Encoding object outlines through 3-D sound for object shape recognition

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Mammals such as bats and dolphins, including humans, have developed natural sensory-substitution capability such as echolocation. Previous studies have shown that humans with impaired vision are able to achieve a high degree of independence and self-reliance once they learn echolocation. Further studies using MRI and PET reveal that echolocation activates both cortical auditory and visual area of the human brain, where the latter is not known for auditory processing. However, studies have demonstrated that dolphins are capable of detecting the objects' globe appearance and features through echolocation, and bats are able to detect object shape by echolocation. There is no clear indication that human ecolocators can achieve object shape recognition similar to dolphins and bats. Previously, we have presented a proof of concept study on the LIDAR Assist Spatial Sensing (LASS) system that is inspired by echolocation. The system intends to provide people with impaired vision of their surrounding spatial information through stereo sound at varying pitch. The study has demonstrated that blindfolded individuals equipped with the LASS system are able to quantitatively identify surrounding obstacles, differentiate their relative distance, and distinguish the angular location of multiple objects with minimal training. In this paper, we further explore the potential of representing the shape of objects through stereo sound, to enable the visually impaired users obtain shape information through the LASS system.

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