Learning from Fish: Ultra-sensitive Infrasound Sensor for Early Detection of Geologic Hazard Events

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Abstract

Landslides constitute a major geologic hazard because they are widespread, occur in all 50 states and U.S. territories, and cause $1 – 2 billion in damages and more than 25 fatalities on average each year. Landslides commonly occur in connection with other major natural disasters such as earthquakes, volcanoes, wildfires, and floods. Early detection of imminent landslides is thus important to the reduction of casualty and economic losses in areas prone to such geologic hazard events. Field evidence has shown that geologic hazard events such as landslide, volcano eruption, avalanche and possibly earthquakes can radiate infrasonic waves. Infrasound is not absorbed to the same degree as higher frequencies, and it can travel great distances, which provides useful early warning for detecting such geologic hazard events.

Sensitivity to infrasound may be a widespread ability among aquatic organisms, and has also been reported in cephalopods and crustaceans. Certain fish species have a tremendous ability in sensing infrasound, even down to well below 1 Hz. This talk is concerned with developing ultra-sensitive infrasound sensor that if successfully developed, may give early warning signals of an imminent geologic hazard event such as landslides. The sensing principle of this infrasound sensor gains inspiration from the ultra-sensitivity of the auditory system of certain fish species in detecting infrasound. The talk gives a description of the conceptual development of this novel bio-inspired ultra-sensitive infrasound sensor that is comprised of hundreds of tiny sensing elements mimicking cilia, including an overview of the infrasound sensing mechanism in fish auditory system; and nonlinear signal amplification realized through MEMS technology sensor network. This paper also describes the establishment of models to simulate the selected fish's auditory system that is

responsible for infrasound sensing, and adaptive signal amplification functions of the hair cells based on nonlinear vibration theory.

Biography

Yunfeng Zhang received his Ph.D. in applied mechanics California Institute of Technology in 2001. He worked on the faculty at the Lehigh University for 6 years before taking an associate professor position in the Department of Civil & Environmental Engineering at the University of Maryland. His research has been primarily in the areas of sensor technology, structural health monitoring, steel structures, and seismic response modification technology.