

Ira A. Fulton Schools of Engineering

Collaborative Digital Modeling Simulation

Background and Inspiration

Background

Building inspection and monitoring is a rather expensive and time-consuming process requiring specialized equipment and expertise.

Can we use Visual Computing and SLAM to tackle this problem?

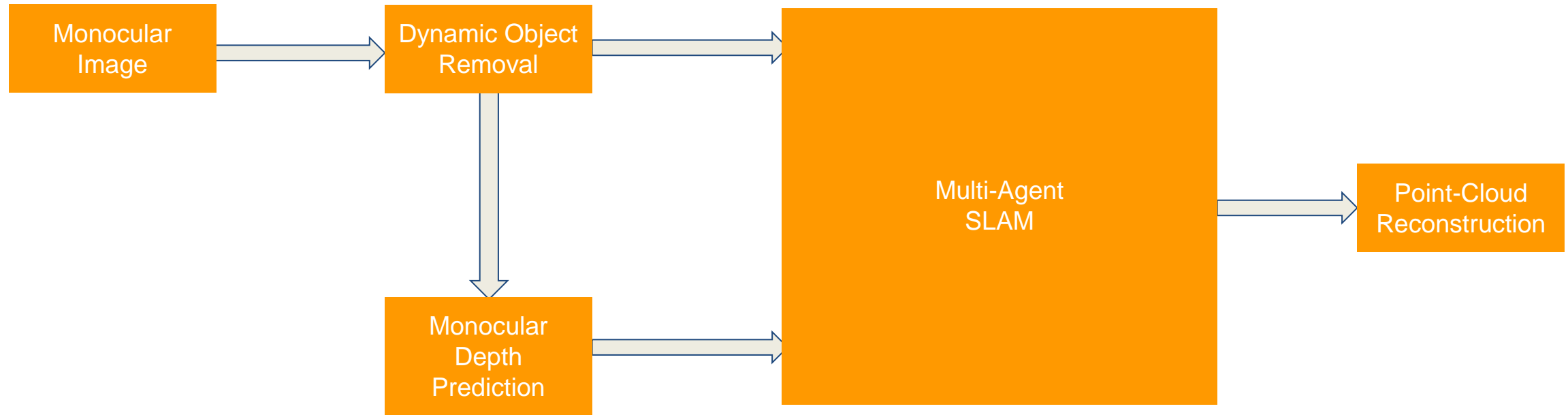
Challenges

Current multi-agent SLAM systems work well ONLY in static environments.

Aim

To develop a distributed,scalable system with minimal human intervention requiring only monocular vision, and IMUs capable of working in dynamic environments.

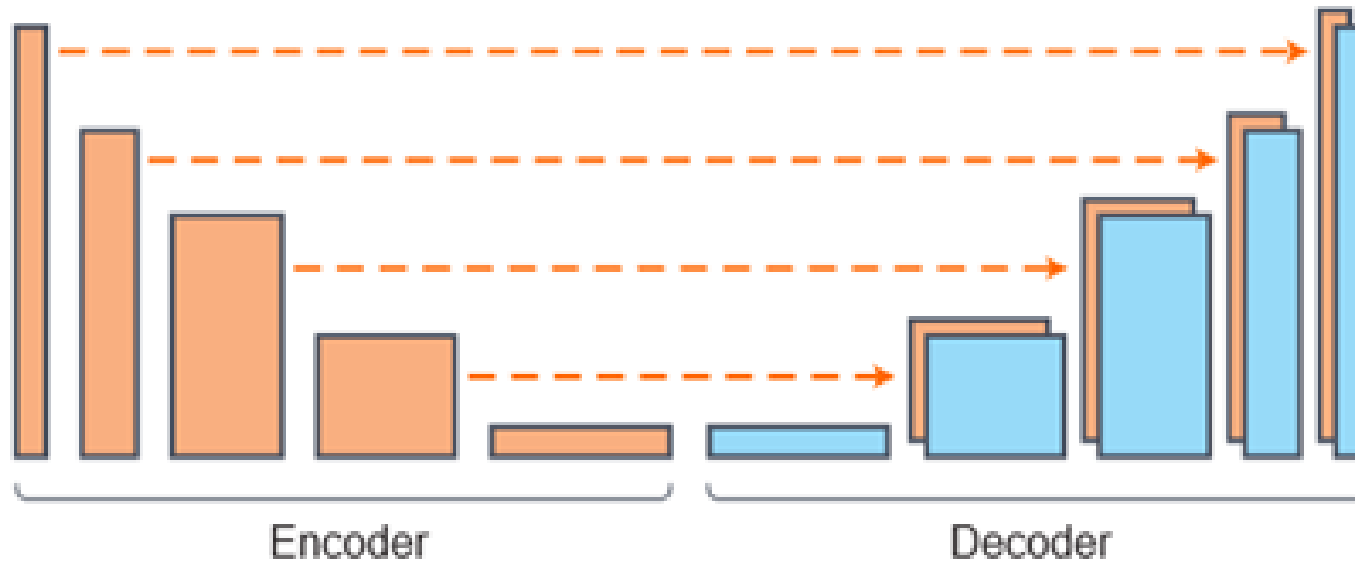
Proposed SLAM System



Modularity maintained!

