Out of distribution detection in 3D semantic segmetation models

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Motivation

- We study the out of distribution(OOD) detection in 3D semantic segmentation setting using the uncertainty estimation proposed in [1].
- Recent days, study of OOD is important for the safety and access the performance of the models especially in context of autonomous driving.
- Examples for importance of OOD is discussed in next slide.

[1] S. Bhandary, N. Hochgeschwender, P. Plöger, F. Kirchner, and M. Valdenegro Toro. Evaluating uncertainty estimation methods on 3d semantic segmentation of point clouds. arXiv e-prints, pages arXiv–2007, 2020.

Motivation - Examples

- The following two examples specify why OOD is required for safety in real world applications.
- The below two misdetections question the safety and performance of model in Tesla autopilot.

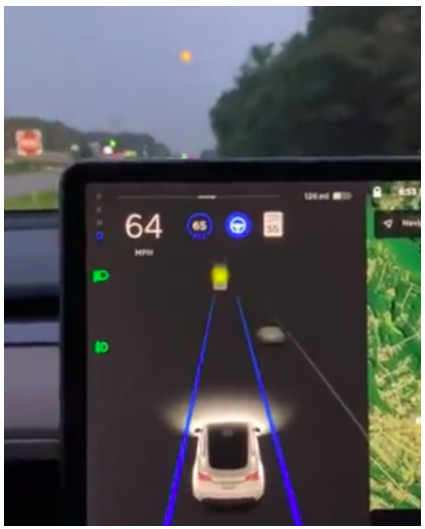

Figure: Tesla autopilot detecting the moon as the yellow sign board [1]

Figure: Another misdetection from tesla autopilot, burger king sign as stop sign board [1]

[1] T. Levin. Tesla's full self-driving tech keeps getting fooled by the moon, billboards, and burger king signs, 2021.

Research questions

The research questions answered in this thesis are:

RQ1 How to create a benchmark over 3D segmentation datasets for the out of distribution(OOD) setting? i.e., create the in and the out distribution datasets.

RQ2 How to extend the current OOD detection methods from 2D classification task to 3D semantic segmentation?

RQ3 Is uncertainty quantification an effective approach to classify the OOD detection in 3D semantic segmentation models?

RQ4 How to evaluate the OOD detection over the 3D semantic segmentation task?

Deliverables

Minimum Viable

- Systematic literature survey of
  - Datasets in 3D LiDAR semantic segmentation.
  - Existing out of distribution methods.
  - 3D models for semantic segmentation on LiDAR data.
- Proposal of 3D benchmarking datasets for out of distribution detection.
- Study of uncertainty estimation over 3D models for OOD detection.
- Extension of OOD detection method to a baseline 3D model.

Deliverables

Expected

- Systematic evaluation of the extended baseline model over the benchmarked dataset.
- Extension of the state of the art model for OOD detection.
- Evaluation and comparison of the extended state of the art model to baseline algorithm.

Desired

- Draft a research paper with the insights/findings from thesis.
- Proposal of a refinement over the current OOD model for higher performance.

Questions

Progress

- ☑ Study of the LiDAR datasets available for 3D semantic segmentation
- ☑ Study of available models for 3D semantic segmentation
- ☞ OOD dataset benchmarking formulation
- ☞ Study of uncertainty methods
- ☞ Understand and run code for uncertainty estimation in 3D models as proposed in [1]
- ☐ Study of OOD methods available and their application in 3D models

[1] S. Bhandary, N. Hochgeschwender, P. Plöger, F. Kirchner, and M. Valdenegro Toro. Evaluating uncertainty estimation methods on 3d semantic segmentation of point clouds. arXiv e-prints, pages arXiv–2007, 2020.