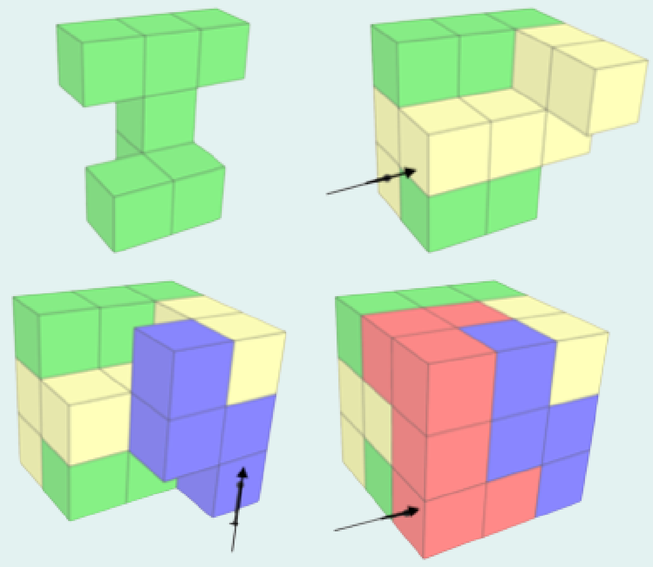
puzLock

Interlocking Printable 3D Puzzles

Background

Interlocking puzzles are a type of three-dimensional structure where its pieces lock together to form a final stable shape. Finding a viable interlocking design is a complex computational geometric problem. While there have been several attempts to tackle this problem, the most prominent approach was proposed by Song *et al.* (2012). Their solution recursively subdivides a voxelized model into a uniquely generated configuration of puzzle pieces.



Objectives

By studying the method proposed by Song *el al.* in their paper, *Recursively Interlocking 3D Puzzles* (2012), we seek to implement a system that is able to take in a 3D (.STL) file, and extract individual pieces which, when assembled, are interlocking.

We subdivide this aim into two sections:

1. **Voxelization** of the initial structure & **Realisation** of the puzzle decomposition.
2. **Implementation** of the puzzle generator framework.

Voxelization & Realisation

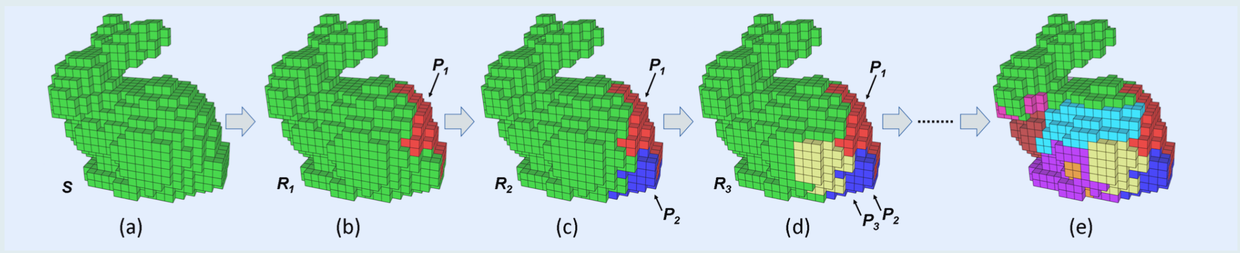
Our approach actively transforms 3D mesh models into **volumetric/voxelized** representations of themselves, with input shapes of any size and voxelizations of any given uniform dimension.

original object 32x32x32 128x128x128

We generate STL files for each puzzle piece and observe their ordering and placement via our built dedicated viewing application. Each piece can then be processed and 3D printed.

Implementation

Our implementation of the algorithm relies on constructing pieces sequentially using a system of blockages and anchor voxels. In doing so, we ensure that each piece is only mobile in a single direction, and only once the previous piece has been removed.

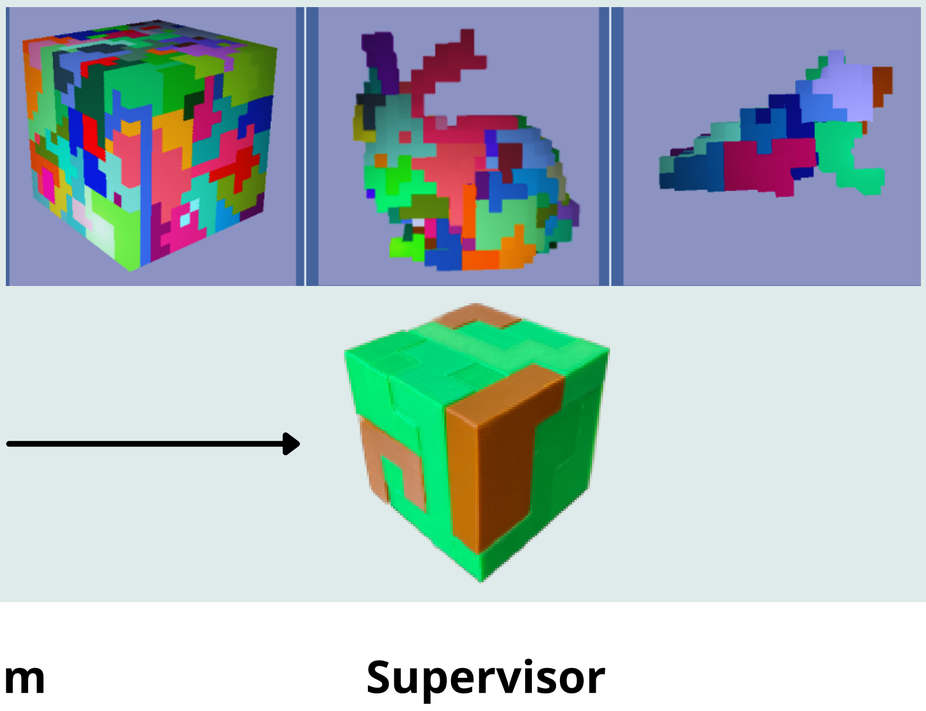


This method is ***recursively interlocking,*** meaning that there is exactly one, fixed sequence of assembly and dissassembly.

Results

Our system is able to process a range of different geometries, with varying dimensions (***N***) and number of pieces (***K***). However, there are some geometric exclusions, namely holllow shapes and those with excessive gaps. In terms of performance, processing times generally increase with both ***N*** and ***K,*** with an approximate complexity of O(*nlogn*).

We successfully 3D printed a 25cm^3, 10 piece, interlocking cube puzzle that is both structurally solid and durable.



University of Cape Town
Department of Computer Science
Email: dept@cs.uct.ac.za
Tel: 021 650 2663

IT | SCHOOL OF IT

Project Team
Avi Lurie
avilurie24@gmail.com
Nabeel Dockrat
nabdockrat@gmail.com

Supervisor
Professor
James Gain
jgain@cs.uct.ac.za