Models For Real-Time Feedback Control Of Robotic Fused Filament Fabrication System

Dr. Rakshith Badarinath

Senior R&D product development engineer
TE Connectivity

Seminar: Thursday, Mar 2, 10 AM, 125 Reber

ABSTRACT

Fused filament fabrication (FFF) continues to be among the most widespread additive manufacturing process for making polymeric functional prototypes, and in several cases end-use parts. Robots are well established in manufacturing and their flexible nature is well suited to serve the dynamic demands of manufacturing. There is a large installed base of serial-link industrial robots, some of which could be potentially retrofitted with an extruder head as an end-effector to serve as FFF systems. Additionally, there is a dearth of engineering science for process models for monitoring and closed-loop control of the FFF process.

In this talk, I will discuss solutions to key engineering challenges that arise in retrofitting such robotic FFF systems in terms of integrating robot motion controller with extruder controller and evaluating the quality of the fabricated parts. Specifically, an approach for integration and real-time synchronization of controllers is proposed that ensures the extrusion velocity and deposition velocity match closely by building upon an analytical model for predicting road geometry as a function of process parameters. Additionally, to gain a better understanding of the physics of the FFF process, I will discuss engineering an instrumentation system for sensing and signal processing for real-time estimation of key process variables in the FFF process. Finally, a computer-aided control system design (CACSD) approach is used for developing mathematical plant models that describe the temperature and flowrate dynamics in the FFF process through data-driven system identification.

BIOGRAPHY

Rakshith Badarinath obtained his Ph.D. in Industrial and Manufacturing Engineering (2022) from The Pennsylvania State University where his dissertation focused on real-time feedback control of robotic fused filament fabrication (FFF) process. His research resides at the intersection of robotics and additive manufacturing, with interests that include sensing, automation, and control of additive manufacturing. He was also the first resident graduate from Penn State's newly launched master's program in Additive Manufacturing and Design (2018). Additionally, He has a bachelor's degree in Electrical Engineering from the Siddaganga Institute of Technology (S.I.T), India (2013). He currently works as a Sr. R&D product development engineer within the Additive Manufacturing Corporate