



## Covariance estimation for Multi-Modal SLAM

**Abstract:** Multi-Modal SLAM consists of fusing information generated by different sensing modalities (Visual Cameras, LiDARs, IMU etc.) to provide an accurate estimate of the location of a robot as well as a map of its environment. This fusion has typically been modeled in the form of a non-linear least squares optimization with the residuals accounting for their respective uncertainties. For good results, and especially in degenerate scenarios, it is imperative that the uncertainty of the information being fused is well estimated.

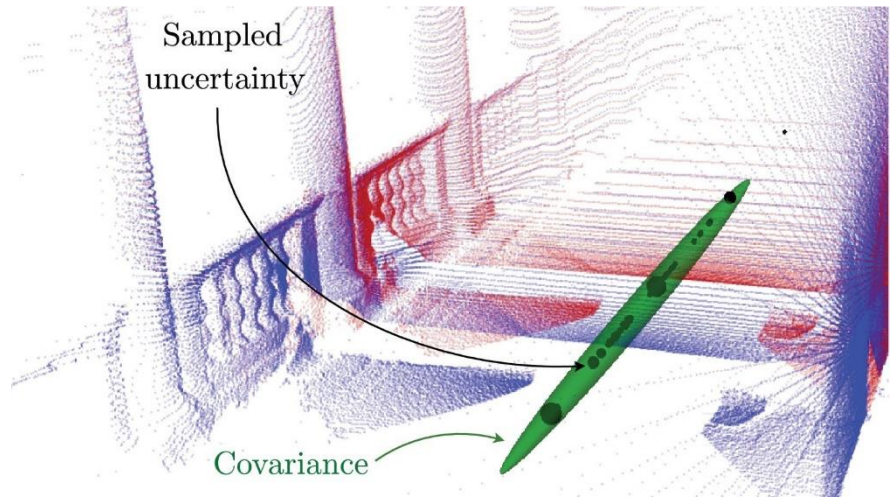


Image from: Landry, D., Pomerleau, F. and Giguere, P., 2019, May. CELLO-3D: Estimating the Covariance of ICP in the Real World. In 2019 International Conference on Robotics and Automation (ICRA) (pp. 8190-8196). IEEE.

However, as this information is obtained from sensors measuring different physical properties/phenomena, a direct comparison of uncertainties is semantically not meaningful and past approaches have dealt with this by using fixed or heuristically scaled covariances. This thesis will explore the problem of covariance estimation specifically for such fusion of multi-modal information taking a data-driven approach.

### Tasks:

- Study approaches for covariance estimation in SLAM systems containing Visual Cameras, LiDARs and IMU(s).
- Setup simulated environments and sensors for collection of training data with perfect ground truth.
- Neural net design and training on simulated data.
- Extensive evaluation of the method on relevant field data collected by our lab.

### Literature (indicative):

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#### **Relevant Funded Project:**

- **Title:** REDHUS: REmote Drone-based ship HULL Survey
- **Partners:** DNV, NTNU, ALTERA, Klaveness, ScoutDI
- **Funding Agency:** Research Council of Norway

**Main supervisor:** Kostas Alexis, Professor, NTNU

**Co-supervisor:** Nikhil Khedekar, PhD Candidate, NTNU