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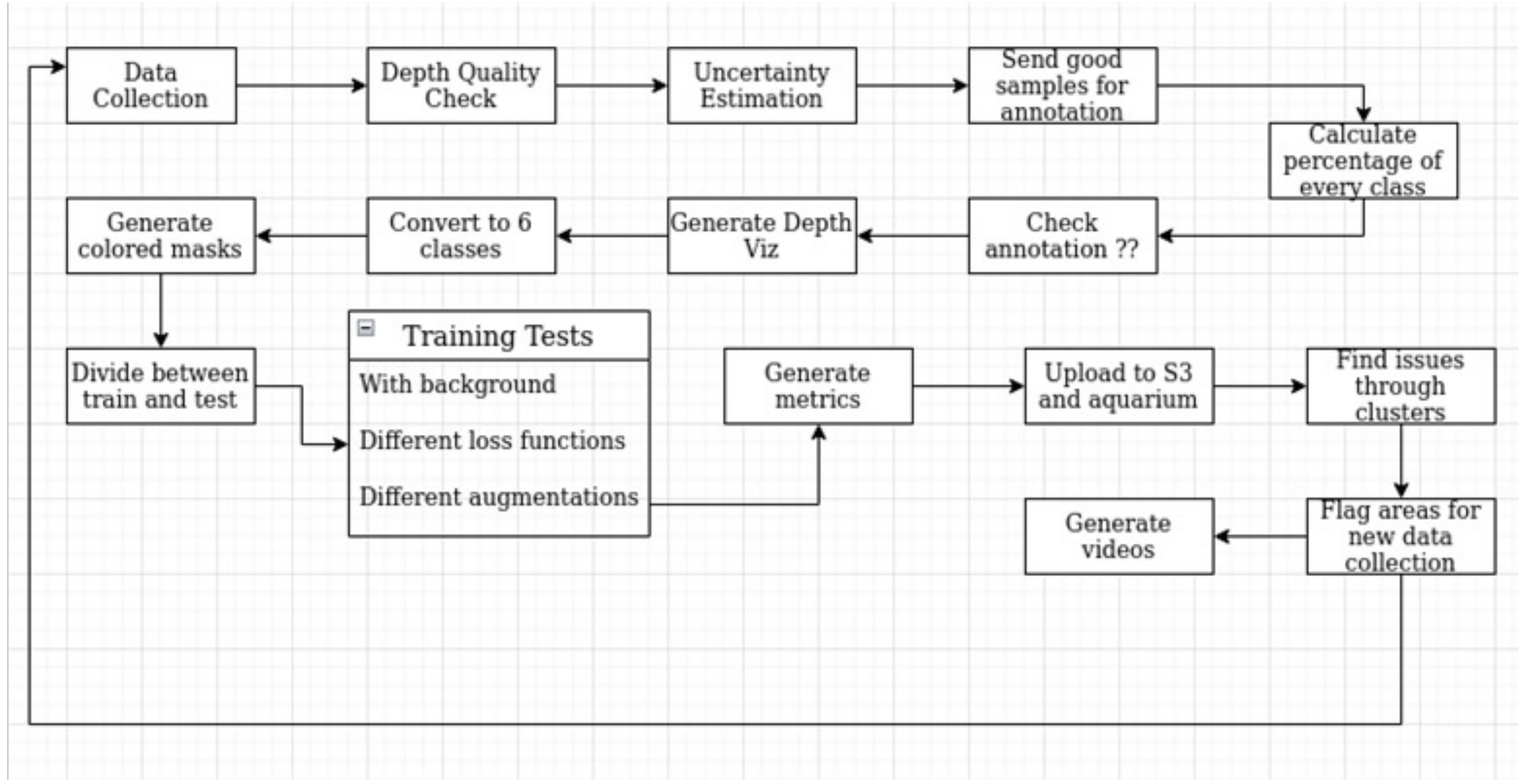
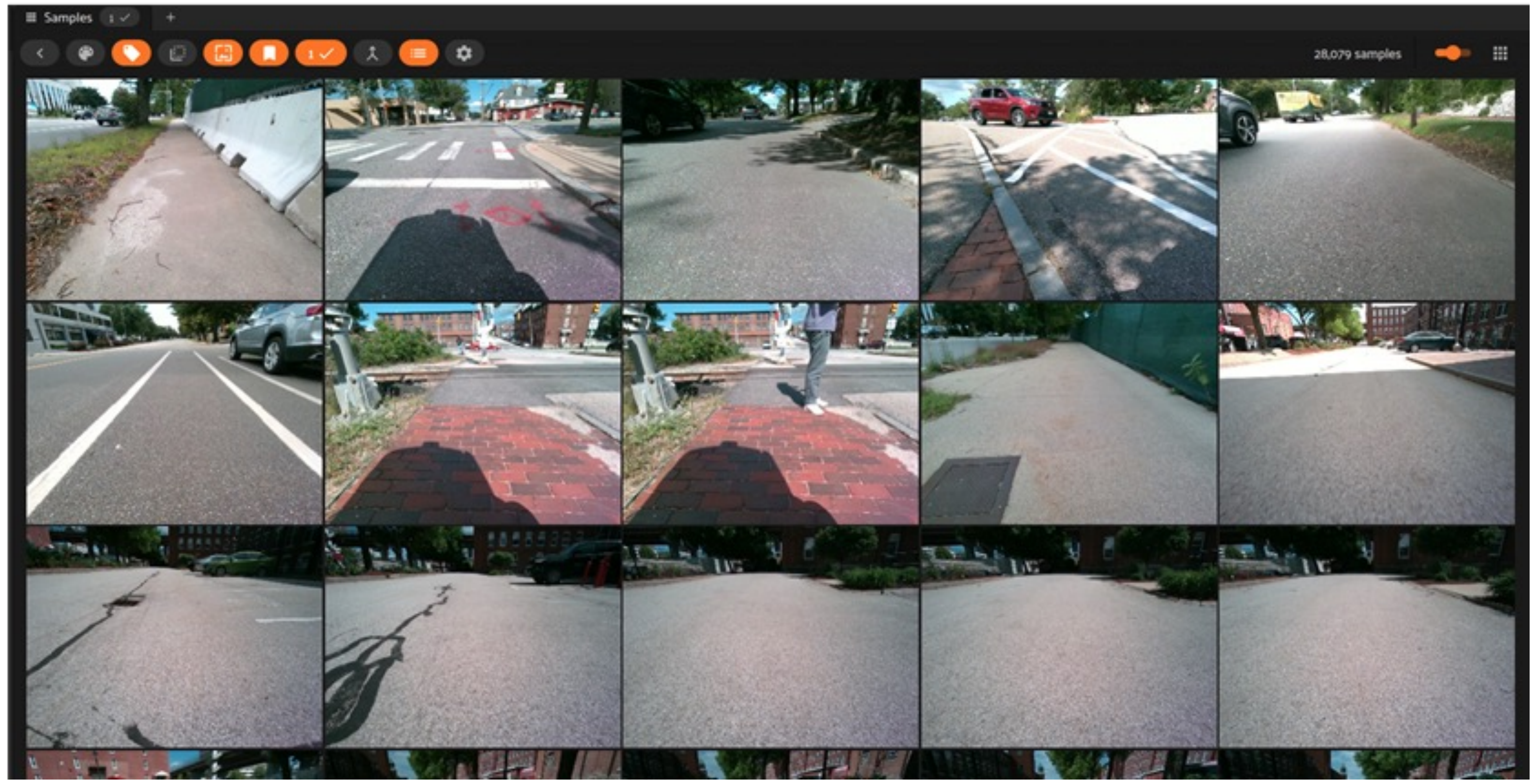
The potential PhD Candidate

