2021 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

CPS: Medium: Collaborative Research: Towards optimal robot locomotion in fluids through physics-informed learning with distributed sensing

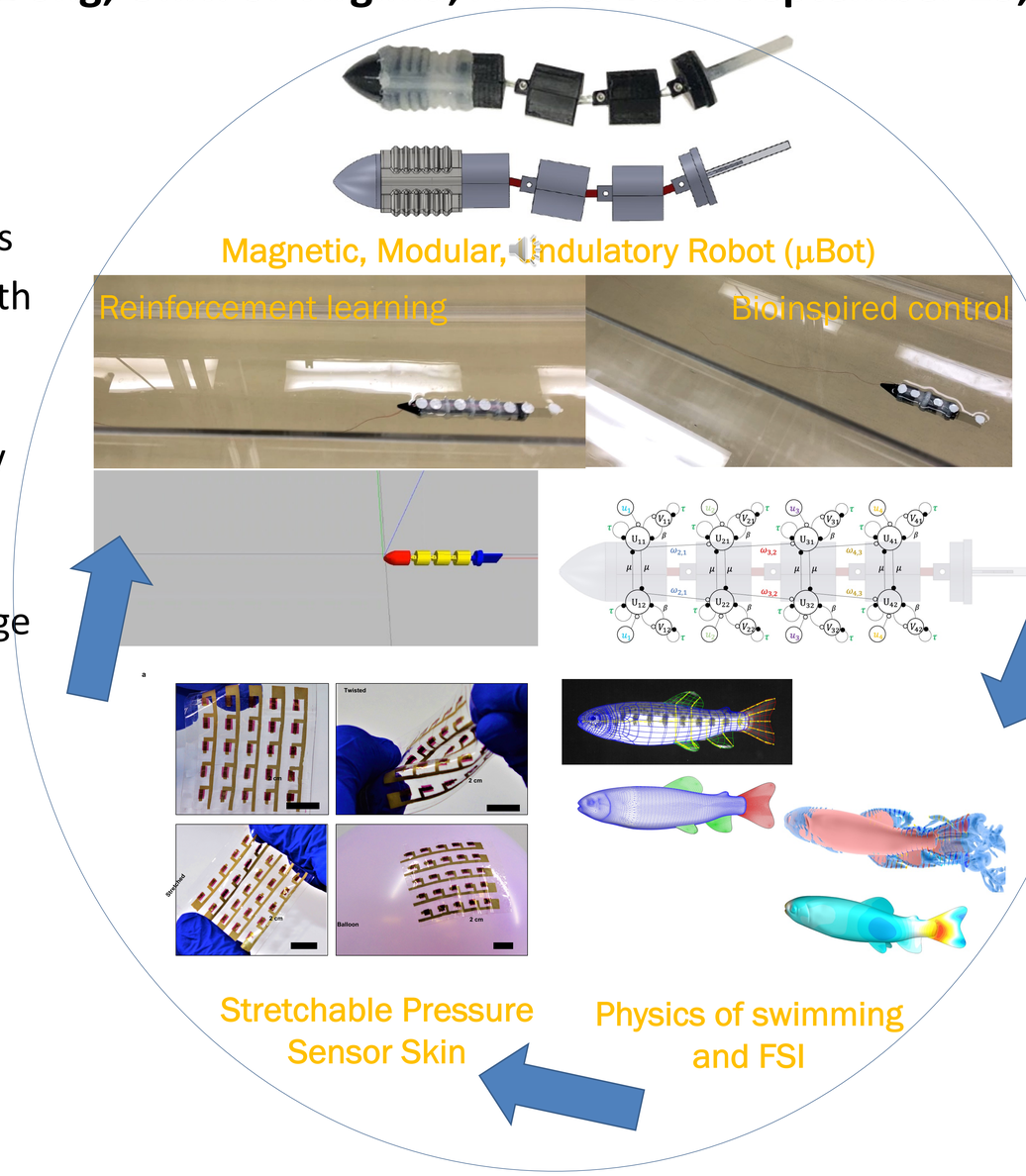
(Award #1932130, Bo Cheng/Asok Ray, Penn State; #1931893,Cunjiang Yu, Univ. of Houston, #1931929, Haibo Dong, Univ. of Virginia; Award Date: September 13, 2019)

Challenge:

- Highly complex forms of swimming (morphology and gaits)
- Coupled fluid dynamics and robot/fish body structural dynamics
- Perception of fluid environment with pressure feedback
- High density arrays of sensors in a skin format that mimics the biology counterpart

Solution:

- Modular robotic fish to explore large design space
- Reinforcement learning to explore robot gait and control in fluids
- Electronic skins with distributed stretchable sensors for perception
- Adaptive-mesh-refinement based high-fidelity flow simulations of swimming fishes and robots to better understand physics and surface pressure distribution



Scientific Impact:

- Generate new knowledge on how to achieve data-efficient, physics-informed learning for robotic systems operating in complex environment
- Achieve stretchable electronic materials, intrinsically stretchable transistors and pressure sensors
- Understand fundamental interdependencies and interactions among robotic systems and the physics of fluids

Broader Impact:

- Water and environment monitoring, healthcare, defense, space
- CPS areas: control, data analytics, autonomy, design, and real-time systems
- Create tools for STEM education
- Impacts on both engineering and biology communities
- Inclusion of unrepresented students