Efficient Point Cloud Segmentation of Transportation Assets

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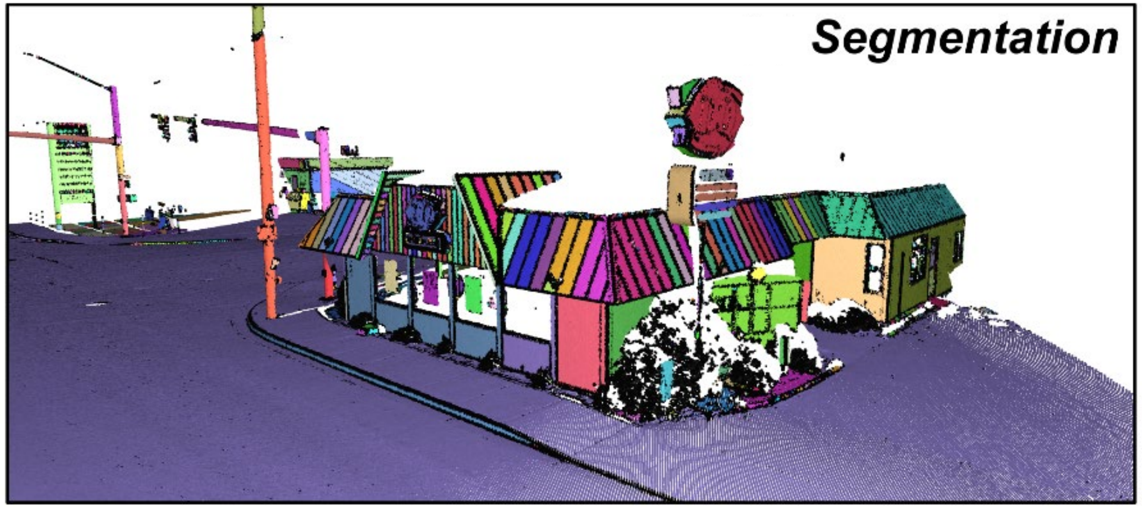
Preview of Key Takeaways

- Mo-norvana mobile lidar processing framework
  - **Automatic** (saving time & cost of manual processing)
  - **Efficient** (faster than other methods by orders of magnitude)
  - **Managing Data via Trajectory** (supports Per-point QA/QC)
  - **Point Cloud Segmentation** and **Feature Extraction**



Importance of Asset Management

Illinois County Pay $3M to Settle Case Over Missing Stop Sign in Fatal Crash

October 17, 2018

Missing stop sign blamed for serious crash

Benjamin Griffiths, James Felton
| Posted Sep 24, 2018 | 0

Jury must decide if missing stop sign or dangerous driving caused fatal crash near Langham

The Crown says Robert Major's dangerous driving caused a fatal crash on Highway 16. The defence blames the crash on a missing stop sign.

