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A bio-inspired and self-powered triboelectric tactile sensor for underwater vehicle perception

Abstract

Marine mammals relying on tactile perception for hunting are able to achieve a remarkably high prey capture rate without visual or acoustic perception. Here, a self-powered triboelectric palm-like tactile sensor (TPTS) is designed to build a tactile perceptual system for underwater vehicles. With the assistance of palm structure and triboelectric nanogenerator technology, the proposed TPTS has the ability to detect and distinguish normal and shear external load in real-time and approximate the external stimulation area, especially not affected by the touch frequency, that is, it can maintain stable performance under high-frequency contact. The results show that the TPTS is a promising tool for integration into grippers mounted on underwater vehicles to complete numerous underwater tasks.

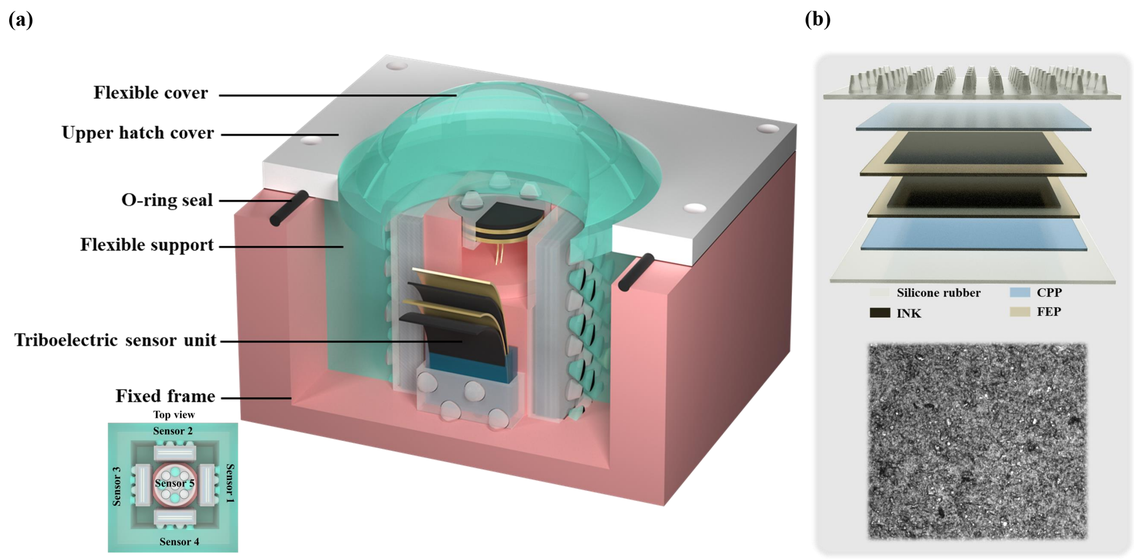

Figure 1 The structure and working mechanism. (a) Structural diagram of TPTS. Inset: top view of the sensor unit layout. (b) Structural diagram of the sensing unit and SEM image of the FEP membrane surface.

Design and application

Fig. 1(a) shows the structural diagram of the tactile sensor based on TENG. This structure consists of a triboelectric sensing unit with the spinosum structure, a flexible support, a fixed frame, an upper hatch cover, an elastomeric O-Ring seal, and a flexible cover. Fig.1(b) depicts the structure of the triboelectric sensing unit, including silicone rubber with a spinosum structure aiming at producing a localized and high-stress concentration near receptors, a cast polypropylene (CPP) film for voiding electrostatic interference, and FEP films sprayed with conductive ink. The ROV uses the manipulator to grasp the pipeline. The magnitude of the grasping force depends on whether the TPTS is in contact with the pipe in Fig.2

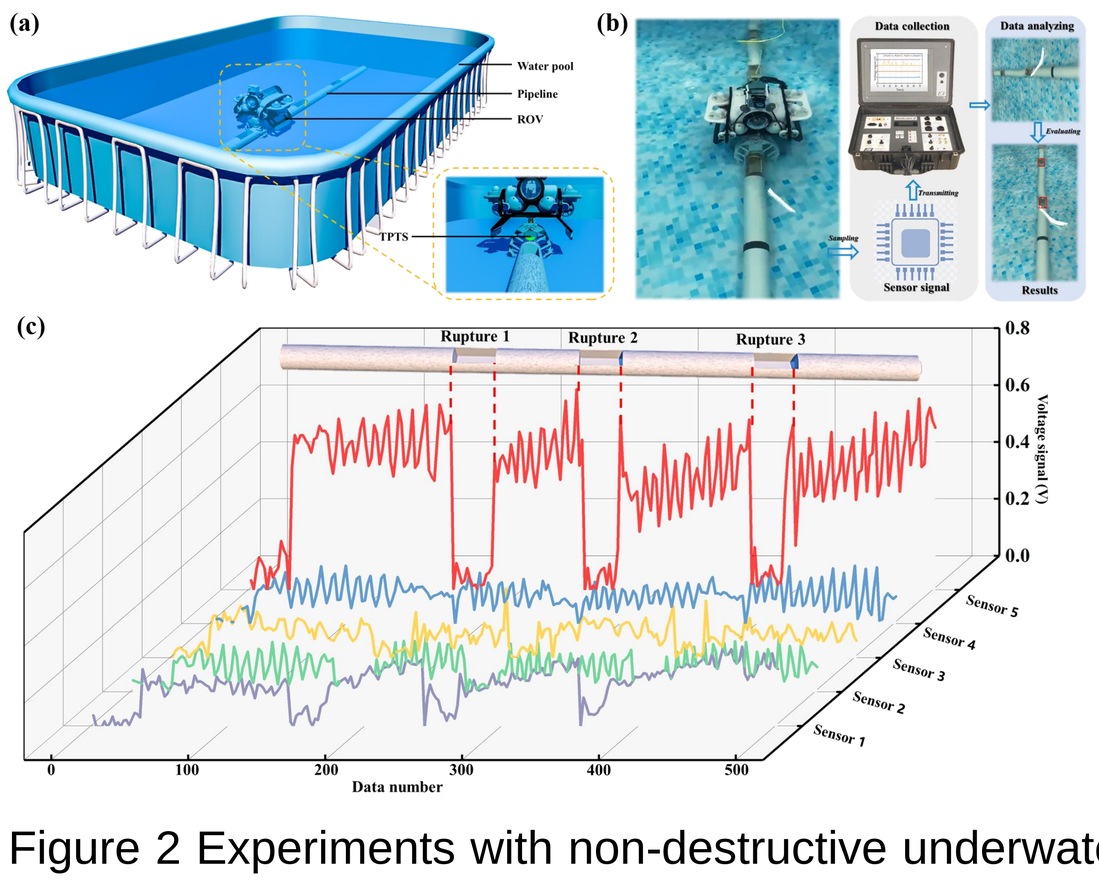

Figure 2 Experiments with non-destructive underwater pipeline evaluation.

Conclusion

In summary, a TPTS for underwater tactile perception based on triboelectric nanogenerators is proposed and investigated in this paper. The underwater sensory tactile system is used to conduct non-destructive underwater pipeline evaluation, illustrating its potential future application in various fields, including underwater object monitoring and tactical surveillance.