evaluating the identifiability of many everyday sounds. The results from these experiments are used to derive a number of preliminary guidelines for using auditory icons.

USING AUDITORY ICONS

There are many factors which may affect the usability of auditory icons[3]. These factors are:

- Identifiability
  The user must be able to recognize the sound. The ecological frequency (how common is the sound) versus the relative uniqueness of the sound help determine its overall identifiability.
- Conceptual Mapping
  How well does the sound map to the aspect of the user interface represented by the auditory icon?
- Physical Parameters
  The physical parameters of the sound such as length intensity, sound quality and bandwidth (frequency range) may affect its usability.
- User Preference
  How the user responds emotionally to the auditory icon is also important. Is the sound harsh or too cute?

The auditory icons used in an interface must also be evaluated as a cohesive set. For example, the auditory icons must be relatively unique. They should not sound too similar and their conceptual mappings should not be counterintuitive. The physical parameters of the auditory icons such as length, intensity and sound quality should be roughly equal as the user might attempt to attribute some meaning to any perceivable differences.

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Proposed Design Methodology

A methodology for designing with auditory icons can be derived from the above factors. Some basic steps in this methodology are:

1. Choose short sounds which have a wide bandwidth, and where length, intensity, and sound quality are roughly equal.
2. Evaluate the identifiability of the auditory cues using free-form answers.
3. Evaluate the learnability of the auditory cues which are not readily identified.
4. Test possible conceptual mappings for the auditory cues using a repeated measures design where the independent variable is the concept which the cue will represent.
5. Evaluate possible sets of auditory icons for potential problems with masking, discriminability and conflicting mappings.
6. Conduct usability experiments with interfaces using the derived auditory icons.

A major step in this methodology is evaluating whether the user can identify the auditory cues. This step is addressed in the following discussion.

Identifying Auditory Icons

To assess the identifiability of common auditory cues, I collected 64 sounds (short "everyday" samples from sound effects CDs with minimal editing). The sounds were digitally recorded and stored on a digital audio tape (DAT). During the experiment, the sounds were played over two BOSE speakers to a classroom of 83 students. The acoustics of the room were sufficient to ensure that the sounds were not distorted from increased volume levels. Under tight time constraints, subjects were asked to describe (free-form) the sounds as best they could. Since many of the sounds are difficult to identify, I suggested that the subjects attempt to identify an object and/or an action which could be causing the sound.

The subjects' responses were analyzed by transforming their answer into a point in a 4x4 matrix. One axis on the matrix is how well the subject identified the object associated with the sound. The other axis is how well the subject identified the action associated with the sound. Per object/action, four scores were possible.

Y Correct identification

P (Partial) Either the subject identified a base material, an object with the same affordance or a similar/general action.

A (Alternate) Sometimes the group appears to have a consistent (alternative) answer which is "incorrect," but it is interesting that they tend to identify the sound in the same way.

N Incorrect or no answer

Preliminary results indicate that only approximately 15% of the sounds have high rates of identification with a Y score over 80%. The majority of sounds do have high partial (P) or alternative (A) scores. In other words, the subjects are hearing some of the information in the sound. Only 10% of the sounds have overall low rates of identification. This realization motivates future work in the learnability of auditory cues.

The distinction between identifying a sound as an object or an action is clearly evidenced. Many sounds are consistently identified as objects (camera, printer, door, zipper) while other sounds are consistently identified as actions (closing, tearing, winding, locking). This separation supports the guideline for choosing some sounds to represent objects while using other sounds to represent actions which are not tied to one type of object.

Many sounds naturally conflict. For examples, machines which afford typing such as typewriters, keyboards, cash registers are natually confused. Likewise printing and copying sounds are often mistaken for each other. These conflicts indicate when it will be difficult to present two similar concepts in an interface using auditory cues.

Further analysis is ongoing. This database of sounds and test results will be used in the following studies in the next four months:

- The first experiment has already been repeated with the ordering of the sounds counter-balanced to validate the initial responses given in the first experiment.
- In addition to collecting average scores of sound identifiability, I will be looking for correlations between characteristics of the subjects (e.g. musical ability) and their ability to identify sounds. Likewise, I will investigate correlations between characteristics of the sounds themselves (length, bandwidth (or frequency variation), existence of a repetitive pattern (e.g. footsteps)) and their identifiability.
- I will evaluate possible conceptual mappings between the sounds and general user interface concepts including objects (i.e. menus), actions (e.g. selection) and states (e.g. busy).

The final goal of this work will be to execute each point in the design methodology and compare the resulting interface against an interface built without using these design steps.

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