BRE MCADAM, SASKATOON STARPHOENIX Updated: January 25, 2019

$45 Million Lawsuit Stems from Missing Stop Sign Accident in Queens

On behalf of Law Offices of Nussin S. Fogel | Mar 6, 2018 | Diving Accidents

Stolen Stop Sign Causes Serious Crash in Benton City

Updated on: 4/15/2019

Missing stop sign blamed for Hyrum crash; victim requires plastic surgery

Posted: 9:40 PM, Jul 10, 2017 Updated: 9:11 PM, Jul 10, 2017
By: Jeff McAdam

Missing stop sign blamed for crash that hurt three people

By Danielle Furfaro and Reuven Fenton January 11, 2018 | 10:59pm | Updated

Man claims missing intersection stop sign caused crash

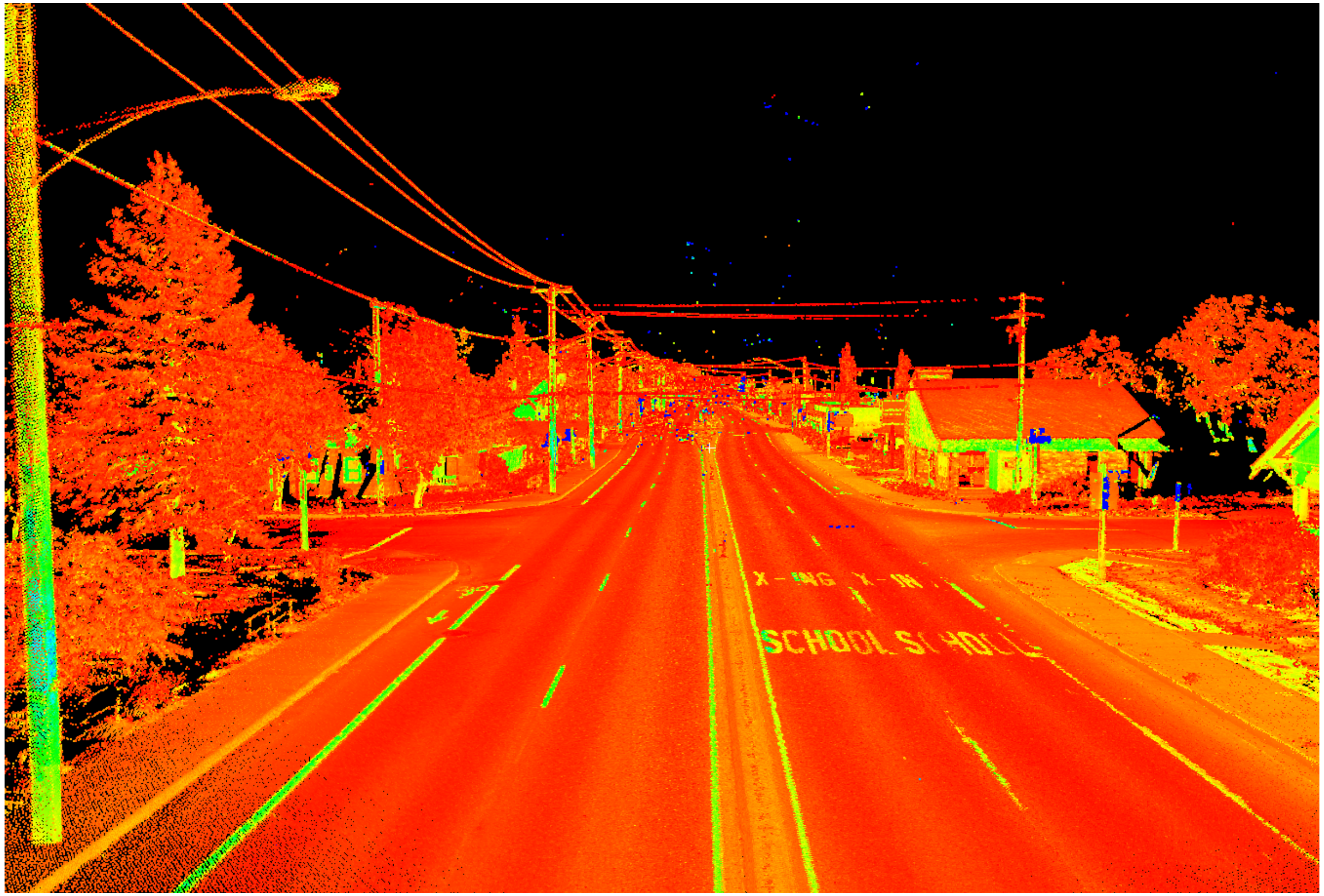
Author: Arrianee LeBeau
Published: 6:46 PM EDT March 15, 2017
Updated: 6:58 PM EDT March 15, 2017

Missing stop sign causes crash that seriously injures woman

By ABC12 News Team | Posted: Mon 2:53 PM, Aug 27, 2018 | Updated: Mon 3:35 PM, Aug 27, 2018

Mobile Lidar Technology Benefits

- Geo-referenced
- Safety
- Accuracy
- Efficiency
- Rich Information
- More Applications



