NRI: INT: Collaborative Research: Buoyancy-assisted Collaborative Robots That are Cheap, Safe, and Never Fall Down.

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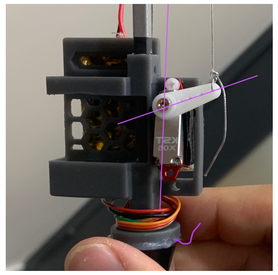
Objective

We aim to develop novel buoyancy-assisted robots (BAR) that are inherently safe in everyday environments.
These sensitive systems require compact but capable Balloon-based robot hardware and novel control and learning algorithms.

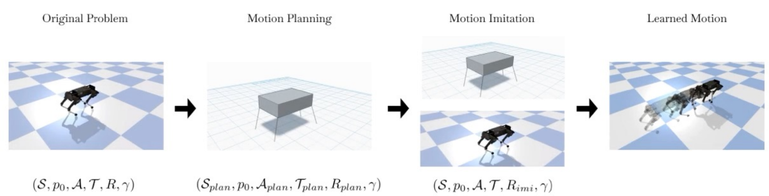
Progress #1. Hardware Upgrades

We upgrade servo motors from Dymond D47 to KST-x06. This change resolves the reachability issue that makes BALLU difficult to walk or turn.



Progress #2. Two-staged Deep RL

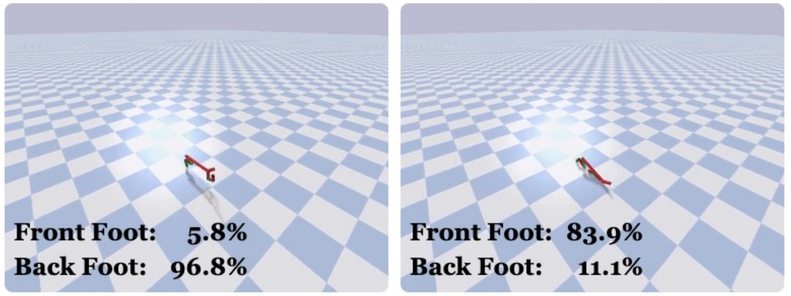
We develop a novel deep reinforcement learning algorithm that consists of planning and imitation stages to tackle challenging control problems [1].



[1] Sontakke, Nitish, and Sehoon Ha. "Solving Challenging Control Problems Using Two-Staged Deep Reinforcement Learning." arXiv preprint arXiv:2109.13338 (2021).

Progress #3. Quality Diversity Optimization

We develop two variants of the differentiable quality diversity algorithm CMA-MEGA, each with different gradient approximations, and evaluate them on four simulated tasks [2].



[2] Tjanaka, Bryon, Matthew C. Fontaine, Julian Togelius, and Stefanos Nikolaidis. "Approximating Gradients for Differentiable Quality Diversity in Reinforcement Learning." Genetic and Evolutionary Computation—GECCO (2022)

Progress #4. Simulation framework

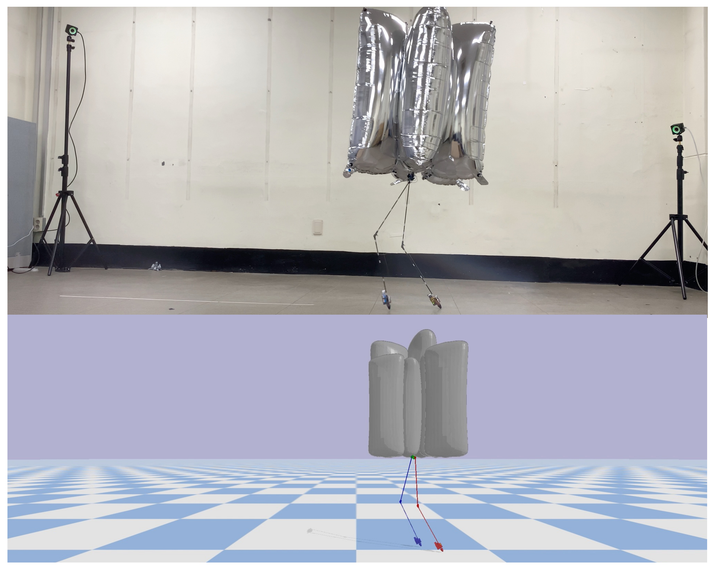
We develop a software framework that can control both simulation and hardware within a single codebase.
We measure the sim-to-real gap by collecting the hardware data and improve simulation by matching hyperparameters of rigid and aerodynamics models.

Impact: Human Interaction

BARs can safely interact with humans using microphones, speakers, and cameras. BARs may be the only legged robots that can mingle in a crowd.

Impact: Education

BARs are suitable for STEM education due to the safety and affordable costs.



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