

Foes or Friends: Embracing Ground Effect for Edge Detection on Lightweight Drones

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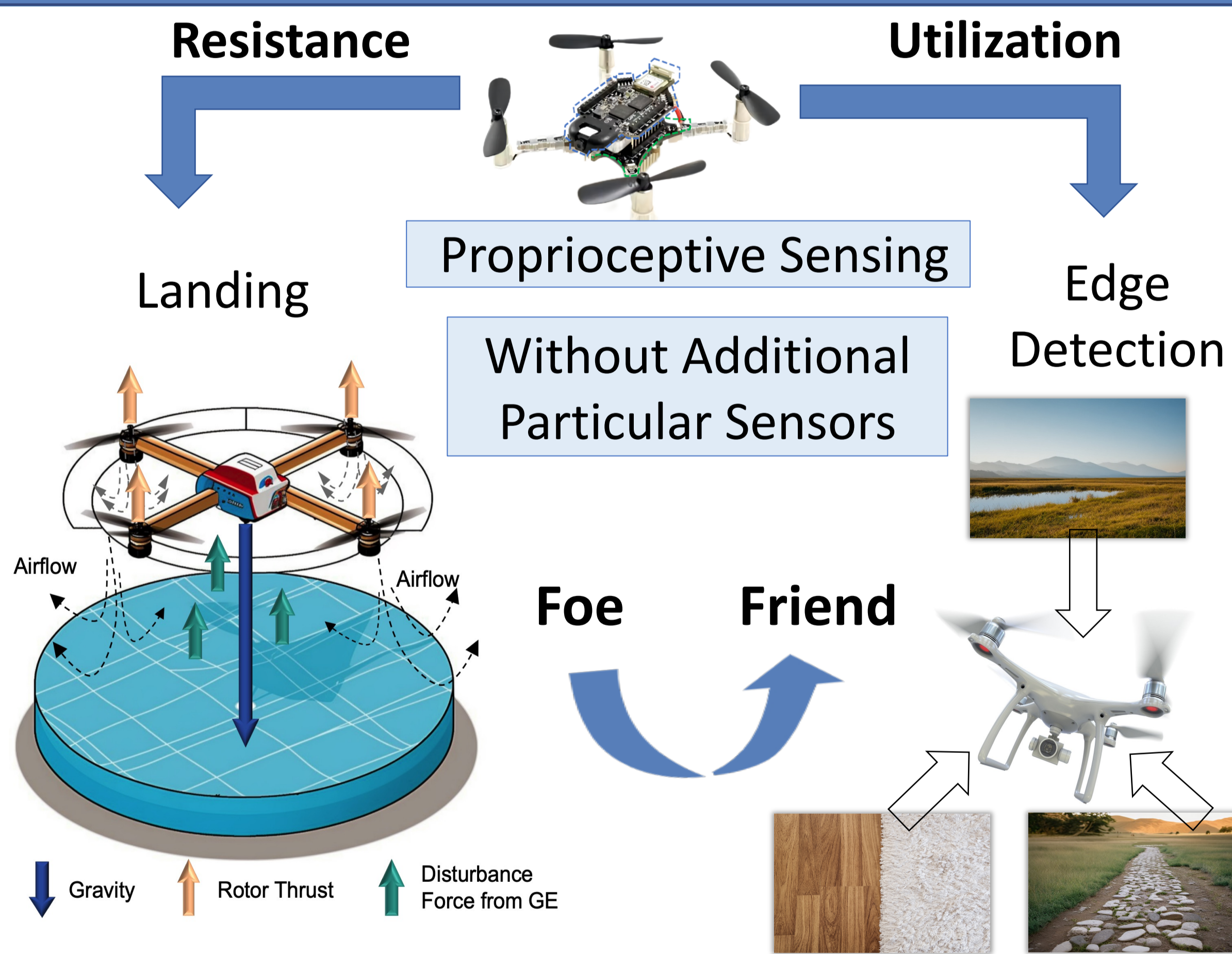
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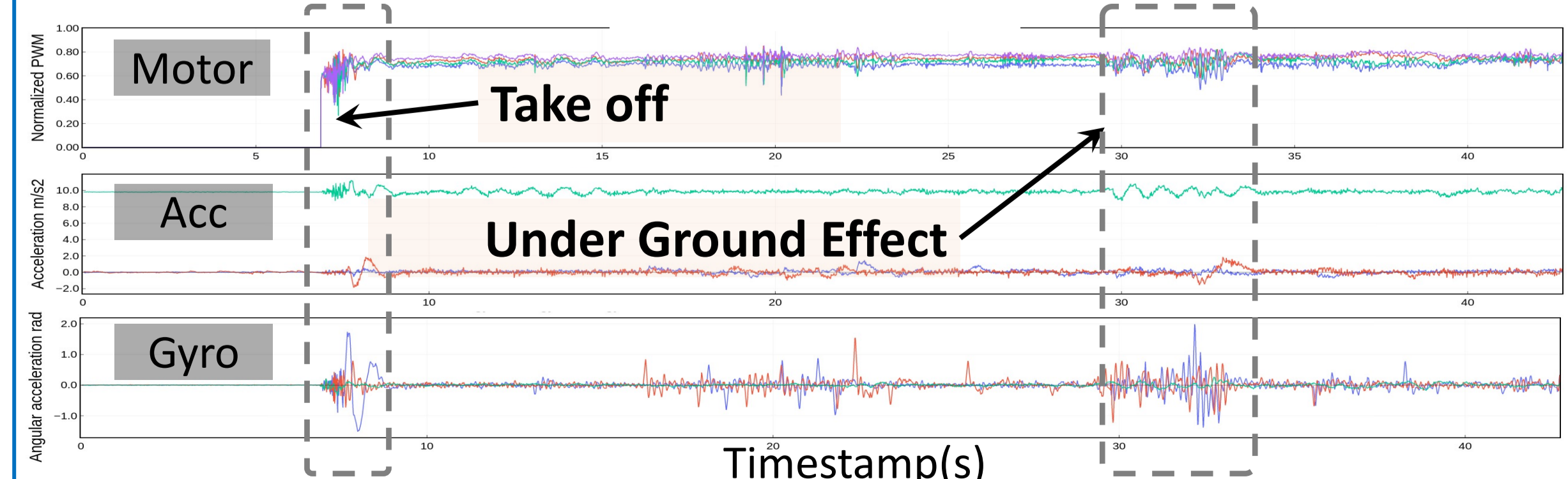
Abstract

