Z3.04-6074 - In-space Assembly and Manufacturing Using Synchronized Robotics

PI: Babak Raeisinia , Machina Labs, Inc. - Los Angeles, CA

SBIR·STTR America's Seed Fund™ POWERED BY NASA

NASA

NON-PROPRIETARY DATA

IDENTIFICATION AND SIGNIFICANCE OF INNOVATION

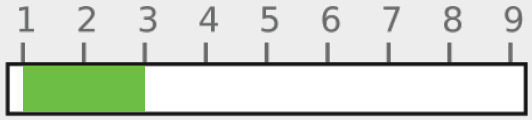
Ground-based manufacturing processes are traditionally not designed with resource constraints and versatility in mind. Single-purpose, heavy machineries are commonly used to carry out a single operation in a long chain of operations. They are, for most part, not autonomous in that they do rely on skilled labor for continued operation and quality assurance. These are all luxuries that cannot be afforded in space. However, the know-how in these manufacturing processes and the processes themselves are essential to success of NASA in extending its presence into deep space. Sheet metal forming is one of such processes where in its current form, it is not ready for deployment in space. Sheet metal parts are, however, extensively used in a multitude of applications, making their processing an essential enabler for deep space travel. In this work, hardware/software developments on an intelligent, two-robot sheet metal forming system with integrated metrology system and guided by simulation is proposed. Considerable lowering of energy, cost, and lead times is achievable.

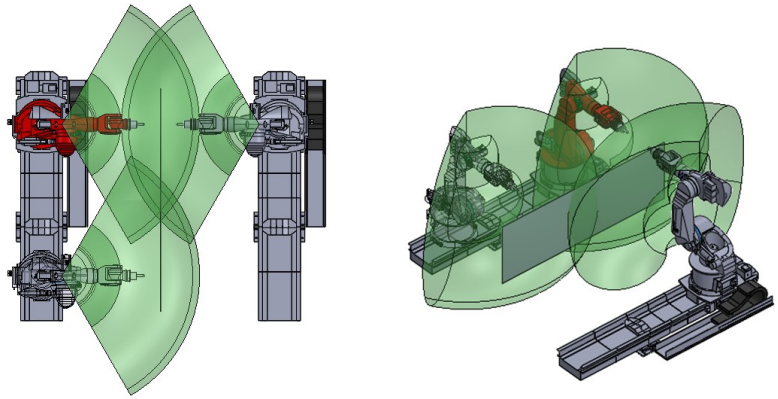
TECHNICAL OBJECTIVES AND PROPOSED DELIVERABLES

The overarching objectives of this work are two-fold: i) deliver software implementations that allow precision sheet metal forming to be carried out autonomously using robotic kinematic solutions (CAD to part with no human intervention) and ii) hardware demonstration of the technology and fabrication of proof-of-concept parts. Several different software modules, each targeting a different functionality of the overall physical system, will be developed and integrated. Overall, strategies and algorithms will be formulated that allow for adaptive control of the sheet metal forming process through learnings achieved from feedbacks from the physical system and simulations of the process. With respect to hardware, trials are planned to validate the noted software implementations. Specifically, a model geometry will be used to correlate process repeatability and accuracy with the positioning of the robots and forming variables. Experiments will be carried out on a formable alloy and a high strength alloy to evaluate process precision under very high payloads. To demonstrate the utility of the process for applications relevant to NASA, a trial is planned to repurpose an electronics enclosure panel and fabricate a lightweight, structural panel; an exercise aimed at demonstrating the capability of the system for manufacturing of lightweight structures and in In-Situ Resource Utilization.

TRL

Estimated





Machina Labs
Modular, Autonomous Robotic Cell for Manufacturing of Sheet Metal Parts

NASA APPLICATIONS

First, the developed software modules and control strategies can be adopted to enable autonomous in-space manufacturing and on-orbit assembly operations. Second, the robotic cell can be used to manufacture lightweight parts for various NASA programs (e.g., components for solar arrays, lander systems, and ultra-lightweight dewars). Third, the forming technology can be adopted for in-space manufacturing and in-situ resource utilization (e.g., repurposing metals from spacecraft to manufacture structures or molds to build habitats).

NON-NASA APPLICATIONS

The robotic forming cell will be used to manufacture and supply sheet metal parts to a multitude of industries (e.g., aerospace, automotive, energy, architecture). The system allows for rapid iteration over design/material at reduced time and cost. It also enables fabrication of parts with previously impossible-to-achieve performance. Composite mold fabrication is an application of the technology.

FIRM CONTACTS

Babak Raeisinia
Machina Labs, Inc.
EMAIL: br@machinalabs.ai
PHONE: (770) 769-0114