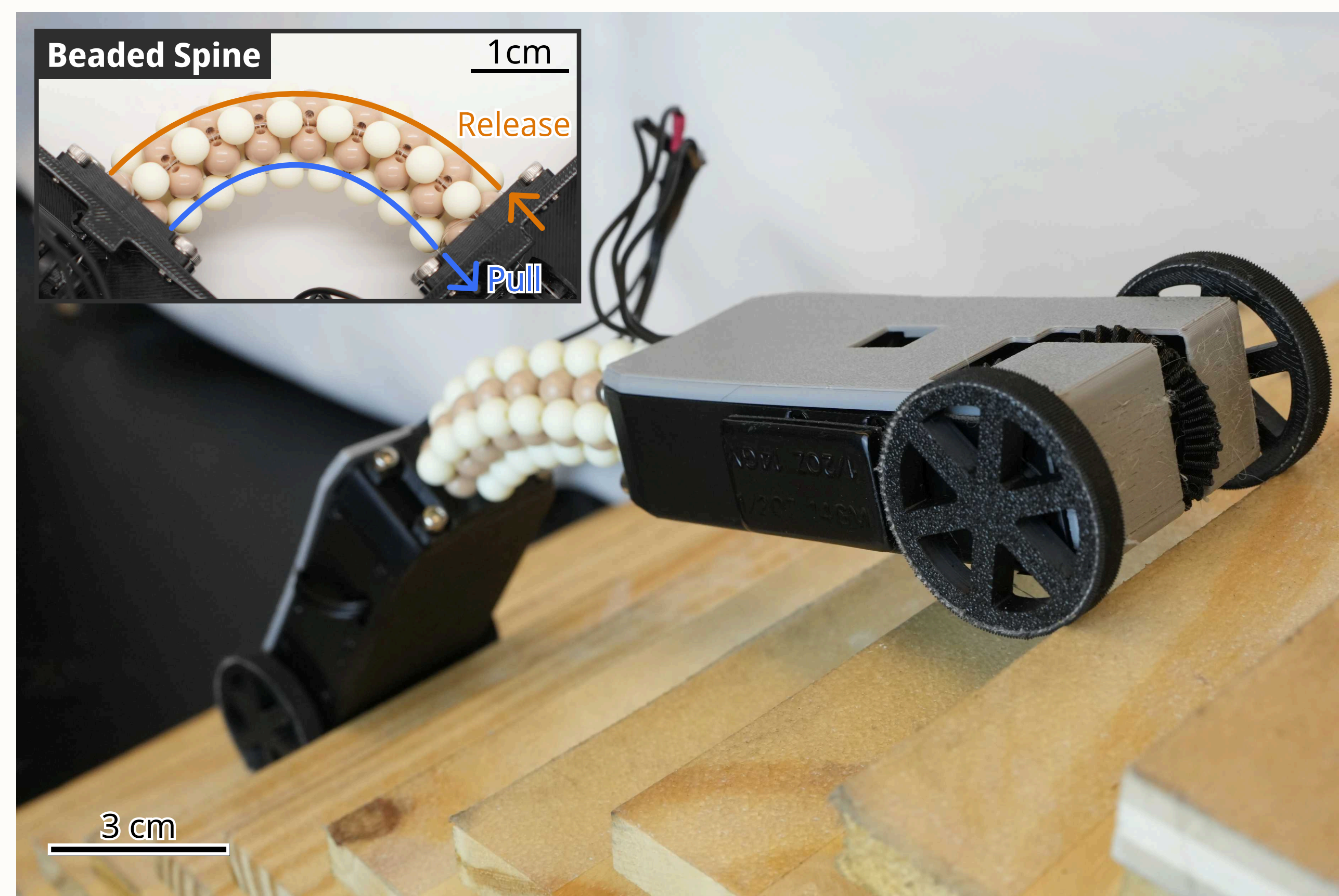


BaSiL: A Tendon-Driven Beaded Spine Robot for Shape-Adaptive Locomotion

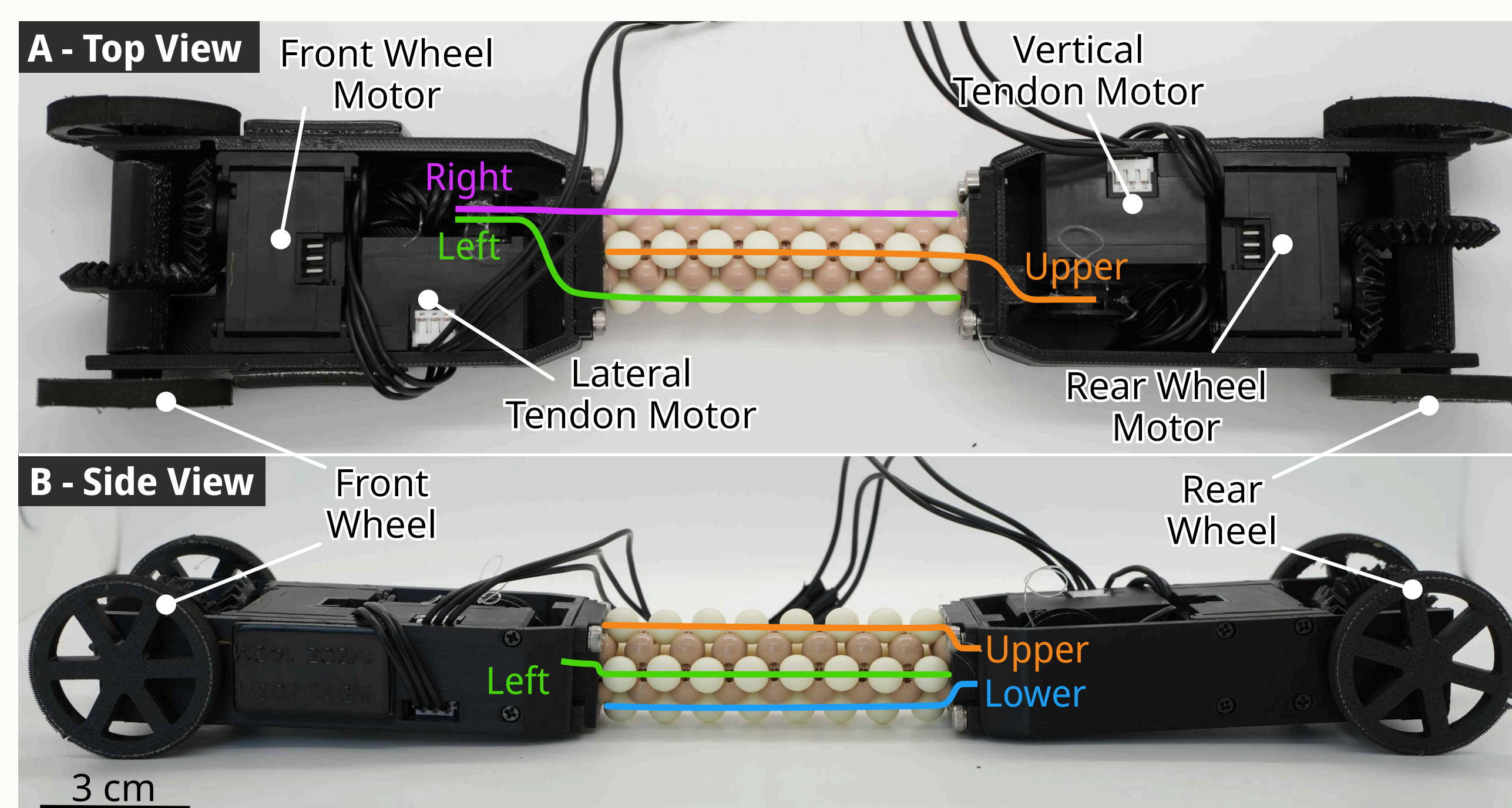
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Project Overview

Fixed structure can limit traversability on uneven surfaces. **BaSiL** is a compact wheeled robot whose tendon-driven beaded spine combines passive terrain adaptation and active body movement within the same mechanical structure.



Design Overview



BaSiL has two motors for locomotion, each driving two wheels through a bevel gear transmission. Two tendon motors control vertical and lateral spine bending, each pulling one tendon while releasing the opposing tendon. Released tendons allow passive terrain adaptation.

