USCILab3D: A Large-scale, Long-term, Semantically Annotated Outdoor Dataset

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Introduction

- Why do we need a new semantically annotated 3D dataset?

| Dataset	Frames	Indoor	Outdoor	LiDAR Point Cloud	Semantic
LLFF[14]	< 1K images	✓	✓	✗	✗
DTU[11]	30K images	✓	✗	✗	✗
ScanNet[6]	2,500K images	✓	✗	✗	✗
Tanks and Temples[13]	147K images	✓	✓	✗	✗
ETH3D[21]	<1K images	✓	✗	✗	✗
Matterport3D[4]	195K images	✓	✗	✗	✓
Habitat[17]	-	✓	✗	✗	✓
iGibson[24]	-	✓	✗	✓	✓
SemanticKITTI[3]	23K scans	✗	✓	✓	✓
USCILab3d (ours)	10M images 1.4M scans	✗	✓	✓	✓

Dataset features

- **<u>Long-term</u>**: Dataset collected over 12 months

- **<u>Large-scale</u>**: Data across 1.17 sq miles / 3.0 sq km.

- 10M 360 deg Multi-view RGB images

- 1.4M pointcloud scans

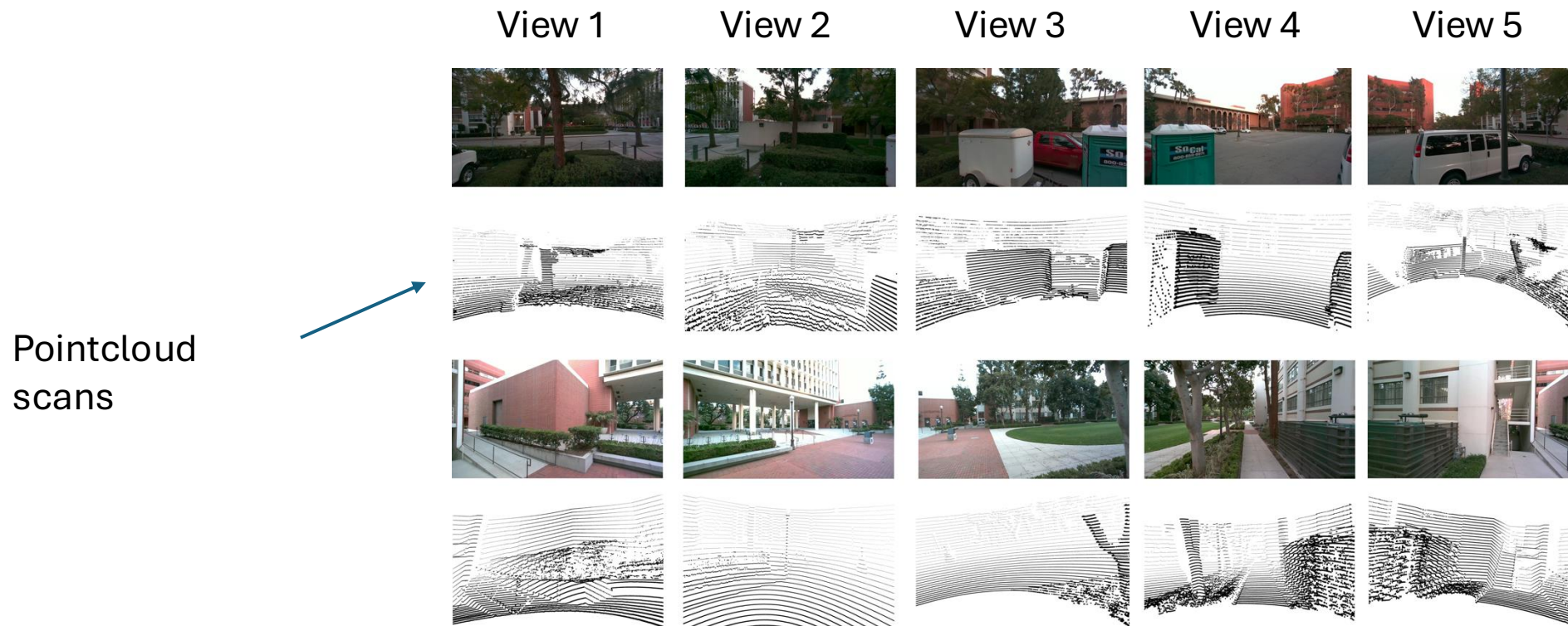- Automated pipeline for semantic annotations of pointcloud
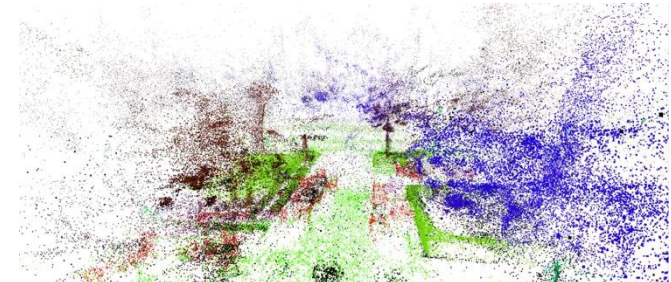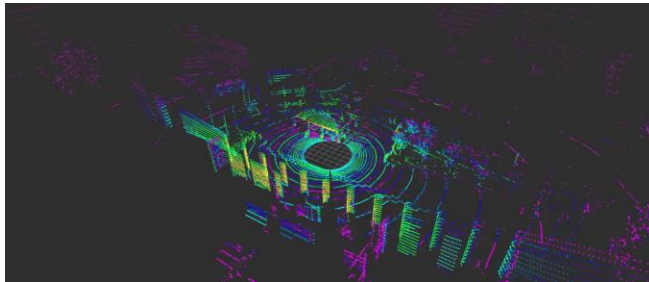
Dataset collection

