MEMS based hydrophones for high resolution monitoring of underwater activities

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Microelectromechanical Systems (MEMS) based hydrophones for high resolution monitoring of underwater activities

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Grand Challenge: Great Lakes

Creatures living in great lakes are in danger. In a time when species extinction rates are peaked due to human activities, there is a need for high resolution monitoring of underwater species. In this research project we propose to contribute to the high resolution monitoring of underwater creatures by distinguishing underwater acoustic signals that can be used to monitor some activities of underwater creatures. Many aquatic animals generate various levels of acoustic sounds, and to be able to accurately detect these signals will aid us in saving their lives. In the natural world, many aquatic creatures hear underwater through 'lateral lines', which are a collection of cells running across vertebrate's body, each with a hair like cell that picks up vibrations that give important information about noises, pressure gradients and vibrations. Semiconductor based micro-fabrication processes mimic similar sensory systems at a microscopic-scale, with high sensitivity. MEMS (Microelectromechanical Systems) based devices have made a rise in modern technology, and are ideal for acoustic sound detection due to the small scale. Inspired by the aquatic vertebrates' lateral lines, we propose a MEMS acoustic vibrating sensing system to pick up sound underwater. A collection of small MEMS devices with a circular base and a resonating cilium (rod) running through the center will detect acoustic frequencies. These small devices have the same basic design but slightly changing dimensions across the array, to have a wide range of frequencies detected rather than one. So far there have been other MEMS designs for underwater sound detection, however none work with an entire membrane used as the base of the cilium. Our circular membrane acts as the base of the MEMS device, as opposed to separate pillars, is poised to provide greater sensitivity in sound detection and more underwater information to work with. Finite element analysis is used to iterate the design of membrane and rod as well as numerically predict the device performance. Our results show resonant frequencies in the range of 309.1 kHz to 1255.4 kHz. Advanced design iteration in terms of device performance in underwater is on-going. This miniature device will be manufactured using conventional MEMS fabrication and will be interfaced with signal-processing and advanced controllers to achieve a standalone device to monitor underwater acoustic activities. The creatures of great lakes are a matter of importance to our sustainable future, and monitoring their acoustic activities will further aid towards preserving them for the generations to come.

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