Program participation supported by

SoftBank Group

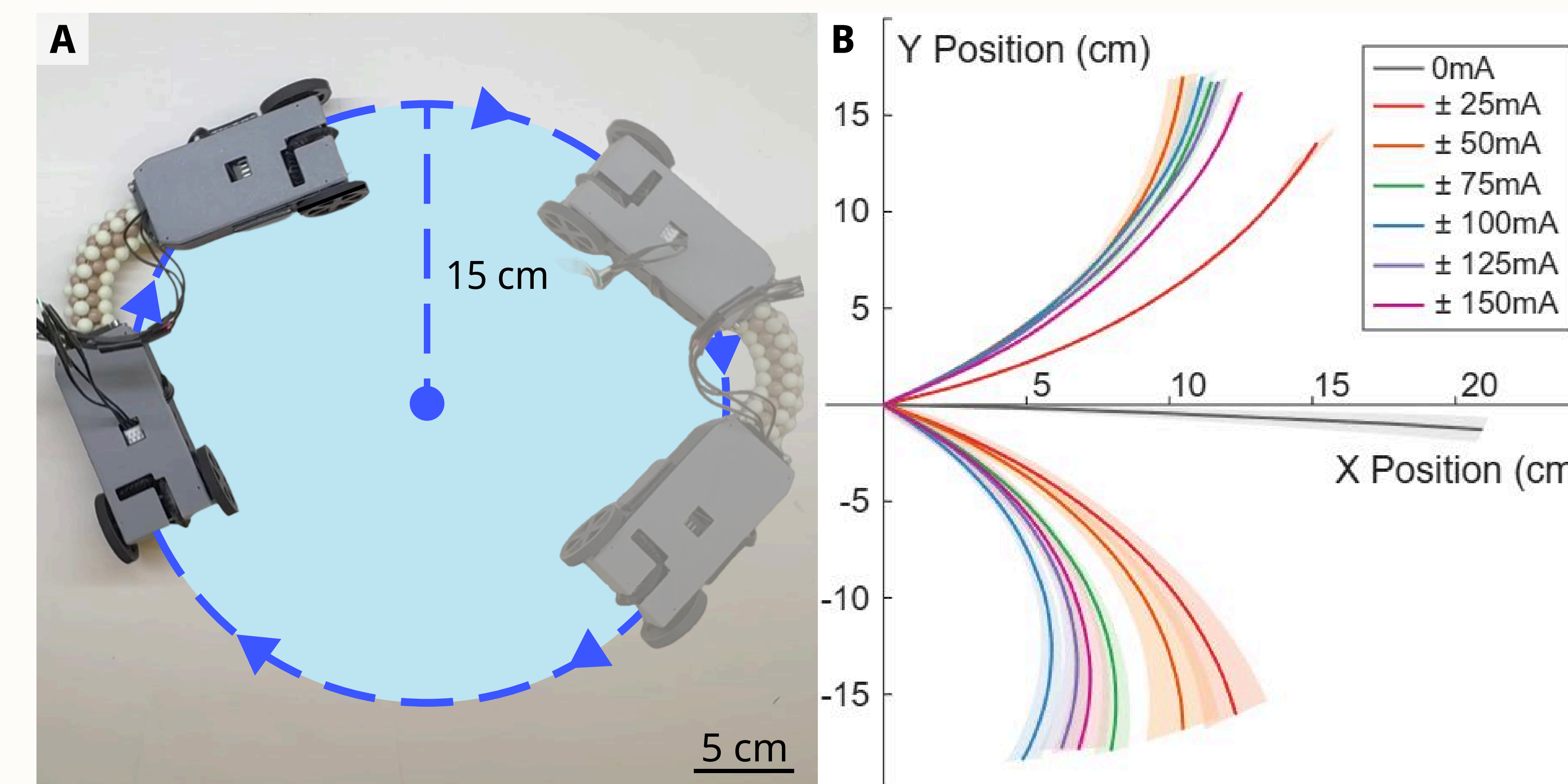
arm

More details



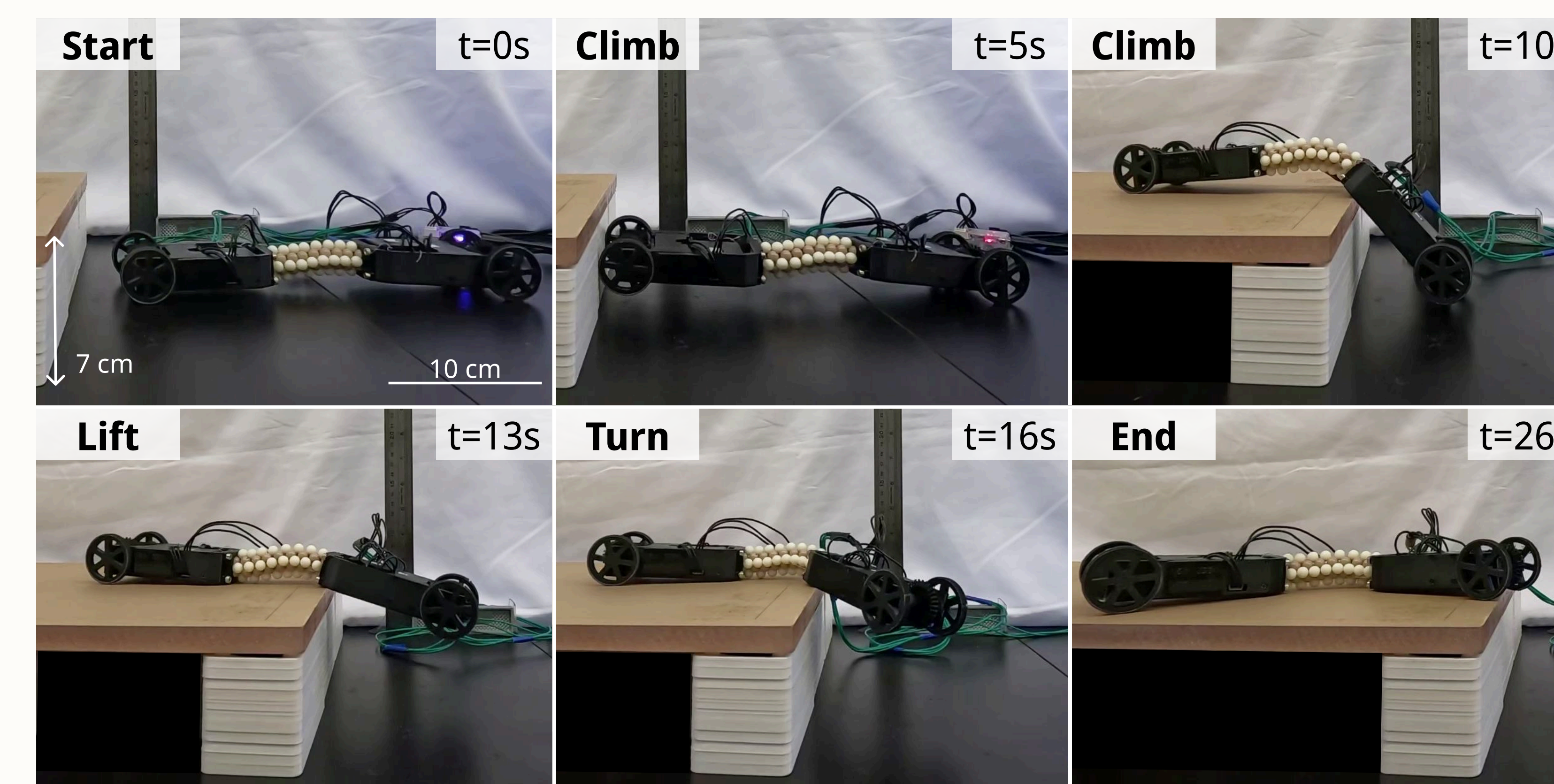
Turning Performance

Lateral tendon actuation bends the spine and changes the relative orientation of the wheeled modules, enabling turns in both directions. BaSiL achieved a minimum turning radius of 15 cm.



