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What it is like to be a bat: a sonar system for humans

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Echolocation is a method of perceiving the world by emitting noises then listening to the reflections of these noises off objects in the world. It is used by animals for hunting and navigation. Some visually impaired humans use echolocation as part of their orienting repertoire.

This work describes a device designed to enhanced one's existing echolocation ability. The device repeatedly emits an inaudible, ultrasonic "click", several times per second. Each click reflects off surfaces; this reflection is detected by head-mounted microphones. Computer processing converts the signals into audible signals, which are presented to the user over custom open-ear earphones.

ILD, ITD, HRTF, and Doppler shifts in the reflections allow the user to distinguish the location and size/surface properties of objects. The spatial cues presented by our device match those used to localize ordinary audible objects.

The auditory "image" generated in this way causes objects in the world to seem to emit sounds, and for objects with different shapes/textures to have subtly different sounds.

A prototype has been constructed. Simple detection of objects and open spaces is readily possible, as well as Doppler-based gross surface texture. Further refinement in the areas of emission design, spectral spatialization, externalization, and miniaturization is required.