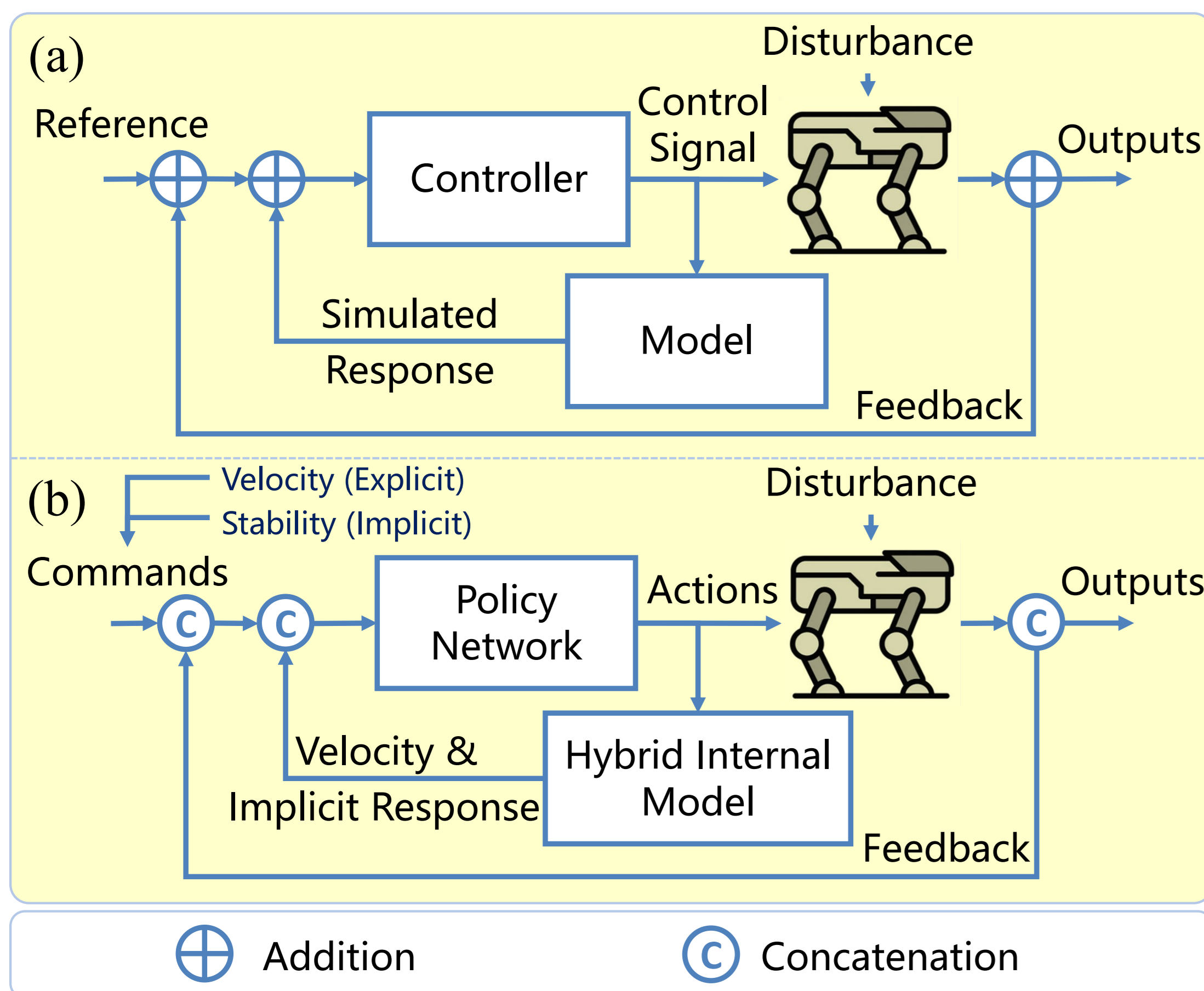


Backgrounds

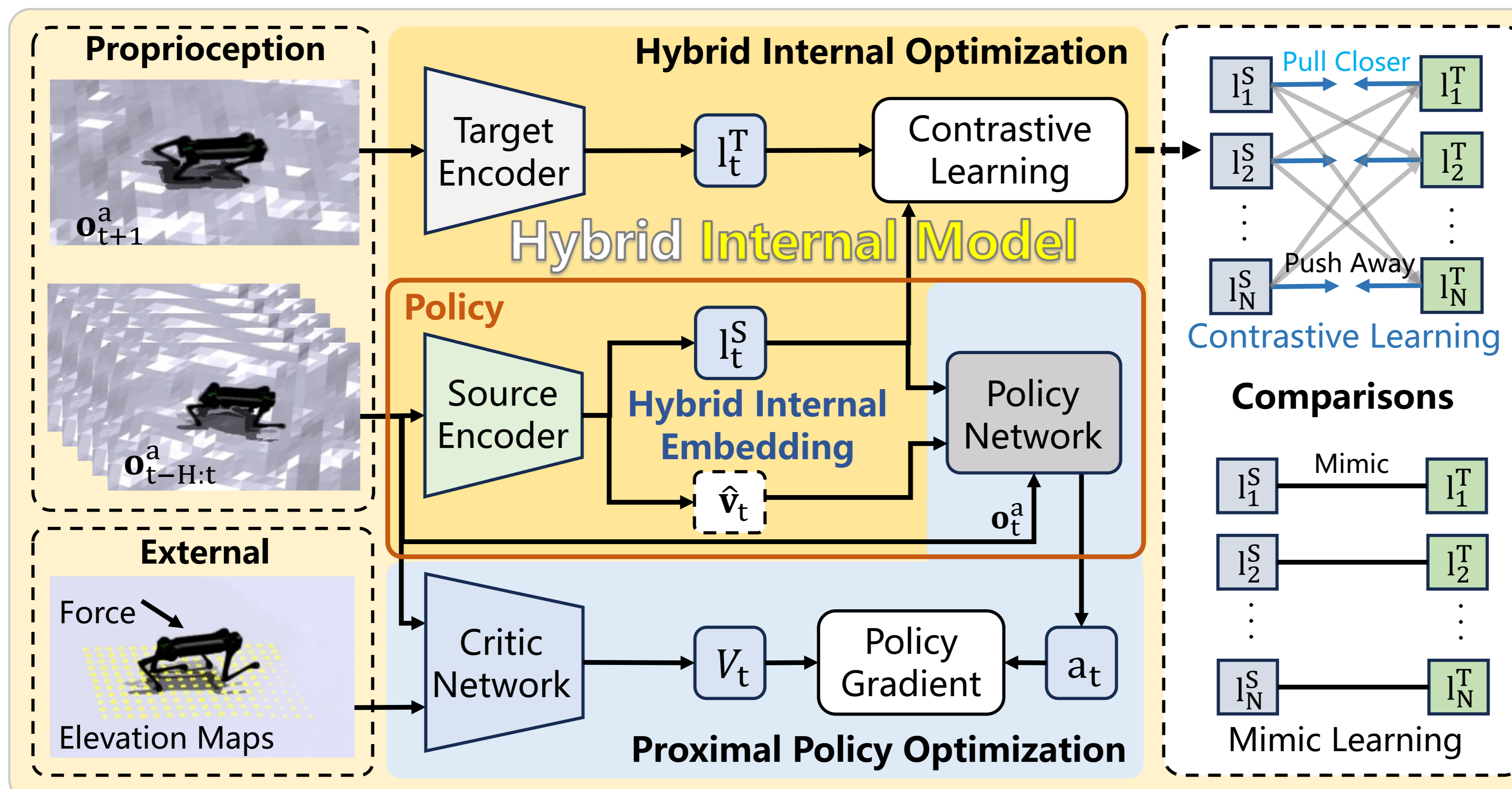
- Robust locomotion control depends on accurate state estimations.
- The sensors of most legged robots can only provide partial and noisy observations.
- Previous two stage pipeline inevitably introduce information loss and may suffer from the noise brought by domain randomization.

