Student Project Proposal

Segmented woven shells from deployable gridshell units

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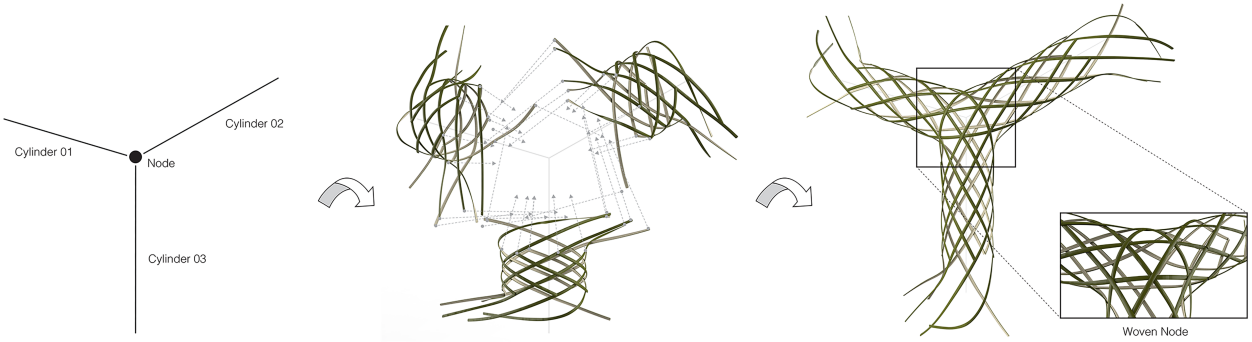

Description

Segmented shells are commonly defined as discrete shells shaped from rigid planar components. A novel approach that we are currently exploring involves incorporating elastic principles at the component level. Starting with a segmentation pattern on a 3D surface, cylindrical components can be designed as compact-to-volumetric linkage units created from thin flexible ribbons. By sequentially deploying these cylindrical units and connecting them at nodes using weaving principles, the overall geometry of the discrete shell gradually takes shape. The introduction of woven nodes enables the scissor mechanism within the cylinders to lock which progressively stabilizes the entire structure without the need for additional external elements.

The goal of this project is to investigate the design space of such material systems by making use of an in-house simulation framework. The main technical challenges we aim to address are:

- Optimization of Global Segmentation: The segmentation of the target surface directly impacts the design of components and force transfer, as it can disrupt material continuity at the connection points, affecting the structure's stiffness.
- Topology Exploration of Woven Nodes: Woven nodes are by-products that result from connecting cylindrical units. Different topologies can be generated by altering the connectivity and arrangement of cylinders.
- Assembly Sequence Exploration: Since the assembly process is gradual and involves deploying and connecting cylindrical units, it is crucial to comprehend the logic behind deploying and connecting these units. This is essential because certain assembly sequences may result in units that cannot be deployed and connected to the woven nodes.

Prerequisites

The scope of the project can be adapted for semester projects at the master level, for one student or two students working as a team, as well as a master thesis project. Basic knowledge of physics-

based simulation, rhinoceros/grasshopper, and at least one programming language is required. A strong background in C++ and C# will be helpful.

References

[1] Suzuki, Seiichi, Martin, Alison, Ren, Yingying, Chen, Tzu-Ying, Parascho, Stefana and Pauly, Mark. *BamX: Rethinking Deployability in Architecture through Weaving*, Advances in Architectural Geometry 2023, Berlin, Boston: De Gruyter, 2023, pp. 207-220. https://doi.org/10.1515/9783111162683-016