July Progress Report

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July Projects

Summary:

CSL is currently working on the robotic assembly of truss structures. During July, I worked on two projects as part of two different lab sprints. First, I designed and prototyped an attachment for truss voxels that requires minimal stimulus from the robotic assembler. Second, I designed and prototypes a worm-like robot that could be used to traverse a lattice structure.

Minimal Stimulus Attachments:

In order to ease and hasten robotic assembly, I designed attachment mechanisms for a vertex-adjacent, vertex-attached octahedral lattice. The attachment mechanisms would allow up to five nodes to be locked in place with a single rotation. The design was inspired by Penrose's self-assembling mechanisms.

The minimal stimulus voxel consisted of two different attachment mechanisms. At the top and bottom, a friction-fit, genderless "twist" node (shown in 1a and 1b) helps correct for misalignment during the initial voxel placement. At the remaining four nodes, friction-fit, genderless "claws" (shown in 2a and 2b) lock in place as the voxel is rotated by the robotic assembler. The complete voxel design is shown in 3a, and a two-by-two lattice is shown in 3b.

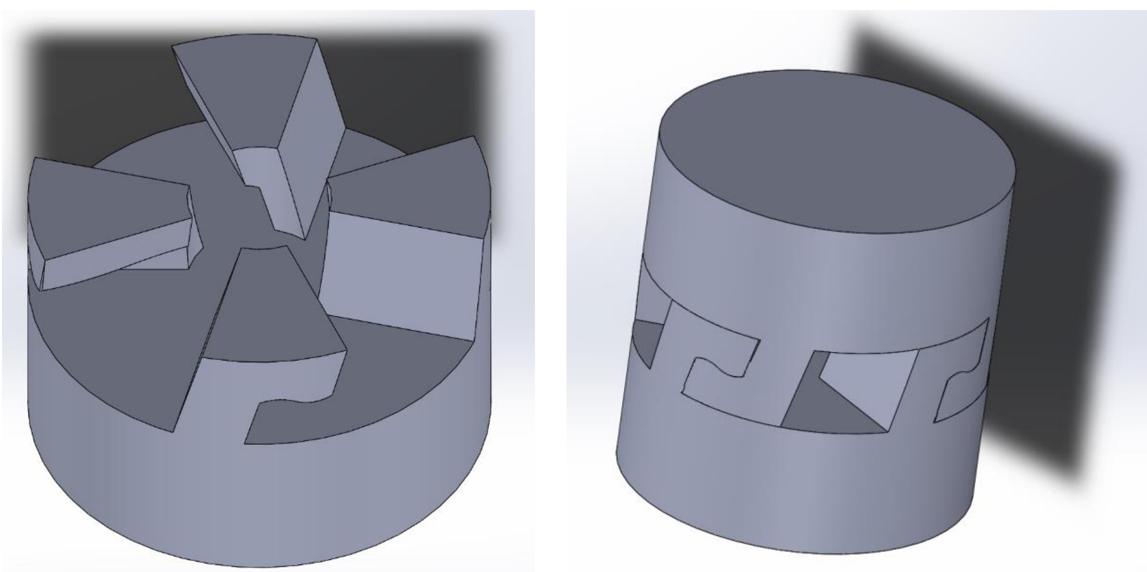


Figure 1 (a) Friction-fit, genderless "twist" node (b) Two "twist" nodes locked in place

