IDETC-CIE 2022

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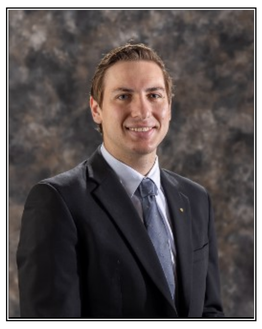

Z-Chunking for Cooperative 3D Printing of Large and Tall Objec
CIE 2022 Graduate Research Poster

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TEXAS
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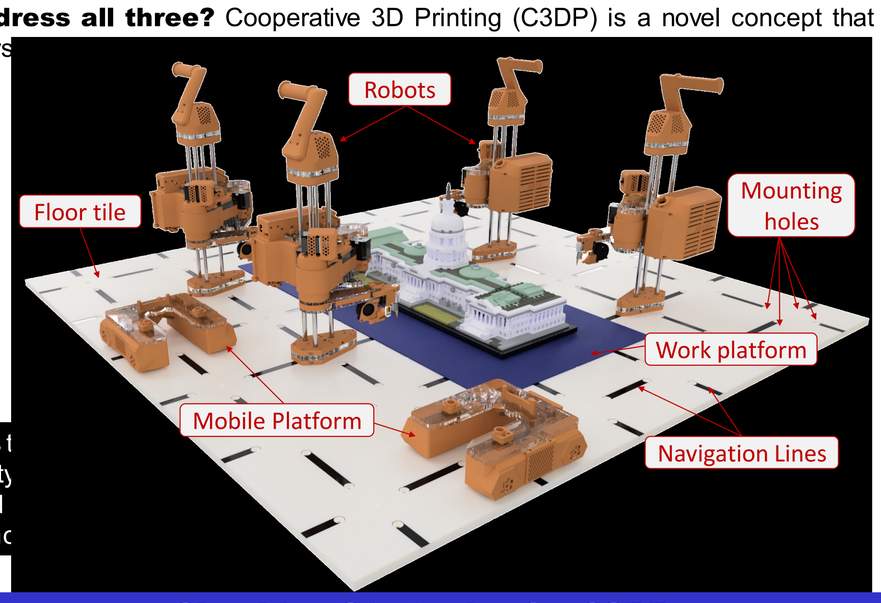
SiDi lab

Background

Three primary barriers of advancement in traditional 3D printing:

-Size -Speed -Scalability

How to address all three? Cooperative 3D Printing (C3DP) is a novel concept that integrates multi-robot sys



C3DP aims t
- Scalability
- Improved
- Autonomo

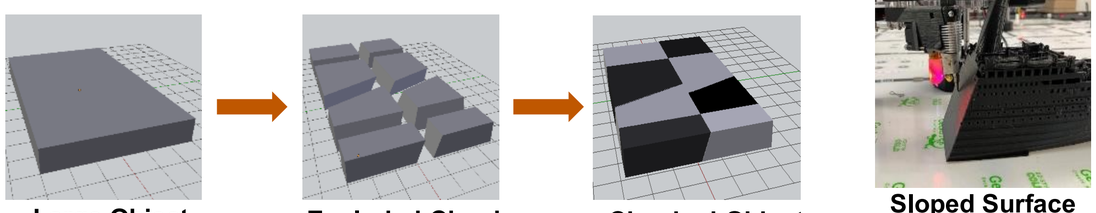
Chunking Strategies for C3DP

For C3DP, we split a job into chunks, which are individually printed by a single robot and reassembled. There are two primary chunking directions, **XY-Chunking** and **Z-Chunking.** Regardless of directions, the **Two Basic Question to Enable C3DP** are:

1. Where to chunk a job **2.How to reassemble the chunks**

XY-Chunking

XY-Chunking is a process established in our previous work. Chunk boundaries are determined by the discrete positions that printing robots can occupy. Chunks are directly bonded together during printing by using a sloped surface interface.



Large Object | Exploded Chunks | Chunked Object | Sloped Surface Interface

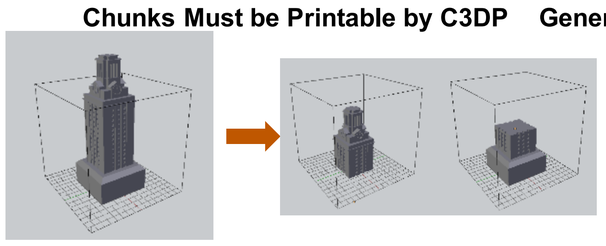
Z-Chunking

Design for Additive Manufacturing (DfAM) → Rules for Z-Chunking ← Creation of Assembly Geometry (AG)
Design for Assembly (DFA) Guidelines → Rules for Z-Chunking ← Geometric Partitioning for 3D printing

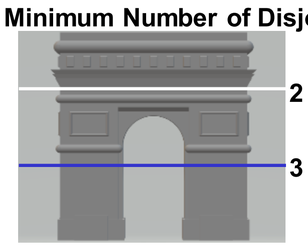
Because robots can not be moved infinitely in the Z direction, as they can in the XY direction, tall objects must be divided into layers, or Z-Chunks, which are printed at different locations are re-assembled. For this reason, Z-Chunking is not only a partitioning problem but also an **Assembly Problem**.

Rules for Z-Chunking

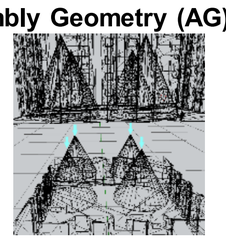
Chunks Must be Printable by C3DP



Generate a Minimum Number of Disjoint Chunks



Generate Assembly Geometry (AG) to Join Chunks



Chunking is Deterministic

Chunking Location

From a finite set of optional cuts, determine which should be active and inactive to have the lowest number of chunks that can all accommodate an AG.

