Shaky Perception: Learning Inertial Odometry under High Dynamic Motion

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Motivation

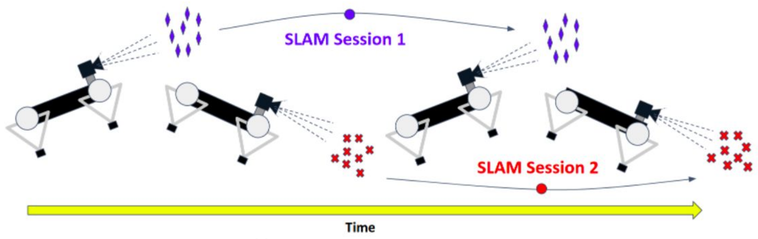
SLAM technology plays a vital role in robots localization. However, it faces a significant challenge when confronted with high dynamic robotic motion, leading to feature distortion and unstable measurements when using LiDAR and Stereo Sensor.

In this work, we propose:

- Prove purely Inertial Odometry for quadruped robots under high dynamic motion can increase odometry precision
- Use AirIMU[1], a novel CNN framework, to capture gyroscope and accelerator corrections and its covariances to enable high precision Inertial Odometry
- Conduct real world experiments using Ghost Minitaur (inherently prone to intense shaky motion)

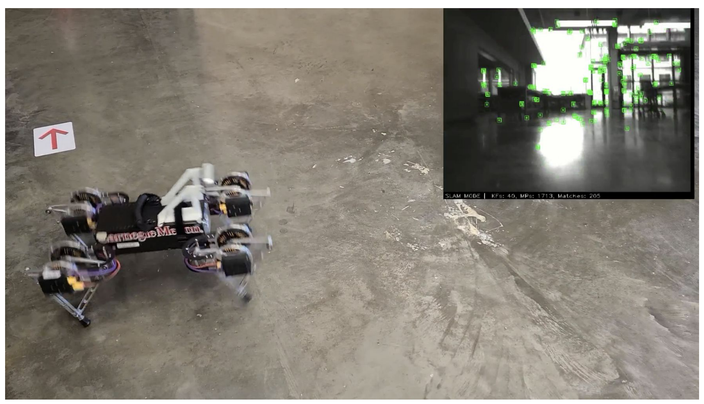
Main Challenges

The features captured by stereo can be drastically different from frame to frame (The same applied to LiDAR)

