

Highly rigid extendable boom using corrugated structure for deployable mobile gantry robot system

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Overall Proposal

A deployable structure, which can be transformed into a target shape by extending or expanding the stored structure, serves as a strategy to address space and transportation issues. Meanwhile, the large-scale structure's self-weight has a significant impact on its implementation, necessitating two additional considerations: 1) scalability in rigidity and 2) automation in actuation.

Here, we are suggesting a corrugated structure with a Slide and Fold Enabling (SaFE) joint, which offers significant rigidity and compactness through rolling in a hub, working with simple actuation, as well as a scalable design property.

Design & Principle

* Principle

• Sliding motion is necessary to roll corrugated structure in a hub



Fold in layers

Transverse to the corrugation direction - Stiffening Along the corrugation direction – Flattening for rolling

Even if # of layers increases, the overall folded form factor is not changed.



The inner layer starts to buckle(failure) due to the shear stress from the perimeter difference when rolled

Roll(succeed) Sliding between layers

The piled-up structure can be rolled without buckling failure by releasing shear stress through sliding motion

• Concept of the Slide-and-Fold Enabling (SaFE) joint

Example) 2-layered SaFE structure



Easy to fold



Fully unfolded state Fully folded state **Corrugated shape**

Each folding joint of the structure is SaFE joint

Easy to slide



Smoothly rolled



SaFE joint (Allows to slide and fold along the fold line)

Design

Design schematic: corrugated structure rolling in a hub



Specifications of made Density: 869g/m El(main dir.): 632.67 Nm² (expected) SaFE structure *2020 aluminum profile: 492 Nm² Hub radius 100mm (0.5% strain) 723mm * 445mm * 75mm Stored state (Minimum) (without motor) **Extended state** Length: 4025 mm (556%) (Maximum) (3300mm extension) **BLDC 12V 105W** Motor 100mm/s Speed (extend/retract)





SaFE structure's gravity directional ultimate strength > 85Nm (external load + maintaining components + self-weight)



SaFE structure's fully extended state

Application

Deployable mobile gantry robot system

Utilizing it as a hang printer





Stored state: 0.9m*0.7m



Deployed state: 3.46m*3.64m (x26.4 volume)





Tendon-driven Hang printer system

- Over 10kg
- Moving mass
- Additional tension applied to structure
- Working accuracy with error Width: 1.02m below 0.4mm

Not only deploy into meter-scale structure, but also capable of additional load bearing!



Height: 1.6m

Total 4000 layers



Printing time: 80 hours



