Supplementary Information: Multi-Modal Mobility Morphobot (M4) with Appendage Repurposing for Locomotion Plasticity Enhancement

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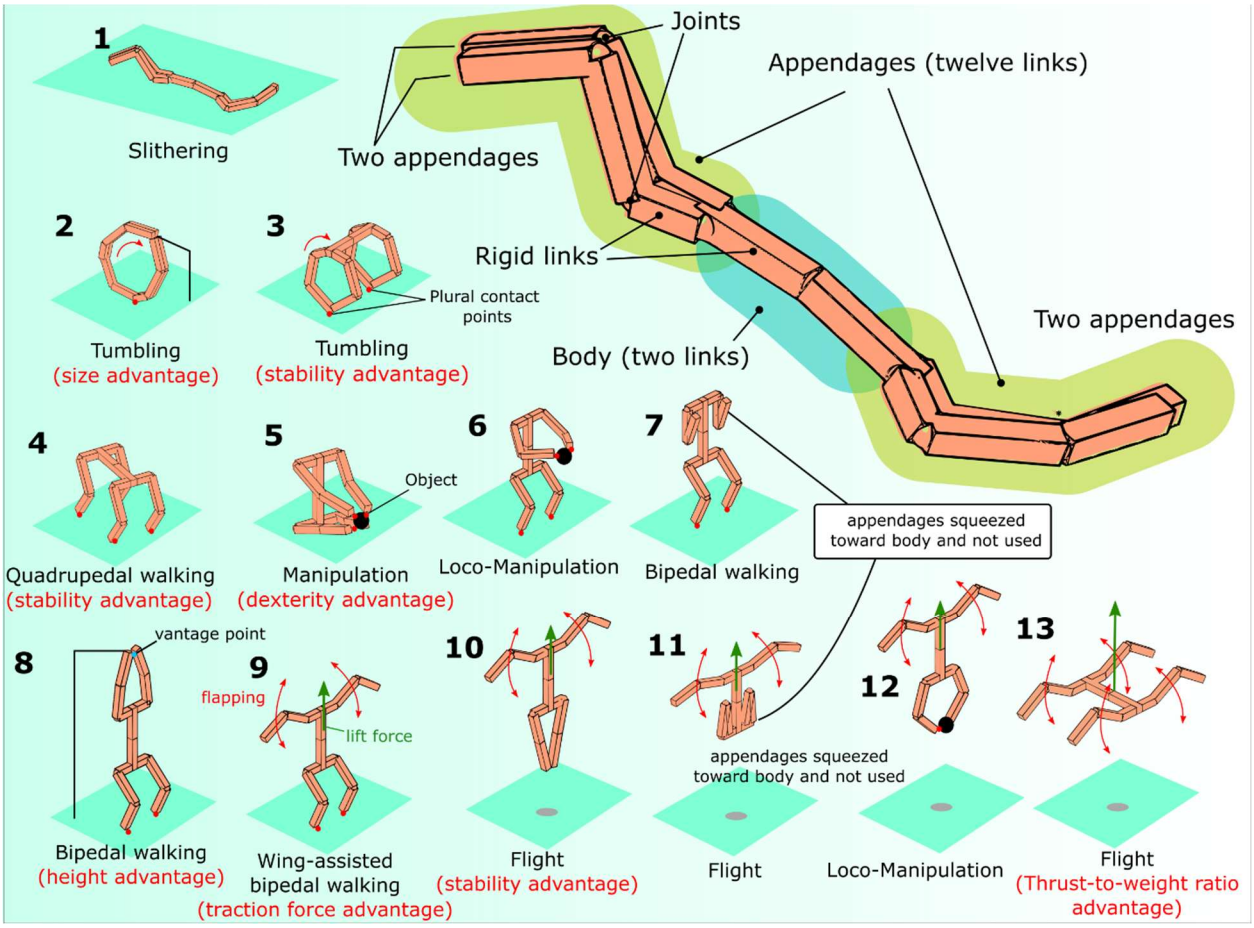
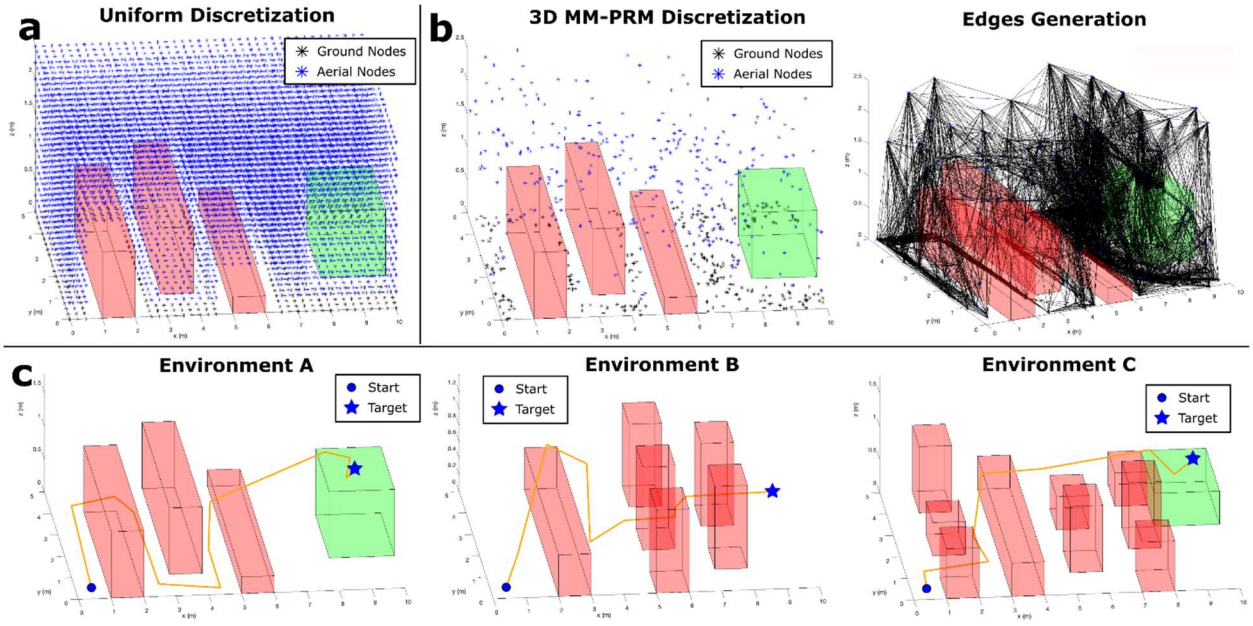
Supplementary Notes