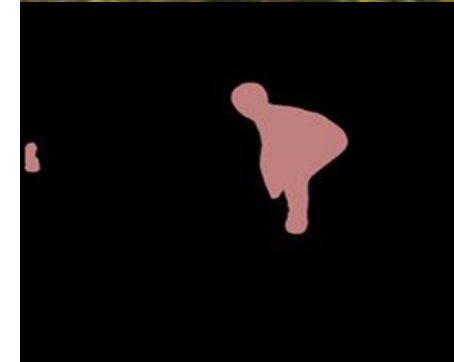
Dynamic Object Removal Block

We treat this as a segmentation+image inpainting problem



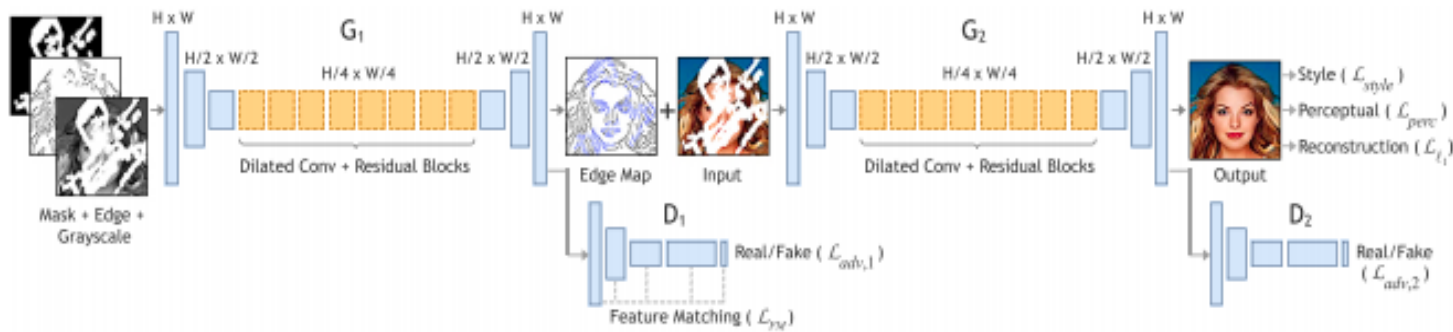
**Dense U-Net Backbone for
Semantic Segmentation**

Can be replaced with any standard segmentation
architecture. - DeepLabv3 is promising.



Dynamic Object Removal Block

We treat this as a segmentation+image inpainting problem



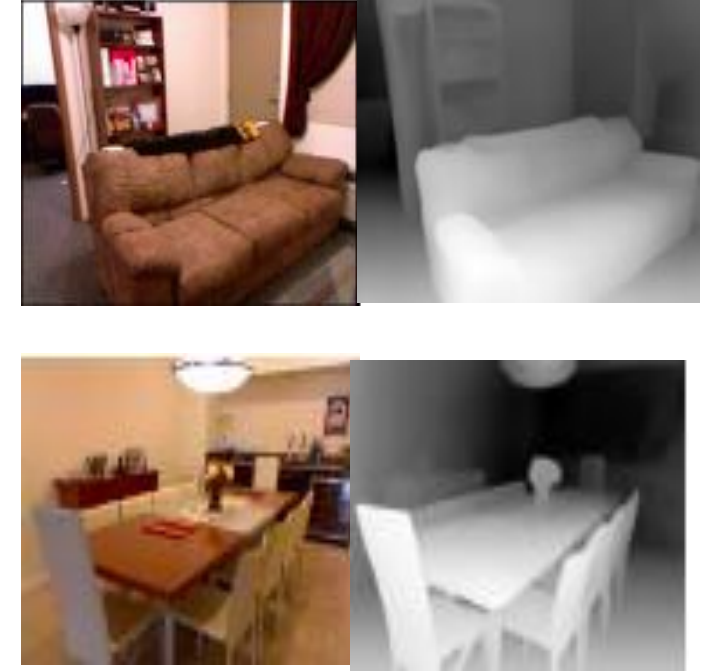
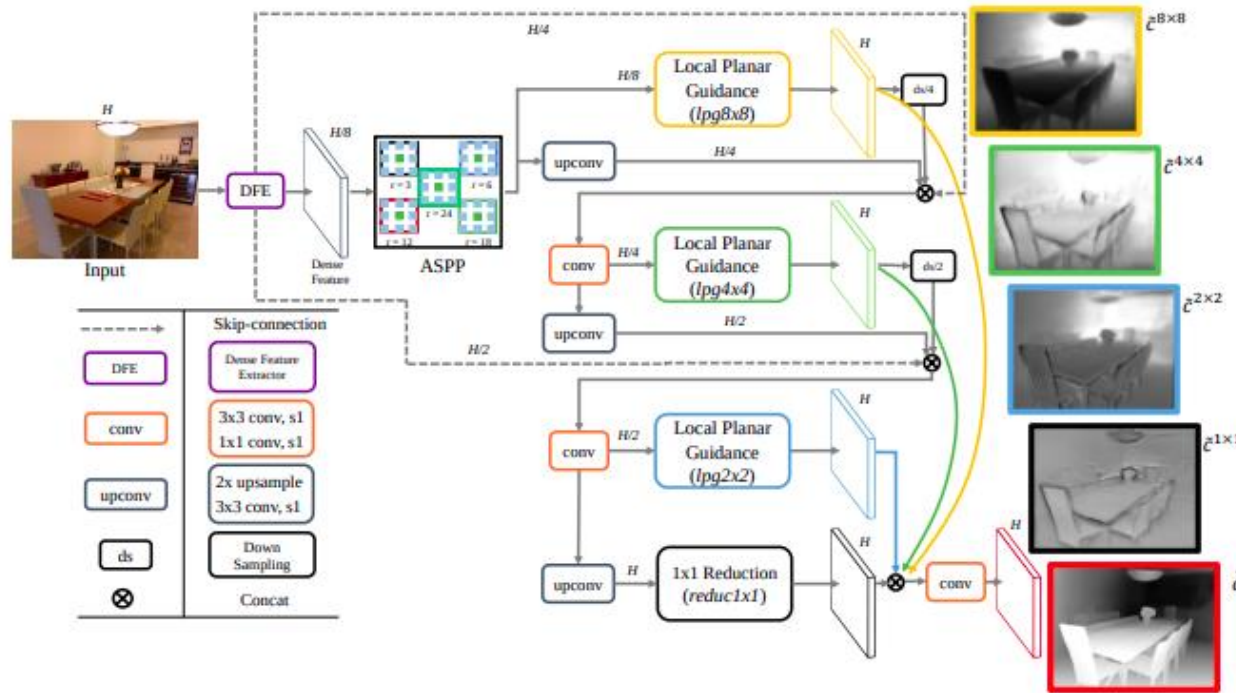
Edge Connect for image inpainting