Challenges with Data Processing

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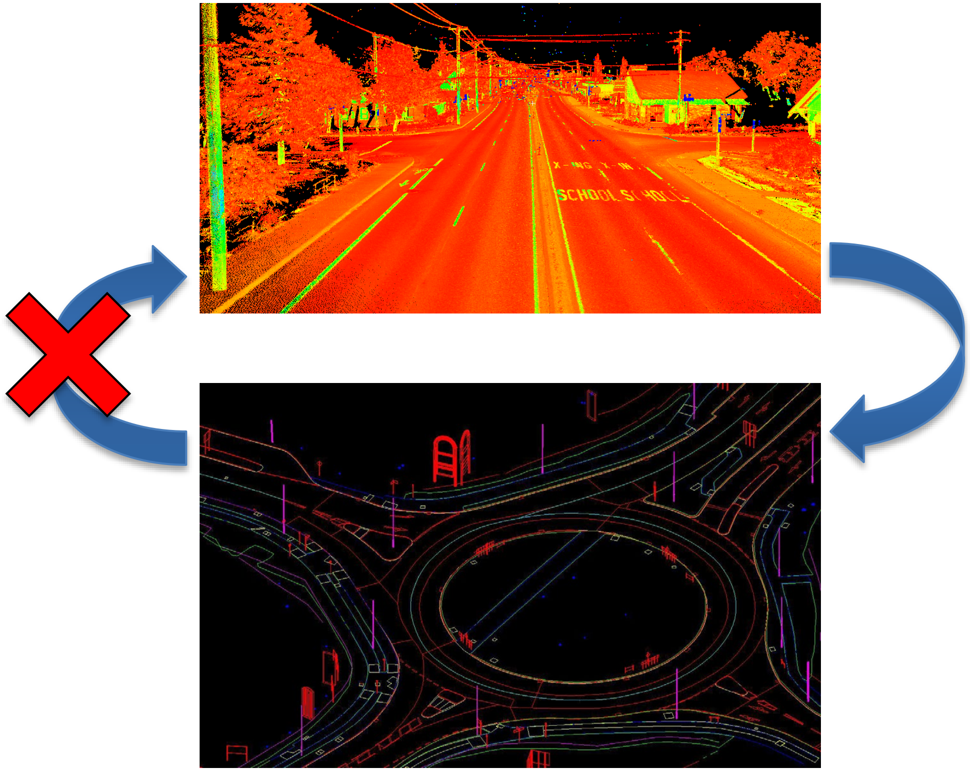
