

Problem Description

Lunar Terrain Vehicles (LTVs) require safe, effective operation in environments characterized by:

- ★ Rugged terrain
- ★ High contrast lighting
- ★ Regolith interference



Our Solution

We've designed and tested a hazard detection system using **mmWave RADAR** for enhanced situational automation and navigation safety.

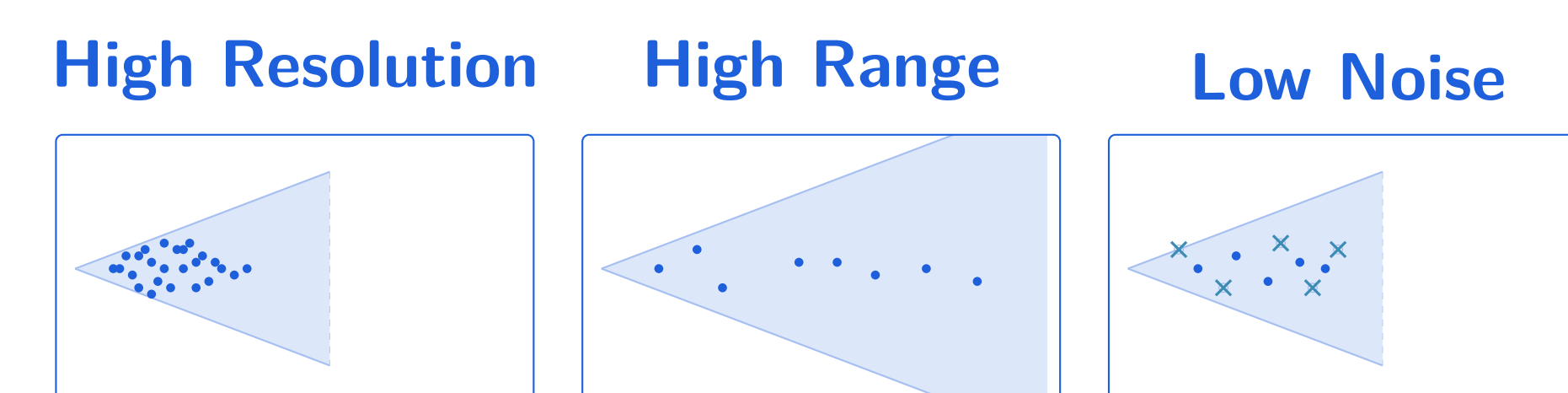
- ★ Detects rocks and craters in real time
- ★ Zero visibility required for operation
- ★ Hazards encoded as bounding boxes[◊]

[◊] Each bounding box encodes a hazard's polarity, shape, size, position, and tracking ID.

