Rapid Quadrupedal Locomotion on Deformable Terrain

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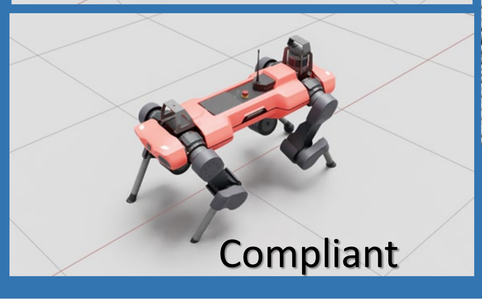
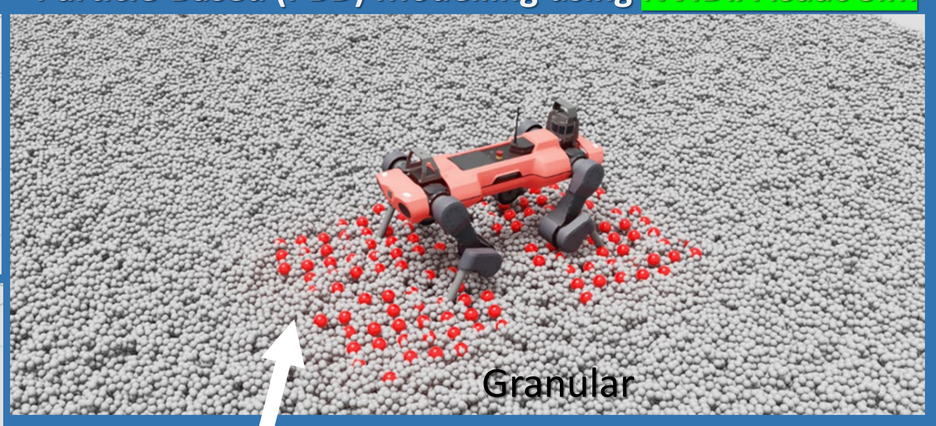
Developing an end-to-end learned robust controller using Reinforcement Learning (PPO) capable of rapid quadrupedal locomotion that generalizes across diverse deformable substrates (soft soil, gravel, rocky, etc)

Previous simulation methods often rely on simplified or rigid-contact models that fail to capture deep foot penetration, coupled interactions, and the inertial effects of deformable terrain.

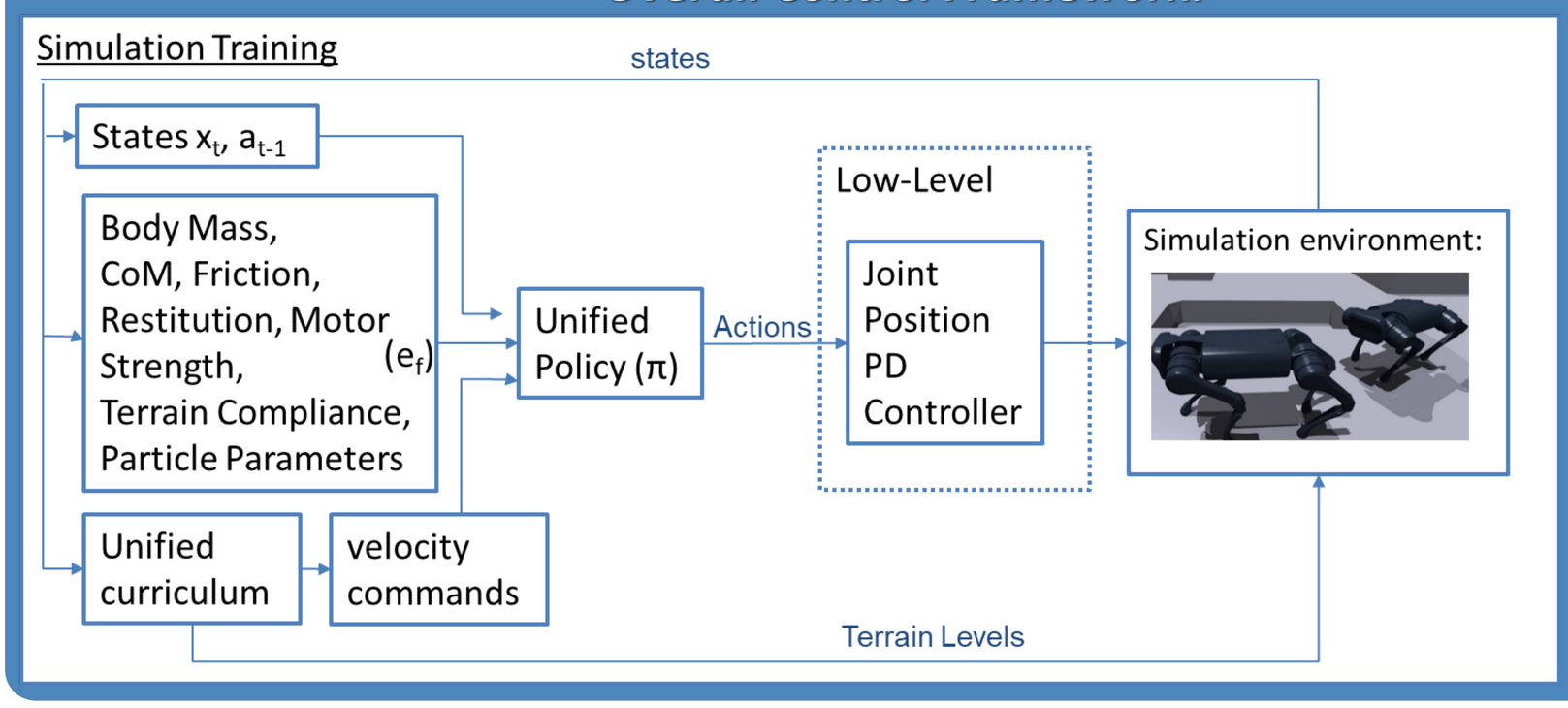
Simulation approach: Particle-Based (PBD) Modelling using NVIDIA Isaac Sim

