The Importance of Head Movements for Localizing Virtual Auditory Display Objects

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1 Introduction

In most of our research we produce virtual sound sources by filtering stimuli with head-related transfer functions (HRTF's) measured from discrete source positions and present the stimuli to listeners via headphones. With this synthesis procedure head movements create no change in the acoustical stimullus at the two ears, in contrast with what happens in natural listening conditions. To compare the localizability of virtual and real sources under these conditions, we require that listeners not m their heads, even when localizing real sources. Some listeners make large numbers of localization errors known as "front-back confusions" (a report of an apparent position in the front hemifield given a rear hemifield stimulus, and vice-versa). Head movements can, in theory, provide the cues needed to resolve front-back ambiguities. The experiment described here seeks to clarify the issue by meassuring both the nature and consequences of head movements during a sound localization task.

2 Methods and Results

Virtual sources synthesized from each listener's own HRTF's were presented over headphones. In one condition head movements were discouraged, and the stimuli delivered to the headphones were not influenced by movements of the listener's head. In another condition the listener was encouraged to use head movements to aid localization. The position of the listener's head was tracked and the synthesis of each virtual source was modified in real time, in accordance with the head movements, to stimulate a stationary external source. Listeners reported the apparent direction and distance of the virtual sources. For those listeners with high rates of front-back confusions in the first condition, head movements aparently provided the cues needed to resolve those confusions, since the confusion rate was near zero in the second condition. There was also some improvement in elevation preception. The results suggest that effective auditory displays will have to incorporate means for synchronizing virtual source synthesis to the listener's head position in real time.

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