Designing Spatial Audio Interfaces for Mobile Devices: Supporting Multitasking and Context Information

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ABSTRACT
Audio interfaces are becoming more important due to the increasing functionality of today's mobile devices. As a result, more complex audio-driven eyes-free interactions are required when mobile. The aim of my work is to evaluate 3D audio techniques used to implement auditory displays that support multitasking and access to context information in interactive mobile environments.

Categories and Subject Descriptors
H.5.2. User Interfaces: Interaction styles.

General Terms
Design, Experimentation, Human Factors.

1. SUMMARY
As the functionality of mobile devices increases, users perform more tasks when mobile and increasingly require multitasking. Also, many tasks performed on mobile devices are related to context information such as finding a restaurant on a mobile service search application. Thus, future audio interfaces will have to support multiple audio streams to enable multitasking and potentially some means of audio spatialization to represent context, i.e. location-based information. However, up till now very little work has focused on these issues, especially on mobile platforms. Previous research has investigated the use of 3D audio techniques to either passively browse multiple audio streams such as news [1], or to reinforce the cognitive mapping between sequential audio items and their spatial location in for instance a radial menu around the user's head [2]. However, it is still unclear how 3D audio techniques might be implemented in an interactive environment, where we need to consider how to manage multiple audio streams without overloading the user. The aim of this research is to examine the factors affecting spatial audio presentation and the spatial arrangement of the audio streams, in order to provide guidelines for designers when building eyes-free audio interfaces for interactive mobile environments.

3D Audio calibration: significant differences in the implementation of spatial audio can be found amongst different mobile devices resulting in unknown levels of localization accuracy. For this reason, a calibration was carried out of the positional 3D audio controls supported by the mobile device of choice for this work, i.e. Nokia N95 8GB [3]. Participants were required to adjust an auditory pointer to the same direction of a static auditory source. In this way, the extent to which listeners were able to discriminate the auditory sources as originating from different locations was tested. The results from this calibration showed that participants were able to use the 3D audio system on the Nokia device to identify unique targets at 45° intervals, so these location controls were considered appropriate for developing a 3D audio interface.

Auditory multitasking: after the successful calibration of the 3D audio controls on the Nokia mobile device, a number of 3D audio techniques were evaluated in an interactive multitasking environment [4]. These techniques have been suggested in previous research but have never been evaluated formally against each other. Our research questions were: 1) Can users maintain coherent attention on dual audio streams in a mobile interface? 2) What 3D audio techniques can be used to alter focus on the streams and move them from foreground to background and *vice versa* (I call this spatial minimization)? 3) How efficient and usable is such an interface under different degrees of cognitive load? Results showed an important interaction between cognitive load and the method used to present multiple audio streams.

Access to spatial context information: An initial user study has also been carried out to test an auditory display supporting access to context information in an outdoor locative eyes-free audio environment [5]. Currently, I am setting up an experiment to calibrate the accuracy of an indoor localization system. This study will act as a baseline to investigate the requirements for user interaction with location-based information.

This work contributes to the better understanding of the affordances of different delivery mechanisms for simultaneous presentation in mobile auditory interactive environments, and seeks to quantify the performance of different potential approaches.

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