

# SMAR: Soft Modular Autonomous Robot for Terrestrial Locomotion

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**Abstract**—Soft-bodied mobile robots are appropriate for disaster relief scenarios due to their robustness and ability to negotiate unstructured environments. This capability has initiated the development of several robot platforms to explore terrestrial locomotion, meanwhile igniting debate over suitable control algorithms, modeling strategies and design tools. This research proposes a soft bodied robot to be used towards answering these questions. The current research presents the design of a soft, locally controlled and actuated semi-autonomous platform for terrestrial locomotion capable of implementing such algorithms. The modular platform collectively provides sensing and control abilities with all electronics on board. The design process facilitates variation of morphology and actuator configurations of the basic modular unit.

**Contribution:** A modular platform that provides sensing and control ability with all electronics on board making it semi-autonomous. It collectively provides a solution for morphology, friction manipulation, soft actuation and flexible electronics to facilitate exploration of high level modeling and control problems.

Soft materials provide robots with the capability to change *dimension*, *morphology* and withstand *impact*. There are a large number of soft robot designs, each with a different approach to locomotion and actuation [1,2]. To help create a self-contained research platform, we propose building a robot module incorporating each of the following design features:

- 1) *Body Shape*. The body shape should promote modularity in the robot i.e. multiple smaller robots can be connected to assemble a larger robot. Figure 1 illustrates possibilities with unified modules.
- 2) *Friction manipulation*. The importance of friction mechanism is unique to robots performing terrestrial locomotion [3]. A proposed mechanism is the combination of macro-scale mechanical spines and directional adhesives that engage with the surface.
- 3) *Sensors*. The robot is equipped with MEMS inertial sensors (e.g. IMUs and accelerometers), vision camera and haptic sensing.
- 4) *Actuation*. Actuation of the soft body can be viewed as global and local actuation. A global actuator has ability to deform large areas of the body, whereas the local actuator controls local deformation and stiffness.
- 5) *Electronics*. To maintain a semi-autonomous and 'soft' nature of the robot, on-board processing, wiring, battery and communication will be implemented as flexible circuits encapsulated within the soft body.

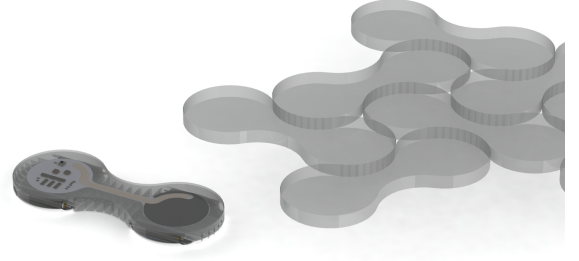


Fig. 1: The semi-autonomous nature of the platform is derived from localized sensing and control. Multiple modules can join together or cooperate to create a unified sheet with the capacity to re-configure its shape for different functions. As an extension of this method, one can imagine other shapes, such as a sphere or box if this sheet is folded out of plane.

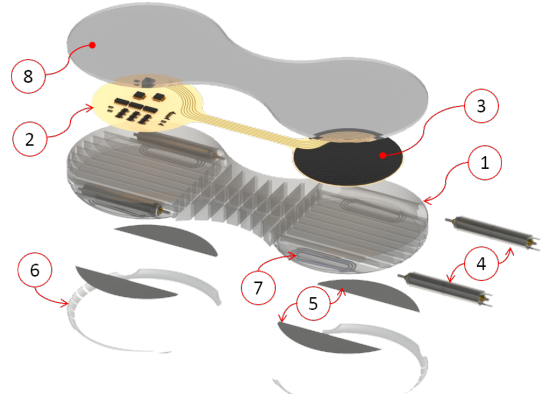


Fig. 2: An exploded view of the assembly showing the following components: 1) Soft, flexible body. 2) Flexible circuit board for wiring, controller and other electronics. 3) Flexible battery. 4) Motors for actuation. 5) Friction elements that act to hold a particular section of the body in place. 6) Slip elements that provides a surface for the robot to drag a particular section of the body. 7) Embedded haptic sensing. 8) Encapsulation.

## REFERENCES

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