Simulation Framework for Driving Data Collection and Object Detection Algorithms to Aid Autonomous Vehicle Emulation of Human Driving Styles

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Research Question: **Is it possible to align Autonomous Vehicle's decision-making capabilities with the moral priorities, values, and social motivations of trustworthy human drivers?**

Motivation:

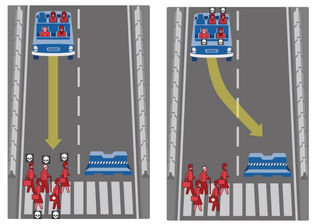
- While advances have been made towards the development of safe and competent autonomous vehicles, there has been inadequate attention to the control of autonomous vehicles in unanticipated situations, such as imminent crashes.
- In order to reproduce human driving behaviors in a simulated vehicle, it is necessary for the AV to be able to identify objects in the environment and evaluate the volume of their bounding boxes for prediction and planning.

Background:

- The ideal driving behavior or best crash outcomes can never be determined due to varying perspectives of the society
- To produce a well-rounded solution to this people started analyzing few imaginary crash scenarios inspired by philosophical works from 1960s till date – The Trolley Problem, The helmet problem etc.
- In order to comprehend the motivations and moral priorities of good drivers, we plan to use Schwartz Basic Individual values questionnaire in conjunction with the participants' crash responses towards the trolley problem-like scenarios created in an immersive driving simulator named CARLA (Car Learning to Act)

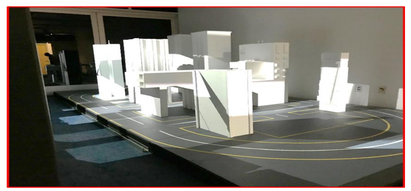
Literature Review:

- MIT Moral Machine Conducted a survey and collected around 40 million responses from people all over the world. This was done with an intention to establish a consensus over the ethical dilemmas in crash scenarios
- Instead of a Utilitarian or a Deontological approach, a possible approach is to align Autonomous Vehicles' with Virtue Ethics
- For the purpose of 3D Object Detection we use a Sensor Fusion Approach using a Multi Layer Perceptron over a PointNet architecture



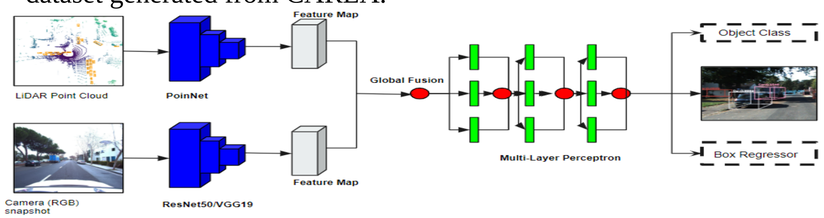
Method:

- A simulation framework for collecting, analyzing, and replicating human driving behaviors in a variety of scenarios, including crashes has been created in CARLA for this purpose.





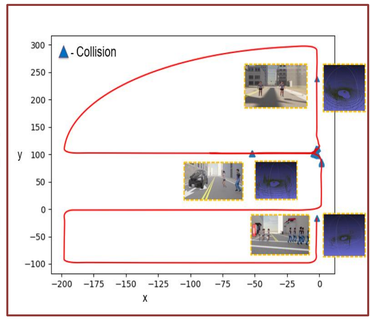

- An object detection algorithm is proposed, which can used to analyzes LiDAR point cloud data using the PointNet neural network architecture, processes RGB images via transfer learning using the Xception convolutional neural network architecture and fuses the outputs of these two networks. This algorithm was trained and tested on both the KITTI Vision Benchmark Suite dataset and a virtual dataset generated from CARLA.



Results and Discussions:

Simulation Framework:

Human driving data in the simulator such as mean distance to lead car, distance maintained during lane change and merges, braking distance, maximum and mean speeds at turns, speeds through school zones, and crash decisions will be collected from drivers with different Values Profiles (e.g., Benevolent or Powerful).



3D Object Detection:

KITTI Vision Benchmark		
TRAIN	TEST	VALID
6700 (no of images)	390 (no of images)	391 (no of images)

	VGG19	ResNet152	Inception	Xception
IoU	0.61	0.7	0.67	**0.72**
Class Accuracy	94.08%	95.62%	95.38%	**96.72%**

Van: **GREEN** Car: **BLUE** Pedestrian: **YELLOW** **Ground Truth: RED**

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