This supplementary note includes three composite figures referenced in the main draft. These figures illustrate:

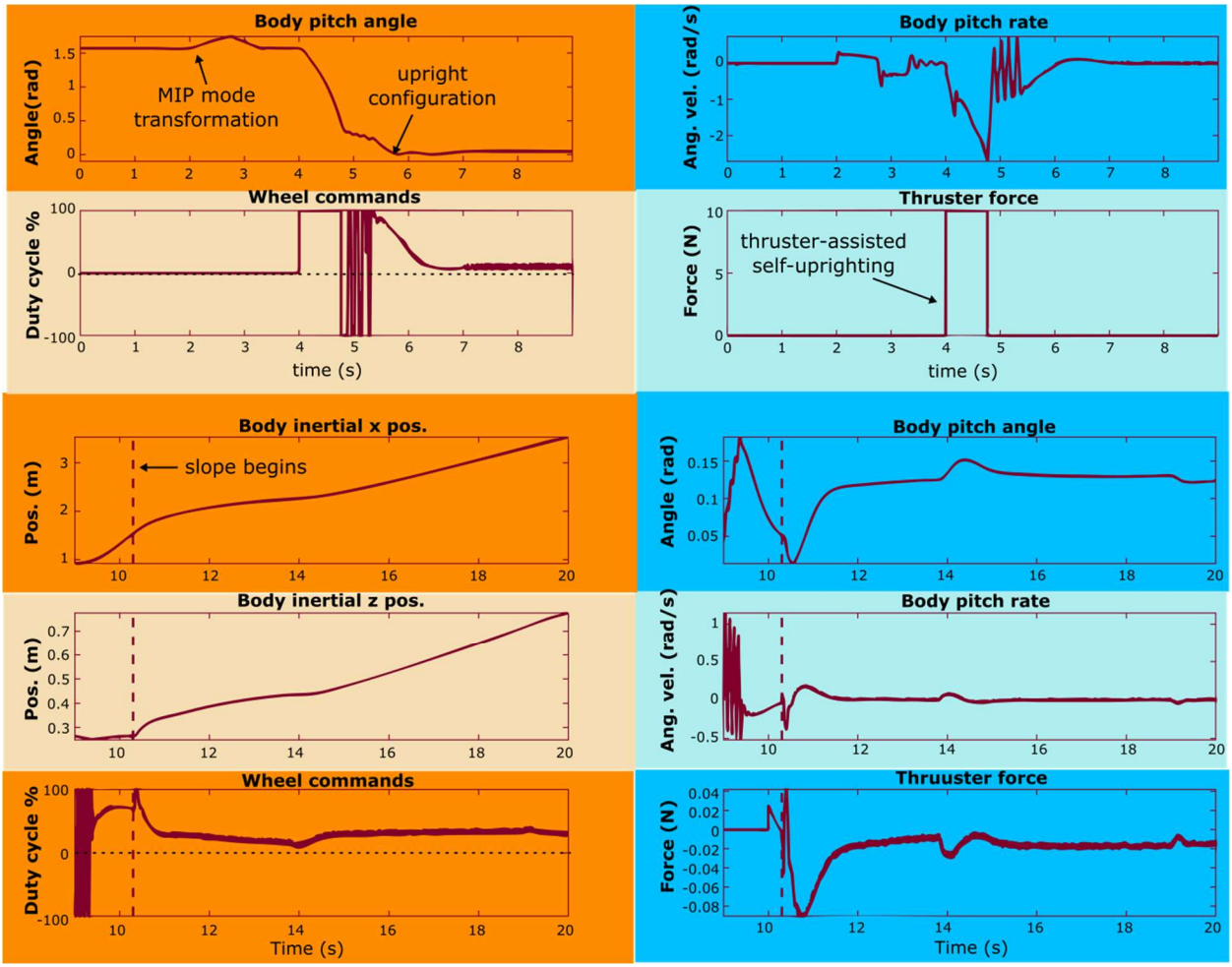
1- A conceptual design of a machine with extensive locomotion plasticity (Supplementary Figure 1).
2- Simulated multi-modal path planning results based on multi-modal PRM (Supplementary Figure 2).
3- WAIR simulation trajectory (Supplementary Figure 3).



Supplementary Figure 1: Shows an imaginary morpho-functional robot, where body morphing and appendage repurposing are utilized to achieve several modes. This concept is not physically realizable due to large range of motions in joints, part collisions, and actuation challenges. It is only used for illustration purposes. Note that within each numbered state, other modes of operation are conceivable (e.g., walking, trotting, galloping, etc., within mode #4), yielding additional locomotion plasticity.



Supplementary Figure 2: Illustration of the path planning algorithm for navigating an environment using both ground and aerial mobility. **(a)** Representation of the set of nodes generated by a uniform grid discretization. **(b)** Example of graph generated by the 3D MM-PRM Algorithm with the following parameters: R = 4 meters, Nw = 300, and Nf = 300. The MM-RPM method generates a significantly reduced amount of nodes which greatly reduces the computational time and cost of performing the path-finding algorithm. **(c)** The trajectories generated by the 3D A * path planning algorithm on three different environments. The red box represents an obstacle that cannot be driven over, while the green box represents a drive-able platform.



Supplementary Figure 3: Plots in the first two rows show the pitch angle states and controller inputs during the thruster-assisted self-uprighting maneuver. Plots in rows 3, 4, and 5 depicts the states and controller inputs during WAIR. The non-zero thruster force on the slope indicates that the thrusters assisted in driving up the incline.