Project 1

Terrain Analysis –Stereo Camera

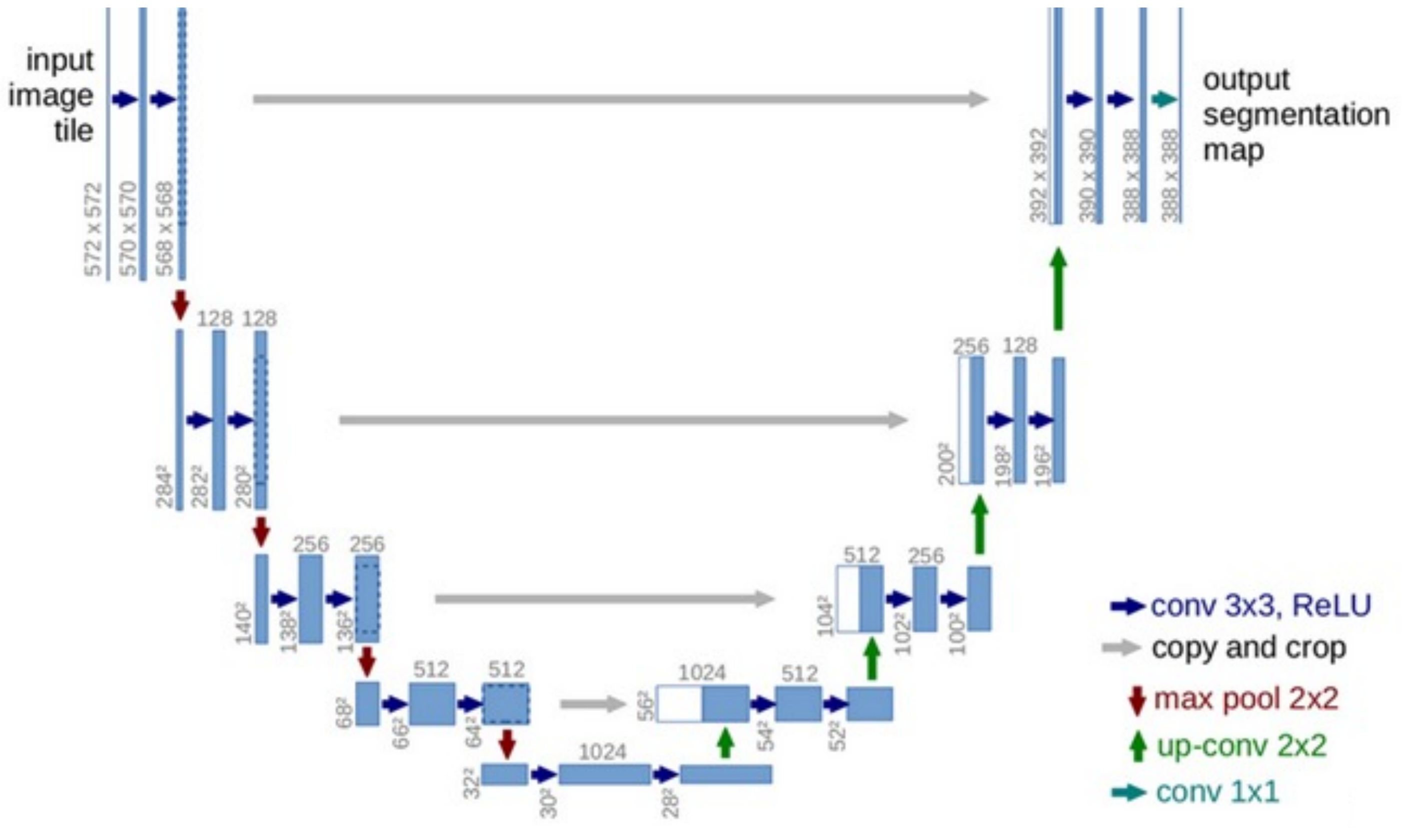
Upon joining Deka, my initial assignment involved classifying different terrains within images based on their drivability, specifically identifying areas where the robot could navigate.