Again can be replaced with any standard inpainting architecture.



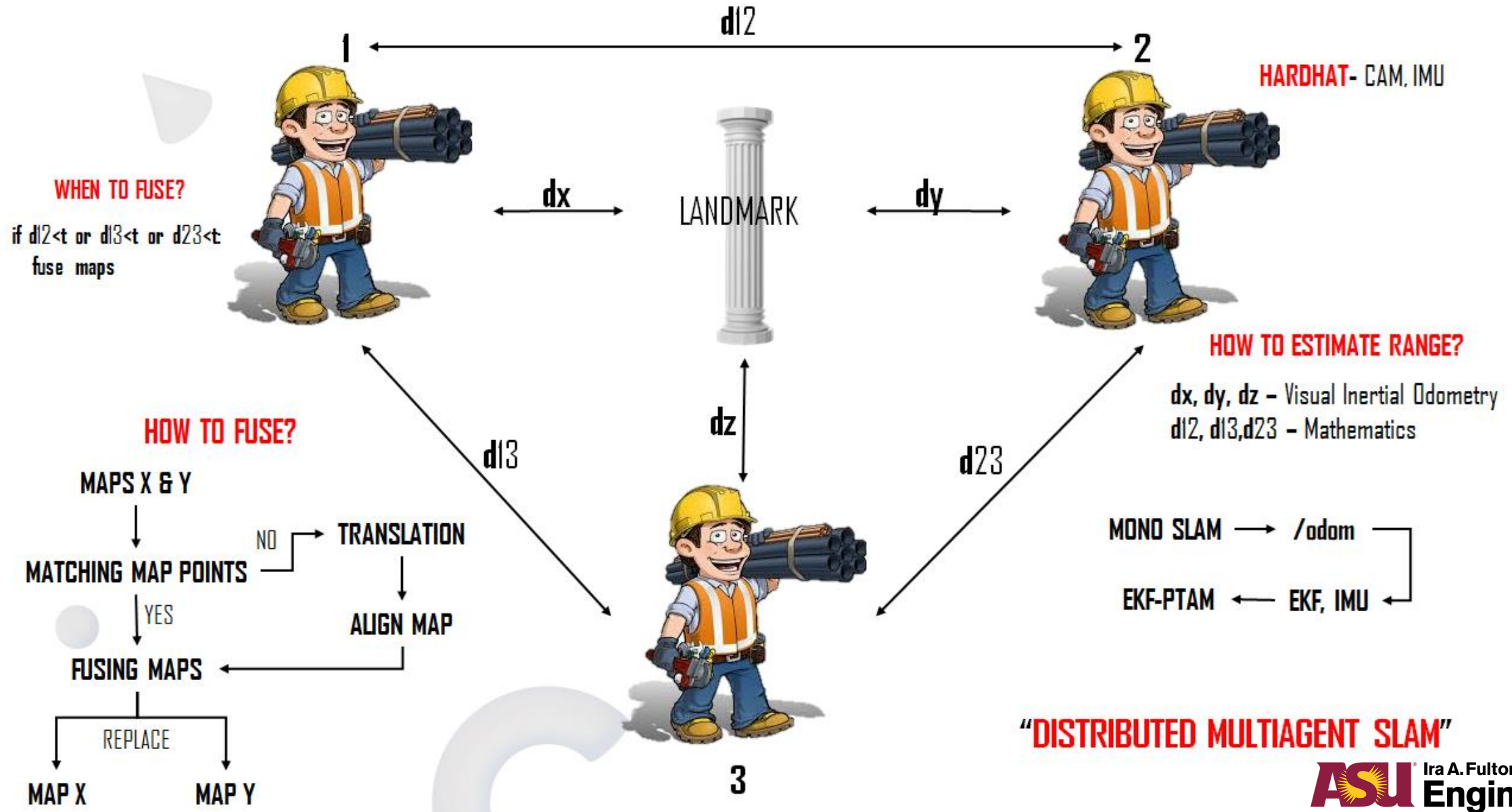
Monocular Depth Prediction Block

Perform Monocular Depth Prediction on processed image

