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Soap-bubble Optimization of Gaits SURESH RAMASAMY, ROSS HATTON, Oregon State Univ — We present a geometric gait optimizer that applies Lie bracket theory to identify optimal cost-of-transport (displacement divided by effort) gaits. This optimizer builds on our previous work, where we have shown that for drag-dominated systems, the efficiency of a gait corresponds to a ratio between "metric-weighted perimeter length of the cycle and the area integral of the Lie bracket it encloses. In this work, we encode this geometric insight into a variational gait optimizer. For a system with two shape variables, the dynamics of this optimizer are similar to the dynamics of a soap bubble, with the Lie bracket providing internal pressure which causes the boundary of the bubble to expand, the metric-weighted path length providing surface tension constraining the growth of the soap bubble, and a pace-balancing term corresponding to the concentration gradient that evenly distributes soap across the surface of the bubble. In systems with three shape variables, the dynamics are more akin to a windsock, capturing maximum flux through a loop. The variational form of the optimizer allows us to extend it to higher dimensional shape spaces beyond these physical analogies.

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