- **Goal:** Develop a new sensing modality for lightweight drones for rapid and accurate edge detection with minimum number and lowest-level sensors, for precise landing, mobile terrain mapping in agriculture, etc.
- **Research Question:** How can ground effect be turned into a new sensing modality for accurate edge detection?
- **Challenge:** Target discrepancy between sensing and flight control complicates ground effect profiling. Noisy sensing data overwhelms vital feedback related to the ground effect.
- **Novelty:** Transforming a “foe” to a “friend”: new sensing modality for edge detection. Implementing the system on edge computing device, including a light-weight NN.

Motivation



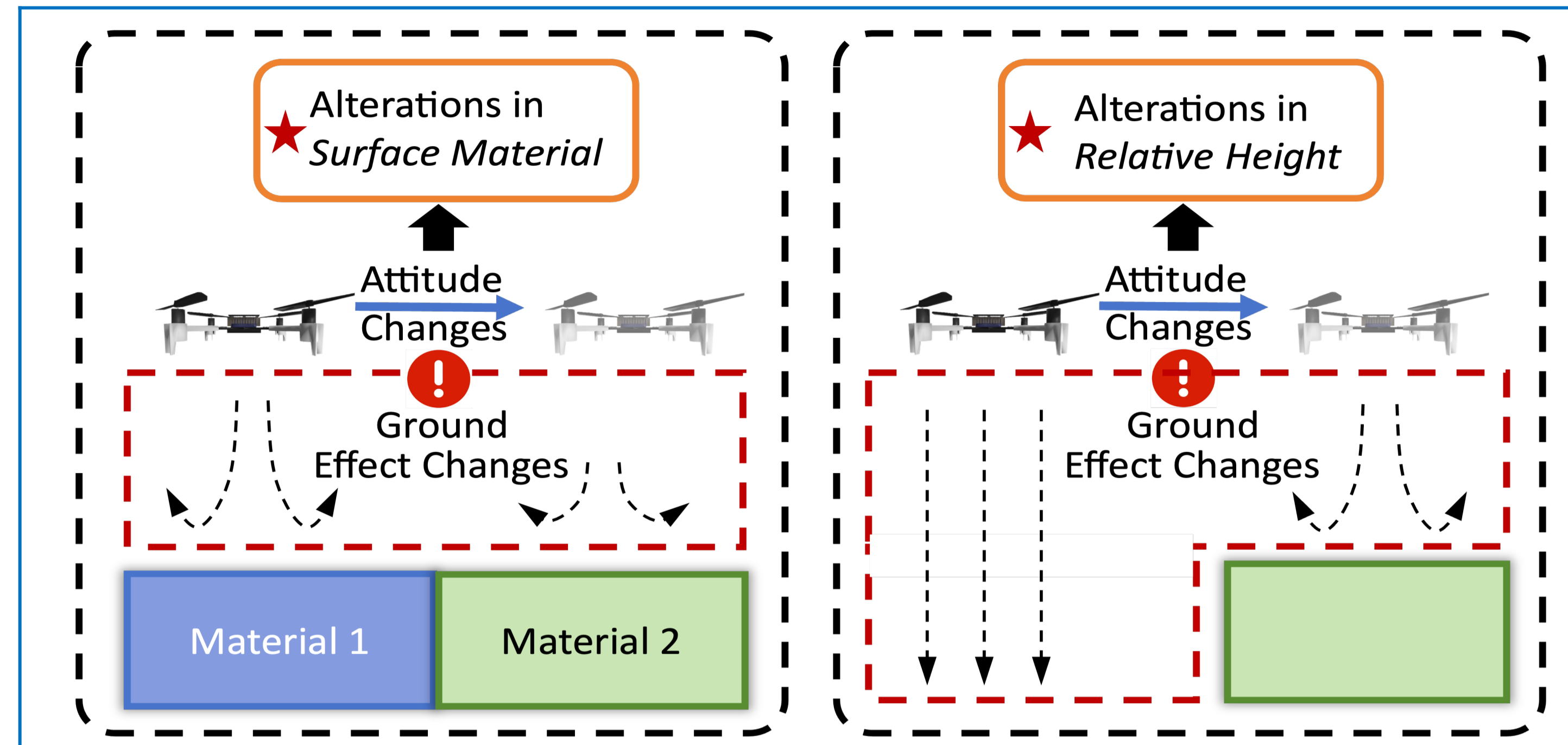
Raw Data



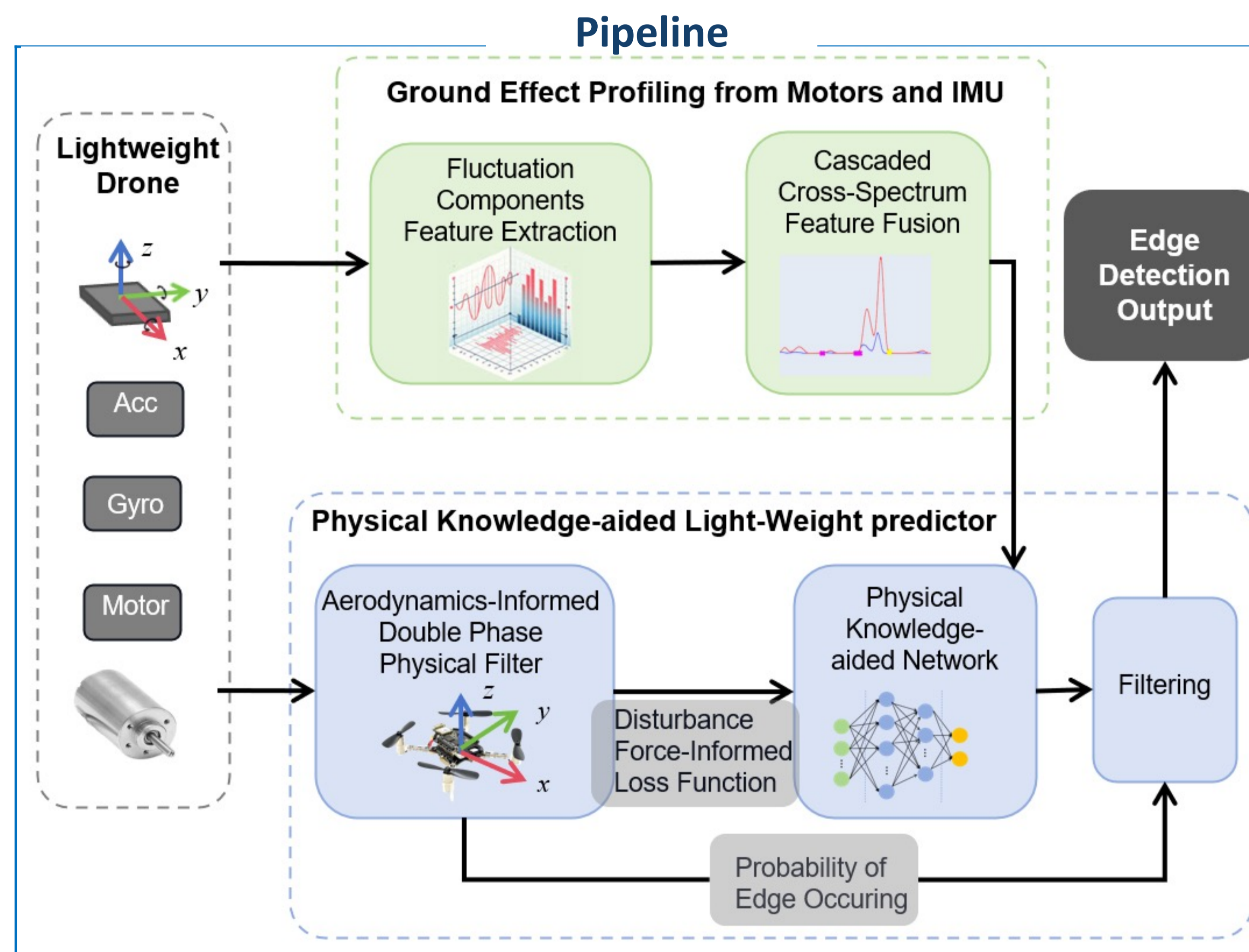
References

[1] H. Wang, J. Xu, C. Zhao, Z. Lu, Y. Cheng, X. Chen, X.-P. Zhang, Y. Liu, X. Chen. Transformloc: Transforming mavs into mobile localization infrastructures in heterogeneous swarms. In Proceedings of IEEE INFOCOM, 2024.