Step Climbing Performance

Climb → **Lift** → **Turn**. Vertical spine actuation raises the front module, then reverses to lift the rear. Lateral actuation turns the body to complete traversal.



Maximum step height (5/5 successes)

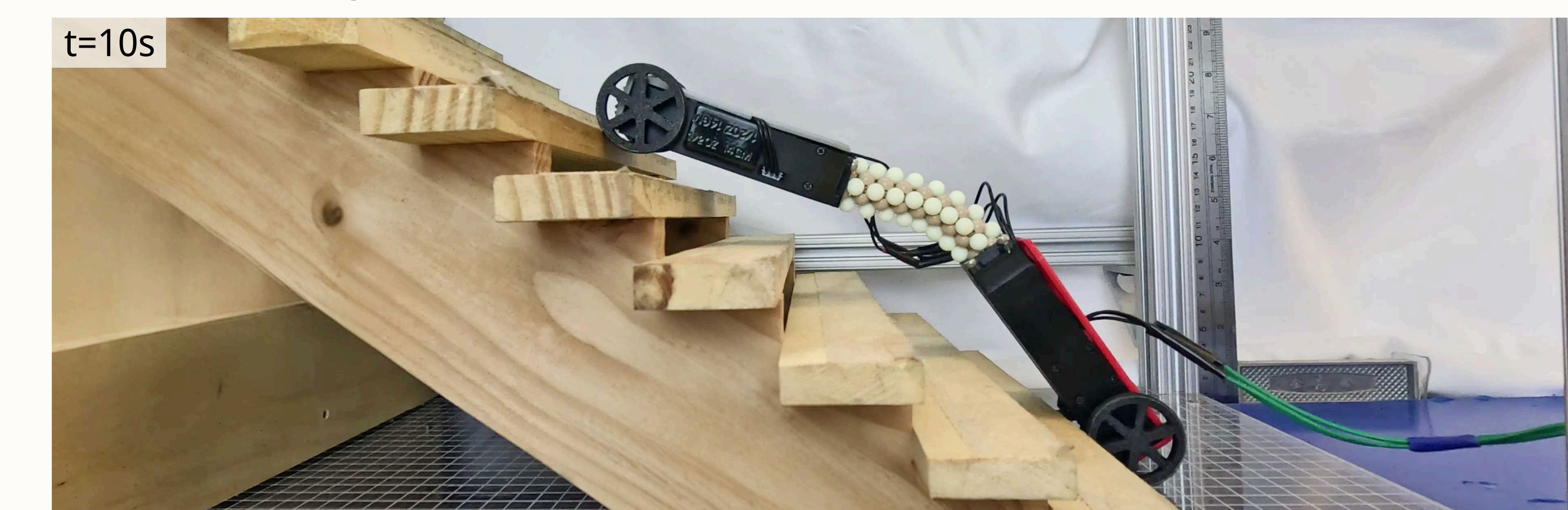
Condition	Rigid	Passive	1 phase	2 phases	3 phases
Step height	10 mm	20 mm	35 mm	50 mm	65 mm