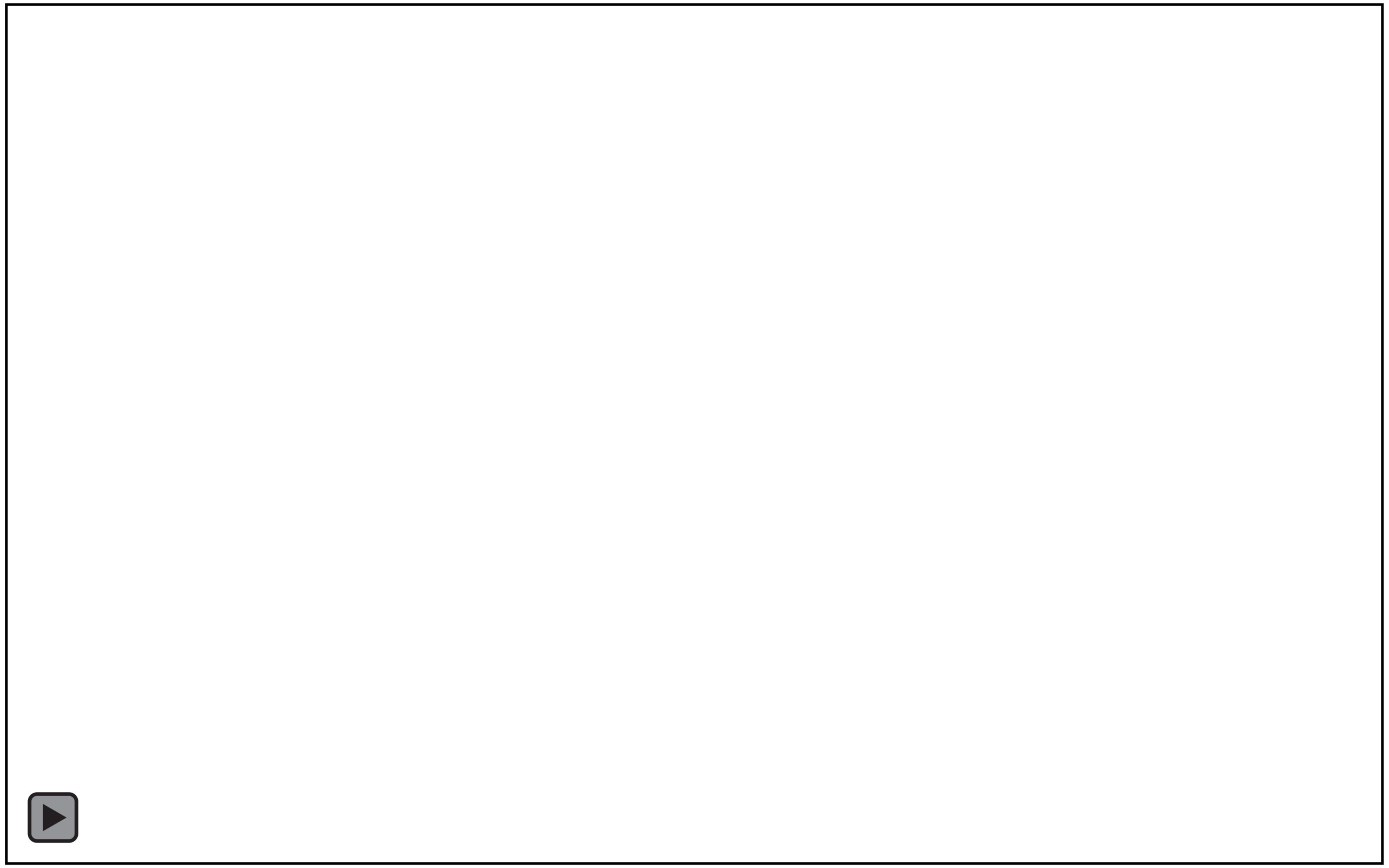
- Large Data Volumes
- Loss of Detailed Information
- Time & Labor Intensive
- Limited Applications



