

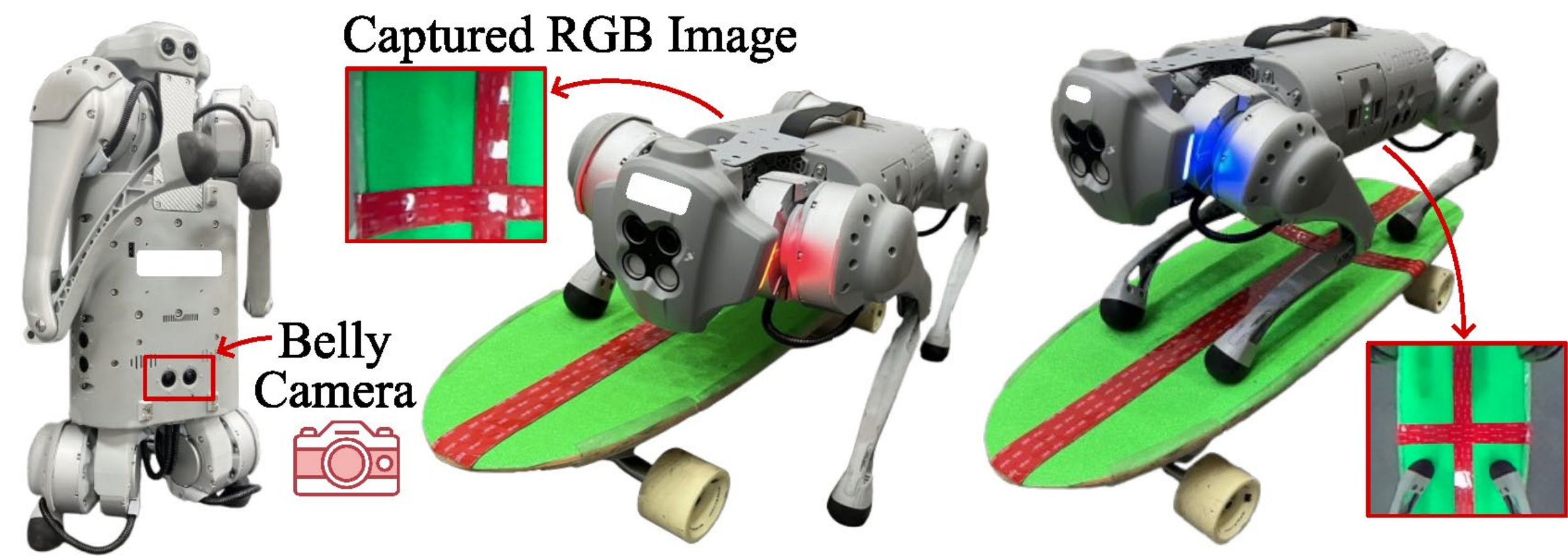
# Phase-Aware Policy Learning for *Skateboard Riding of Quadruped Robots* via Feature-wise Linear Modulation

