Group Lab 3

End to End Problem Solving
Applications of AI in Autonomous Navigation

Learning Objectives:

At the end of this group lab experiment, you will have a complete end-to-end understanding of Machine Learning application in a specific domain i.e. Autonomous Navigation.

Domain Background:

The Machine Learning/Deep Learning in Autonomous navigation is very extensively used today. However, possibly for a long time to come, the full driving task is too complex an activity to be fully formalized as a sensing-acting robotics system that can be explicitly solved through model-based and learning-based approaches in order to achieve full unconstrained vehicle autonomy.

Localization, mapping, scene perception, vehicle control, trajectory optimization, and higher-level planning decisions associated with autonomous vehicle development remain full of open challenges. This is especially true for unconstrained, real-world operation where the margin of allowable error is extremely small and the number of edge-cases is extremely large. Until these problems are solved, human beings will remain an integral part of the driving task, monitoring the AI system as it performs anywhere from just over 0% to just under 100% of the driving.

Experiment:

For this group lab we expect you to pick or formulate any **one of the problems** that is related to Autonomous Navigation. Please read Computer Vision for Autonomous Vehicles: Problems, Datasets and State-of-the-Art to understand the related domain in detail.

Here is a simple framework that might help you build an end to end problem.

Would you be able to prioritize the **problem** you have considered above, based on the following (but not limited to):

- Impact of the solution
- Ease of finding the solution
- Availability of support infrastructure
- Cost of implementation
- Acceptability of the solution in the society
- Feasibility of deployment of the solution
- Necessary skill level required to use the solution

Questionnaire to be answered in the Presentation:

Your presentation must answer the below questions for the problem that you have formulated:

a. What are the five most important pieces of information you need to solve the problem (chosen) using Machine learning? Why? What are the sources for that information?
b. Is the final problem supervised, semi supervised or unsupervised? Describe.
c. What are the deficiencies that you are likely to encounter with the data collected?
d. How do you preprocess/represent the data, in order to feed it to the algorithm?
e. What is the algorithm that you choose for solving the problem with this data in this setting? Why?
f. What is the metric that you choose to evaluate and why?
g. How do know that the solution obtained is useful?
h. Brief the plan for entire process of model building and experimentation with all relevant details

Evaluation Criterion and Grading Scheme: Total Marks: 20

Prepare a 10 slide presentation using the template.

Each Team will have 8 minutes to present in their respective labs.

The Rubric of evaluation is the following:

a) Problem Statement (5M)
b) Responses to the Questionnaire and Concepts (5M)
c) Overall Presentation (10M)

Total Marks = 50% of marks awarded by lab mentor out of 20 + 50% of average of the marks awarded by the rest of the teams(one SPOC only) in the lab.

Example: Lab Mentor: 16 (50 % is 8 Marks) ; Team 1: 18; Team 2: 16; Team 3: 14

Average of Team 1,2 and 3 = (18 +16+14)/3 = 16 (50% of 16 is 8 Marks)

Total Marks: 8+8 = 16 Marks

Quick Reference to Datasets:

- You are free to use any other datasets as well.

No.	Organization/Dataset	Description of dataset	Source
1	IDD	The dataset consists of images obtained from a	https://insaan.iiit.ac.in/datasets/

		front facing camera attached to a car. The car is driven around the Hyderabad, Bangalore cities and their outskirts.	
2	CityScapes	The Cityscapes Dataset focuses on semantic understanding of urban street scenes.	https://www.cityscapes-dataset.com/news/
3	KITTI	The KITTI dataset has been recorded from a moving platform (while driving in and around Karlsruhe, Germany. It includes camera images, laser scans, high-precision). GPS measurements and IMU accelerations from a combined GPS/IMU system. The main purpose of this dataset is to push forward the development of computer vision and robotic algorithms targeted to autonomous driving	http://www.cvlibs.net/datasets/kitti/raw_data.php
4	Ford Campus Vision	A dataset collected by an autonomous ground vehicle testbed, based upon a modified Ford F-250 pickup truck. The vehicle is outfitted with a professional (Applanix POS LV) and consumer (Xsens MTI-G) Inertial Measuring Unit (IMU), a Velodyne 3D-lidar scanner, two push-broom forward looking Riegl lidars, and a Point Grey Ladybug3 omnidirectional camera system.	http://robots.engin.umich.edu/SoftwareData/Ford

5	Málaga Stereo and Laser Urban Data Set	This dataset was gathered entirely in **urban scenarios** with a car equipped with several sensors, including one **stereo camera (Bumblebee2)** and five **laser scanners**. One distinctive feature of the present dataset is the existence of **high-resolution stereo images** grabbed at high rate (20fps) during a **36.8km** trajectory, turning the dataset into a suitable benchmark for a variety of computer vision techniques	https://www.mrpt.org/MalagaUrbanDataset

Reference:

Research papers:

- Computer Vision for Autonomous Vehicles: Problems, Datasets and State-of-the-Art
- MIT Autonomous Vehicle Technology Study
- https://idd.insaan.iiit.ac.in/media/publications/idd-650.pdf

Research Articles related to the datasets

- https://idd.insaan.iiit.ac.in/media/publications/idd-650.pdf
- http://www.cvlibs.net/publications/Geiger2013IJRR.pdf
- https://arxiv.org/pdf/1604.01685.pdf
- https://journals.sagepub.com/doi/pdf/10.1177/0278364909103911