- Data collected in various terrains, lighting conditions
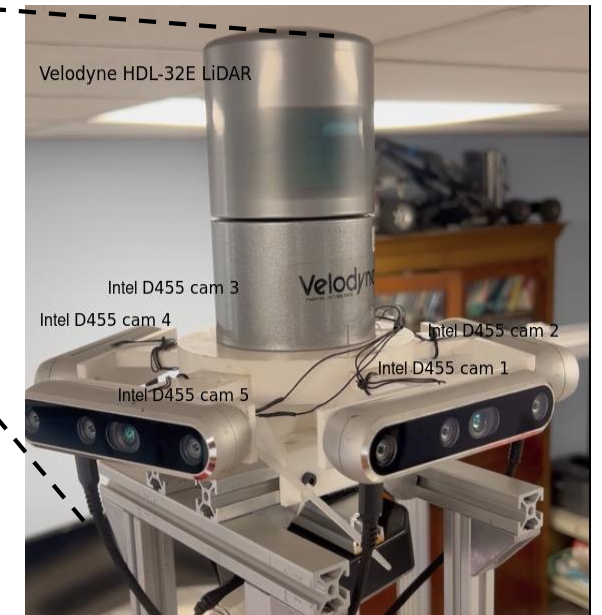
Synchronized multimodal pairs