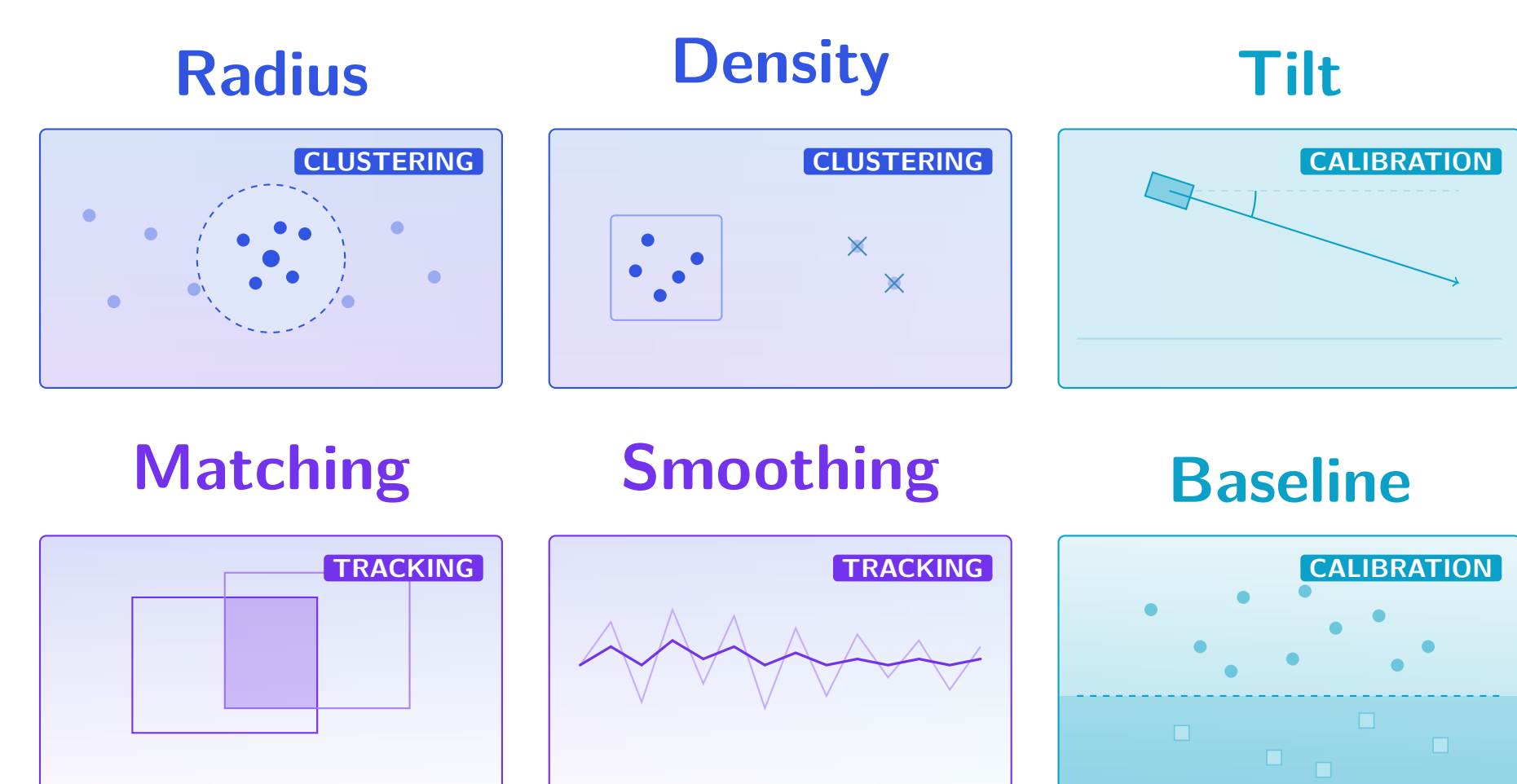
Features

The system exposes **configurable endpoints** at every stage. Sensor profile and operational modes are selected at startup, detection parameters are tuned in real time via GUI or JSON.

