Department of Advanced Design and Systems Engineering
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Nature-inspired emerging sensing technologies and their applications on underwater robots

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Abstract

Marine animals perform fascinating survival hydrodynamics through perfectly evolved sensory systems. For example, fish have lateral line sensory systems that allow them to locate objects a few body lengths away, and seals have ultrasensitive whiskers that can track the hydrodynamic trails left behind by fish 180 m away. Over millions of years, these species have evolved sensory systems perfectly suited to challenging environments. Fish and seals use these sense organs to perceive and localize local information, enabling them to perform impressive actions like schooling, escaping predators, and hunting for food in murky conditions.

Underwater robots have been developed in recent years and are widely used in the sustainable development of marine economies and the extraction of underwater resources. However, due to the complex underwater operating environments with complications such as seawater corrosion, dim light, disturbed magnetic fields, and complex terrain, sensor systems-based environment detection and information interaction among swarms of underwater robots are challenging.

To address the above problems, I will present two types of nature-inspired emerging sensing technologies, including fish lateral lines-inspired and seal whisker-inspired sensory systems. Sensing mechanisms of fish lateral lines and seal whiskers, nature-inspired artificial sensory systems, and several underwater robot applications will be presented in this talk.

About the Speaker

Dr. Xingwen Zheng is a JSPS Fellow in the Department of Mechanical Engineering at the University of Tokyo. He completed his first Ph. D. degree in Robotics at Peking University and his second Ph.D. degree in Biomimetics at the University of Groningen, with the Cum Laude distinction. He has been awarded the Japan Society for the Promotion of Science (JSPS) Postdoctoral Fellowship, which fully supports his research on Micro Robotic Manipulation Systems at the University of Tokyo. He published papers as the first author in several esteemed journals and flagship conferences, including Advanced Functional Materials (selected as a Cover paper), Advanced Science (selected as a Cover paper), IEEE Transactions on Robotics, IEEE/ASME Transactions on Mechatronics, IEEE IROS, IEEE MEMS, Transducers, IEEE SMC, IEEE IECON, etc. In addition, He is the author of two books. He also has 10 issued patents. Furthermore, he received the IOP Publishing 2018-2020 China Top Cited Paper Award, Wiley Open Science Excellent Author Award, and student support grants of IEEE IROS and IEEE SMC. His works were in the spotlight in the Annual Review 2022 of Holland High Tech for the high-tech sector. His research interests include bio-inspired robotics, biomimetics, MEMS/NEMS technology, and micromanipulation.

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