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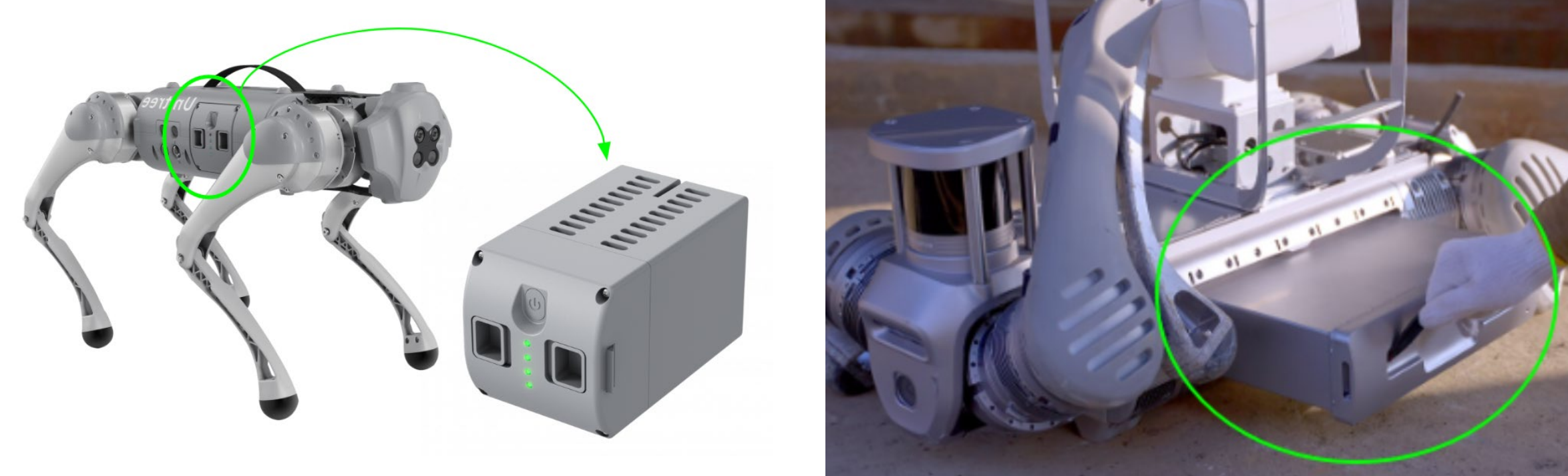
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## Overview

PAPL enables a quadruped robot to ride a skateboard robustly with exteroceptive perception.



## Motivation

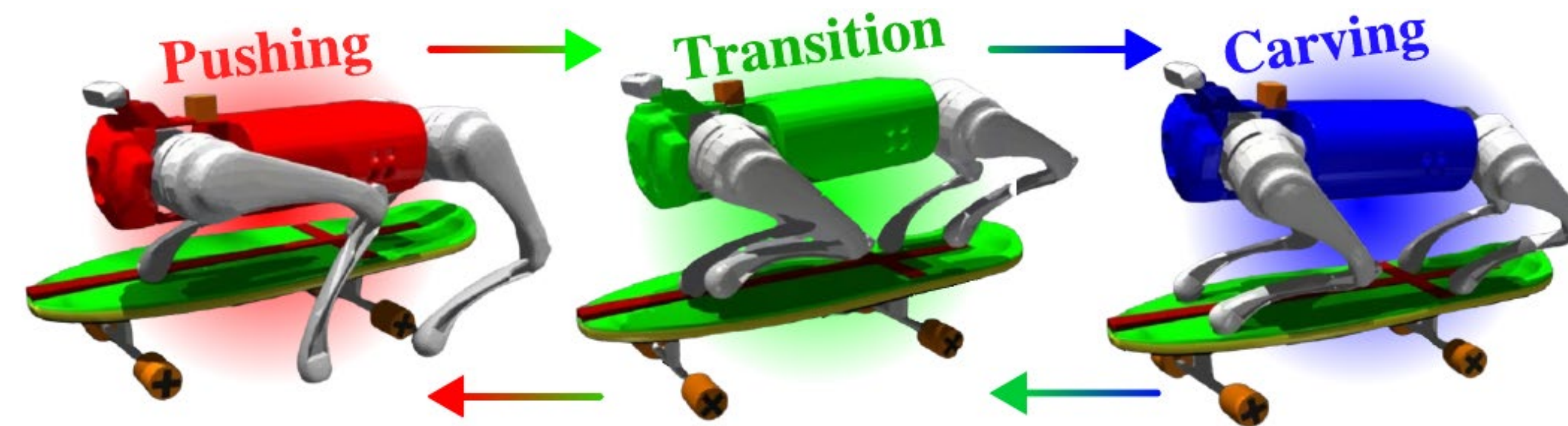


	Unitree Go1	Unitree B2
Battery Life:	~ 2.5 hours	~ 6 hours
Battery Capacity:	6Ah (133.2Wh)	45Ah (2250 Wh)
Standard Voltage:	22.2V	50.4V