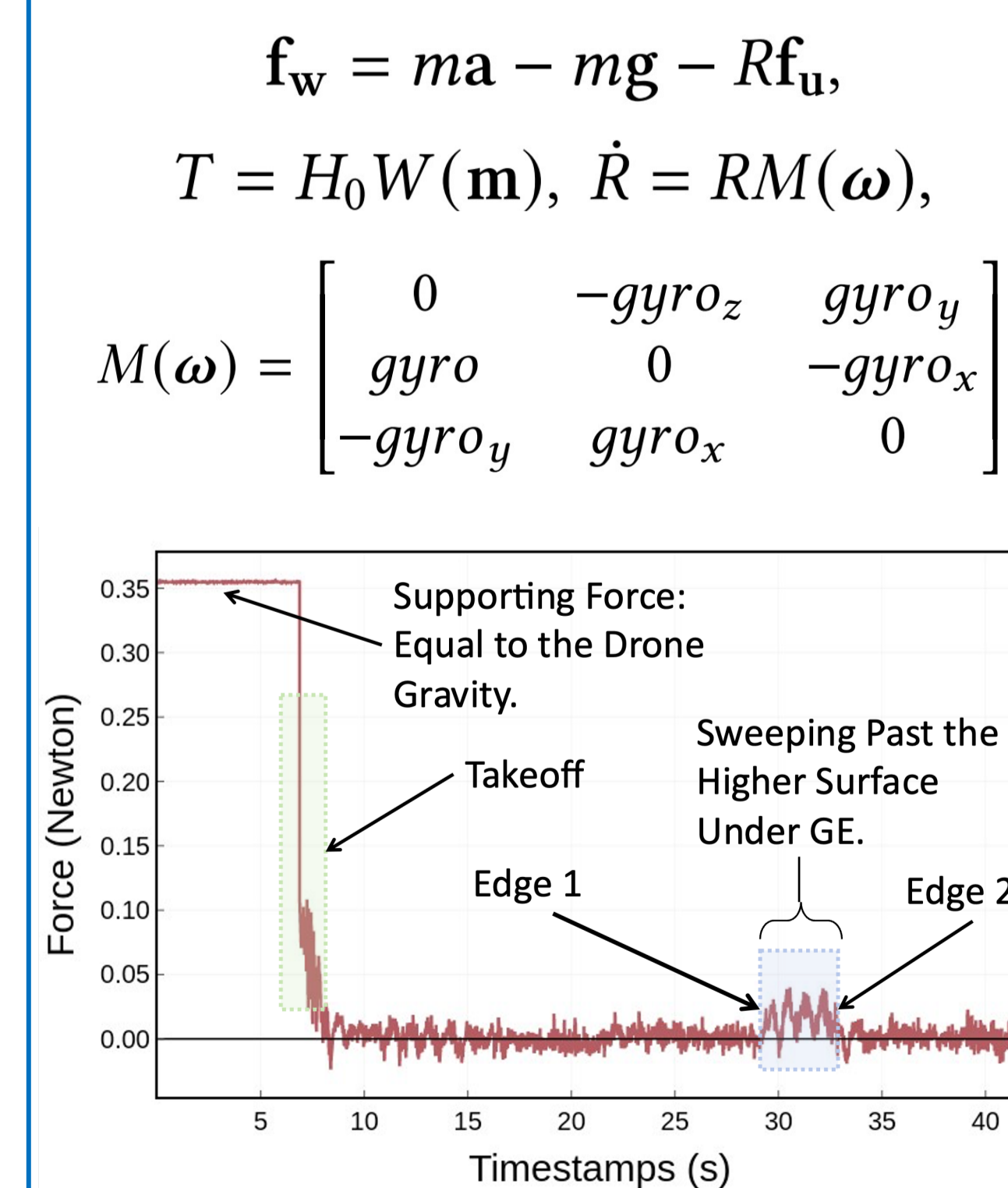
Insight



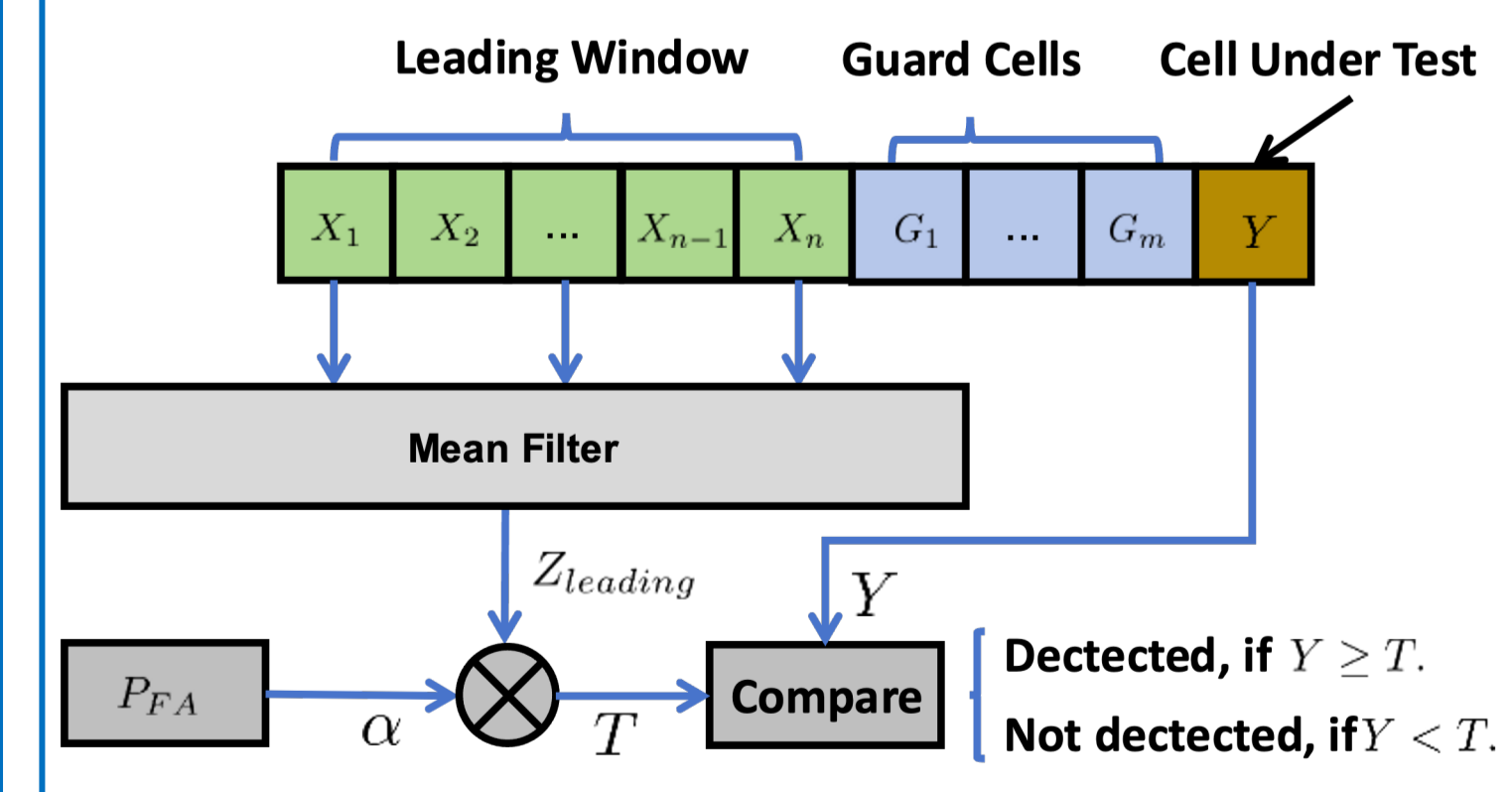
System Design



Disturbance Force



FR-CFAR Algorithm



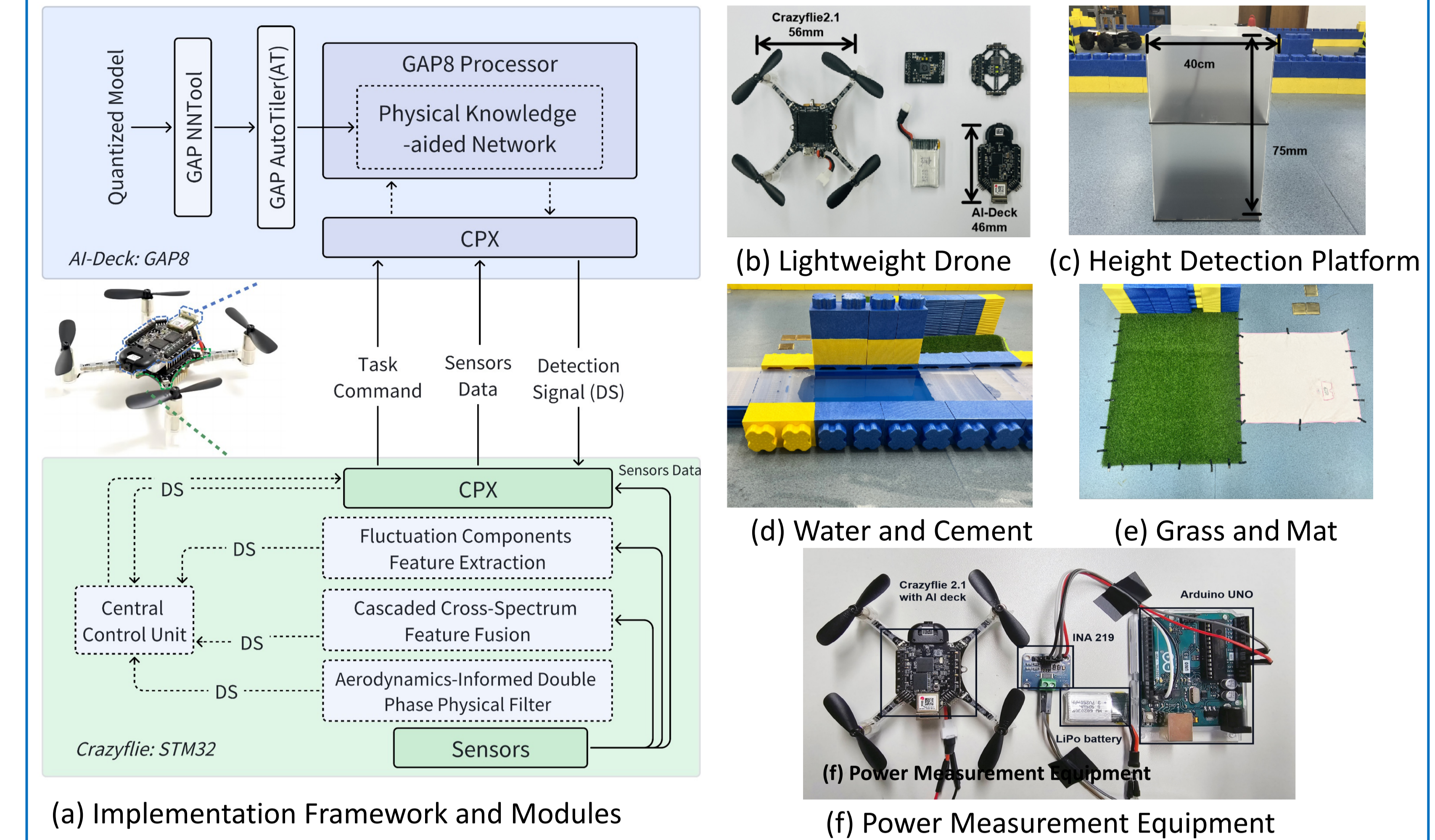
CCS-Feature Fusion

$$|P_{CCS}(f)| = \prod_{i=1}^{n-1} |G_{x_i x_{i+1}}(f)|$$

