Docket #: S25-067

Whisker-inspired Tactile Sensor and a Sim2Real Framework for Contact Tracking

Stanford researchers have developed an innovative underwater sensing system inspired by the whiskers of aquatic mammals, enabling robots to detect and track contact with high precision in low-visibility conditions.

Underwater robotic systems often struggle to localize contact points accurately, particularly in murky or dynamic environments. Existing solutions typically rely on cameras or require precise motion tracking, limiting their effectiveness when visibility is poor or exact positioning is unavailable.

To overcome these limitations, the Stanford researchers developed a whisker-like tactile sensor using Fiber Bragg Grating (FBG) technology, combined with a simulation-to-reality learning approach. These flexible, passive sensors detect contact through optical strain signals and are highly resistant to water pressure, corrosion, and physical stress. The learning framework allows the system to generalize from simulation data and adapt effectively to real-world conditions. It achieves contact-tracking accuracy of under 2 mm, even without detailed knowledge of the robot position.

Combining precision, resilience, and fast signal processing, this technology offers a powerful tool for underwater manipulation, inspection, and environmental monitoring. It could also enable robots to detect and interpret water flow, expanding possibilities for underwater exploration.

Applications

- Enhanced perception for underwater remotely operated vehicles (ROVs)

- Tactile sensing for deep-sea inspection robots: Improves navigation and manipulation around submerged structures, pipelines, or shipwrecks
- Flow and current detection for autonomous underwater vehicles

Advantages

- Robust in deep, corrosive saltwater
- High sensitivity: detects strains as small as 10^{-5} using optical fiber-based sensing
- Remote signal transmission: the interrogator can be placed up to 1 km from the sensor
- Scalable signal resolution: dozens of sensors can be multiplexed on a single fiber at 2 kHz rates

Publications

- Li, H., Xing, C., Khan, S., Zhong, M., & Cutkosky, M. R. Whisker-inspired tactile sensing: A sim2real approach for precise underwater contact tracking. arxiv

Innovators

- Mark Cutkosky
- Hao Li
- Chengyi Xing

Licensing Contact

Matthew Ryan

Licensing Manager

Email