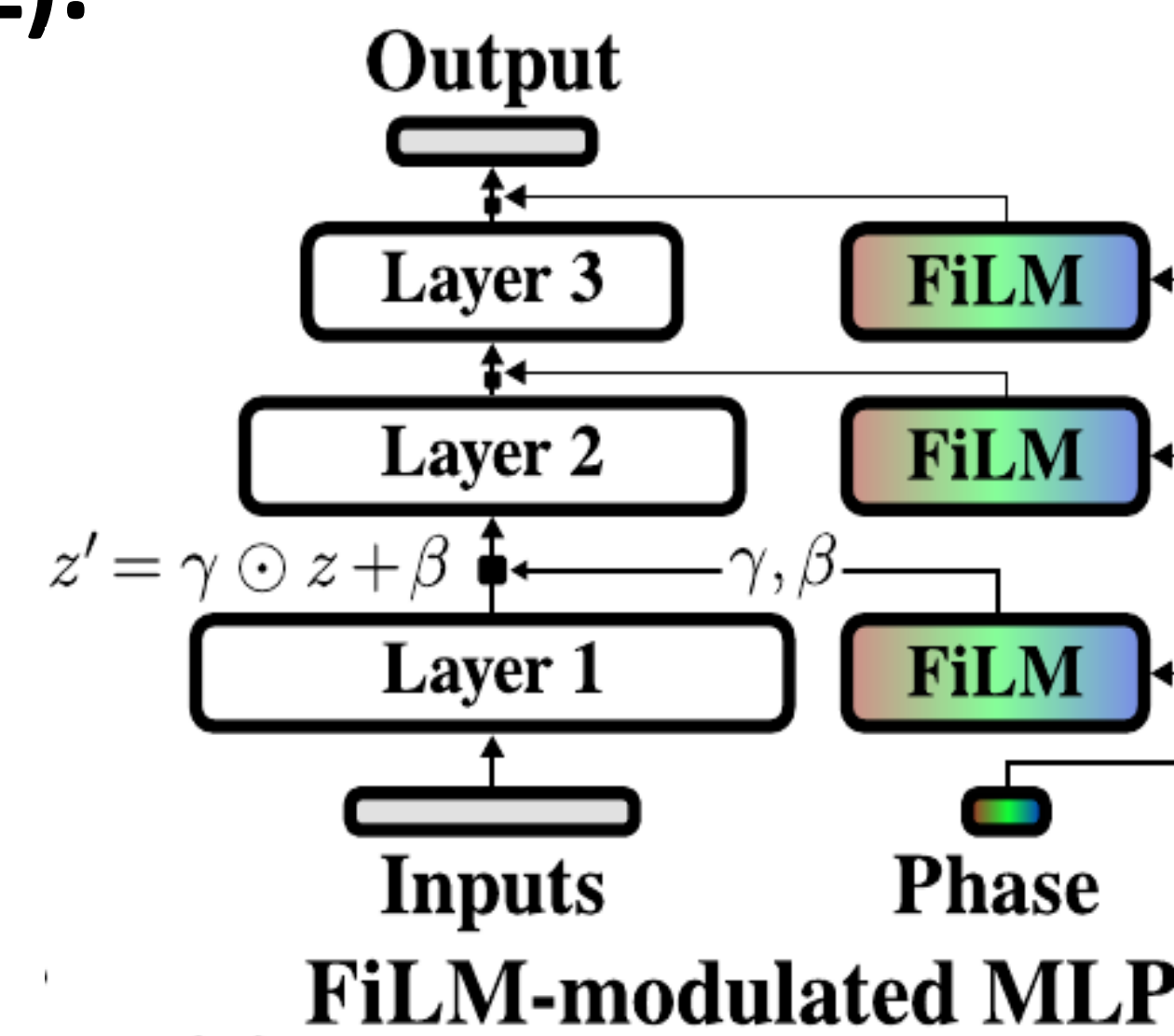
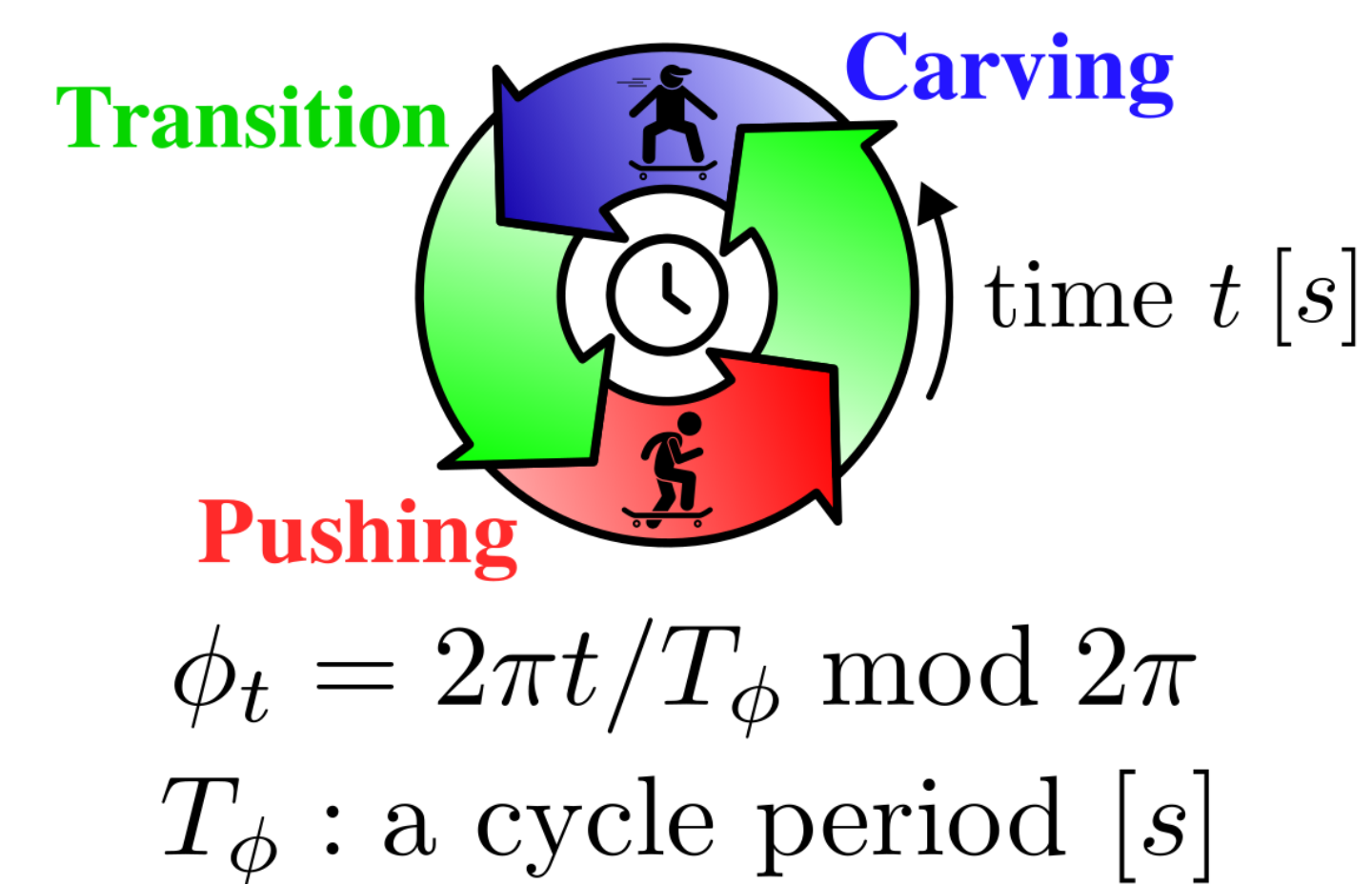
**The actual running time is much lower than expected due to the sensor suite and onboard PC.**