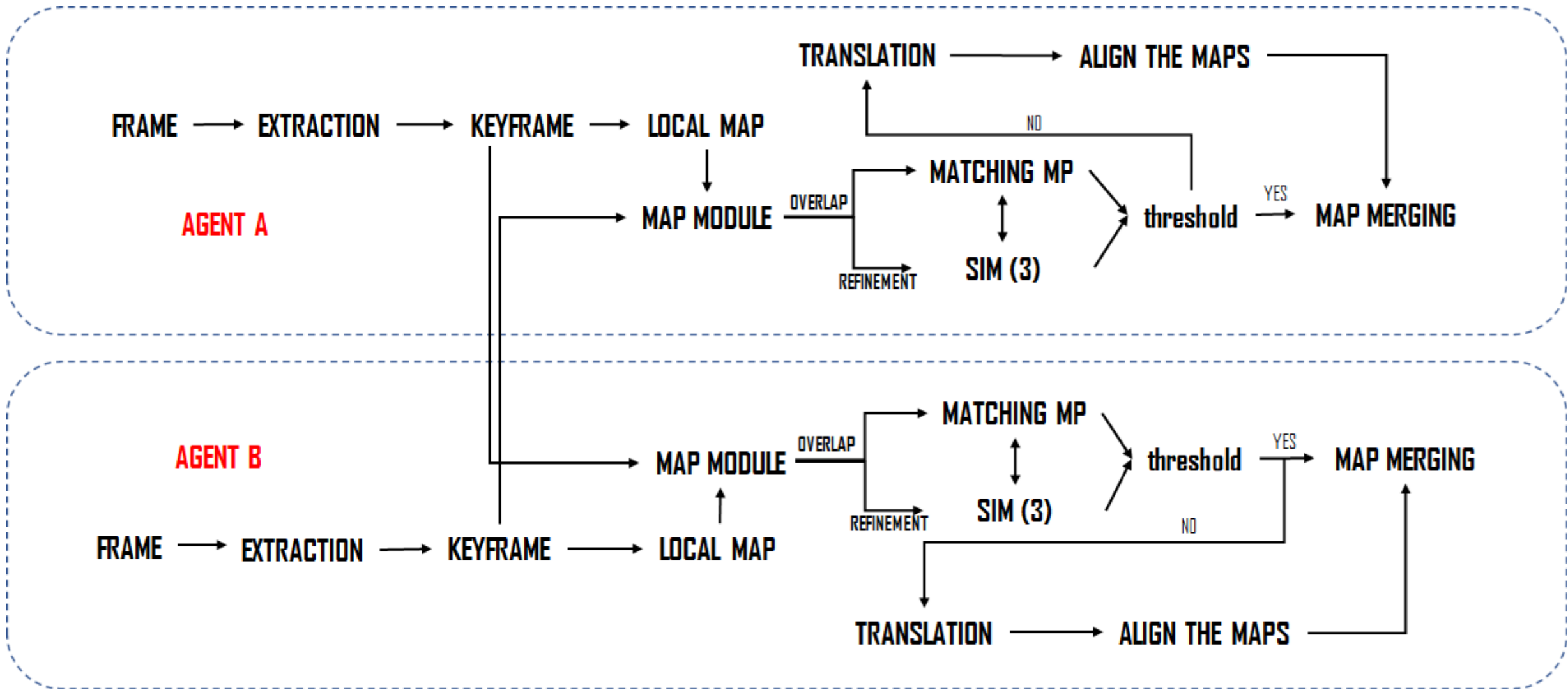


**Big To Small Monocular
Depth Prediction**

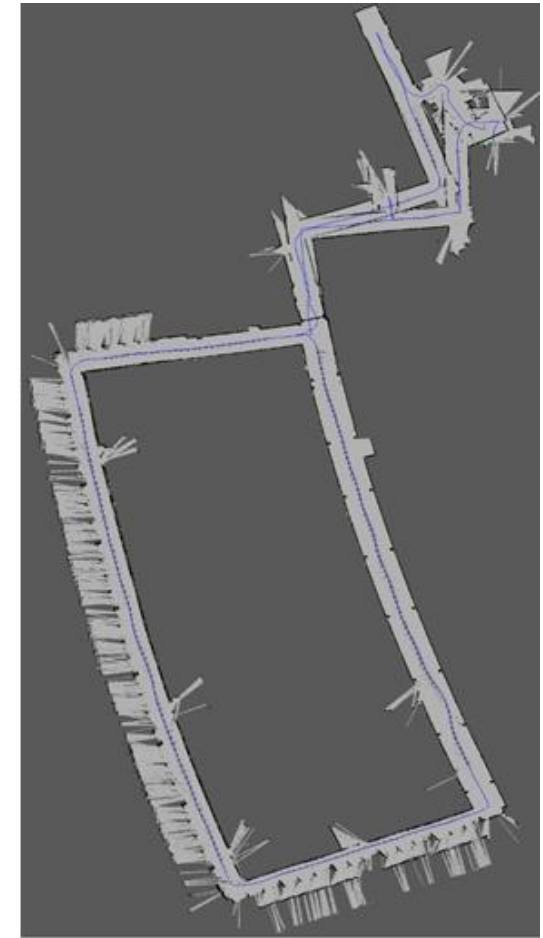
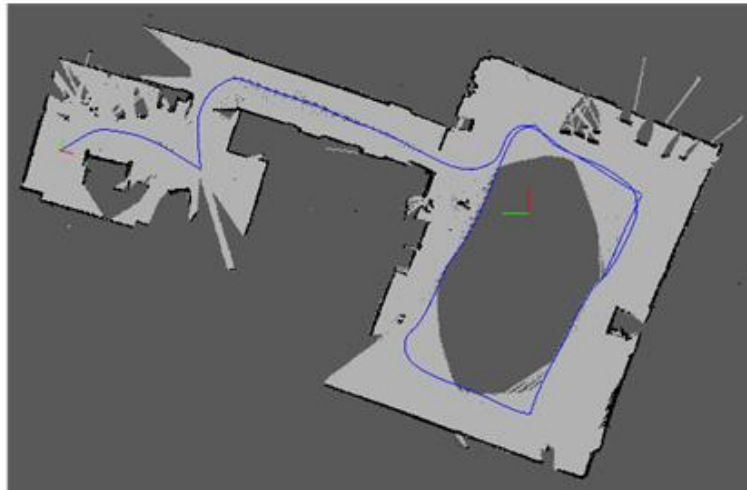