- Pairs of multi-view images and pointcloud scans

View 1   View 2   View 3   View 4   View 5
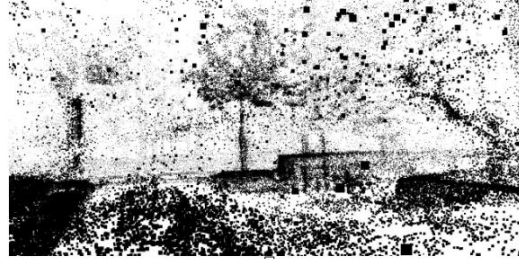
Pointcloud scans
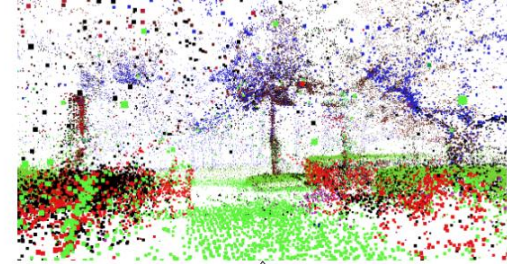
Annotation pipeline
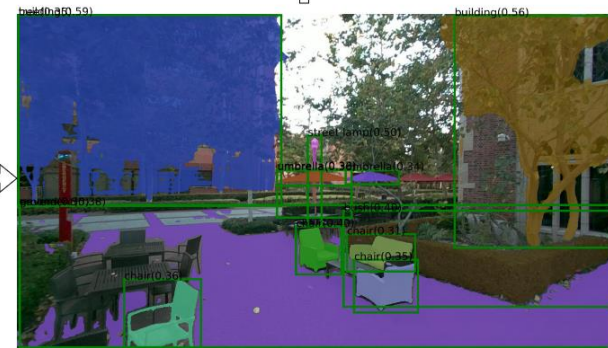
Input image

Raw pointcloud

Semantic pointcloud

Align 2D pixels with 3D points

GPT4

background, building, street lamp, building, umbrella, pavement, chair, ground, bush, umbrella, chair, chair, tree, chair, umbrella
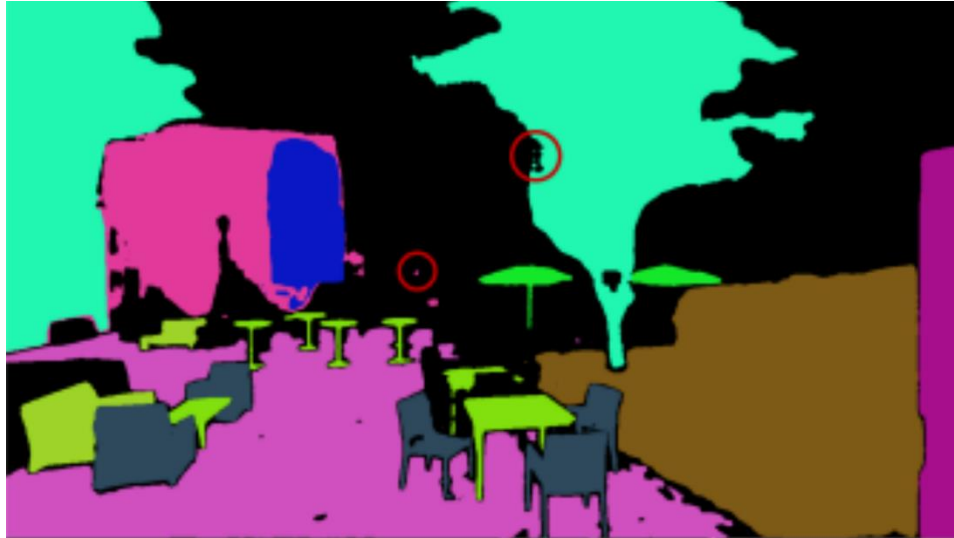
Grounded SAM

Semantic mask

Input prompt: *"Generate semantic labels.."*

Robustness

Only 0.92% pixel error with 10 additional candidate labels!

Prompt: Trees, Bushes, Benches, Tables, Chairs, Pavement, Buildings, Windows, Doors, Emergency Call Box, Umbrellas, Leaves, Grass

Prompt: Trees, Bushes, Benches, Tables, Chairs, Pavement, Buildings, Windows, Doors, Emergency Call Box, Umbrellas, Leaves, Grass, Fire Hydrant, Person, Car, Parking Lot Lines, Boat, Scooter, Dog, Bear, Cat

Additional spurious labels

Conclusion

- Following are our contributions:
  - Dataset consisting of multi-view images and pointcloud scans
  - Automated semantic annotations using foundation models and VLM
    - Postprocessing methods to avoid and remove outliers

- USCILab3D can be used for training/evaluating:
  - Models related to 3D perception
  - 3D generative models
  - NeRF/Gaussian splatting
  - 3D-LLMs

Thank you!

**Wed, 11 Dec
1PM-4PM CST**