

Developing a CAD-Based Digital Twin for Simulating Human-Robot Collaborative Disassembly of Complex Aerospace Components

Abstract

The effective simulation and optimization of human-robot collaborative (HRC) disassembly require detailed and structured digital models of end-of-life products. This research presents a practical methodology for developing a high-fidelity digital twin for this purpose, using an Avro Canada Orenda 10 turbojet engine combustion chamber as a case study. We detail the process of creating a comprehensive CAD model incorporating 32 interconnected components and their specific geometric and physical properties. This model serves as the geometric foundation for spatial analysis and for quantifying key task parameters, such as operational difficulty, which is derived from component mass and volume. Furthermore, we demonstrate the transformation of the CAD assembly's structural dependencies into a graph-based representation, which provides the primary input for a reinforcement learning (RL) planning algorithm. This work showcases the critical link between detailed engineering design and AI-driven manufacturing, providing a replicable framework for creating virtual testbeds to validate advanced disassembly planning systems.

Keywords

CAD, Digital Twin, Simulation, Human-Robot Collaborative , Disassembly, Complex Aerospace Components.