

# Structured degradation in VLP

## Introduction

RSS-based Visible light positioning (VLP) matches measured LED intensities with a fingerprint database. Over time, LED aging, contamination, thermal effects, blockages, and failures alter the RSS values, reducing positioning accuracy

### Research Question

How can structured illumination drift in RSS-based Visible Light Positioning systems be modeled and compensated for using lightweight algorithms suitable for microcontrollers?

### Contributions

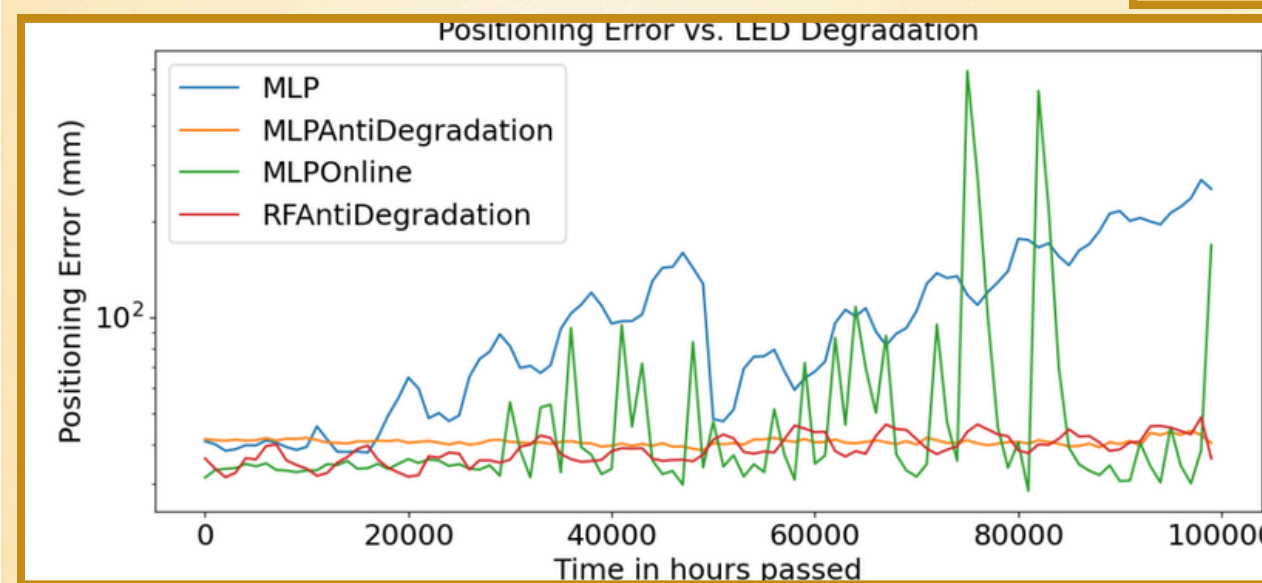
- Modeling of gradual and sudden VLP degradation mechanisms.
- A two-stage degradation-aware compensation algorithm.
- Evaluation over a simulated 100,000-hour deployment.
- Embedded implementation on a Raspberry Pi Pico.

Gradual degradation	Sudden degradation
LED aging	LED failure
LED/sensor contamination	Blockage
Thermal droop	Permanent Damage

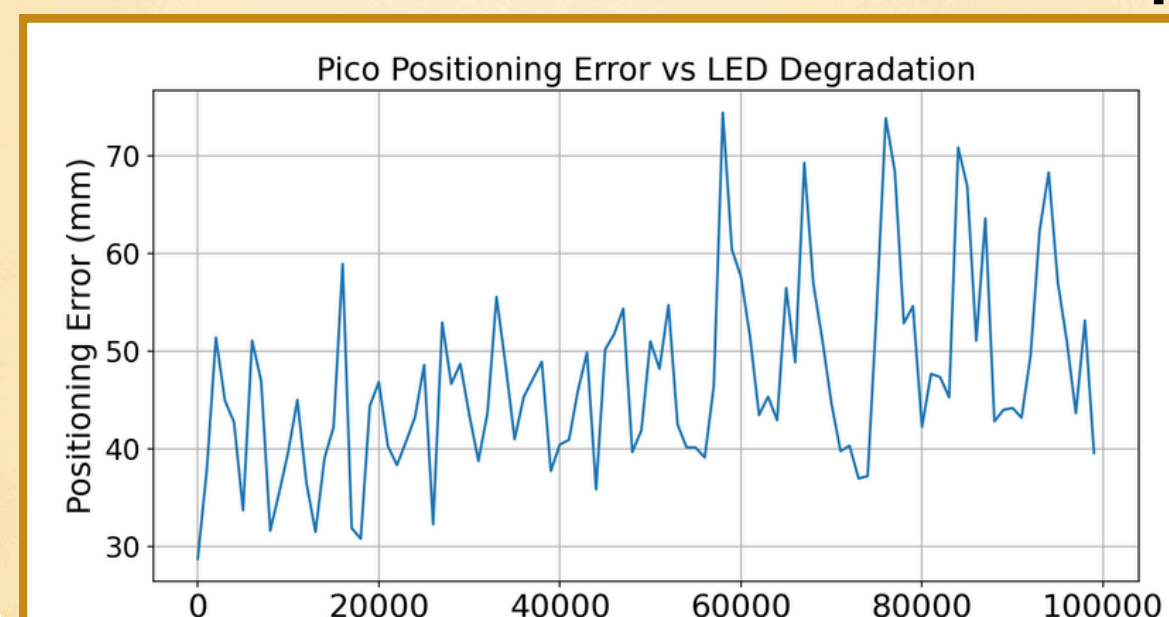
## Results

### Long-term positioning performance

- No compensation:** positioning error increases as degradation accumulates.
- Existing online calibration:** lower average error, but large error spikes occur under sudden or combined degradation.
- Proposed method:** more stable positioning error throughout the deployment, although with a higher baseline error in some conditions.



