TOPIC

Spatial Free Form Additive Manufacturing of Lattice Structures

In this talk the conceptualization and realization of a system that deploys an industrial robot arm platform for additive manufacturing of lattice structures is presented. Conventional 3D printers, especially those employing fused deposition modeling (FDM) processes, are restricted to depositing material in a single toolpath plane (e.g. x-y plane). To ameliorate this limitation, we have been exploring various kinematic architectures and motion planning methods. The focus of this study was to explore the feasibility of integrating commercial off the shelf (COTS) additive manufacturing technologies with a six degree of freedom industrial robot arm to yield a 3D additive manufacturing system with the capability to perform free-form six degree of freedom fused deposition modeling. Here, we utilized the general motion capabilities of an industrial robot arm to yield the ability to deposit material as desired in three dimensions. A Yaskawa Motoman SV3X six degree of freedom general purpose industrial robot arm was equipped with a fused deposition modeling extruder print head. This integration combined two mature technologies, industrial robot arms and FDM print heads, into a new system with new additive manufacturing capabilities that we call MotoMaker. Using the MotoMaker system a three dimensional lattice structure generator for multi-plane fused deposition modeling printing was investigated. Experimental results show the achievable capabilities of the 3D lattice structure generator for use with the multi-plane platform. In this talk we summarize the knowledge gained and lessons learned in developing the MotoMaker robot platform for additive manufacturing of lattice tructures.

ABOUT THE SPEAKER

Pierre Larochelle serves as Department Head and Professor of Mechanical Engineering at the South Dakota School of Mines & Technology. Previously he served as an Associate Dean and Professor of Mechanical Engineering at the Florida Institute of Technology. His research focuses on the design of complex robotic mechanical systems and enabling creativity and innovation in design. He is the founding director of the RObotics and Computational Kinematics INnovation (ROCKIN) Laboratory, has over 100 publications, holds three US patents, and serves as a consultant on robotics, automation, machine design, creativity & innovation, and computer-aided design. In 2012 at NASA's request he created a 3-day short course on Creativity & Innovation. This course has been very well received and he has taught it exclusively more than 30 times at NASA's various centers and laboratories across the nation to more than 600 of NASA scientists and engineers. He currently serves as the Chair of the U.S. Committee on the Theory of Mechanisms & Machine Science and represents the U.S. in the International Federation for the Promotion of Mechanism & Machine Science (IFToMM) (2016-22). He serves as a founding Associate Editor for the ASME Journal of Autonomous Vehicles and Systems (2020-23). Moreover, he serves on ABET's Engineering Accreditation Commission (EAC) and as an ABET Accreditation Visit Team Chair. He has served as Chair of the ASME Design Engineering Division (2018-2019), the ASME Mechanisms & Robotics Committee (2010-2014), and as an Associate Editor for the ASME Journal of Mechanisms & Robotics (2013-19), the ASME Journal of Mechanical Design (2005-11), and for Mechanics Based Design of Structures & Machines (2006-13). He is a Fellow of the American Society of Mechanical Engineers (ASME), a Senior Member of IEEE, and a member of Tau Beta Pi, Pi Tau Sigma, ASEE, and the Order of the Engineer.