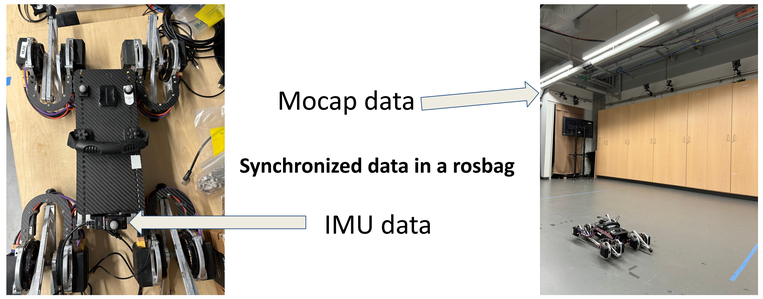


Hans21[2]: Periodic Slam for Shaky perception

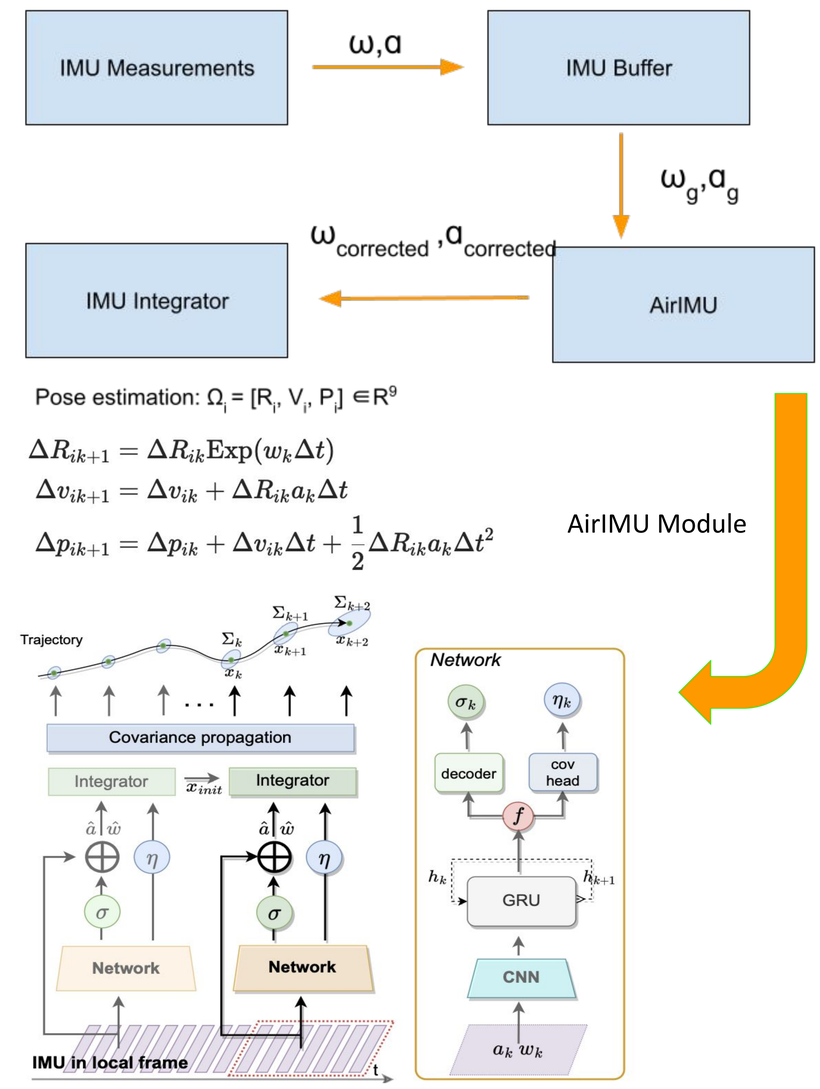
High dynamic motion can cause occlusion to stereo



Experimental Setup



Framework



AirIMU: Through AirIMU network, we learn the corrections and covariance

Result

Our model is Red (Learn Inertial Odometry) is performing better Blue (baseline Raw Integrator) compared to Green (Ground Truth)

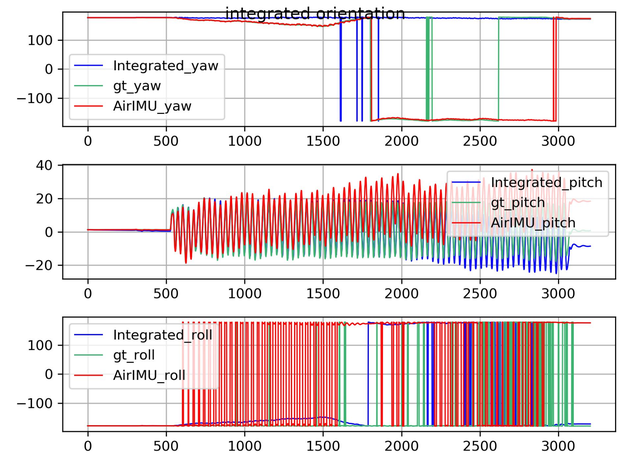


Fig. 1: Rotation Comparison

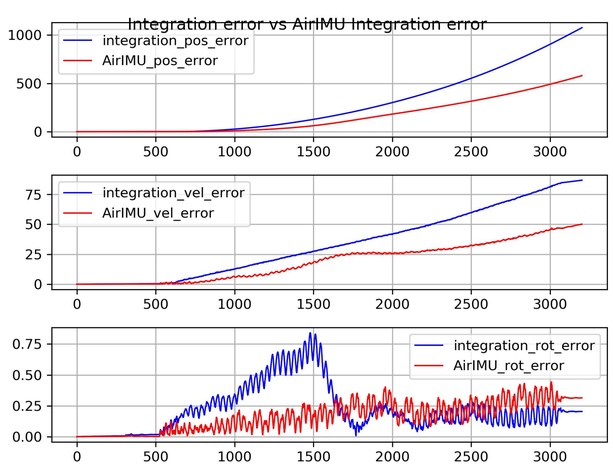


Fig. 2: Absolute pose error

Reality Gap and Future Plan

Gaps between experiments and reality:

- Our model might not be generalizable to all high dynamic conditions
- This is still in the process of offline evaluation

Future Plan:

- Increase the data size for training
- Implementation for real time state estimation

[1] Qiu, et al. "Airimu: Learning Uncertainty Propagation for Inertial Odometry." *arXiv.Org*, 12 Oct. 2023, arxiv.org/abs/2310.04874.

[2] Hans,et al. *Periodic Slam: Using Cyclic Constraints to Improve The ...*, udel.edu/~ghuang/icra21-vins-workshop/papers/04-Kumar_PeriodicSLAM.pdf. Accessed 11 Mar. 2024.

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