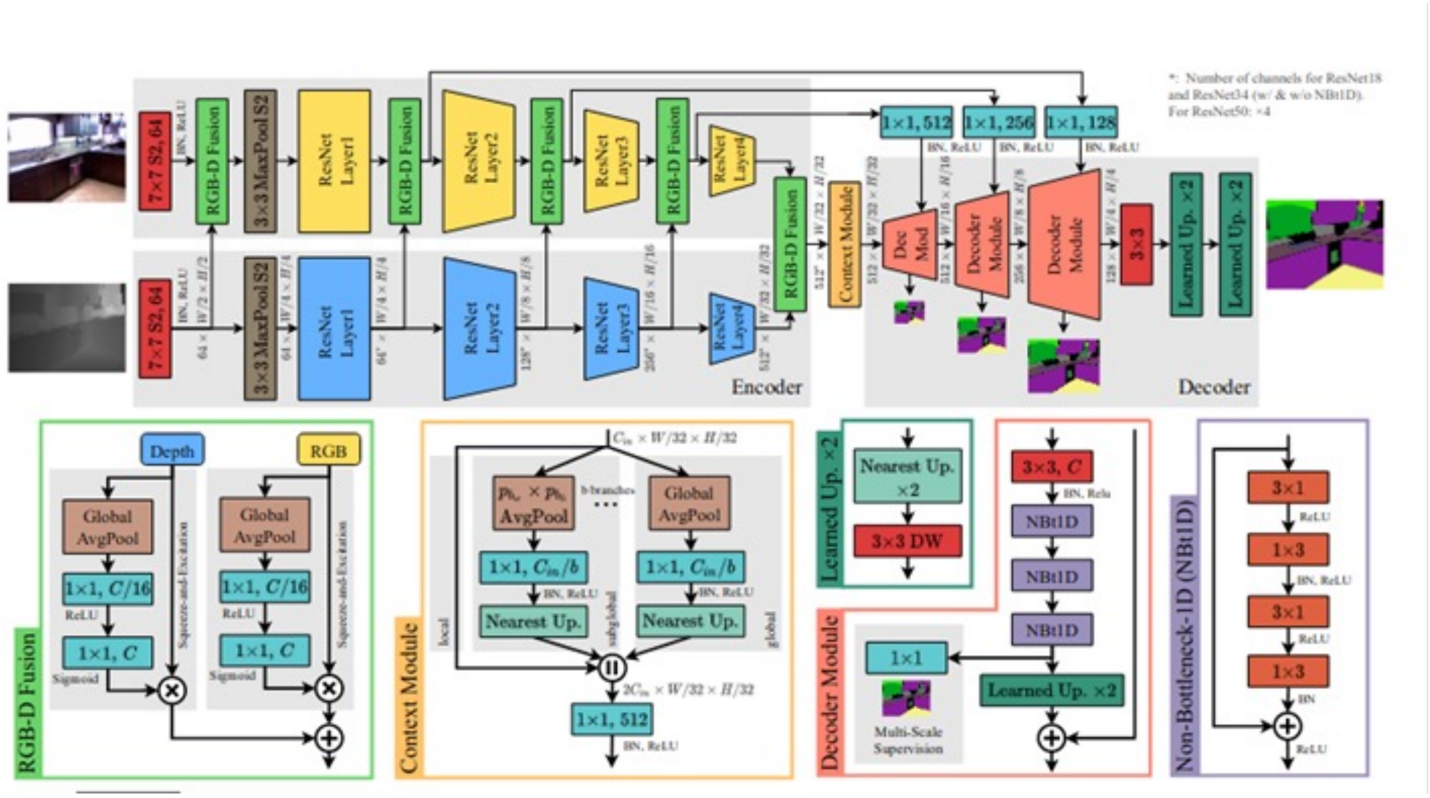




RGB - RGBD

- Trained a segmentation model that processed RGB images and provided pixel-level classifications.
- However, a significant issue arose as the model was consistently failing to distinguish key elements such as flat curbs from regular curbs, tall grass from short grass, and potholes from uneven surfaces.
- These distinctions were essential because the robot's navigation and decision-making processes had to adapt based on these environmental features.
- It became evident that incorporating depth information through stereo cameras was imperative to address these critical limitations.



