ACOUSTIC HOLOGRAPHIC VISION

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Transcript:

Human echolocation is a phenomenon in some visually impaired individuals, whereby they are able to navigate their environment with surprising skill using their sense of hearing. Typically they produce “probe sounds”, flicking their fingers or tongue, and listen for the return (echo).

Human echolocation has inspired several attempts at its technological re-implementation, within applications in visually impairing environments, such as in fire-fighting scenarios, but so far these have been generally unsuccessful. However, recent technological advances suggest that now is the time to re-attempt this challenge.

Animal echolocation as known from dolphins or bats, who are highly specialized in this modality, teach us that ultrasound is probably the best option for echolocation, because it travels better and faster, and can be directed more accurately.

In terms of neuroscience we know that echolocation experts use the visual centres of their brains, which might suggest that it is not merely a question of crudely determining left/right navigation options, but might rather reveal a more advanced reconstruction of the environment. However, there is no accepted neural theory, which would allow the brain to do this.

Fortunately, we have an acoustic theory: The well-known technique of acoustic holography is able to produce detailed scene reconstructions from microphone array measurements; but the technique faces two practical challenges: 1) The resolution of the reconstruction (and in extension its usefulness) depends on the number of microphones, and 2) the required processing power increases with the desired resolution.

We propose to solve these issues by the application of new technological advancements in signal acquisition and mobile data processing:

The first problem can be addressed by the application of compressive sensing techniques whereby data is acquired in an already compressed format, which means that its subsequent decompression dramatically increases the resolution of the data image. Compressive sensing has already been demonstrated in acoustic holography, and several general purpose toolboxes exist.

The second problem can be solved by using mobile signal processing and communication platforms with high acquisition and processing power, and high communication throughput, meaning that excessive computational loads can be off-loaded to real-time cloud computing services, which continually stream problem and solution pairs back and forth between device and cloud.

Our confidence in these solutions comes directly from our most recent work on the generalization of acoustic holography to the analogous electromagnetic case, which has been experimentally demonstrated with electrode arrays recording electrical potentials in neural tissue instead of acoustic pressure in air.

We thus propose that a mobile acoustic holographic vision system can now be created that will allow its users to recognize characteristic objects in real-world environments and scenarios, and enable informed responses in terms of real-time navigation and action.

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