## Challenges & Method

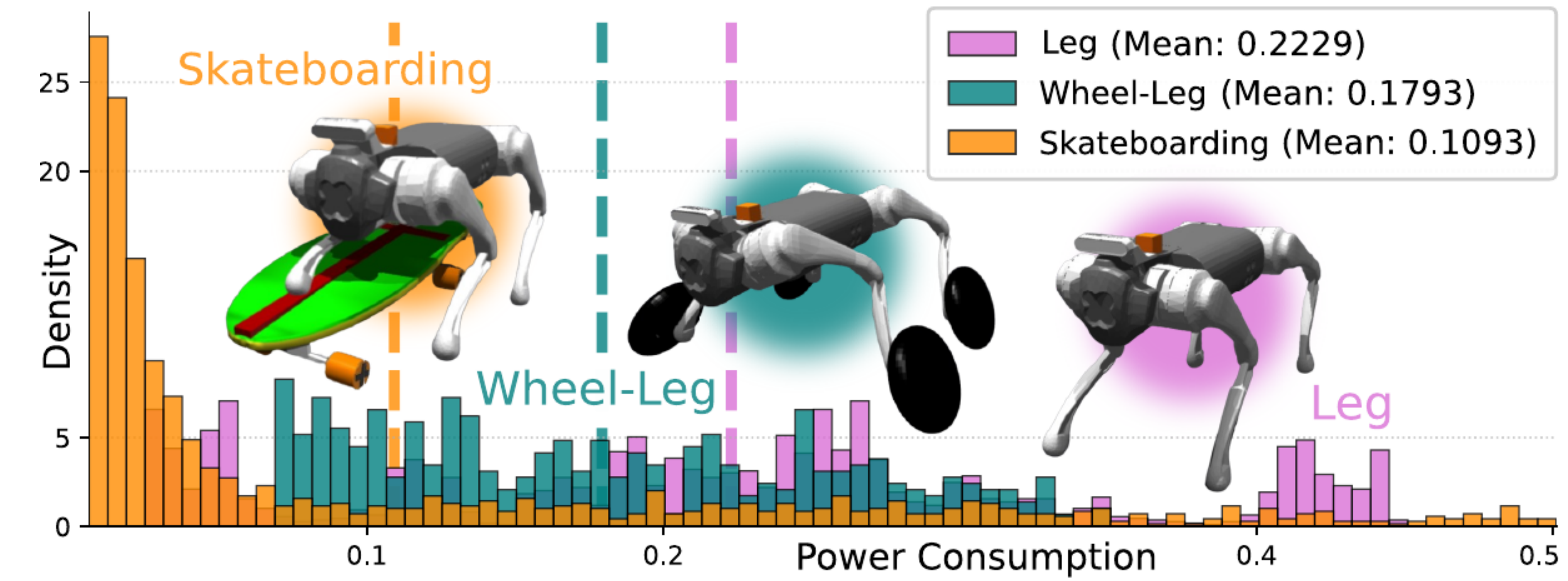
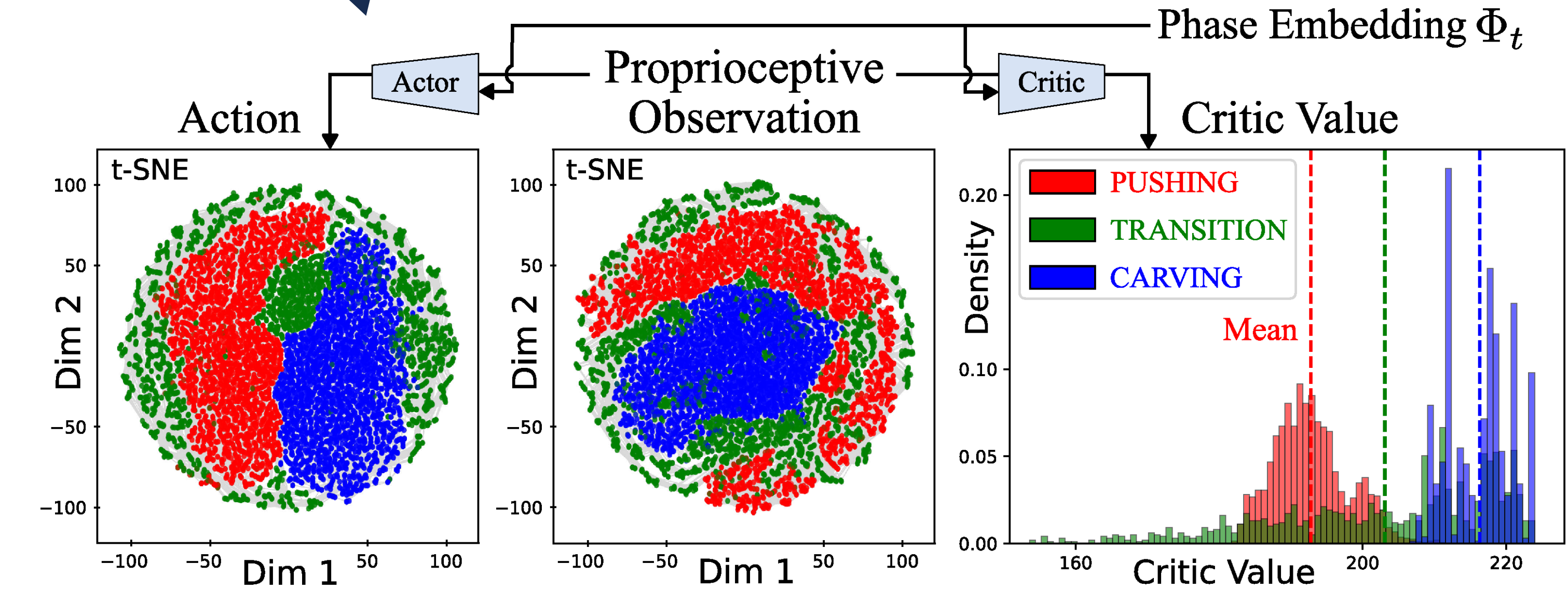
Skateboarding is inherently **multimodal**, making unified policy learning challenging due to phase-dependent dynamics and rewards.