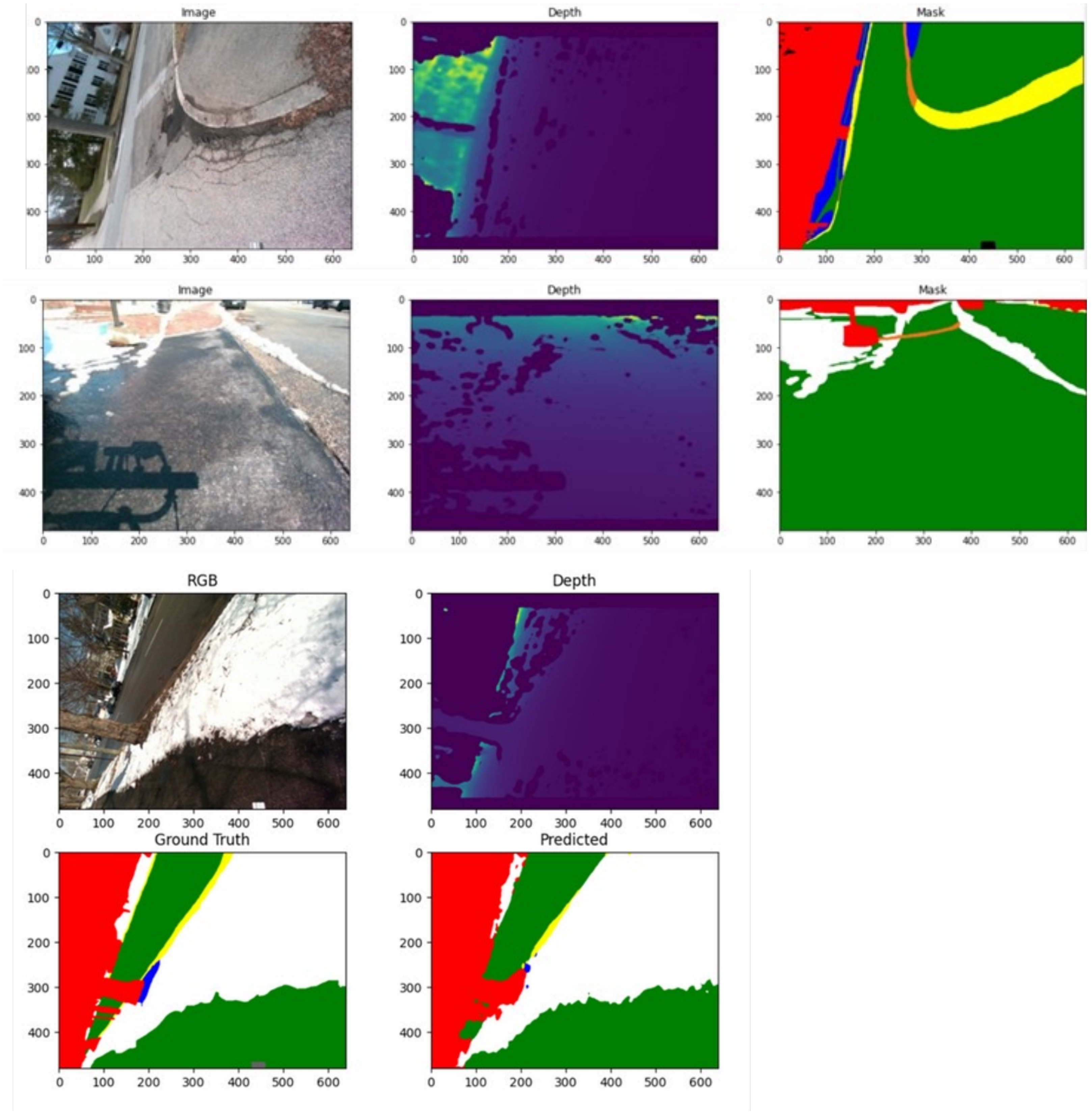


Challenges

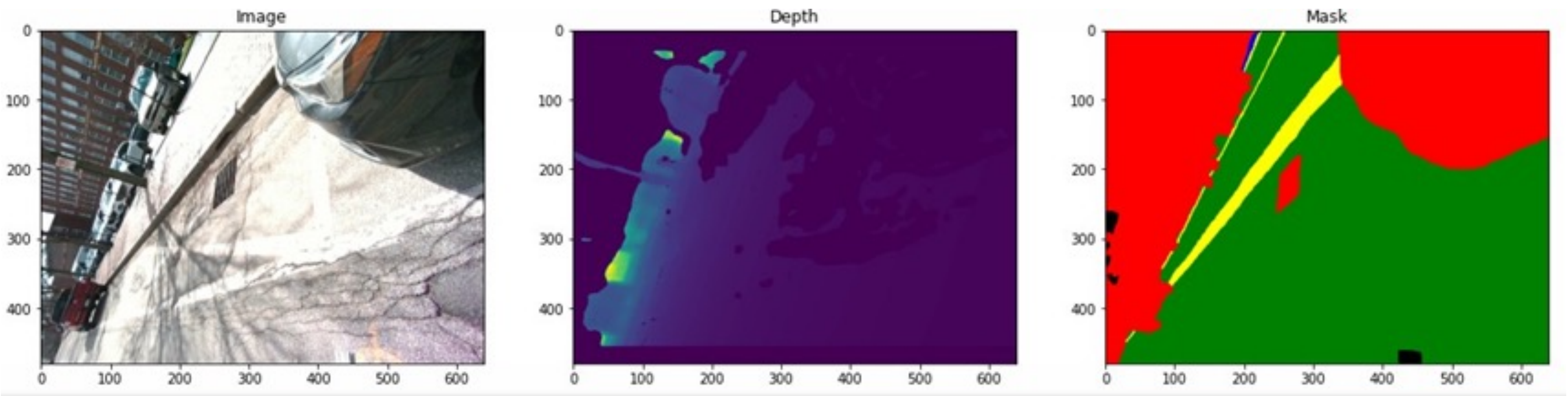
- **Class Imbalance:** One initial issue was class imbalance in the data. I addressed this problem by implementing the Focal Loss function, which helped improve model performance on underrepresented classes.
- **Evolving Project Challenges:** As the project's problem statement evolved, the robot's physical configuration, including the camera's position, underwent frequent changes. These alterations introduced challenges such as data redundancy and variations in perspective. To address these issues, ongoing adjustments, data augmentation, and training with base link depth information were necessary to maintain and improve the model's performance.
- **Depth-related Issues:** There were challenges related to depth perception, particularly in scenarios involving reflections, puddles, and varying lighting conditions. These issues remain a work in progress as I continue to refine the model to handle such complexities.