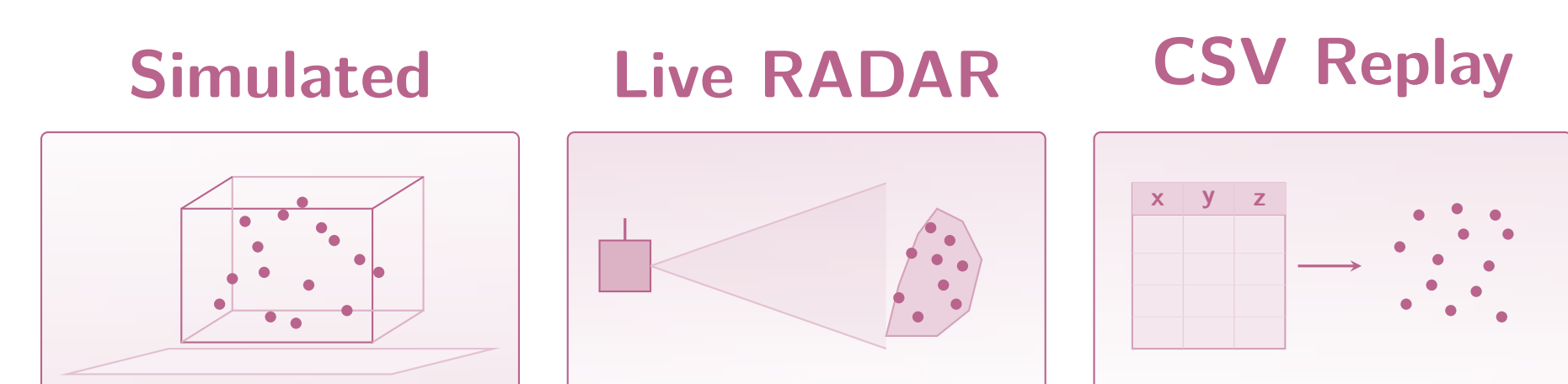
Sensor Configuration Profiles