Objective Function

Minimize:

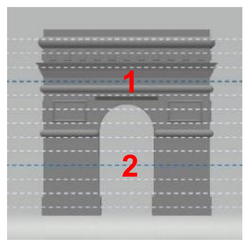
$$Number\ of\ Islands\ +\ k * Number\ of\ Islands\ without\ AG$$

Summed over all active cuts

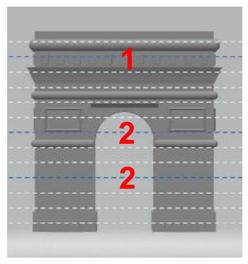
Subject to:

$$Distance\ between\ active\ cuts\ \leq Z\ limit\ of\ printer$$

k is a weighting factor >> 1 to ensure priority for configurations where all Islands have at least 1 AG



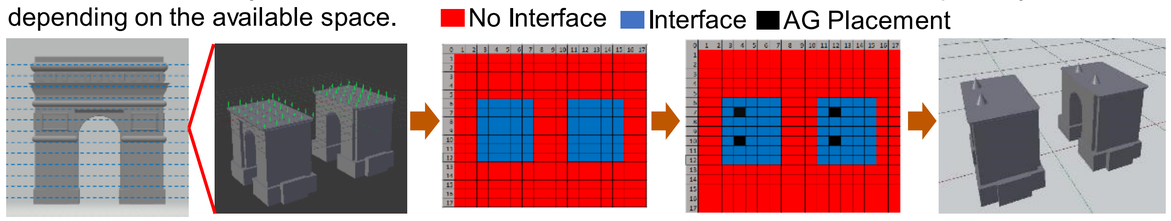
Value of Configuration: 3 ✓



Value of Configuration: 5 ✗

Enable Reassembly with Assembly Geometry

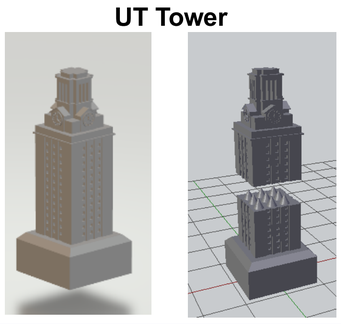
We add Assembly Geometry to join the chunks back together after printing. We do this by analyzing a grid of locations across the chunking interface for solid areas with enough space to place an AG. If there are several disjoint areas on an interface, we create AG for each one separately with sizes depending on the available space. No Interface Interface AG Placement



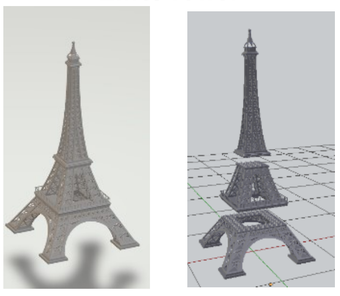
Sublayers | Raycast | Interface Map | Final Placement | Assembly Geometry

Case Studies

UT Tower

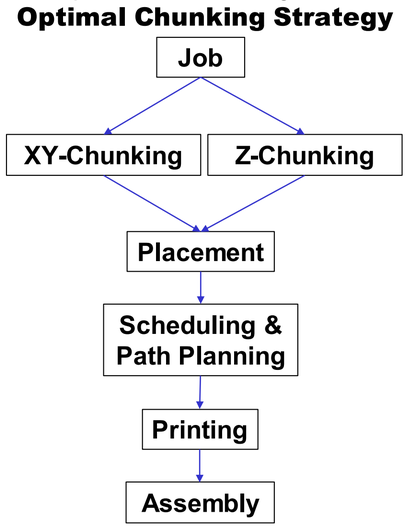


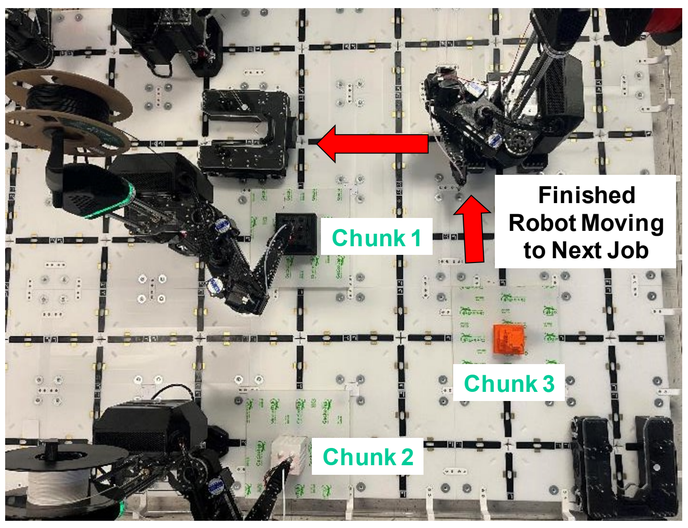
Eiffel Tower



Future Work and Vision

- Implement an Integer Programming Solver to allow for higher sublayer density and better chunking locations
- Incorporate Different Types of AG to allow for a diverse performance space of the assembly
- Develop a Placement Strategy of Z-Chunks on the factory floor
- Incorporate Z-Chunking and Placement Strategy in Scheduling and Path Planning to find the **Optimal Chunking Strategy**





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