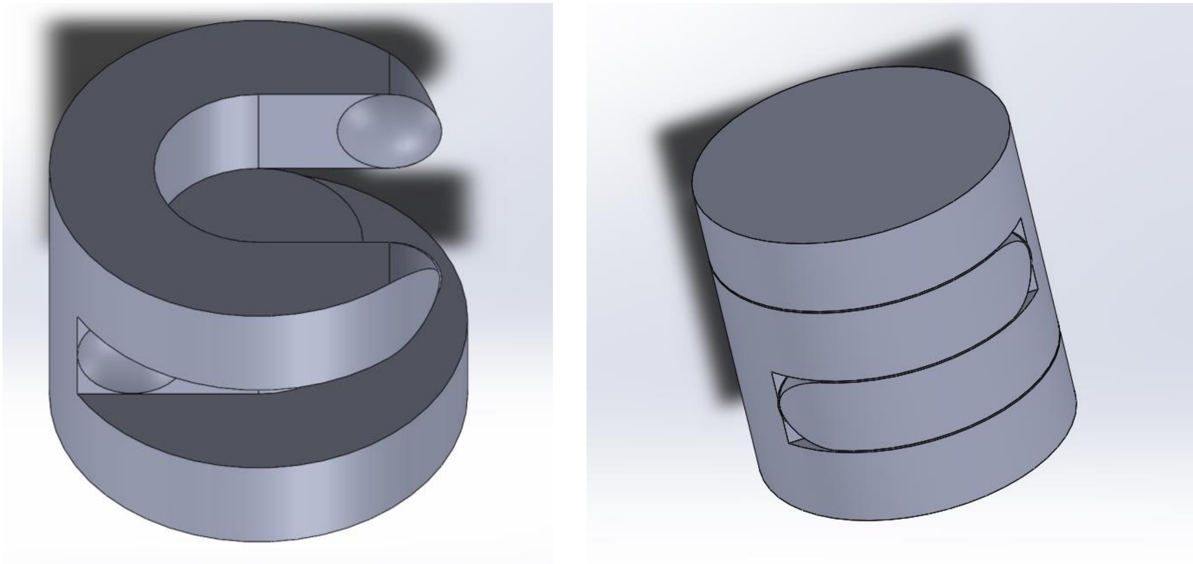


Figure 2 (a) Friction-fit, genderless "claw" node (b) Two "claw" nodes locked in place

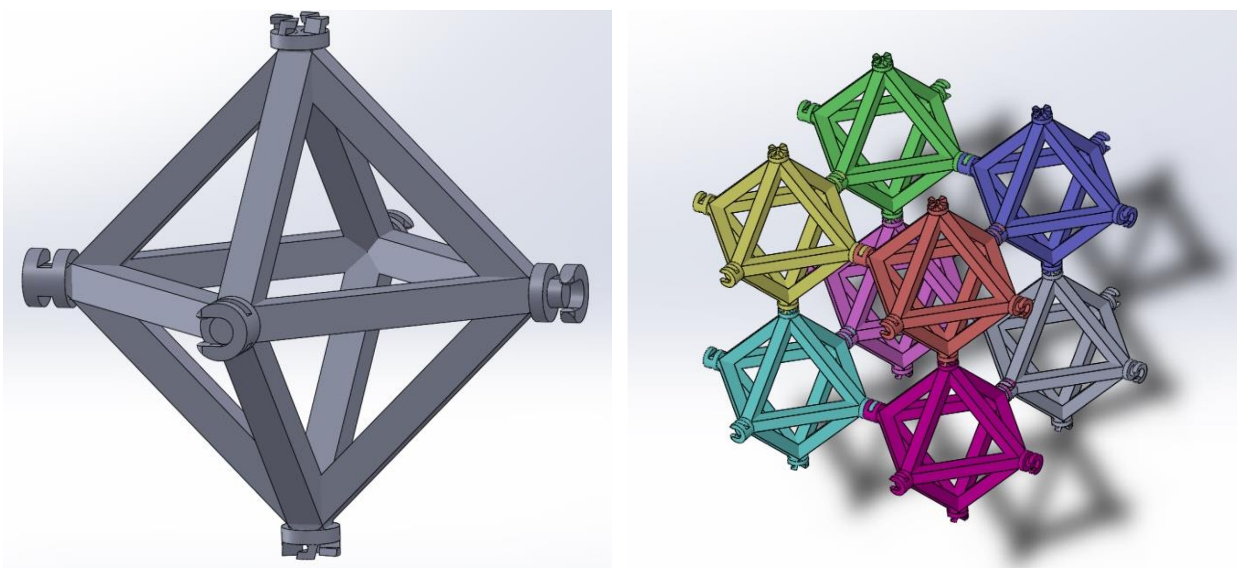


Figure 3 (a) Minimal stimulus voxel design (b) 2x2 minimal stimulus lattice assembly