Real-Time Parameter Tuning*

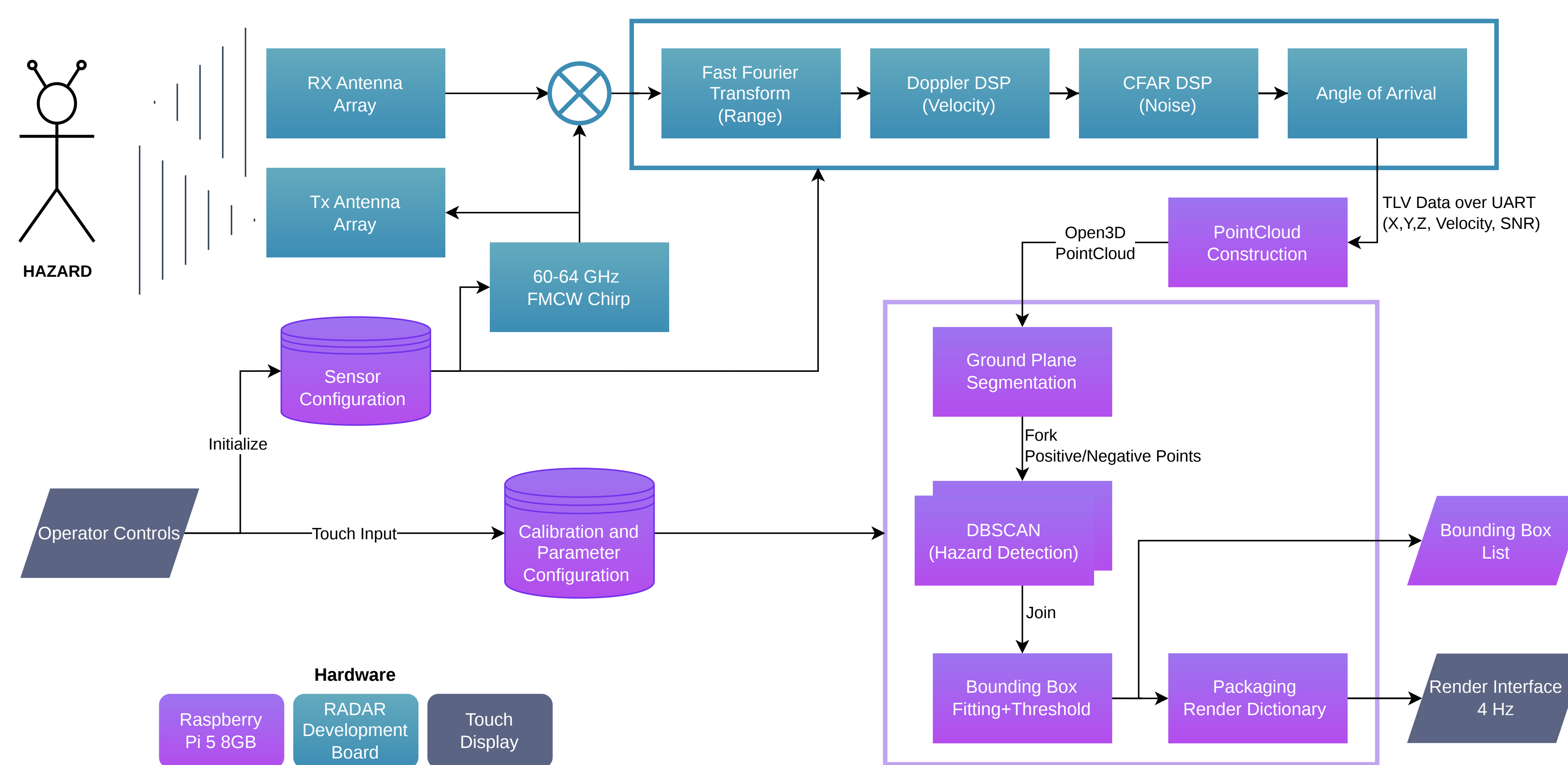


Operational Modes