https://www.directionsmag.com/pressrelease/5771



Example of data cleaning

https://www.youtube.com/watch?v=VmaspCVXWN8&t=1s

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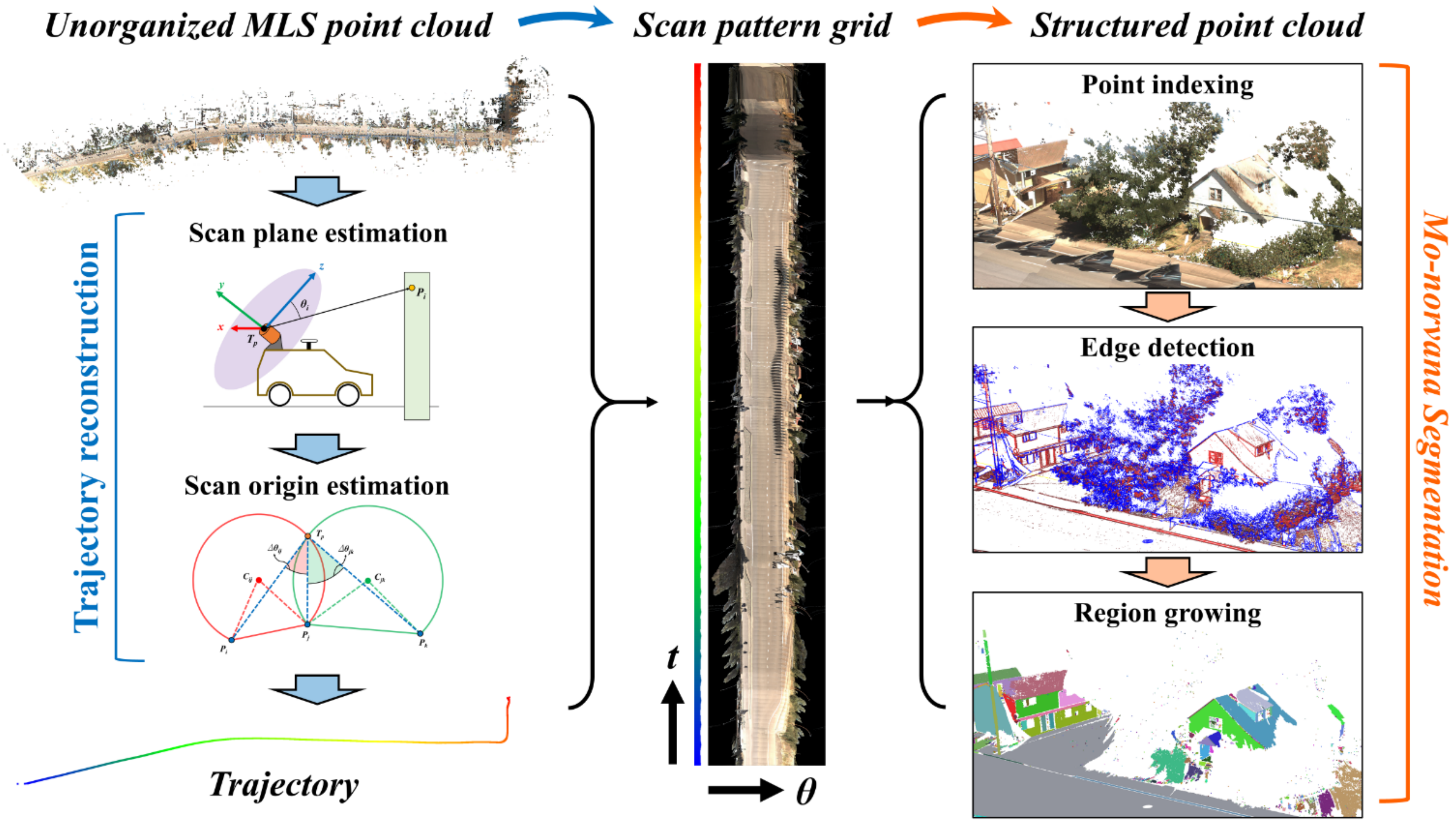
Mo-Norvana Technology



(Che & Olsen, 2019)