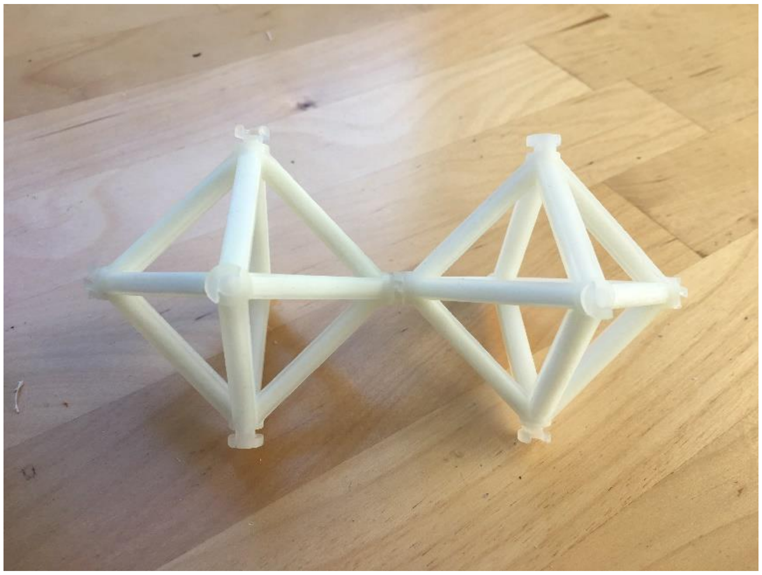


Figure 4 Prototype of voxels with minimal stimulus attachments

The design is advantageous because of its genderless nodes, ability to correct for misalignment, and ability to lock in place with one simple movement. However, these minimal stimulus attachments give the voxel an orientation (a top/bottom vs. side) because two different types of connectors are used. Additionally, these attachments may not be robust enough since they are held together solely by friction.

Robotic Locomotion:

As part of a larger investigation on different mechanisms for robotic locomotion on a lattice, I designed and prototyped a worm-like locomotion system. Inspired by continuum robotics, I prototyped two designs as a proof-of-concept of the different locomotion steps a worm-like robot could achieve.

I first prototyped a robot that showed a simple inchworm behavior (shown in 5). The robot compressed and expanded in order to linear traverse a surface.

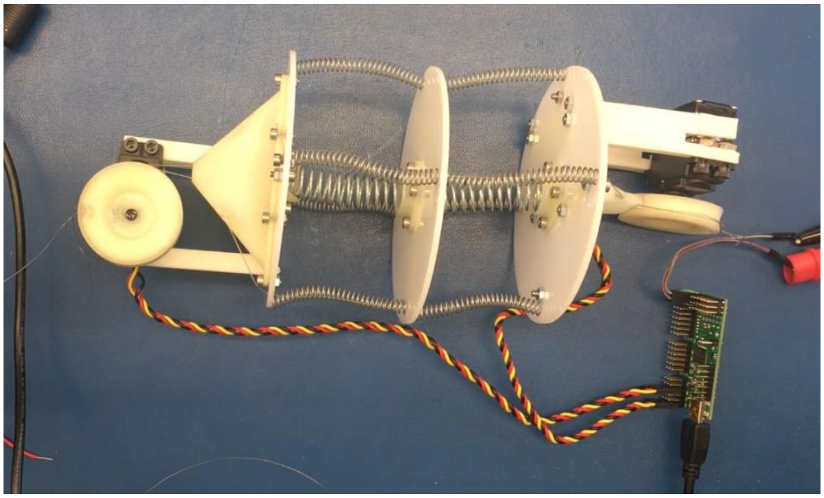


Figure 5 Inchworm robot during compression

Next, I prototyped a robot with more complex behavior. In addition to the simple compression and expansions maneuver, this worm-bot could curve upwards, downwards, left, and right. It also could combine any of these six motions to create intermediate steps.