### Embedded deployment



## Conclusion

Combining model-based scaling with anomaly correction improves long-term positioning stability under gradual and sudden degradation. The method runs efficiently on a Raspberry Pi Pico, but embedded constraints reduce positioning accuracy.

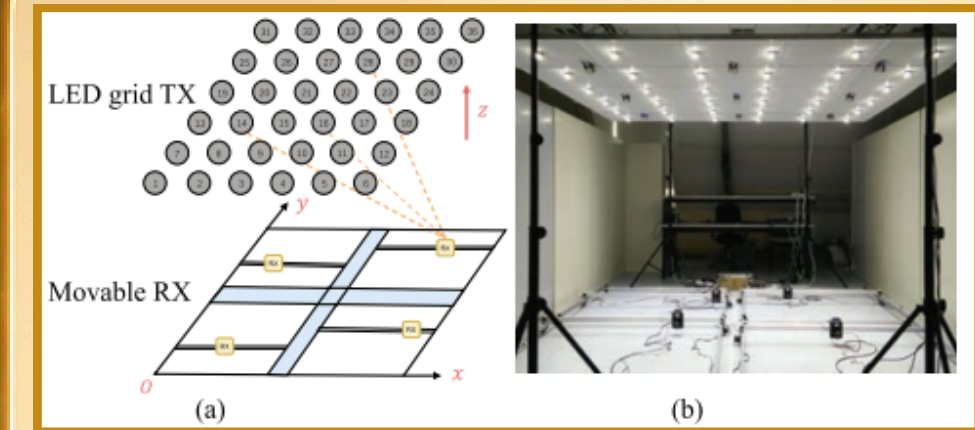
**Reliable long-term VLP requires compensation for both gradual signal drift and sudden degradation events.**

### Limitations and future work

- Limitations: simulation-based evaluation, hardware-dependent degradation parameters, and reduced embedded precision.
- Next steps: validate in a real deployment, use adaptive anomaly thresholds, and improve quantization and reference-point selection.

Metric	Runtime
Mean	<b>3.606 ms</b>
95th percentile	<b>3.657 ms</b>
Maximum	<b>4.008 ms</b>

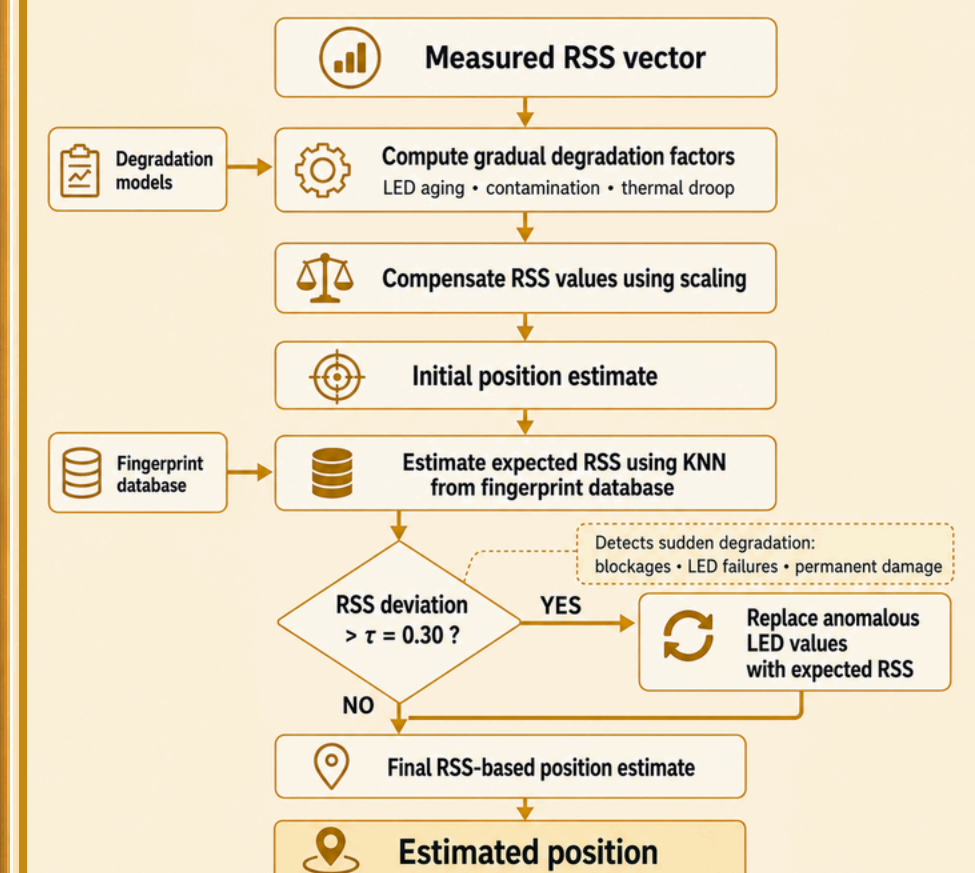
## Method



DenseVLC RSS measurements are degraded using models for aging, contamination, thermal droop, blockages, and failures. Gradual drift is corrected using model-based scaling. Sudden anomalies are detected by comparing measured RSS with expected fingerprint values and replacing anomalous signals before final positioning.

### Proposed Compensation Method

*Degradation-aware RSS positioning for long-term VLP*



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