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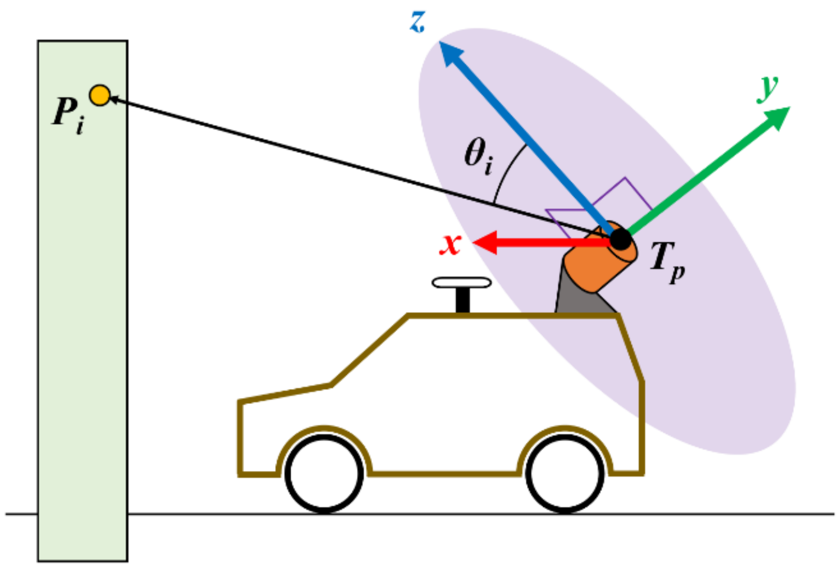
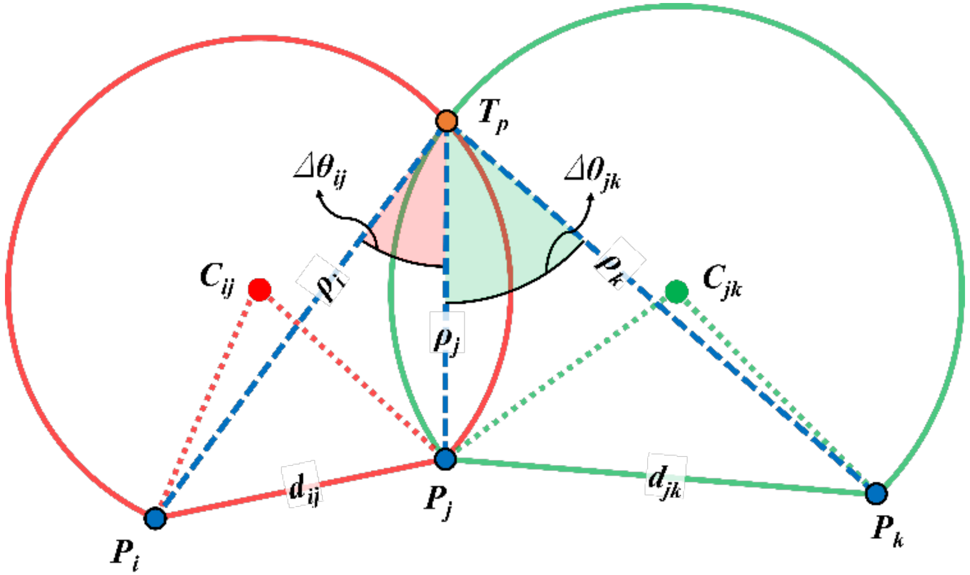
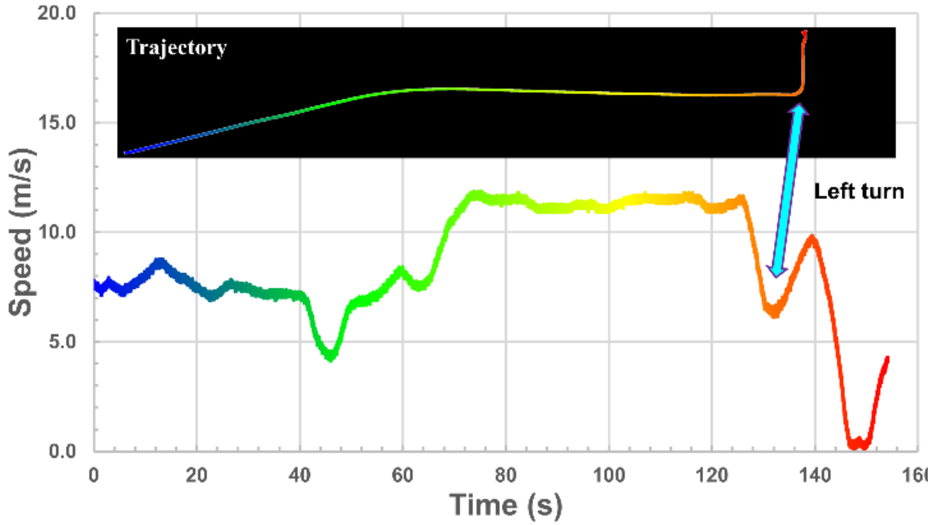
Trajectory reconstruction



$$\omega = \frac{2\pi}{f} = \frac{d\theta}{dt}$$

$$\Delta\theta = \omega \times \Delta t$$





	Vert. error (m)	Horz. Error (m)	3-D error (m)
Max.	0.086	0.142	0.200
Min.	-0.140	0.000	0.000
Median	0.000	0.002	0.002
Avg.	0.000	0.004	**0.004**
RMSE	0.004	0.008	**0.009**

(Che & Olsen, 2019)