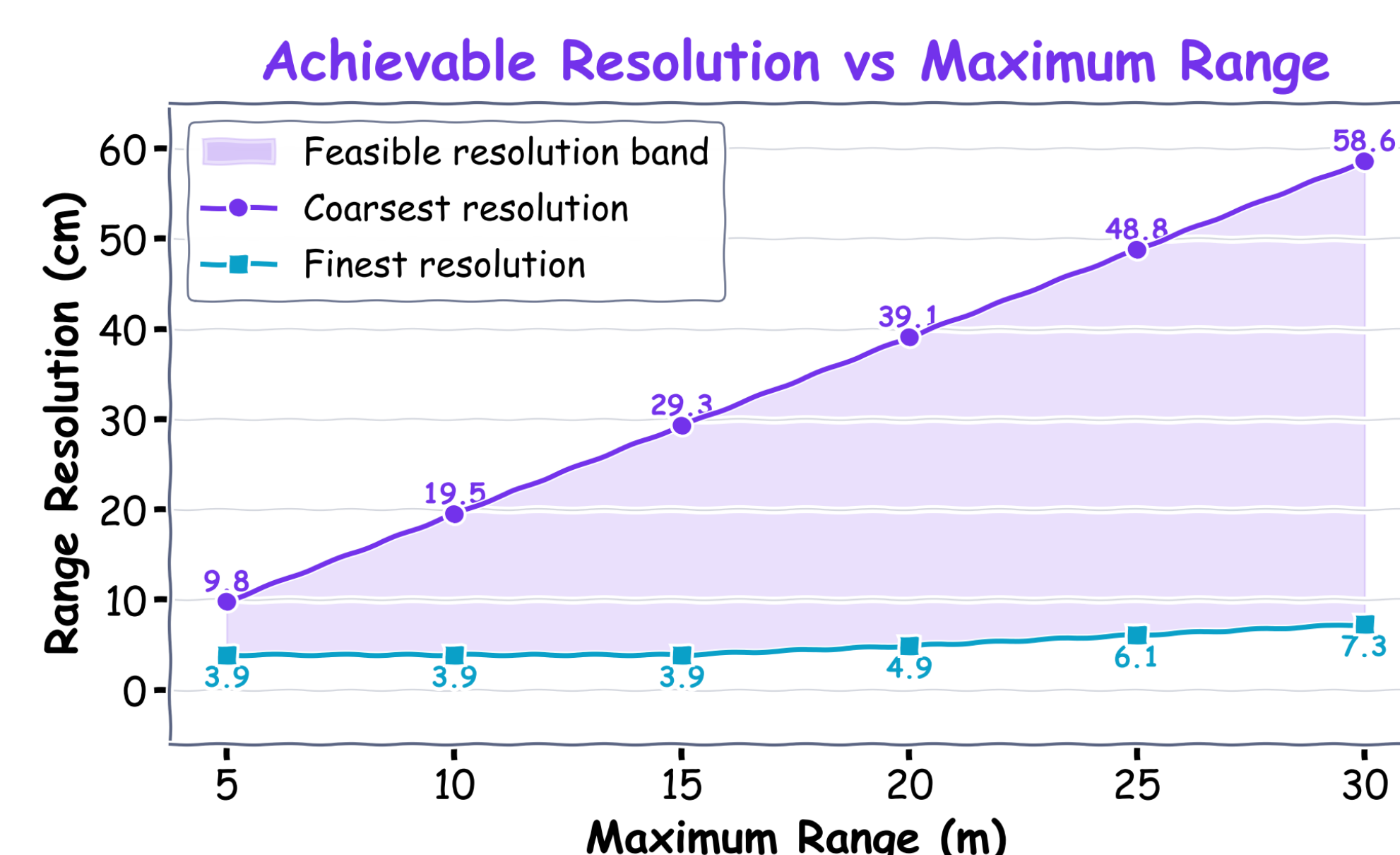
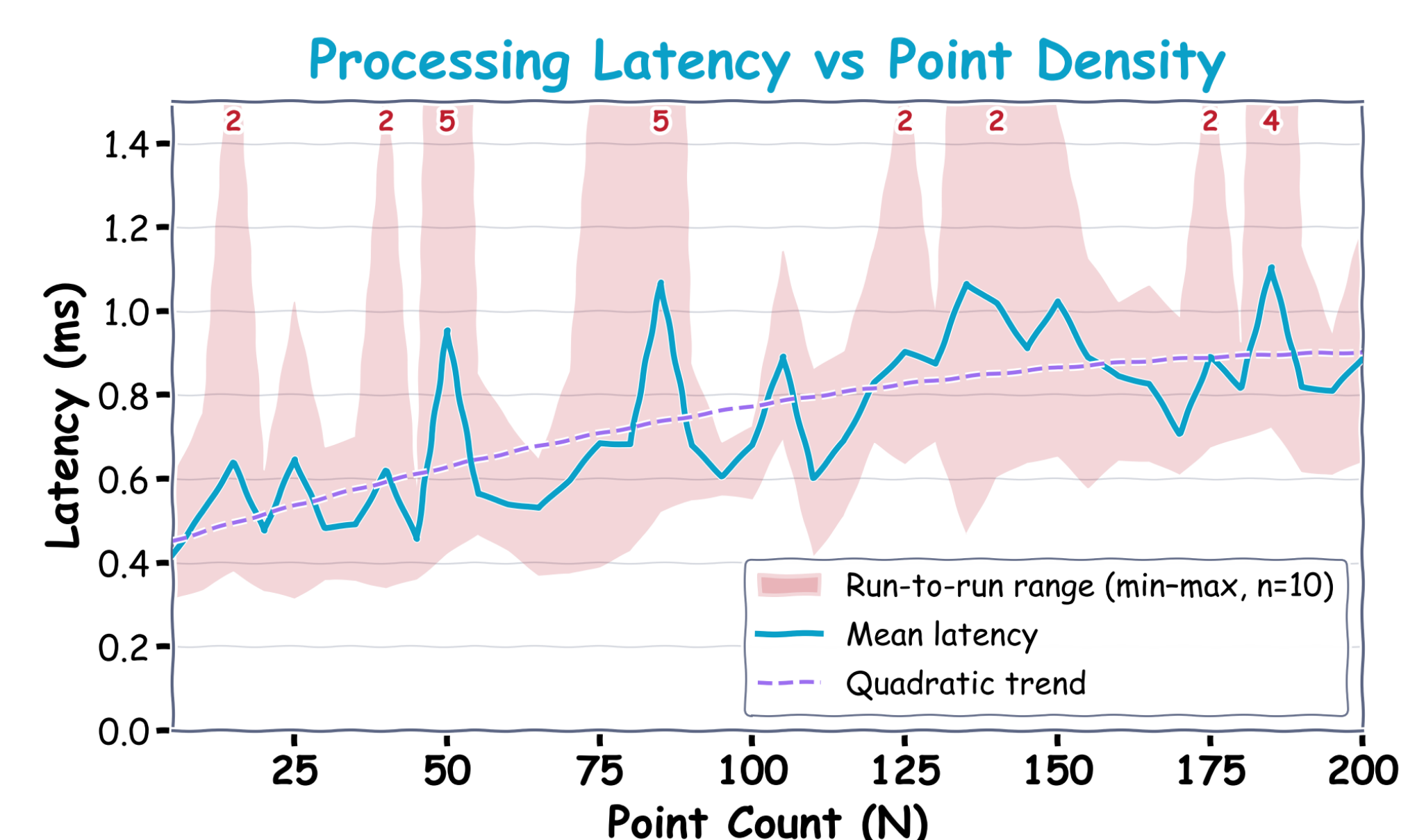


