Studio Title: Novel Construction Methods using Robotic Fabrication

Extended Description:

Computational design and digital fabrication technologies have become a distinct force within contemporary architecture. The translation from digital to fabricated objects is enabled by a wide range of tools and processes such as CNC routing and 3D printing, which have been further democratized with regard to accessibility and affordability within the last decade. These processes have altered how buildings are envisioned and constructed. It has also allowed designers to engage with manufacturing and materials in new ways, which has permitted new opportunities and challenges in realizing architectural elements.

Robotic fabrication permits greater flexibility with double the number of axes provided by a standard cartesian computer numerically controlled (CNC) machine. Robots easily enable and encourage the use and creation of custom end-effectors or tools to create new manufacturing methods. The development of new end-effectors and construction workflows allow for greater customization and variability of the fabricated outputs. The question in this studio is: how robotic construction can facilitate new and innovative methods of architectural construction.

ACADIA (Association of Computer-Aided Design in Architecture) is a conference that focuses on innovations in computational design, digital fabrication, and building construction. The students will be encouraged to submit their final projects as research papers for peer review for the fall 2022 conference. Each studio member will be tasked with developing a novel construction method using a custom-designed end-effector that will attach to the end of a Kuka KR10 robotic arm. This end-effector could be created using 3D printing, CNC routing, laser cutting, or other fabrication methods and may utilize off-the-shelf hardware or electronic components. The robotic arm with this custom tool could perform tasks such as carving, cutting, milling, marking, etc. These investigations will be iterative, meaning that the students will produce multiple versions of the end-effector to refine the design and the fabrication workflow. The iterations will be documented with videos, photographs, and written observations. These new construction workflows will be encouraged to look for ways to limit waste, expedite fabrication processes, and create customization with purpose.

The studio will begin with an examination of the field of architectural robotics. This will be facilitated through a preliminary study where the students will be introduced to CumInCAD, a website housing a cumulative index of the many computational design and digital fabrication publications. Each student will be asked to document ten conference papers through a brief description of their relevance, how the investigation could be expanded, as well as their associated images and diagrams. This study will aid in the student’s understanding of what is possible in addition to the common materials and end-effectors used in robotic fabrication. The goal is to narrow their focus and cultivate a novel research question.

In conjunction with this study, the students will be tasked with small robotic fabrication projects such as foam wire cutting, carving, and milling to understand how to develop a toolpath for the robotic arm to follow using McNeel’s Grasshopper3D. Each week an electronics assignment will be given to further students' capabilities to engage these devices into their robotic end-effector designs. Research methods will be introduced throughout the semester, specifically pertaining to this architecture niche.