# FINAL REPORT: ORB SLAM 3

Introduction:

Orb Slam 3 fails to deal with dynamically changing environments as seen from our video demonstrations in the presentation. So, we looked into why this happens and we concluded that ORB slam saves people into frames, thus, when we revisit a site, instead of merging maps or loop closure, it decides that there aren't enough matching points and fails to create a loop closure. Thus we looked into a solution for this and found these 3 implementations.

Running the NUance dataset:
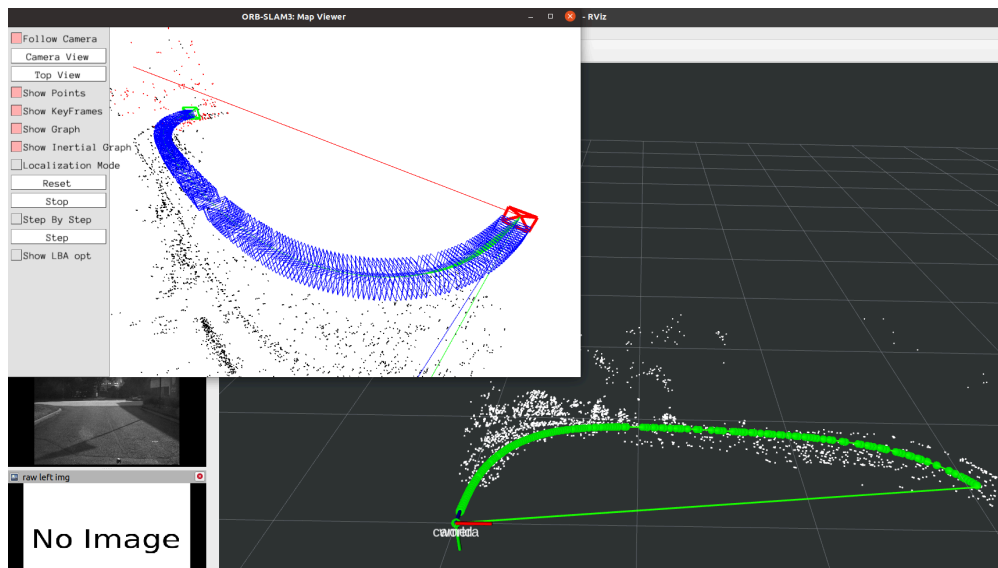
We attempted to run the ORB SLAM3 algorithm on the KRI Nuance dataset using the provided camera calibration parameters (yaml file) and a custom launch file. However, the algorithm ceased functioning after 13 seconds, as no features were detected at a critical turn in the car's trajectory. Despite efforts to address this issue by slowing down the rosbag playback using factors of 5x, 10x, and even 100x!, we were unable to achieve successful execution on the entire dataset.

Methodology:

Det-Slam:
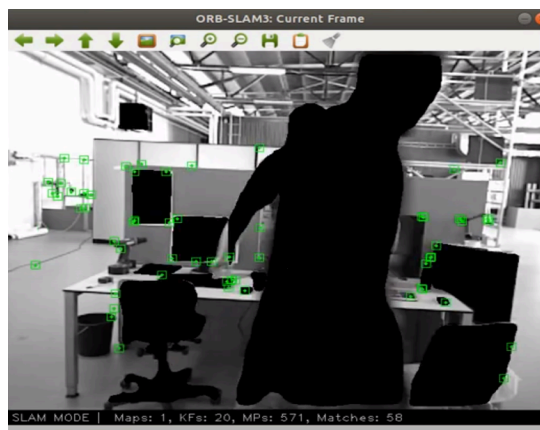
Det-Slam is a fork of orb slam3 which uses Facebook's Detectron2 algorithm for semantic segmentation. As we can see in the above picture, Detctron has removed moving objects (the people, the screens) from the picture. This means that the algorithm won't find and record features in dynamic objects thus resulting in better loop closures. The tradeoff is that computational complexity is increased and the speed of the algorithm is decreased.