* 48 total configurable parameters across 4 subsystems. These 6 are currently in the GUI.

System Level Flow Diagram



System Performance

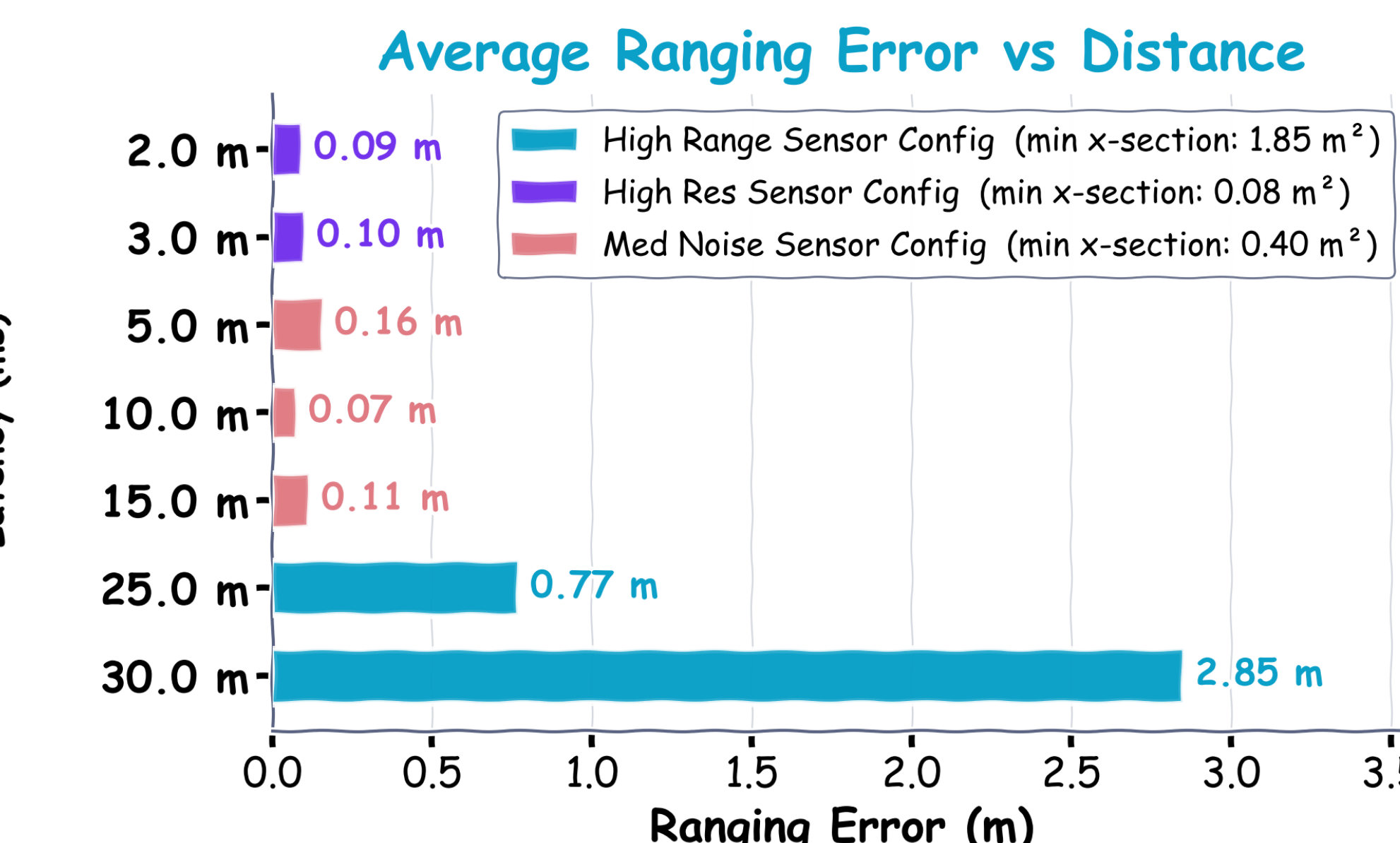
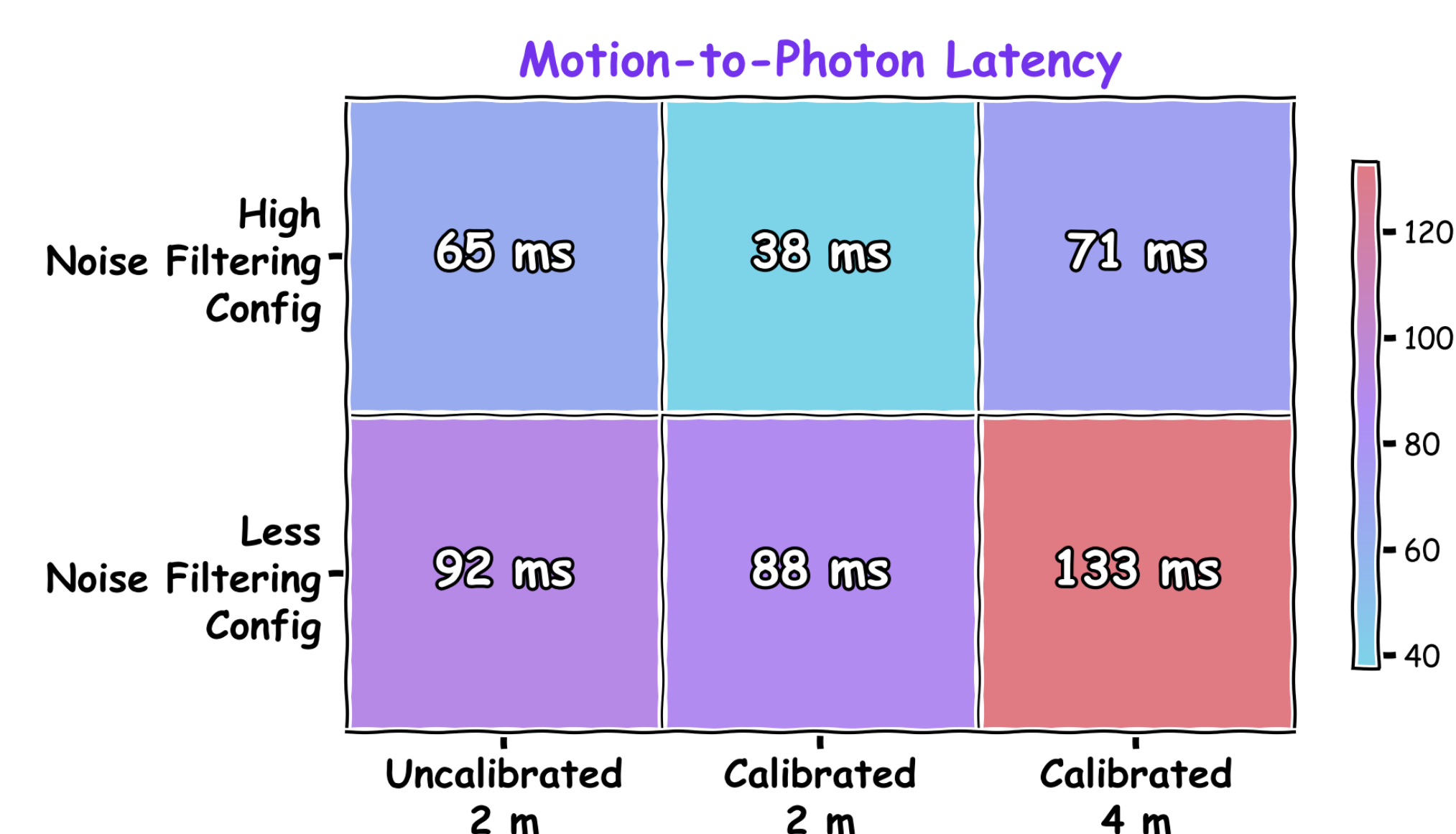