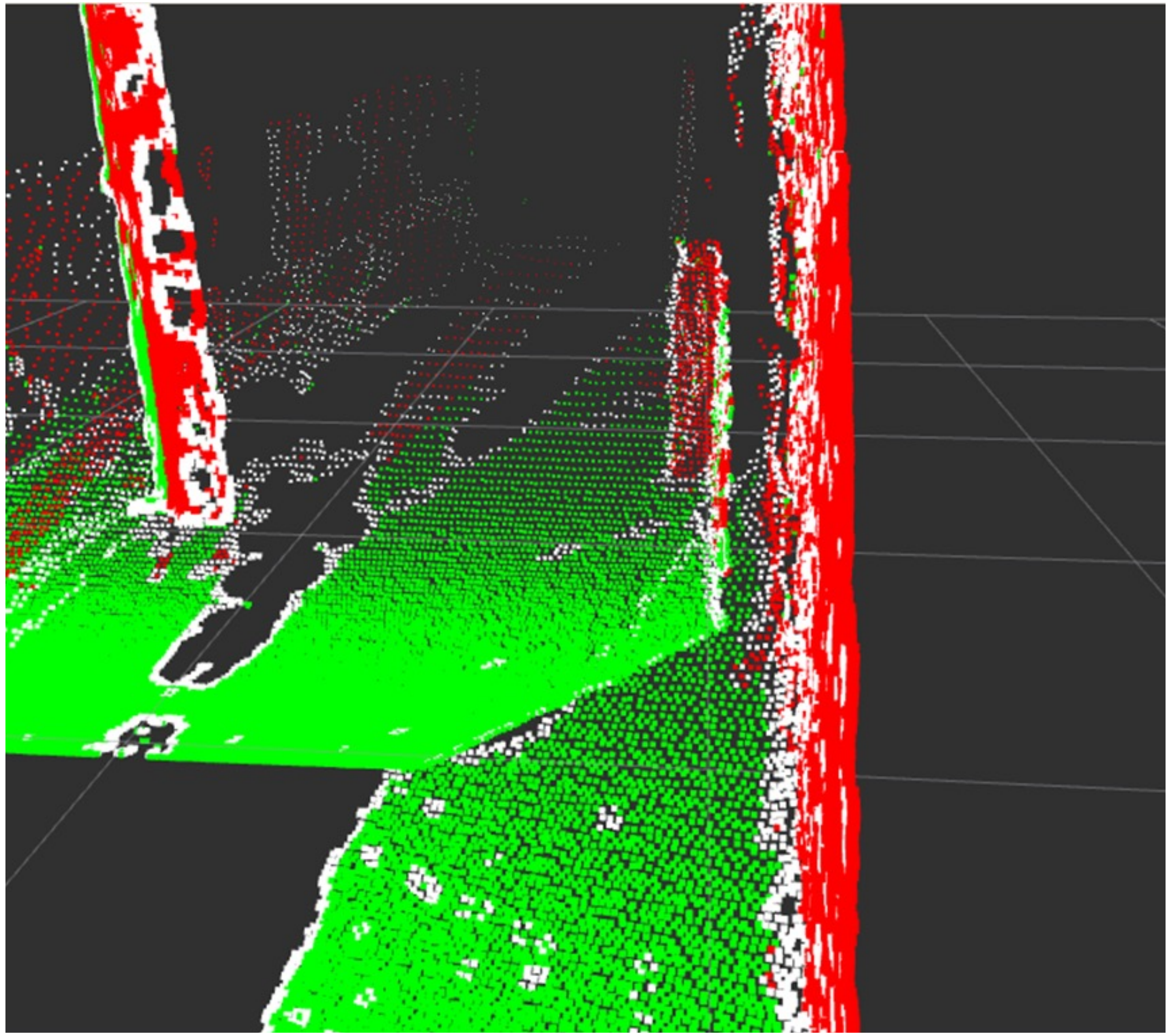
$$FL = -(1 - P_t)^{\gamma} \log(P_t)$$

$$CE = -\log(P_t)$$



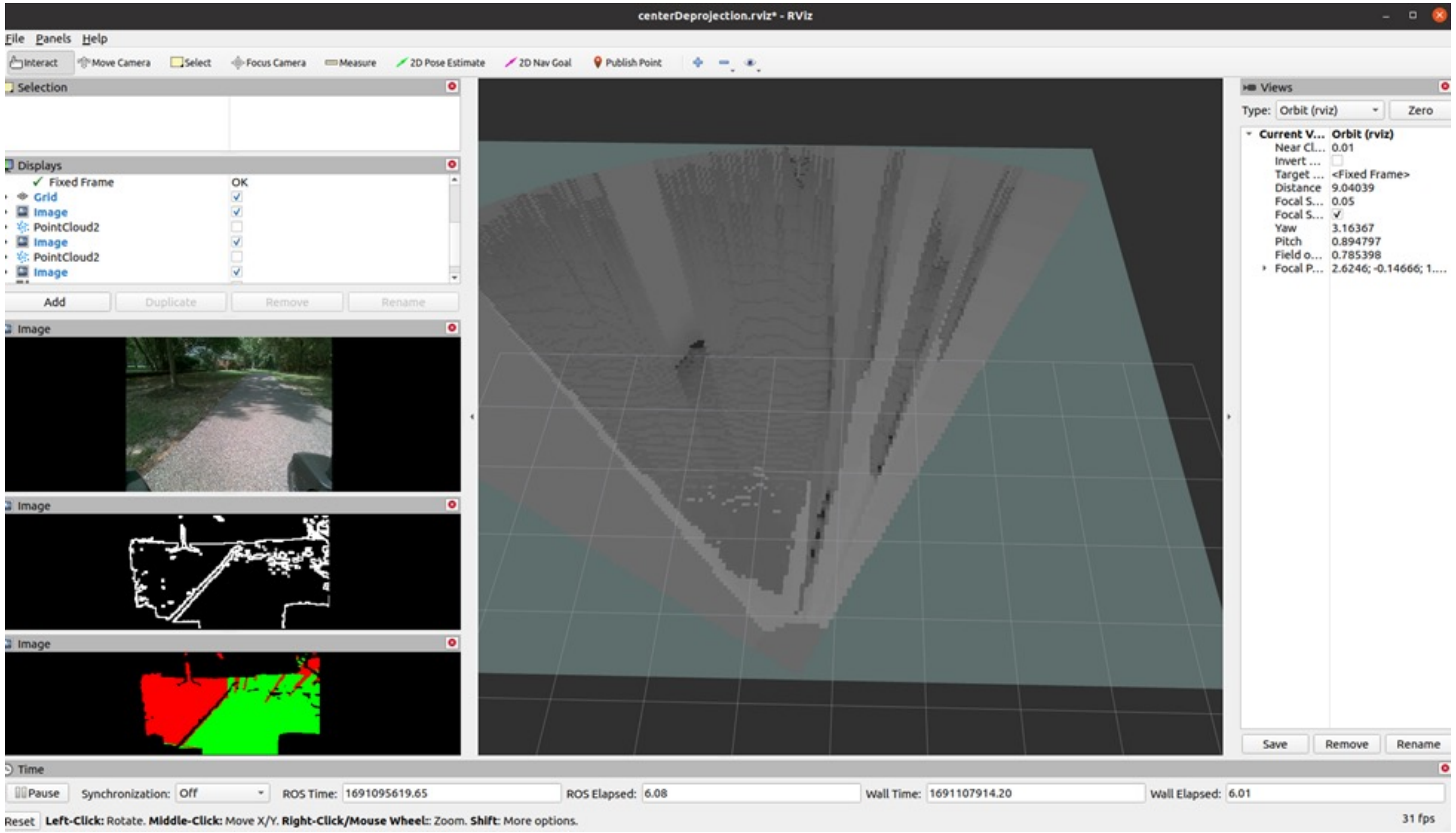
```
-----------IoU of each classes-----------
background        : 79.434233 %
non-drivable        : 87.353057 %
std-drivable        : 95.335846 %
enh-drivable            : 86.125365 %
curbs          : 59.013583 %
flat-curbs        : 39.728308 %
```





