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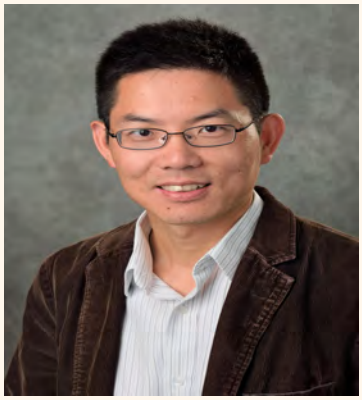
Stalking vampires of the Great Lakes: The role of smart sensors and robots in sea lamprey control



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ABSTRACT:

The sea lamprey, sometimes known as “vampire fish”, is an invasive species in the Great Lakes region that threatens its ecosystems and billion-dollar fisheries. The parasitic sea lamprey uses suctorial mouth to prey on various host fish by attaching to the fish and draining its body fluids. In this talk we first describe our effort in developing a soft pressure sensor array as an electronic skin (e-skin), for detecting the suction by adult sea lampreys during their upstream migration for spawning. Such e-skins can be mounted at strategically chosen places, such as selective fishways, to facilitate the capture and population assessment of sea lampreys. We discuss regularized least-square algorithms for mitigating the crosstalk in the resistor network of the sensor array, to properly reconstruct the pressure profile under lamprey suction. Machine learning is further adopted to automate the lamprey detection process, as verified with data from animal experiments.

In the second part of the talk we explore tracking the movement of fish, such as sea lampreys, with mobile acoustic telemetry. Movement tracking provides key information about fish migration patterns and habitat uses and is thus critical to decision-making in fishery management. In mobile acoustic telemetry, acoustic tags are implanted in fish and emit pings periodically, which are picked up by acoustic receivers mounted on robots to infer the fish location. We discuss the use of gliding robotic fish and unmanned surface vehicles for tracking acoustic tags, and specifically, we show how distributed filtering by a group of robots can result in precise localization of a moving target based on the time-difference-of-arrivals (TDOAs) of the emitted signal.

BIOGRAPHY:

Dr. Xiaobo Tan is an MSU Foundation Professor and the Richard M. Hong Endowed Chair Professor in Electrical and Computer Engineering at Michigan State University (MSU). He received his bachelor's and master's degrees in automatic control from Tsinghua University, Beijing, China, in 1995, 1998, respectively, and his Ph.D. in electrical and computer engineering (ECE) from the University of Maryland in 2002. His research interests include bio-inspired robots, soft sensors and actuators, and modeling and control of systems with hysteresis. In particular, his group has developed and field-tested autonomous underwater and surface robots for mobile sensing applications. He has published over 300 papers and been awarded four US patents in these areas.

Dr. Tan is a Fellow of IEEE and ASME. He is a recipient of the NSF CAREER Award (2006), MSU Teacher-Scholar Award (2010), MSU College of Engineering Withrow Distinguished Scholar Award (2018), Distinguished Alumni Award from the ECE Department at University of Maryland (2018), MSU William J. Beal Outstanding Faculty Award (2023), and multiple best paper awards. Dr. Tan is keen to integrate his research with educational and outreach activities, and has served as Director of an NSF-funded Research Experiences for Teachers (RET) Site program at MSU from 2009 – 2016, Curator of a robotic fish exhibit at MSU Museum in 2016-2017, and PI of a recently awarded NSF Research Traineeship program on water equity and sustainability. He has served the professional community in different capacities, including being a senior editor of IEEE/ASME Transactions on Mechatronics, a member of ASME Dynamic Systems and Control Division Executive Committee, and the general chair of 2018 ASME Dynamic Systems and Control Conference and 2023 American Control Conference.