A DEVICE FOR HUMAN ULTRASONIC ECHOLOCATION

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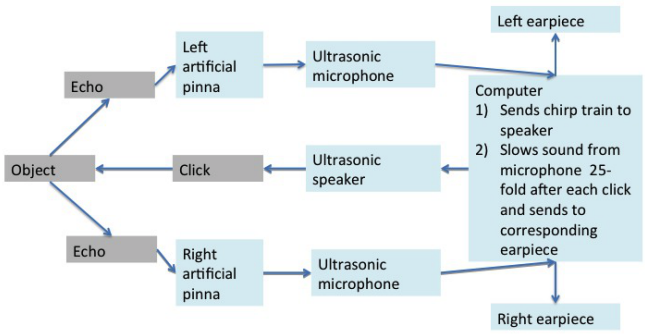


Fig. 1. Diagram of components and information flow.

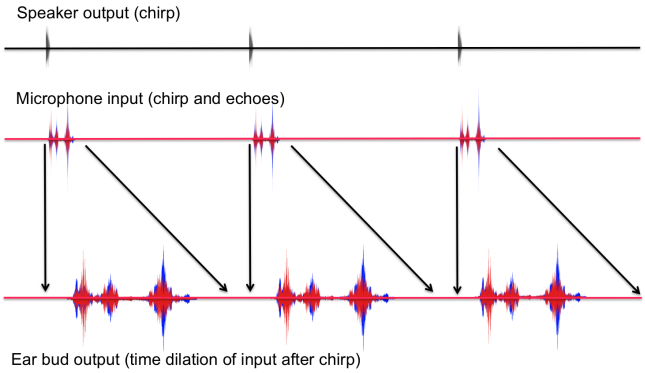
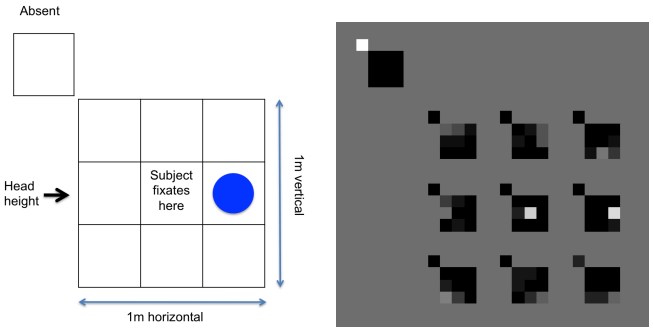


Fig. 2. Recorded waveforms at several processing stages.



(a) Configuration (b) Responses

Fig. 3. *(a)* Nine locations of the plate, and a 10th 'absent' condition. *(b)* Performance at each location. Black: location never indicated. White: location always indicated.

ABSTRACT

Interacting with the external world is a major challenge for persons who are blind or visually impaired. Many species operating without vision sample the environment by active echolocation, in which acoustic pulses are emitted and their reflections interpreted. Here we present a device, the Sonic Eye, that combines principles of echolocation and spatial hearing to present users with environmental cues that are i) not otherwise available to the human auditory system and ii) richer in object and spatial information than similar systems employing extensive processing of echo information.

1. INTRODUCTION: THE SONIC EYE

A head-mounted speaker emits ultrasonic FM sweeps. The echoes are recorded by stereo ultrasonic microphones mounted inside an artificial pinna, modeled after bat ears to produce optimal spatial cues. The recordings are played back to the user at 1/20 of normal speed to magnify temporal cues and shift frequencies into the audible range. The minimal processing of the signal and the use of artificial pinnae distinguish our approach from previous work. See Figs. 1 and 2.

2. PERFORMANCE TESTING

A blindfolded sighted user correctly localized a 30 cm diameter plate held at one of 9 positions on 48% of trials, significantly greater than chance performance (see Fig. 3b).

This result suggests that both vertical and horizontal localization cues were available to the user. While further research is needed to validate such comparisons and, more generally, characterize the behavioral envelope of Sonic Eye-aided echolocation, we consider these preliminary results encouraging.