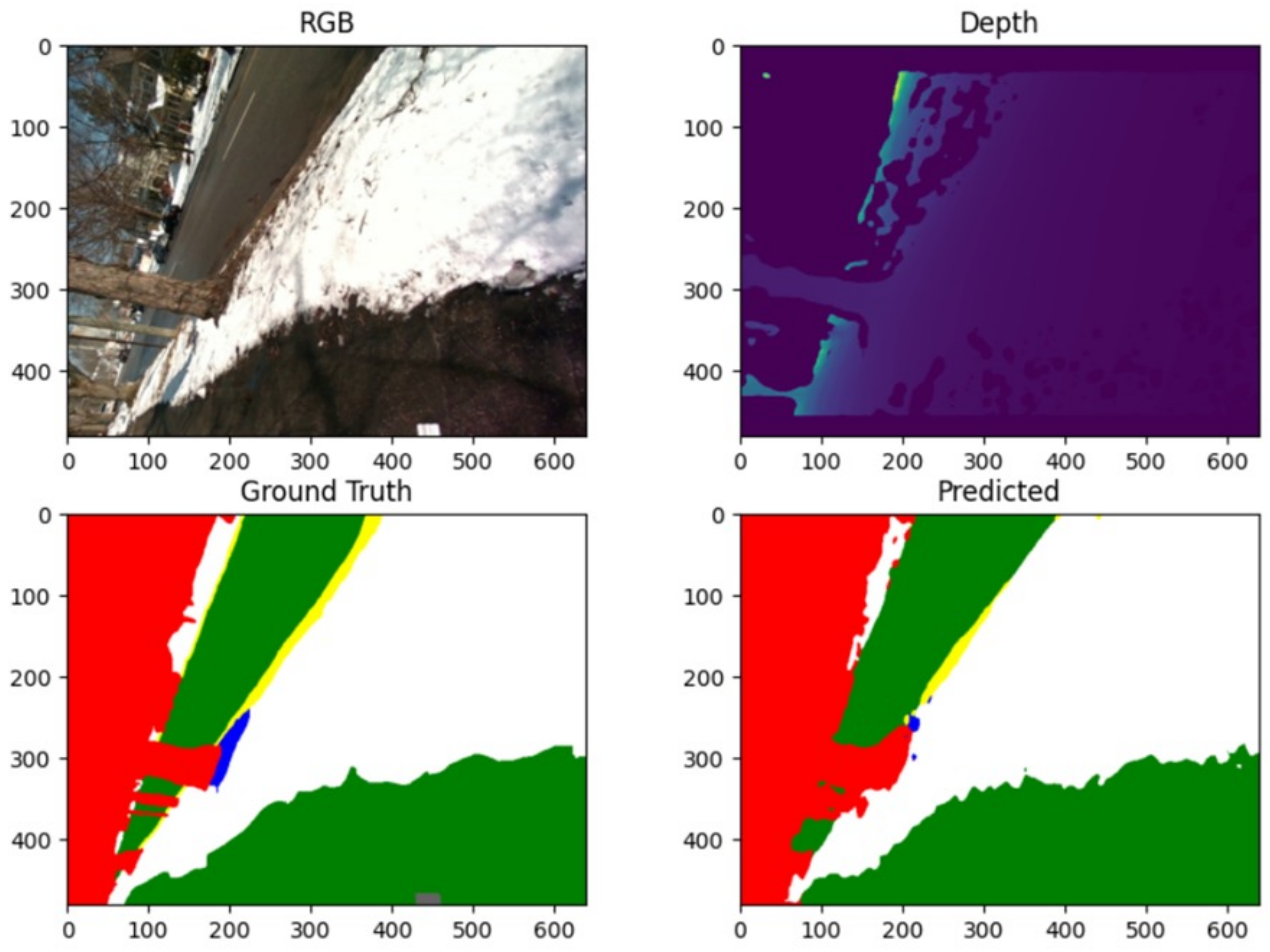
Deterministic Method

- Utilized depth data as the input for analysis.
- De-projected depth information into the base link frame.
- Implemented a smoothening process to reduce noise in the data.
- Applied voxelization in 2D space to simplify the representation of the environment.
- Generated a normal edge map to account for variations in angles and heights.
- Employed a standard ray path mask for systematic analysis.
- Iterated through each ray and segmented edges based on specific criteria.
- Identified and addressed holes in the data through weighted interpolation techniques.
- Encountered numerous edge cases, particularly related to curbs and slopes, which required additional attention.
- Experimented with RGB edge detection but faced challenges including noise, lack of overlap, and excessive processing time.



Multi-task model

- **Input**: Utilizing depth and RGB data for boundary detection, segmentation, and depth hole filling.
- **Hardware Constraints:** Unable to support monocular depth estimation with transformers due to slow processing speed, hindering real-time operation.
- **Lack of Ground Truth:** Absence of ground truth data for depth completion poses evaluation challenges.
- **Shared Backbone:** Considering the possibility of using the same backbone for both depth and RGB tasks, as RGB features are crucial for depth hole filling.
- **Literature Insights:** Exploring the potential benefits of auxiliary tasks, based on findings from literature reviews.