To address this, we combine **phase-aware FiLM modulation** with **asymmetric privileged reinforcement learning (RL)**.

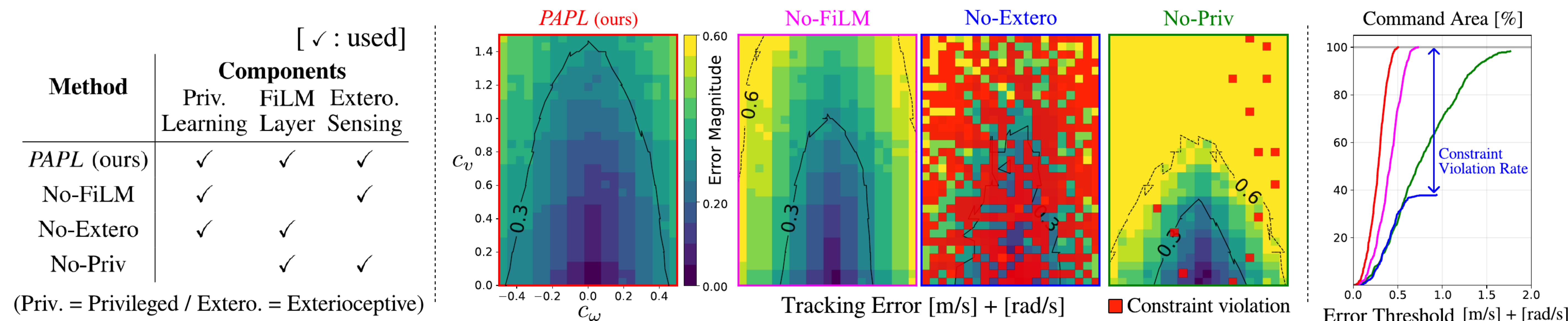


Distinct *proprioceptive, action, and return distributions* across skateboarding phases



**Exp 2.** Skateboarding achieves improved locomotion efficiency compared to legged and wheel-legged baselines.

## Results



**Exp 1.** PAPL achieves robust command tracking across diverse skateboarding phases and commands, even under external perturbations.



(a) Real-world Skateboarding Snapshots



(b) Various Environmental Conditions

**Exp 3.** PAPL achieves robust real-world deployment across low-light and uneven terrain conditions.



Project Page w/ videos

KAIST SGVR Lab

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