Universal Earphones: Earphones with Automatic Side and Shared Use Detection

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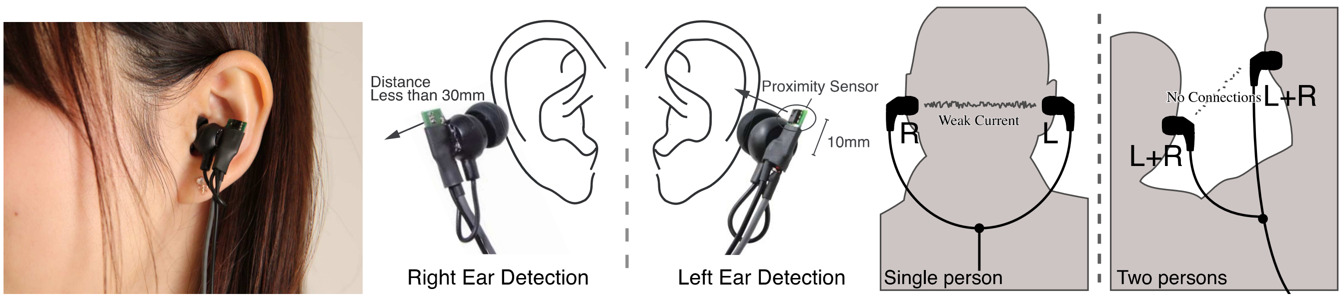

Figure 1 Left: Universal earphone in use. Center: Side detection. Right: Shared use detection.

ABSTRACT

We present universal earphones that use both a proximity sensor and a skin conductance sensor and we demonstrate several implicit interaction techniques they achieve by automatically detecting the context of use. The universal earphones have two main features. The first involves detecting the left and right sides of ears, which provides audio to either ear, and the second involves detecting the shared use of earphones and this provides mixed stereo sound to both earphones. These features not merely free users from having to check the left and right sides of earphones, but they enable them to enjoy sharing stereo audio with other people.

Author Keywords

Earphones, implicit interaction, intelligent interface.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Even though interfaces have been widely prevalent and intuitively used by everyone, they present several problems. For example, when we are using earphones and headphones, we sometimes have problems in using them, i.e., in placing them on the wrong ears. This might be a small problem, but it demonstrates the possibility of refining traditional interfaces, especially in making them more intelligent. We consider that good interfaces and interactions are implicit, and users should not have to worry about them. If interfaces have intelligence to capture the contexts of users, no matter how small, and users do not know about these contexts, the interfaces and interactions will be much better than the previous ones.

We therefore present a device called universal earphones (UEs) that automatically detect the left and right sides of the ears and provide stereo audio to the most suitable side. The single greatest obstacle when using earphones is matching each earphone to the most suitable side of ears as this is necessary to enjoy audio experiences, particularly in professional audio production and modern 3D audio environments like those for 3D games and movies. The UEs not only free users from having to check the sides of earphones, but they also support detection when a single set of earphones is being shared by two people. In such cases, commercially available earphones force users to divide output into two audio channels, i.e., each person is able to hear either the left or right channel. The UEs mix stereo sound and present it to both sides of the earphones. These two features engender implicit interaction between the user and the UEs, and they enable the UEs to act as a good music communication medium.

SIDE DETECTION

We embedded a proximity sensor in a single side of the UEs to detect the left and right sides of the ears, and we measured the distance between the center of the earphones and the pinna (external ear).

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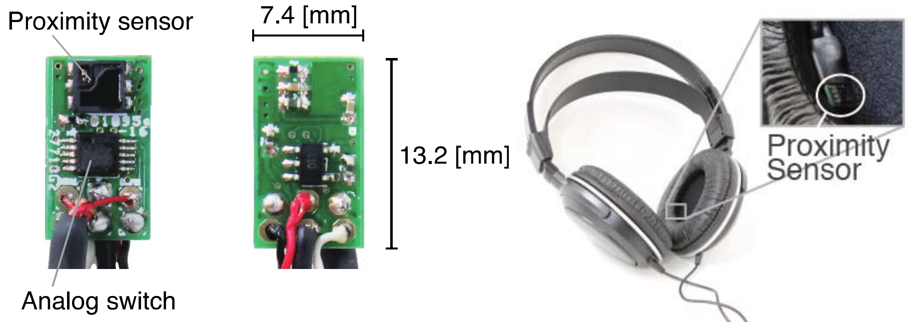

Figure 2 Left: Sensor unit. Right: Photograph of headphones.

When this distance is less than 30 mm, the UEs activate the right channel; otherwise, the channel is changed to the left. We referred to the Anthropometrical Database [5] to determine the threshold for the distance. The channel for the other side of the earphones was automatically changed to the opposite channel. We attached a sensor to the inside of the ear pads of the headphones and the sensor measured the distance from the ear pads to the outside of the pinna. To enable these features, we embedded both a proximity sensor and an analog switch IC into the earphones (Figure 2).

RELATED WORK

Buxton proposed classifying human-computer interactions into two categories of foreground and background interactions [1]. He defined foreground interaction as "activities which are in the fore of human consciousness" and background interaction as "tasks that take place in the periphery 'behind' those in the foreground." According to this, our UEs can be categorized as background interaction. There have been several studies on background interaction. Ju et al. proposed a framework for background interaction and they developed an interactive whiteboard based on the framework [4]. Hinckley et al. integrated sensors into a mobile device and they demonstrated several features that engaged sensors such as recording memos when the device was held like a cell phone and automatically powering the device up when a user picked it up [3]. Dietz et al. proposed a device that sensed when a phone was removed from the ear and that buffered the incoming audio [2]. When the phone was returned, the missed incoming audio was played back at a rate faster than that in real time. Users did not need to operate these devices, which sensed the situation and worked unobtrusively in the background. Our UEs were aimed at working in this way to help users with background interaction, which enabled them to focus on foreground work.

FUTURE WORK

We focused on both single-user and dual-user utilization of our earphones and implemented two features in the earphones, i.e., ear-side and shared-use detection. However, if we could focus on either single-user or multi-user utilization, we would be able to make the design of background interaction for the earphones explicit. This section discusses future work on UEs with respect to either single-user or multi-user utilization. On the one hand, skin conductance sensors can be used to determine if the earphones are attached to the ears or not when focusing on single-user utilization. When earphones are detached from the ears, they could automatically pause music. This feature would free users from having to push play/pause buttons. On the other hand, the feature to detect shared use could be utilized to provide two sets of music separately to both earphones when focusing on multi-user utilization. Two users would be able to enjoy listening to music by sharing both the earphones and the music player.

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