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Master Thesis Proposal

Project Proposal Title

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1 Introduction

Many robotic [cite], autonomous driving [cite] systems deployed in real world, dynamic environments now use LiDAR as the primary sensor. The 3D LiDAR data acquired offers a true-size replica of rich 3D geometry and can be represented as 3D point cloud format or using 2D grids. eg: range image representation [cite]. Semantic scene understanding is one of the key component of autonomous driving systems. Semantic segmentation is an important task in semantic scene understanding. Semantic segmentation requires labelling of each datapoint (3D point in LiDAR/pixel in camera) with its corresponding class.

The existing models for 3D semantic segmentation are insanely complex and uncertain about their detections [cite]. This uncertainty in addition with input as out of distribution (OOD) object question the safety and performance of the models. One such real world example is Tesla autopilot stops after misdetecting a billboard with "STOP" written on it as a traffic stop sign [cite]. Another such failure is the same autopilot detecting the moon as a yellow sign and slows the car [cite]. In all the above scenarios, the model is unable to detect the object as OOD and resulting in undesired outcomes.

A decade long studies has been performed on task of semantic segmentation, [cite 16] referrs to all the traditional approaches based on handcrafted features. With the advent of deep learning, a richer feature representation led to mapping input to semantic labels as an end to end procedure. The most popular 3D semantic segmentation datasets in the context of autonomous driving are Semantic KITTI [cite], nuScenes-lidarSeg [cite] and Sydney Urban [cite] collected by various sensors are publicly available. 3D semantic segmentation datasets are limited in size and diversity because labeling is intensive and requires special skill to handle.

There are diverse range of methods for the task of 3D semantic segmentation. They inlcude point based methods such as PointNet++ [cite], RandLA-Net [cite], and many more. There also exists image based methods which employ various projection algorithms and popular methods in this segment include SqueeseSegV3 [cite], RangeNet++ [cite], and SalsaNext [cite]. Graph based and Voxel based methods are some of their own kind to solve the task of 3D semantic segmentation. In the later sections, we will discuss about the problem statement, corresponding

related work and project plan.

1.1 Problem Statement

2 Related Work

- What have other people done?
- Why is it not sufficient?

2.1 Subsection 1

2.2 Subsection 2

3 Project Plan

In this section, the project plan including work packages, tasks and timeline for each task is proposed.

3.1 Work Packages

The bare minimum will include the following packages:

WP1 Literature Search

- Literature search on the existing 3D datasets on semantic segmentation for benchmarking.
- Literature search on the existing 3D models for semantic segementation.
- Literature search over the out of distribution methods.
- Documentation.

WP2 Dataset OOD benchmark proposal

- 3D semantic segmentation dataset collection for benchmarking.
- Benchmark datasets for in-distribution and out-distribution.

- Documentation.

WP3 Experimentation

- Implement an existing 3D semantic segmentation model as baseline model.
- Implement the state of the art (SOTA) 3D semantic segmentation model
- Extend the implemented 3D model (baseline and SOTA) to out of distribution detection problem.
- Documentation.

WP4 Evaluation

- Evaluate the baseline model and SOTA model on the proposed evaluation methods.
- Compare both the model on OOD detection
- Documentation

WP5 Project Report

- Update and review existing report sections (literature, datasets, experimentation and evaluation)
- Report completion and submission

3.2 Milestones

M1 Literature search

M2 Dataset benchmarking

M3 Models implementation

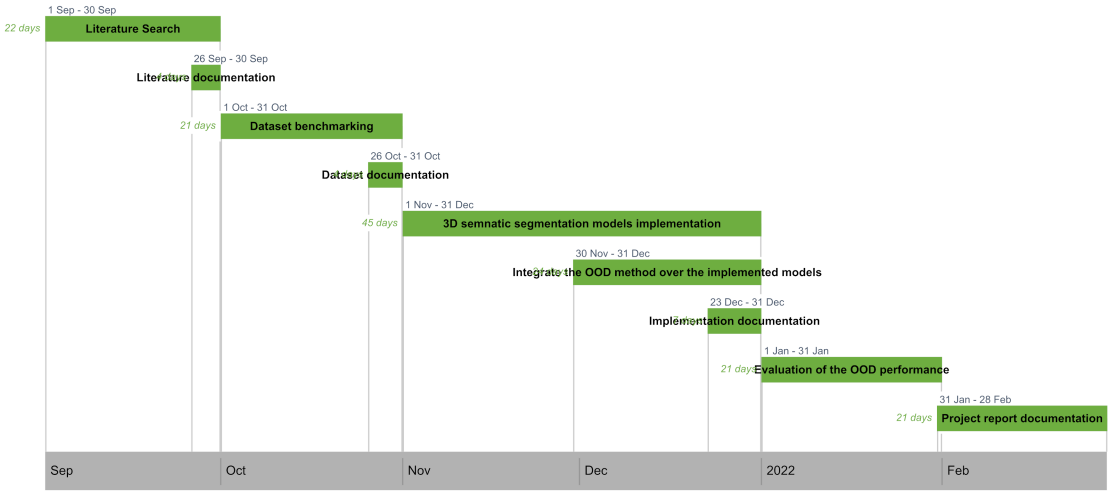
M4 Evaluation and comparison

M5 Report submission

3.3 Project Schedule

The detailed plan of tasks in duration of 6 months of thesis is given in figure [cite].

Figure 1: Illustration of project timeline



3.4 Deliverables

Minimum Viable

- Systematic literature survey of methods over
  - 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

Expected

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

Desired

- Proposal of a refinement over the current OOD model for higher performance

References

[1] Author Name. Book title. *Lecture Notes in Autonomous System*, 1001:900–921, 2003. ISSN 0302-2345.