EPFL-TTO
EPFL Innovation Park J
CH-1015 Lausanne
Switzerland
+41 21 693 70 23
http://tto.epfl.ch/

Research Contact
Josie Hughes
+41 21 693 31 59
josie.hughes@epfl.ch

TTO Contact
Ghislain Singla
+41 21 693 54 77
ghislain.singla@epfl.ch

Licensing Opportunity

TTO – Technology Transfer Office

Compliant Morphing Robot for multi-modal locomotion

Ref. Nr
6.2590

Keywords
Robotics, multi-modal locomotion, frame reconfiguration

Intellectual Property
PCT/IB2025/061828

Publication
Max Polzin et al., Robotic locomotion through active and passive morphological adaptation in extreme outdoor environments. Sci.Robot.10,eadp6419(2025). DOI:10.1126/scirobotics.adp6419

Date
20/11/2025

Description

Robots today can traverse many terrains, yet major limitations persist:
Rigid morphology - most robots cannot substantially change their structure, restricting operation to narrow environmental niches;
High sensing and planning requirements - traditional systems depend on complex perception to navigate unpredictable terrain;
Limited adaptability - reconfiguration, where present, is often slow, mechanically complex, or restricted to small body parts;
Poor robustness across environments - extreme, mixed, or unknown terrains (mountains, rubble, water, snow, cliffs) remain a challenge.

The technology introduces a bio-inspired compliant robot named GOAT (Good Over All Terrains) capable of active and passive morphological reconfiguration, enabling seamless transitions between driving, swimming, rolling, squeezing through gaps, and absorbing heavy impacts.
Its architecture enables deformation from a flat, rover-like shape to a fully spherical configuration, while the robot’s passive mechanical properties vary accordingly.

Advantages

- Multi-Terrain Locomotion via Shape Shifting: Flat/rover configuration, Spherical configuration, Swimming mode.
- Active Control of Passive Properties: Reconfiguration changes stiffness, compliance, and geometry, enabling terrain-dependent behavior without complex sensors or planning.
- Autonomous Navigation with Minimal Perception: The robot follows gradients, rolls passively, stops by unfolding, and drives with low-level waypoint tracking—requiring only position data.
- Energy-Efficient Mobility: Rolling reduces power consumption by up to an order of magnitude; transitions between modes optimize total cost of transport.
- Robustness Across Environments: Demonstrated operation in snow, mountains, rubble, water, and urban obstacles.

Applications

- Search & rescue in rough or unpredictable environments
- Environmental monitoring across land-water interfaces
- Planetary or extreme-terrain exploration
- Infrastructure inspection and remote deployment
- Low-cost, high-robustness field robotics