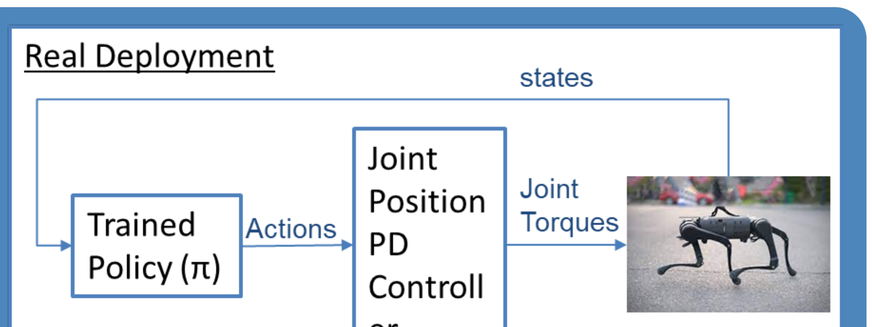




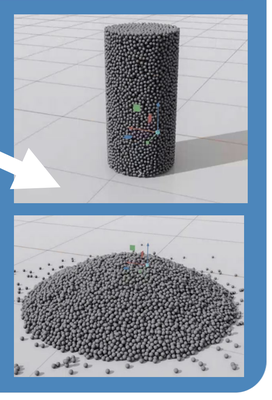
Efficiently computed robot height observations using particle height scans

Overall Control Framework:





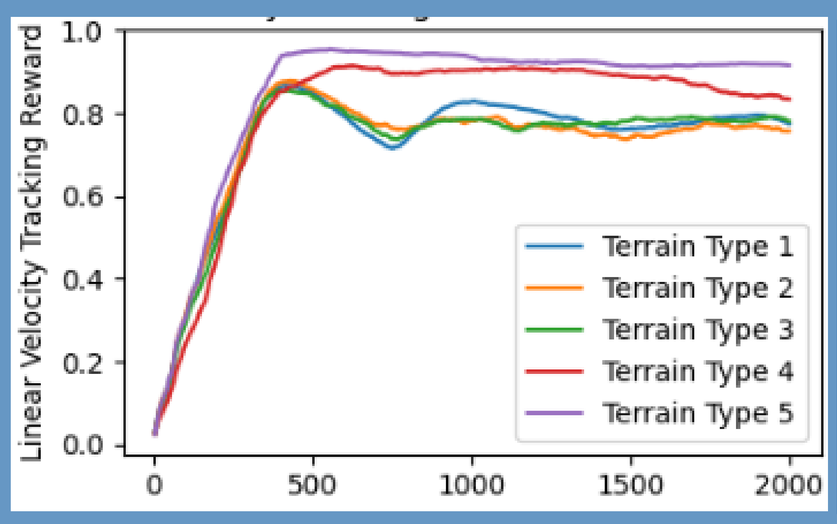
- **Domain Randomization of PBD particle parameters in granular terrain guided by angle-of-repose tests.**
- **Compliant terrain properties based on permissible penetration depth.**