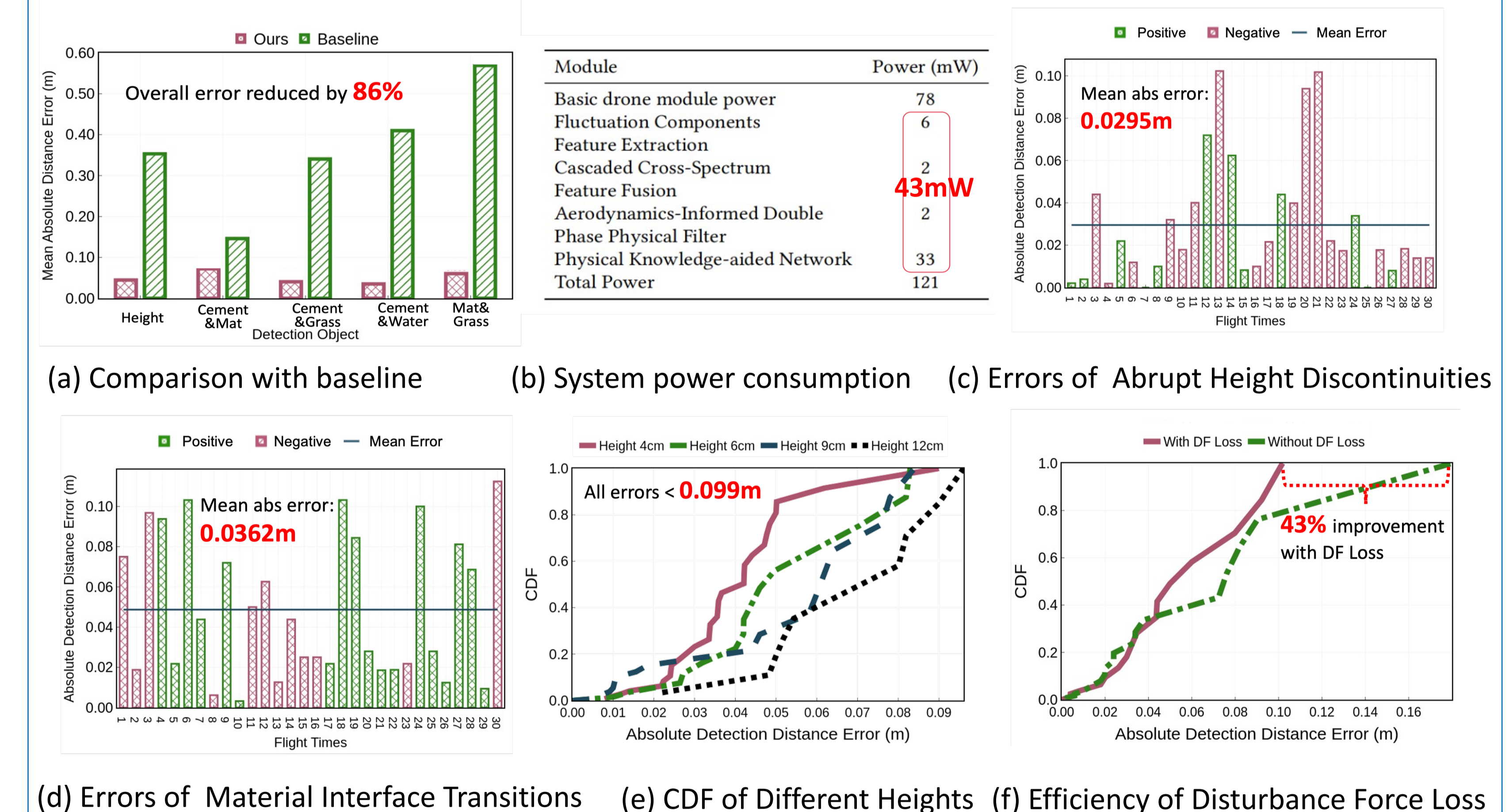
$$= |G_{x_1 x_1}(f)| |G_{x_2 x_2}(f)| \dots |G_{x_n x_n}(f)|.$$

Performance

Experiment Setup



Evaluations Result



Conclusion

- **Novel Sensing Approach:** AirTouch introduces a unique proprioceptive sensing system that leverages the ground effect, typically considered a challenge, as a positive modality for environmental edge detection. This innovation enables more accurate and efficient sensing tasks.
- **Future Work:** The system's potential for enhancing drone capabilities is evident, and future research will focus on expanding edge detection to mobile platforms, promoting air-ground coordination and collaboration in diverse environments.

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