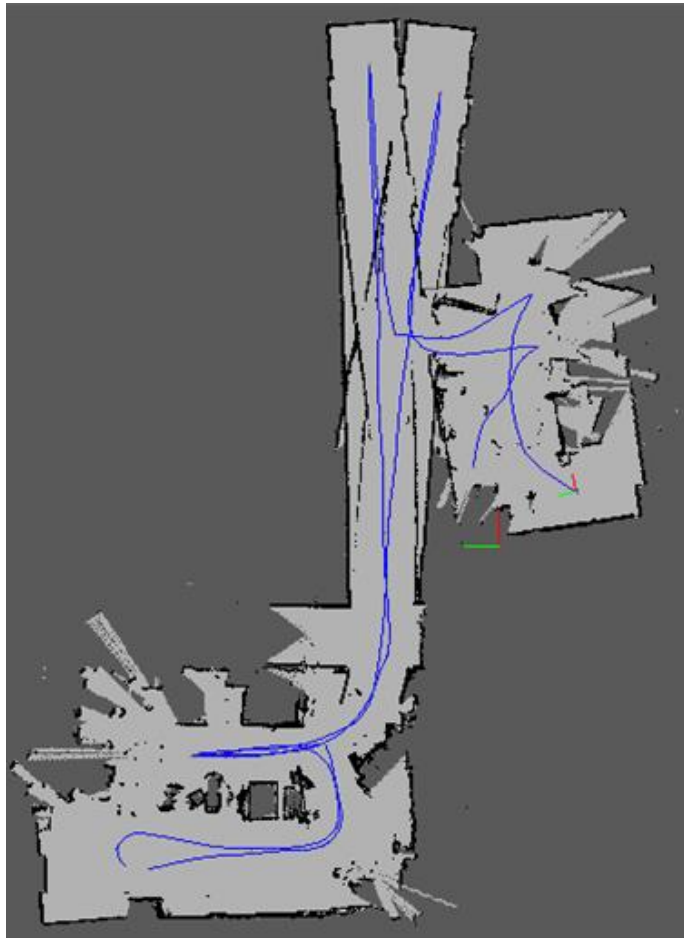
Proposed SLAM Architectures



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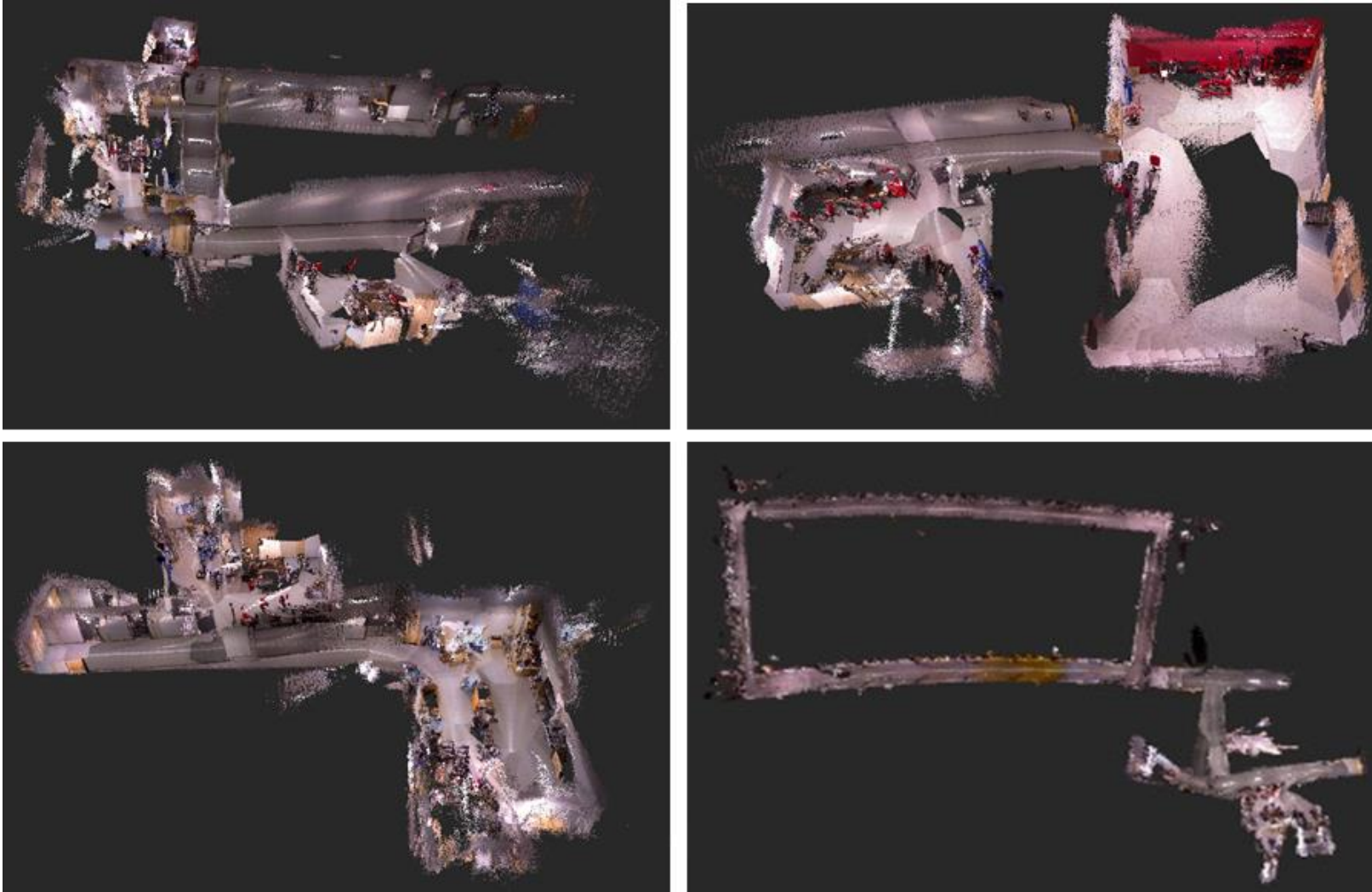