Compared to some other methods, Detectron2-based orb slam performs better for static datasets and performs better than YOLO orb slam in all datasets.

sequences		f/w/xyz	f/w/static	f/w/rpy	f/w/half	f/s/static
YOLO-SLAM	RMSE	0.0146	0.0073	0.2164	0.0283	0.0066
	Mean	-	-	-	-	-
	Median	-	-	-	-	-
	S.D.	**0.0070**	0.0035	0.1001	0.0138	0.0033
Det-SLAM (Ours)	RMSE	0.0482	**0.0017**	0.0389	0.0925	**0.0036**
	Mean	0.0383	**0.0012**	0.0309	0.0739	**0.0031**
	Median	0.0329	**0.0008**	0.0256	0.0631	**0.0030**
	S.D.	0.0296	**0.0012**	0.0237	0.0557	**0.0017**
	Traj	35.12%	50.06%	48.63%	47.99%	49.66%

YOLO-SLAM:

- You only look once (YOLO) is a state-of-the-art, real-time object detection system. On a Pascal Titan X, it processes images at 30 FPS and has a mAP of 57.9% on COCO test-dev.
- One limitation of ORB-SLAM3 is its inability to detect and segment objects, which can be crucial in many navigation scenarios.
- To address this limitation, an enhanced ORB-SLAM3 with YOLO semantic segmentation, which is a high-performance object detection and segmentation framework.
- This is an improved version of ORB-SLAM 3 that adds an object detection module implemented with YOLOv5 to achieve SLAM in dynamic environments.
  - Object Detection
  - Dynamic SLAM
- The use of YOLO for SLAM is a promising research area that can potentially improve the accuracy and efficiency of robot navigation and mapping. The studies reviewed here have shown that integrating object detection with SLAM can lead to more robust and accurate localization, and real-time performance can be achieved with the use of optimized YOLO models.
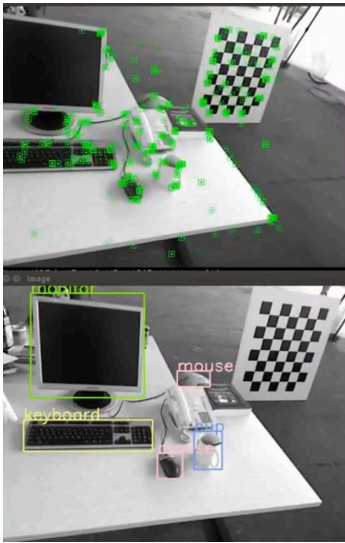
Issues Faced (with the above implementations):

- Issues building Detectron 2 library. Pytorch version mismatch
- No ROS support for the implementation of Det Slam
- Can't find weights for yolo orb slam
- No output/Black screen for other RGB-D datasets for yolo orb slam (KITTI for example)

References:

- https://github.com/aseslamian/Det-SLAM/tree/main
- https://github.com/thien94/orb_slam3_ros
- https://github.com/YWL0720/YOLO_ORB_SLAM3
- https://github.com/qixuxiang/orb-slam2_with_semantic_labelling
- Eslamian, A., & Ahmadzadeh, M. R. (2022, December). Det-SLAM: A semantic visual SLAM for highly dynamic scenes using Detectron2. In *2022 8th Iranian Conference on Signal Processing and Intelligent Systems (ICSPIS)* (pp. 1-5). IEEE.
- Carlos Campos, Richard Elvira, Juan J. Gómez Rodríguez, José M. M. Montiel and Juan D. Tardós, ORB-SLAM3: An Accurate Open-Source Library for Visual, Visual-Inertial and Multi-Map SLAM, IEEE Transactions on Robotics 37(6):1874-1890, Dec. 2021.
- Y. Anebarassane, D. K. P, C. A, A. P and S. K, "Enhancing ORB-SLAM3 with YOLO-based Semantic Segmentation in Robotic Navigation," *2023 IEEE World Conference on Applied Intelligence and Computing (AIC)*, Sonbhadra, India, 2023, pp. 874-879, doi: 10.1109/AIC57670.2023.10263892.