System latency depends on:

- ★ Scene complexity (point density)
- ★ Noise filtering and calibration (processing load)

System accuracy depends on:

- ★ Range-resolution (tradeoff)
- ★ Target distance (R^{-4} signal loss)



Application

Lighting array plugin — demonstrates automated lighting control driven by tracked bounding boxes from the detection pipeline.

Existing Lighting Design



Each frame, the plugin:

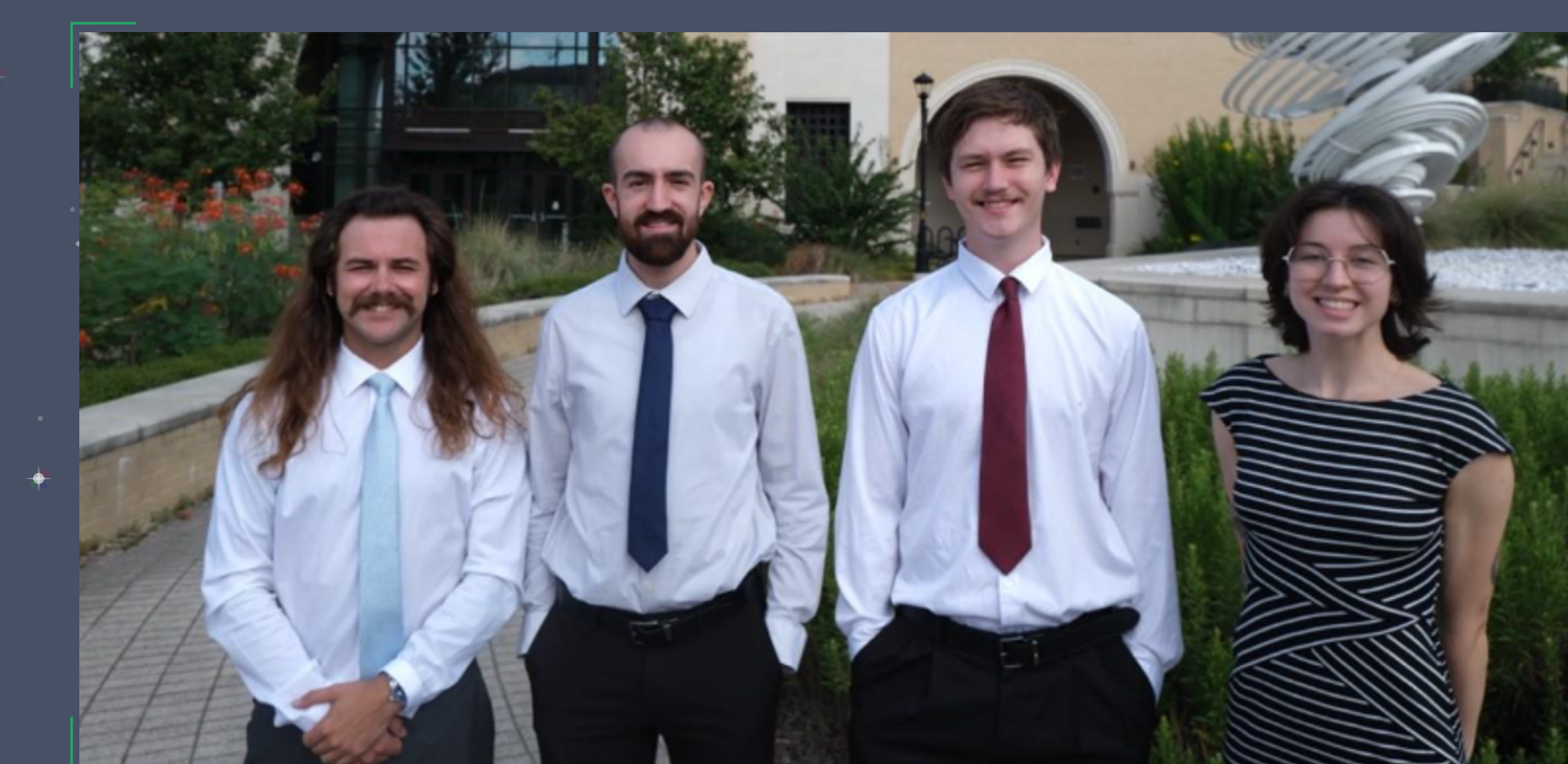
- ★ Reads tracked bounding boxes and the sun-heading angle
- ★ Outputs an **8-channel PWM vector**

Execution Matrix

Solar Angle	Rock ↑	Crater ↓
BACKLIT [†]	Far Flood	High Spot
SIDE LIT	Low Spot	Low Spot
ECLIPSED [‡]	Low Spot [‡]	Close Flood [‡]

[†] Asymmetric lighting to preserve depth perception.
[‡] Dimming as distance decreases to prevent overexposure.

Meet the Team



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