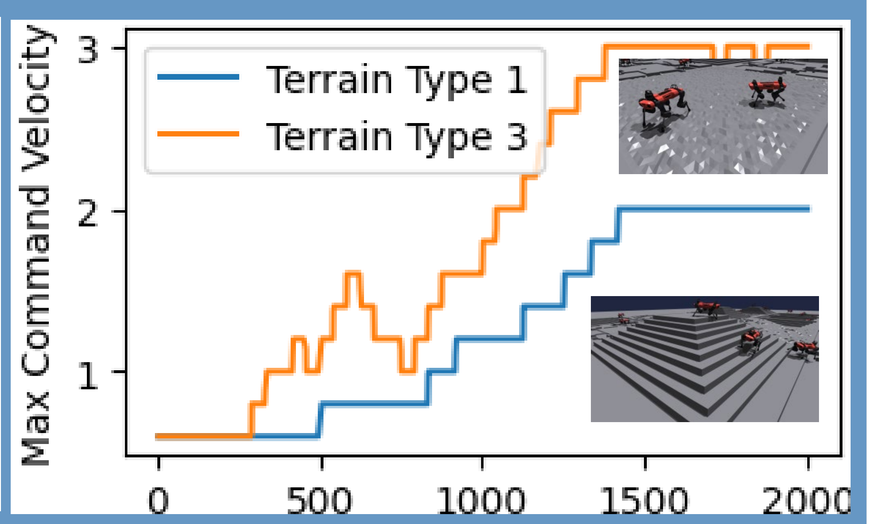


Existing Curriculums do not account for terrain type,
applies a uniform command velocity range across all terrains.

- **Introduced terrain-specific command velocity ranges.**
- **Dynamically adjust velocity based on terrain type and terrain difficulty level progression based on tracking performance.**

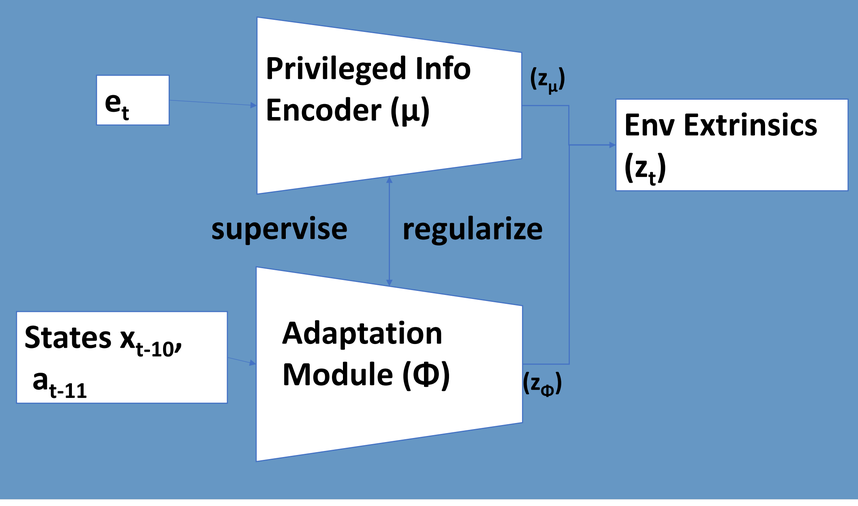
Unified Terrain Aware Curriculum:





Terrain-aware Adaptation Module for Sim–to–Real Transfer

This modified curriculum, combined with domain adaptation techniques, allows us to train robust policies capable of high-speed locomotion.
We are actively working on extending these results specifically to deformable terrain



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