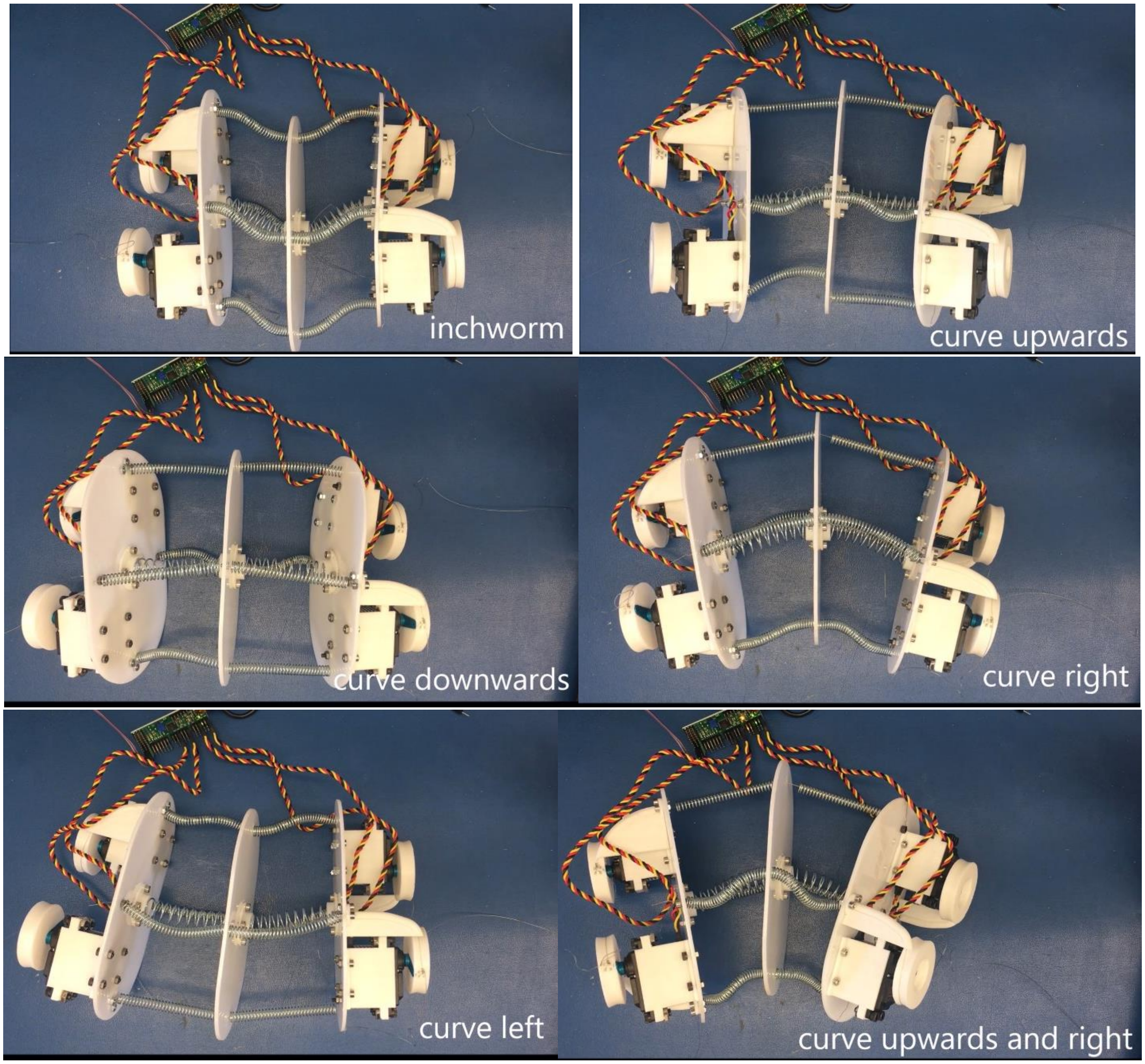
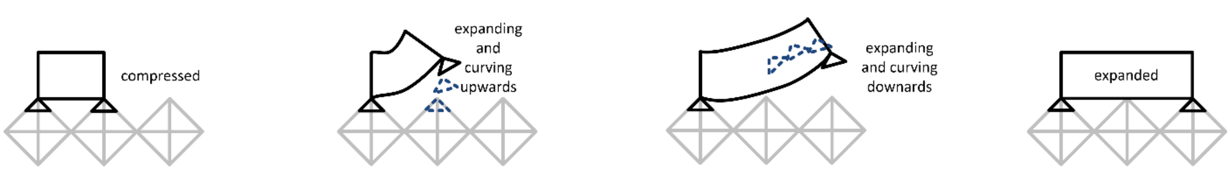
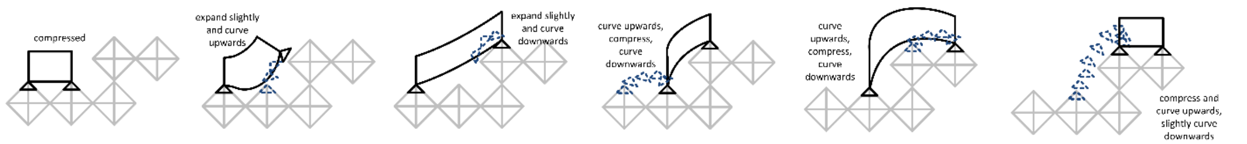


