Ionic polymer-metal composite (IPMC): Modeling and Bio-inspired Sensing Applications

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Abstract

Ionic polymer-metal composite (IPMC) is an important class of electroactive polymers with built-in actuation and sensing capabilities. In this dissertation, the modeling and several bio-inspired sensing applications of IPMC are investigated computationally and experimentally. First, physics-based modeling is studied for a tubular IPMC sensor under pure torsional stimulus. With inspiration from the fish lateral line system, IPMC is then explored for several flow-sensing applications, where modeling of fluid-structure interactions, sensor design, and experimental validation are conducted. Specifically, the sensitivities of IPMC-based artificial superficial and canal neuromasts are examined in terms of their dimensions, shapes, and stiffness properties. A canal lateral line-inspired pressure gradient sensor is further proposed and developed. Another novel flow velocity sensor is proposed, which exploits self-generated von Kármán vortices to produce vibrations that are correlated with the flow speed. Finally, inspired by the vestibular system, an angular acceleration sensor is proposed by integrating IPMC sensors with a fluid-filled circular channel.

Invention disclosures

Xiaobo Tan, Montassar Aidi Sharif, Derek Paley, Matthew McHenry, “Bio-inspired angular accelerometer,” MSU/UMD/UCI joint invention disclosure.

Xiaobo Tan, Montassar Aidi Sharif, “Bio-inspired pressure gradient sensor,” MSU invention disclosure (Under preparation)

Publications

Journals


Conferences
1. Montassar Aidi Sharif (presenter), M. McHenry, and X. Tan, “The Role of Morphology in Sensitivity of Artificial Lateral Lines,” invited talk at 2018 American Mathematical Society (AMS) Fall Central Sectional Meeting, Ann Arbor, MI, 2018