Motivation

- Environmental properties can be **considered as disturbances**.
- Internal Model Control suggests that we can do robust control without directly **modeling the disturbances**.



Pipeline Overview



Construction of Robot Response:

Explicitly, we wish the robot to track a target velocity command, however, we also wish the robot to keep stable, which is implicit. Therefore, the robot's response also compose the real velocity and a variable indicating stability and dynamics.

Auxiliary Task:

Estimating the real velocity of the robot and estimate the variable indicating stability and dynamics.

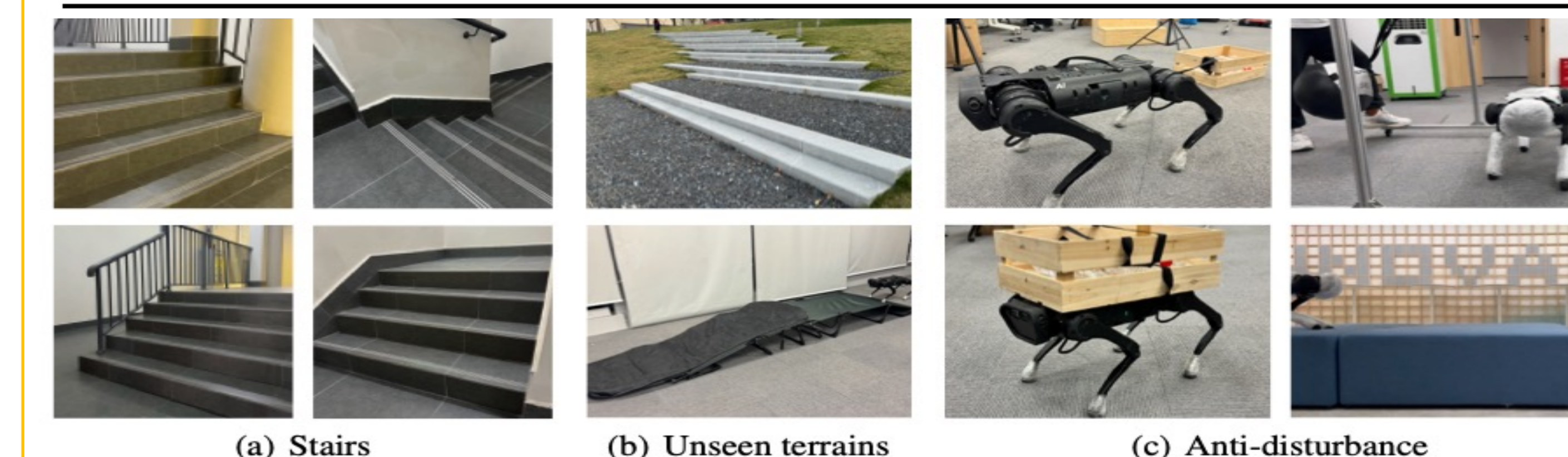
Contrastive Learning:

- Supervision from both positive and negative samples -> higher efficiency
- Fuzzier representation compared with regression and reconstruction -> easier to adapt to real world
- Less sensitive to noise -> less influenced by human-designed noise and domain randomization