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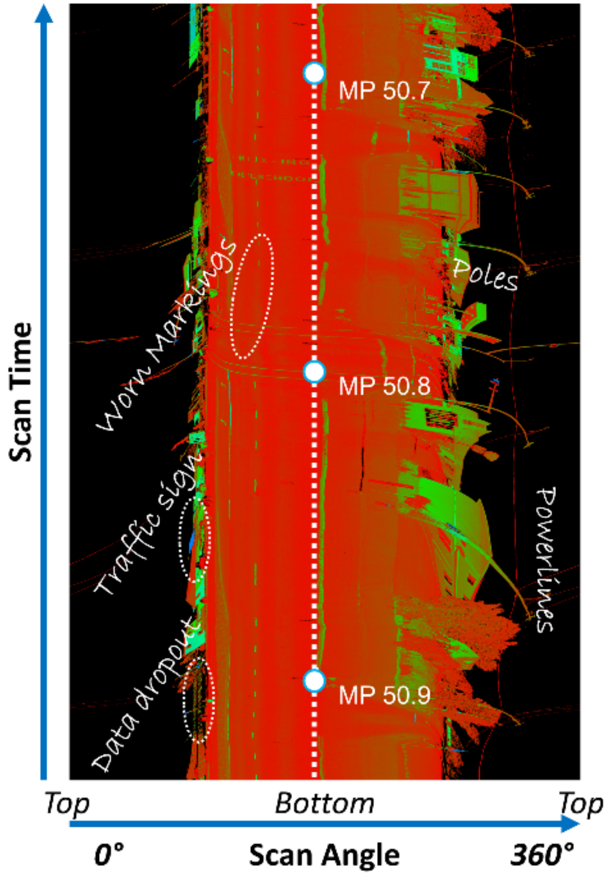
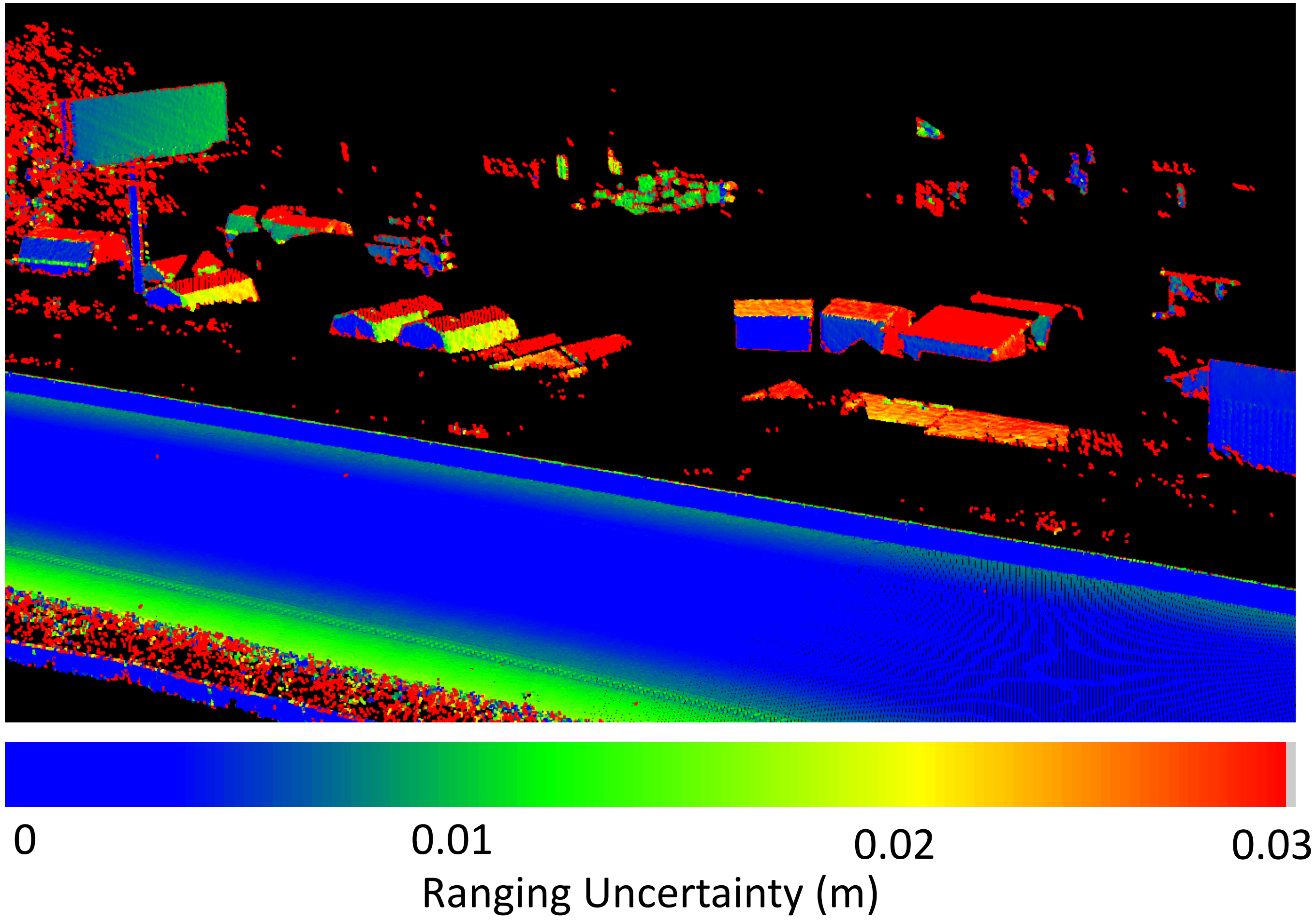
How Trajectory Can Be Used