<u>**Project 2: Overview**</u>

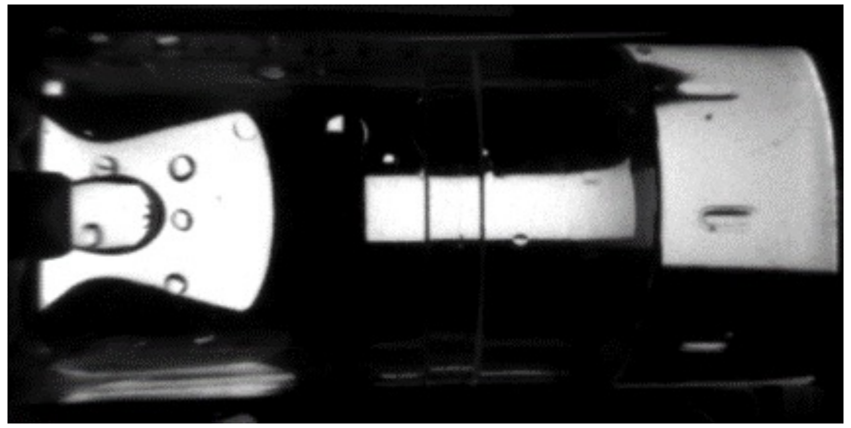
Medical Devices

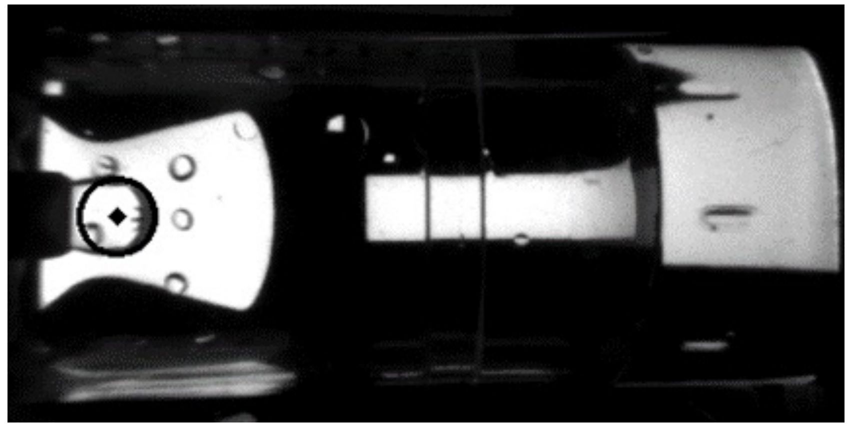
Kidney Segmentation

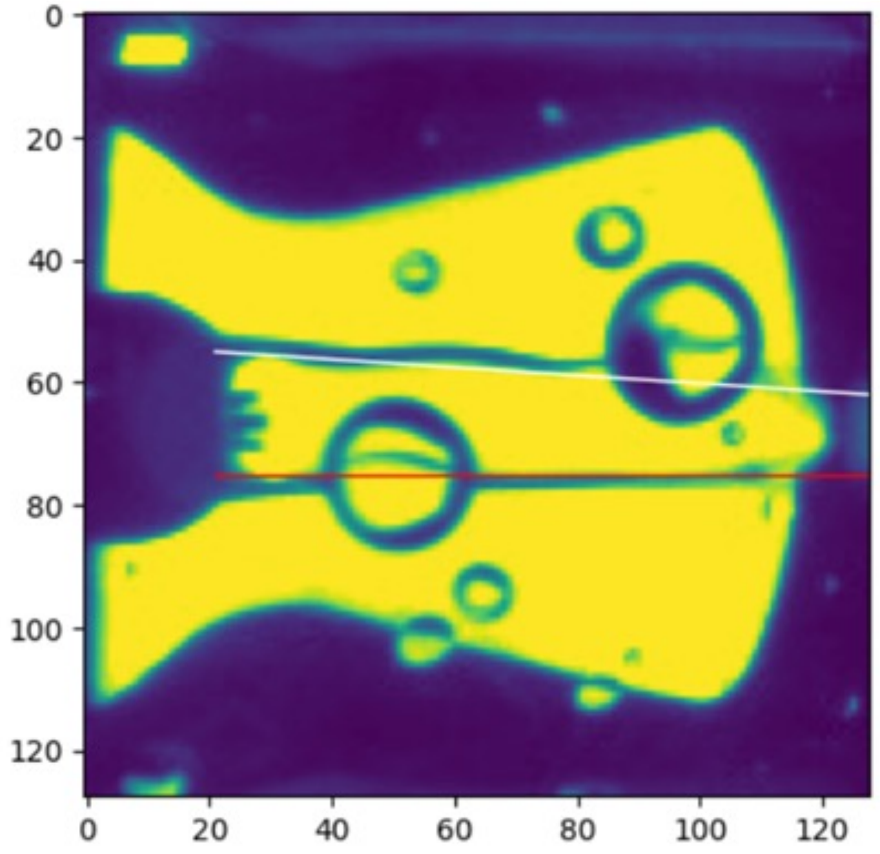
Developed a segmentation model to identify and track changes in the size and color of the kidney.

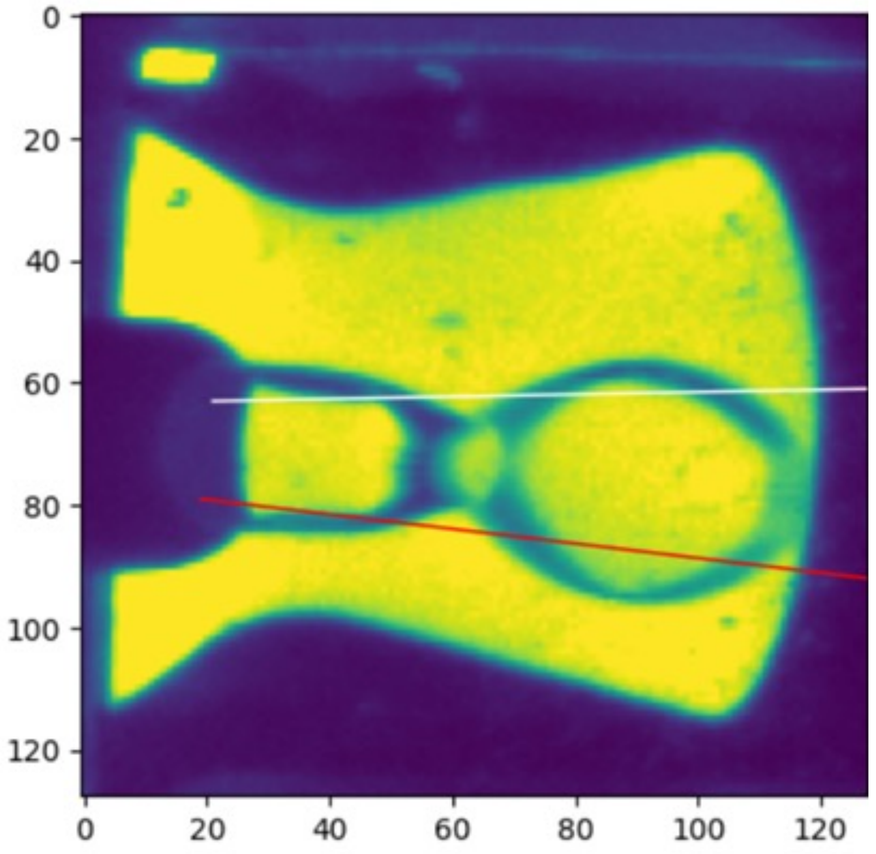
Flow Rate Calculation

Created a solution for identifying drops and streams amidst splashes to accurately calculate the flow rate of medicine. The solution involved the use of Hough transforms.









IT IS A STREAM