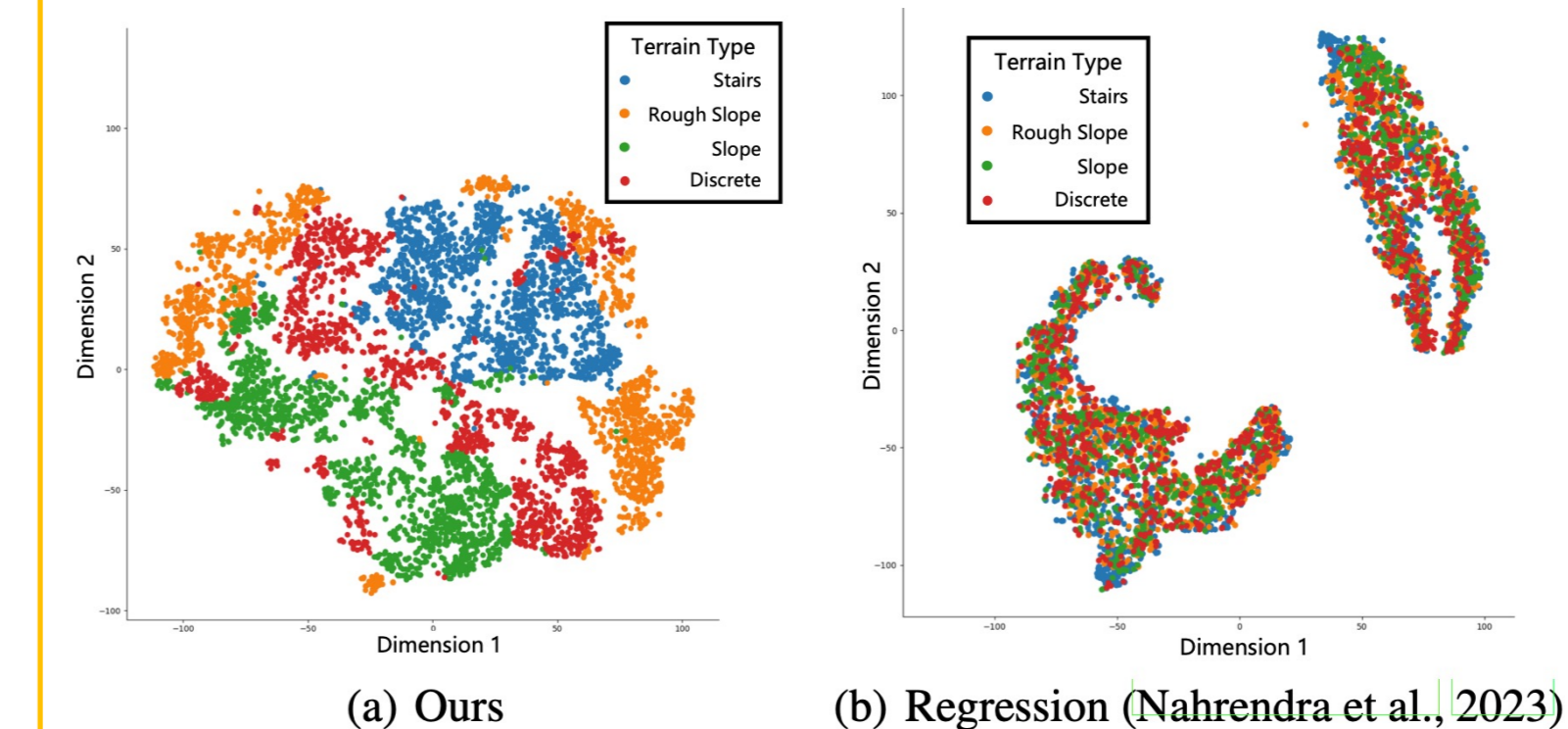
Experimental Results:

Real robot experiments

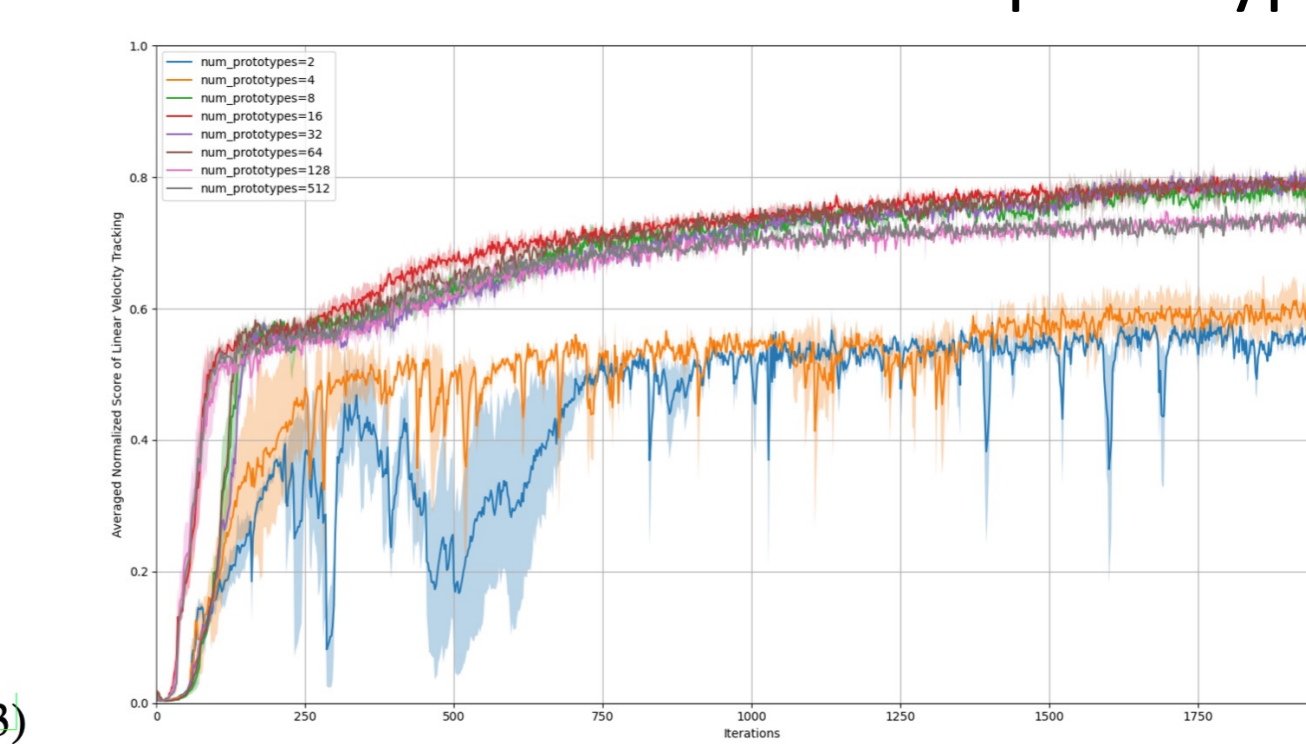
| Benchmarks | Environments | Metrics | Ours | RMA | MoB | Built-in MPC |
|------------------|---------------------------------|---------------------|------------|-------------|---------|--------------|
| Stairs | Short-range (A1) | Success rate (%) | 100 | 60 | 0 | 0 |
| | Long-range (Aliengo) | Number of stairs | 176.5±7.81 | 75.35±19.98 | 0.0±0.0 | 0.0±0.0 |
| Unseen Terrains | Compositional Terrain (Aliengo) | Success rate (%) | 85 | 45 | 0 | 0 |
| | Deformable Slope (A1) | Success rate (%) | 55 | 10 | 0 | 0 |
| Anti-disturbance | Dragging Obstacle (A1) | Maximum weight (Kg) | 10 | 10 | 7 | 3 |
| | Vertical Hit (A1) | Maximum weight (Kg) | 8 | 7.5 | 7 | 5 |
| | Payload (A1) | Maximum weight (Kg) | 8 | 7 | 4 | 7 |
| | Missing steps (Aliengo) | Success rate (%) | 100 | 0 | 0 | 0 |



T-SNE visualization of features



Ablations of number of prototypes



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Project Page