Artificial Intelligent Mechanical Metamaterials that Learn Behaviors

Jonathan Hopkins
Professor and Vice Chair of Graduate Education
Mechanical and Aerospace Engineering
University of California - Los Angeles

Friday, January 12th, 2024 – 10:30 am
McDonnell Douglas Engineering Auditorium (MDEA)

**Abstract:** This seminar summarizes our group’s effort to apply the concept of artificial neural networks (ANNs) to enable the creation of a new kind of mechanical metamaterial (a.k.a., architected material), called a mechanical neural-network (MNN), that can learn desired behaviors and properties via a complex web of active flexible elements (AFEs) that constitute the materials’ lattice. These AFEs, which are joined together by rigid nodes, constitute an analogous physical embodiment of the mathematical weights that determine the values that are summed together by the neurons within traditional ANNs. By actively tuning the stiffness of these AFEs in a similar fashion to how weights are trained within ANNs, the new kind of metamaterial can learn desired mechanical properties and thus enable a variety of applications. Such applications include: (i) aircraft wings that can learn to optimally change their shape and stiffness at select locations as flight conditions change, (ii) aircraft exteriors that can learn to compensate for damage that may occur during combat or overuse by maintaining their designed properties regardless of defects or ware, and (iii) electrical, optical, or other components within aircraft that cannot be made of zero-thermal-expansion-coefficient materials but can learn to maintain their shape regardless of fluctuating temperatures.

**Bio:** Jonathan Hopkins is a full professor and the Vice-chair for Graduate Affairs in the Mechanical and Aerospace Engineering Department at the University of California, Los Angeles (UCLA). He is the director of the Flexible Research Group and conducts research toward enabling the design and fabrication of flexible structures, mechanisms, and materials that achieve extraordinary capabilities via the deformation of their constituent compliant elements. Prior to coming to UCLA, Jonathan was a postdoc at Lawrence Livermore National Laboratory and received his Ph.D., Masters, and Bachelors degrees all in the Mechanical Engineering Department at the Massachusetts Institute of Technology (MIT). He was honored by President Barack Obama at the White House with a Presidential Early Career Award for Scientists and Engineers (PECASE), which is the highest honor bestowed by the United States Government on science and engineering professionals in the early stages of their independent research careers. Jonathan also received ASME’s prestigious Freudenstein/General Motors Young Investigator Award, UCLA's Watanabe Excellence in Research Award, the Northrop Grumman Excellence in Teaching Award, and was most recently made an ASME Fellow. Jonathan is the creator and host of the educational YouTube channel, "The FACTs of Mechanical Design.”