Fine-Scale Structure Design for 3D Printing

Abstract: With 3D printing, geometry that was once too intricate to fabricate can now be produced easily and inexpensively. In fact, printing an object perforated with thousands of tiny holes can be actually cheaper and faster than producing the same object filled with solid material. The expanded design space admitted by additive fabrication contains objects that can outperform traditional shapes and exhibit interesting properties, but navigating the space is a challenging task.

In this talk, I focus on two applications leveraging this design space. First, I discuss how to customize objects' deformation behaviors even when printing with a single material. By designing structures at the microscopic scale, we can achieve perfectly isotropic elastic behavior with a wide range of stiffnesses (over 10000 times softer than the printing material) and effective Poisson's ratios (both auxetic and nearly incompressible). Then, with an optimization at the macroscopic scale, we can decide where in the object to place these structures to achieve a user-specified deformation goal under prescribed forces.

Next I tackle a problem that emerges when using micro-scale structures: fragility, especially for the softer designs. I discuss how to efficiently analyze structures for their likelihood of failure (either brittle or ductile fracture) under general use. Finally, I show how to optimize a structure to maximize its robustness while still maintaining its elastic behavior.

Bio: Julian Panetta is a PhD candidate at NYU's Courant Institute, where he is advised by Denis Zorin. Julian is interested in simulation and optimal design problems, specifically focusing on applications for 3D printing. Before joining NYU, he received his BS in computer science from Caltech and did research at NASA's Jet Propulsion Lab.

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