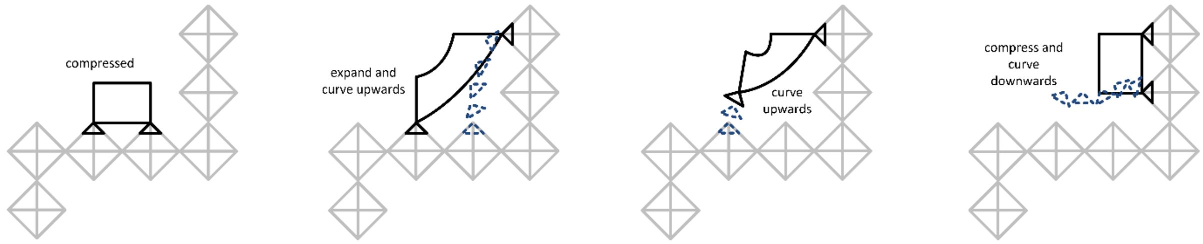
Figure 6 Several behaviors of the worm-bot



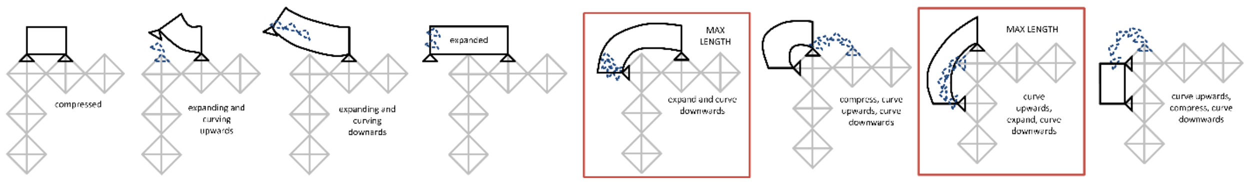
(a) Walking



(b) Stepping Up/Down



(c) Concave Turn



(d) Convex Turn

Figure 7 Locomotion steps

August Goals

- Design and prototype a third version of the worm-bot that can grip onto a lattice structure
- Write out a geometric proof of the worm locomotion for comparison and downselection of the locomotion systems
- Integrate the locomotion system with end effector and voxel transportation systems