RTABMap Multi-Session Simulation



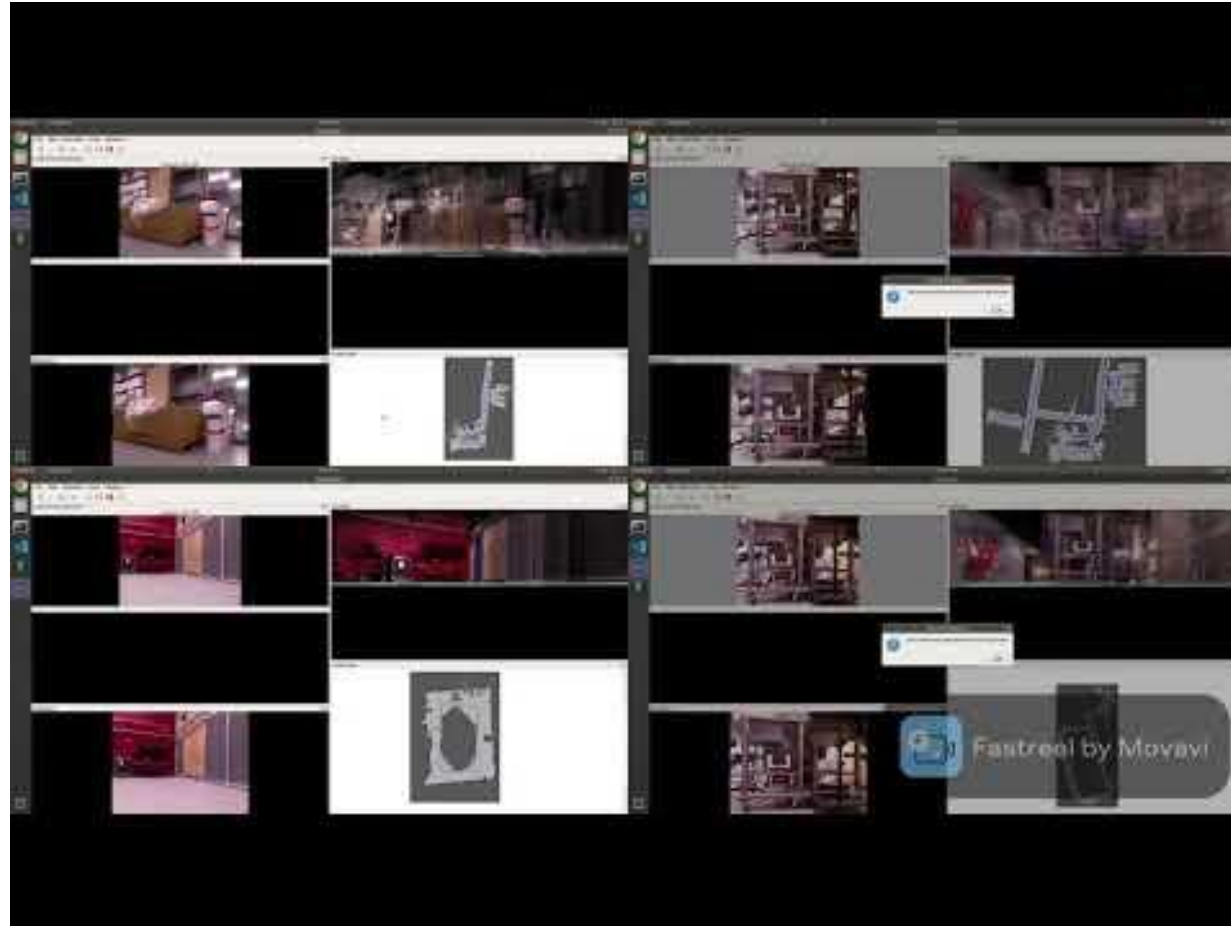
MAPS

RTABMap Multi-Session Simulation



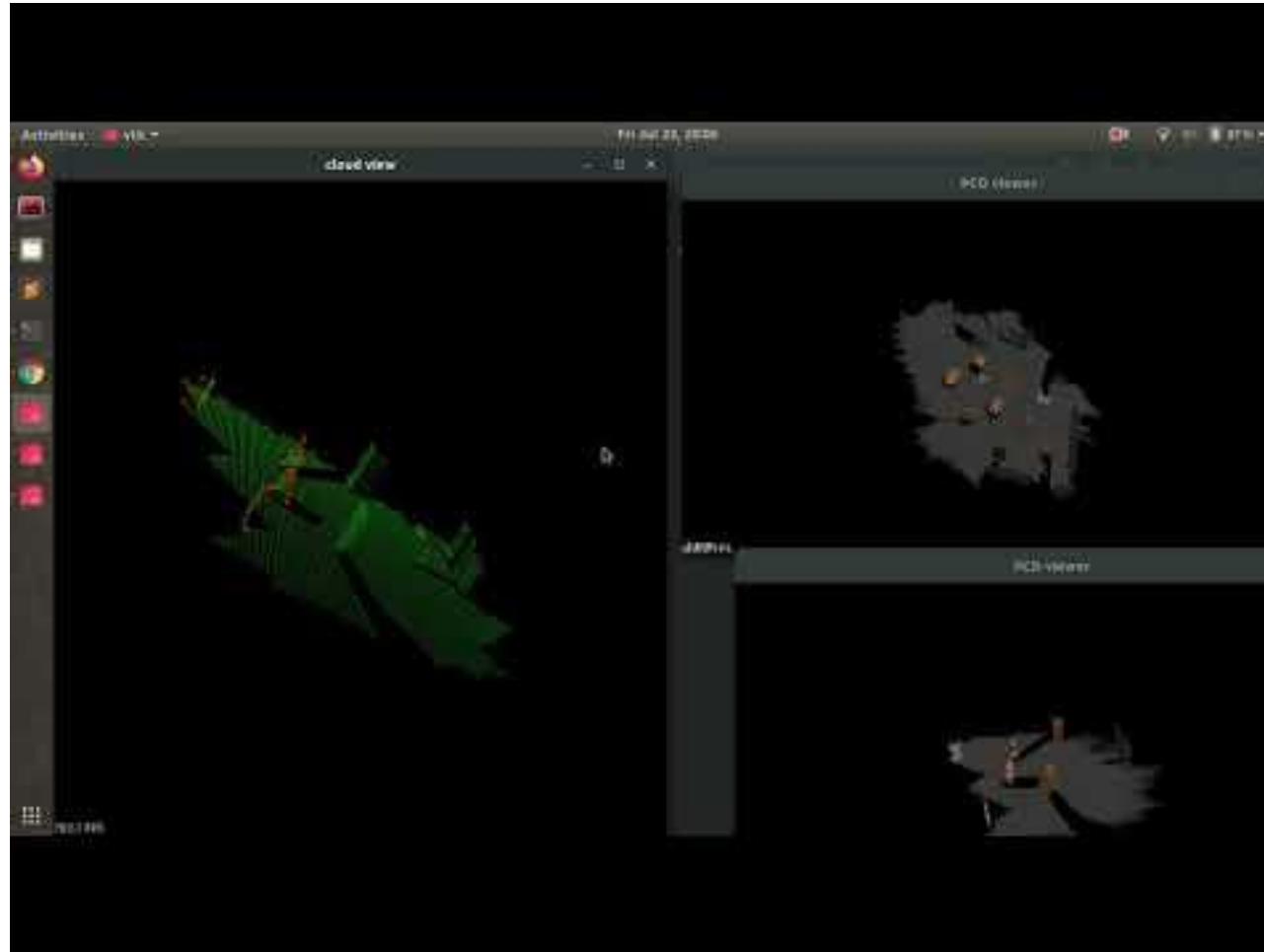
POINT CLOUDS

RTABMap Multi-Session Simulation



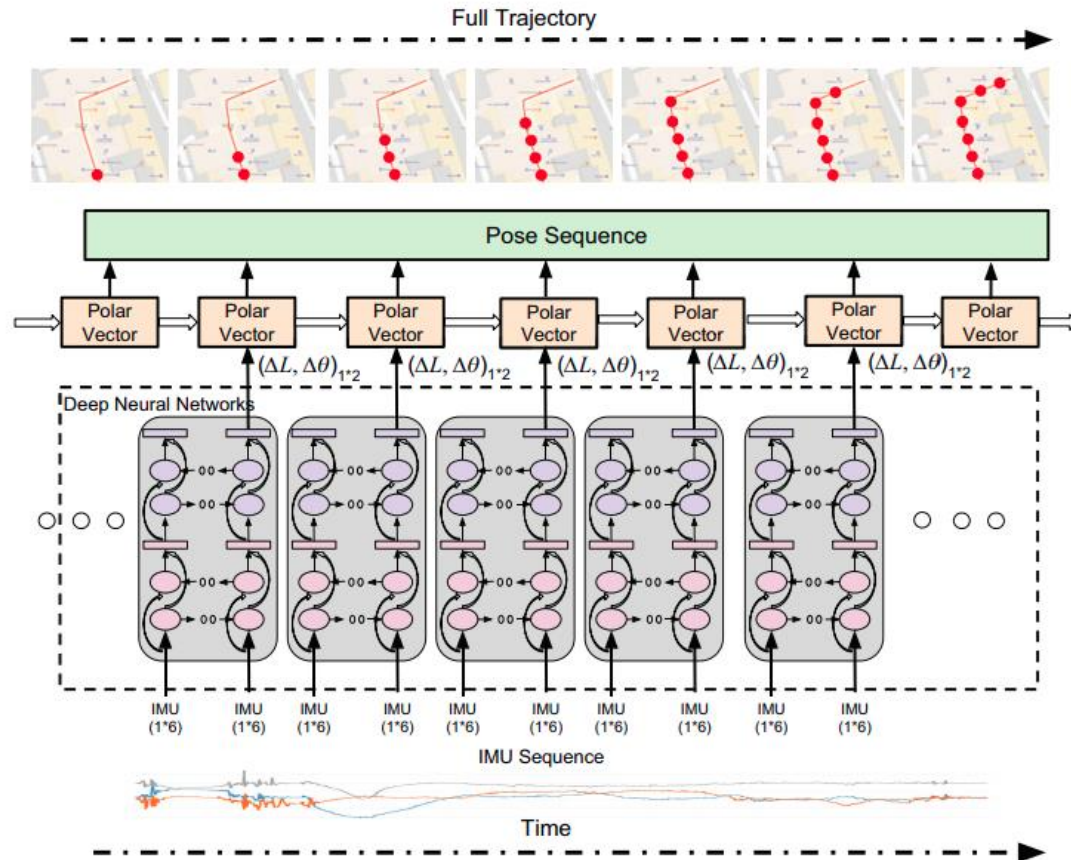
VISUALIZATION

CUSTOM RTABMAP SIMULATION

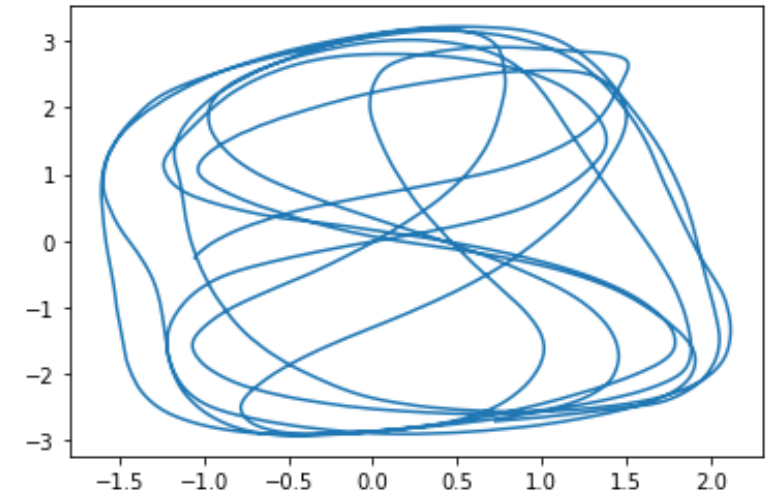
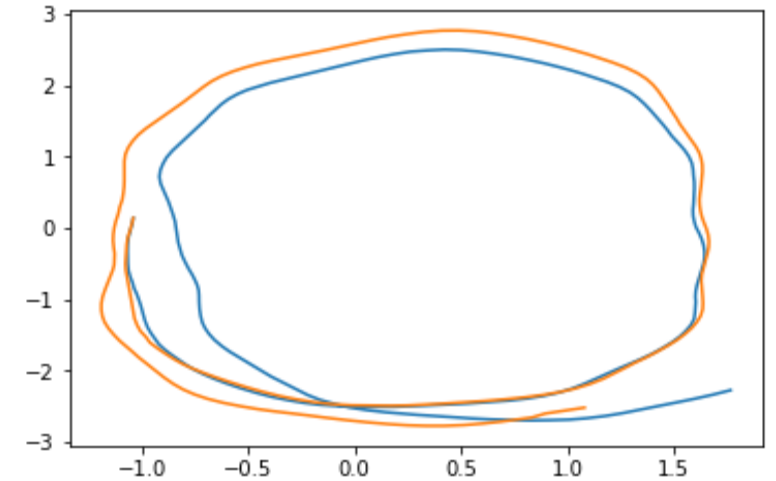


Off-beat experiments

1. OxIOD Dataset for improving inertial and visual-inertial odometry



Can be used for redundancy in cases of temporary feature-loss for lower drift



Future Work

1. We develop a modular system for slam in dynamic environments, such that each part is modular and can be modified individually for better results. In the near future, we aim to perform comparative and ablation studies to test the best module and examine its robustness.
2. The segmentation model requires a pre-knowledge of the classes, we aim to develop a self-supervised/semi-supervised approach for segmenting dynamic objects coupled with optical flow information.
1. For multi-agent SLAM, we aim to also develop a system for feature matching and registration in low-overlap conditions, taking inspiration from PREDATOR.
2. Explore ways of knowledge distillation for reducing number of parameters and making the network faster.
3. Explore the possibilities of an E2E training fashion, something like gradSLAM.
4. How and When to update map? Lifelong SLAM vs Threshold based change.