TRoVE: Transforming Road Scene Datasets into Photorealistic Virtual Environments

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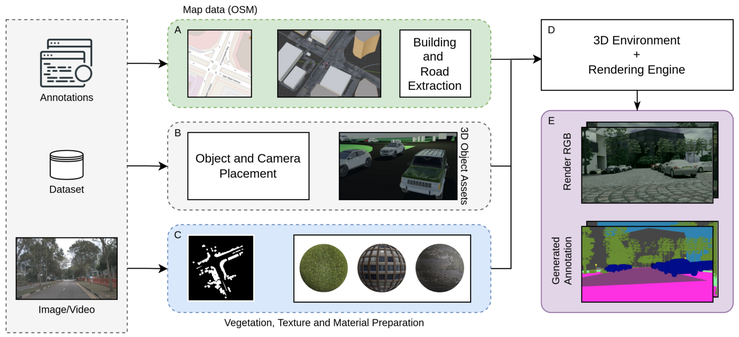
Problem Statement

The aim is to generate synthetic data efficiently with high degree of photo-realism and multi-modal annotations. We propose **TRoVE** as a toolkit for generating synthetic data for real-world locations using existing dataset annotations.

Synthetic Data Generation

The figure below summarizes the process used in TRoVE for data generation process, which we also highlight in the following points:

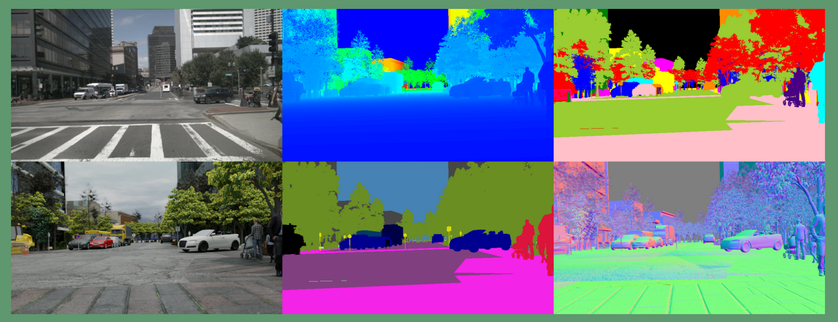


- **Virtual Environment**: We use OSM data and GPS location from annotated meta data to generate the Building and road layouts.
- **Camera and Objects**: For each available bounding box annotation, we select 3D object candidate fitting the box dimensions and place in the scene. Camera poses are simulated from meta-data if available otherwise randomly on vehicles.
- **Textures, Lighting & Background**: High-quality 4K PBR textures along with HDRI images for lighting are used for realistic scene layout. Vegeratation and Traffic poles/signs are spawned in the scene along the roads based on meta-data.

Scan for Toolkit Code Implementation, Dataset, Paper PDF, and 3D Assets used in the work.

https://github.com/shubham1810/trove_toolkit

TRoVE is a toolkit for effectively generating synthetic driving datasets from using existing datasets and annotations. Generating multi-modal datasets for various downstream tasks is one of the highlights in the proposed toolkit.



Highlighted samples from the data generation pipeline shows the multi-modal and diversity capabilities of the method for a similar scene layout with varying materials, lighting, colors and viewpoints.

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Experiments and Analysis

Training Method	Cityscapes		KITTI-STEP	
	mIoU	Accuracy	mIoU	Accuracy
R	70.25	98.88	59.81	98.39
S	30.63	95.50	27.64	92.96
S + R [F]	70.23	98.89	59.79	98.41
S + R [M]	70.82	98.93	**65.37**	**98.42**
S + C	37.03	95.84	46.14	95.92
S + C + R [F]	70.73	98.89	60.71	98.41
S + C + R [M]	**71.98**	**98.94**	63.93	98.38
P	61.44	98.65	56.44	98.28
S + P [F]	63.56	98.70	57.71	98.25
S + P [M]	**67.21**	**98.80**	61.72	**98.34**
S + C + P [F]	63.11	98.69	57.31	98.27
S + C + P [M]	65.75	98.78	**63.09**	98.33

The above table shows a brief report of the results from experiments performed on Cityscapes and KITTI-STEP datasets for semantic segmentation. The training method represents the training configuration where "S" is for synthetic, "R" for real, "P" is for partial-real data. "M" represents the training was done with mixed batch of synthetic and real, and "F" shows the real-world data was only used in fine-tuning. "C" represents usage of color-correction for color distribution alignment. Same results are visualized in the figure below for qualitative analysis.