**Motivation:** In an effort to improve the environmental awareness of maritime devices, MEMS (Microelectromechanical System) pressure sensor arrays based on flexible polydimethylsiloxane (PDMS), liquid crystal polymer (LCP) and LCP/PDMS substrates are being developed for use on autonomous underwater vehicles (AUVs). These sensors can guide an AUV to navigate in a dark, unsteady and cluttered environment where sonar and vision-based systems fail. Microfabricated pressure sensor arrays offer a unique advantage of low-power passive sensing while their low footprint and flexible backing make them conveniently mounted on the streamlined bodies of underwater vehicles. These MEMS arrays have individual sensors that closely mimic the biological neuromasts on the body of many fish. For instance, the blind cave fish, Astyanax mexicanus fasciatus, swims adeptly by solely relying on lateral-line neuromasts to generate hydrodynamic images of its surroundings. Although the lateral-line sensory system has no equivalent in current underwater vehicle detection systems, the goal of this work focuses on developing an ideal artificial lateral-line system by employing an array of MEMS flow sensors.

**MIT Pressure Sensor**

**Array Design**

**Structure:** Pressure-concentrating diaphragms support conductive elastomer strain gauges whose resistances are measured using a four-point probe array.

**Materials:** Substrates and diaphragms are PDMS; strain gauge is a piezoresistive carbon black (CB)-PDMS composite.

**Fabrication**

- CB-PDMS strain gauge is screen patterned onto a PDMS substrate.
- Substrates are bonded together for waterproofing.

**Kayak Testing**

When mounted on the side of a kayak for open-water tests, the pressure response of the MEMS sensor is similar to that of a somewhat-nearby reference sensor.

**Conclusions**

- Sensor is functional in an uncontrolled environment
- Sensor can be mounted on a doubly-curved surface
- Sensor resolution is ≈ 10 Pa
- Array power dissipation is ≈ 2μW per sensor

**Singapore Pressure Sensor**

An array of 2 × 10 silicon piezoresistive pressure sensors were fabricated on flexible LCP substrates and were encapsulated in PDMS before mounting on the kayak. The array of sensors were tested in a reservoir for various pressure signals.

**Fabrication**

- Backside of PCB sensor array
- Front of PCB sensor array

**Kayak Testing: Commercial vs. MEMS**

When mounted on the side of a kayak for open-water tests, the pressure response of the MEMS sensor is similar to that of a somewhat-nearby reference sensor.

**Conclusions**

- The sensors developed can measure air and water flow velocities with a good sensitivity of 64 (μV/V/Pa) and 12.6 (μV/V/Pa), respectively.
- LCP has a very low moisture absorption coefficient and low chemical attack, and therefore offers high reliability.

**References:**


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