Dynamic Control of the Additive Manufacturing Cloud

Farshad Mashhadi
Faculty: Dr. Sergio A. Salinas Monroy
Department of Electrical Engineering and Computer Science, College of Engineering

Additive manufacturing is transforming the way that we fabricate, deliver, and consume a wide range of objects, from consumer products, to automobiles and aircraft. Meanwhile, to improve their efficiency and productivity, manufacturing systems have extensively adopted the Internet of Things (IoT). By combining the flexibility of additive manufacturing with the enhanced monitoring and control offered by IoT technologies, manufacturers can pool their resources to create a new market where manufacturing services are sold on an on-demand and pay-per-use basis, and without having to commit large financial resources up-front. We call this new market the additive manufacturing (AM) cloud. The AM cloud faces two major challenges: 1) setting a price for manufacturing services that fairly incentivizes consumers to request objects while guaranteeing that manufacturers earn a profit; and 2) finding production and inventory decisions for the manufacturers that minimize their operation cost while delivering objects to customers on-time. To address these challenges, we first propose a multi-unit auction that allocates manufacturing capacity to the users at a fair price. Then, based on the auction results, the AM cloud solves an online optimization problem that finds high-quality approximate solutions. We show that the multi-unit auction is truthful, individually rational, and guarantees revenue to the AM cloud. We also show that the solution obtained by our online control algorithm is within a tight bound of the optimal one. Our simulations show that our proposed control algorithm reduces the operating cost of the AM cloud compared to a simple control scheme and delivers object order to consumers before their requested delivery deadlines.