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All-optical non-mechanical fiber-coupled sensor for liquid- and airborne sound detection.

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Most fiber-optic devices for pressure, strain or temperature measurements are based on measuring the mechanical deformation of the optical fiber by various techniques. While excellently suited for detecting strain, pressure or structure-borne sound, their sensitivity to liquid- and airborne sound is so far not comparable with conventional capacitive microphones or piezoelectric hydrophones.

Here, we present an all-optical acoustic sensor which relies on the detection of pressure-induced changes of the optical refractive index inside a rigid, millimeter-sized, fiber-coupled Fabry-Pérot interferometer (FPI). No mechanically movable or deformable parts take part in the signal transduction chain. Therefore, due to the absence of mechanical resonances, this sensing principle allows for high sensitivity as well as a flat frequency response over an extraordinary measurement bandwidth. As a fiber-coupled device, it can be integrated easily into already available distributed fiber-optic networks for geophysical sensing.

We present characterization measurements demonstrating the sensitivity, frequency response and directivity of the device for sound and ultrasound detection in air and water. We show that low-frequency temperature and pressure drifts can be recorded in addition to acoustic sensing.

Finally, selected application tests of the laser-based hydrophone and microphone implementation are presented.