With 3-phase actuation, BaSiL reliably traversed a 65 mm step. It also traversed a 70 mm step, nearly four times its wheel radius ($r = 18$ mm, $h/r \approx 3.89$), in 2/5 trials.

Demonstrations

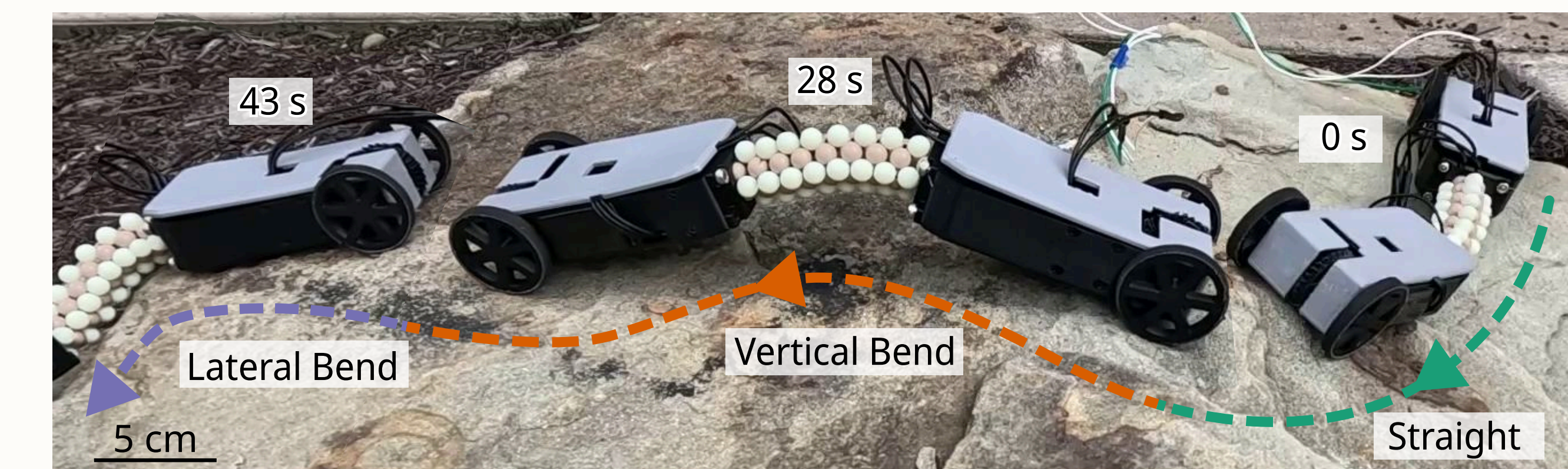
Stair Climbing

Using a constant spine actuation current of 20 mA, BaSiL climbed 11 steps (25 mm each) in approximately 20 s. During the ascent, the spine exhibited a contraction-relaxation motion.



Real-World Demonstration

Vertical bending improved terrain contact. Lateral actuation steered the robot downhill.



Conclusions

Contributions

- ▶ A single beaded spine combines passive terrain adaptation and active body movement using two spine actuators.
- ▶ 3-phase actuation reliably enabled 65 mm step climbing.
- ▶ Minimum turning radius: 15 cm with lateral actuation.

Future Work

- ▶ Integrate onboard power and control for untethered operation.
- ▶ Use learning-based control for autonomous shape-adaptive locomotion.

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