Bio-inspired Additive Manufacturing of Multi-material, Multi-scale Hierarchical Structures

ABSTRACT

Natural organisms provide inspirations for various functional structures with significant applications in multidisciplinary fields. To realize the complex multi-scale architecture of such biological structures and understand their correlation with functionality or properties, it is important to characterize potential material and manufacturing methodology, and correlate material distribution to desired mechanical properties. Additive manufacturing (AM) or 3D printing provides an advanced technology platform that can be utilized for fabricating such intricate structures, in a layer-by-layer fashion directly from a digital design. Despite recent advances in the field of AM, a lot of challenges remain for fabrication of multi-material multi-scale structures with multi-functionality, including the tradeoff for build speed and resolution, and limited material, size to induce functionality in the printed part. In this seminar, I will present some of my recent research to address such challenges. First, I will introduce a novel advanced AM technique, called magnetic-field-assisted stereolithography (M-SL), for production of multi-material objects with multi-scale hierarchical surface structures with locally engineered mechanical and material properties. Secondly, I will demonstrate fabrication strategies for hydrophobic hierarchical surfaces with nano-meso level features and functionality. And finally, I will present a novel computer vision guided design strategy to optimize material distribution in a 3D model, with the goal of producing a biomimetic soft robot that could mimic the locomotion of living organisms. The inchworm inspired soft robot is capable of untethered linear and turning locomotion in dynamic environments. The robot design integrates a drug-carrying chamber, and an embedded tweezer to demonstrated multi-functionality of the robot, i.e., \textit{in vitro} drug delivery in human stomach model and obstacle removal from congested spaces.

BIOGRAPHY

Ms. Erina Baynojir Joyee is a Ph.D. candidate (Spring 2021) in the department of Mechanical and Industrial Engineering at the University of Illinois at Chicago (UIC). Her research interests include smart additive manufacturing (AM), Bio-mimetic fabrication, Soft-robotics, Computer-aided Design (CAD) methodology and Machine Learning based optimization of process parameter control. During her graduate school years, Ms. Joyee has received several awards and honors due to her research excellence. This includes ASME Best Poster Award from the Computers and Information in Engineering Conference (CIE 2017), \textit{National Science Foundation (NSF) Travel Award}, and \textit{UIC Graduate Student Council Travel Award}. She also received seed funding awards from the MIE department as \textit{Faydor Litvin Graduate Award} and \textit{Provost’s Graduate Research Award} from the UIC graduate college.

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