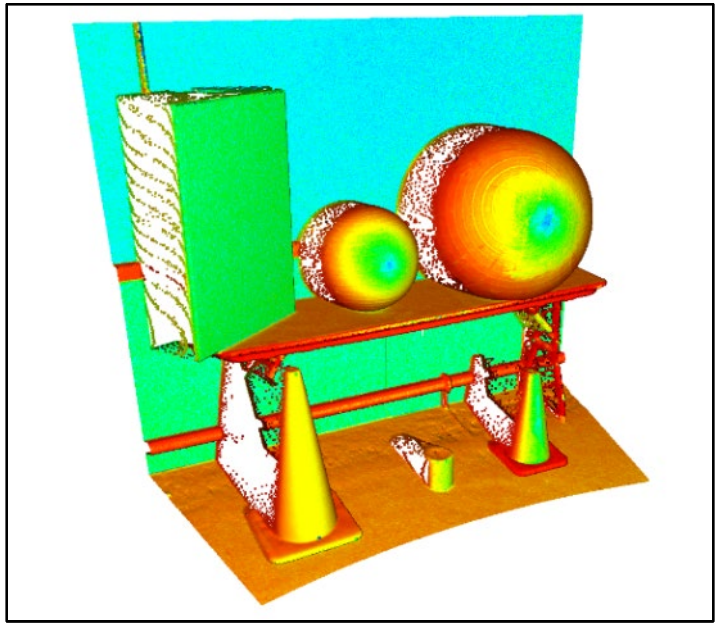
- Data management
- Per-point QA/QC
- Visualization & Annotation



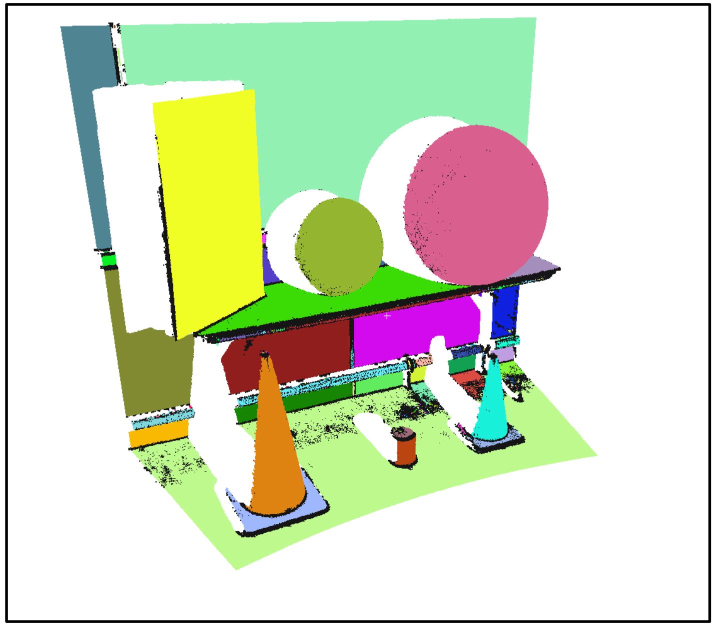


Point Cloud Segmentation

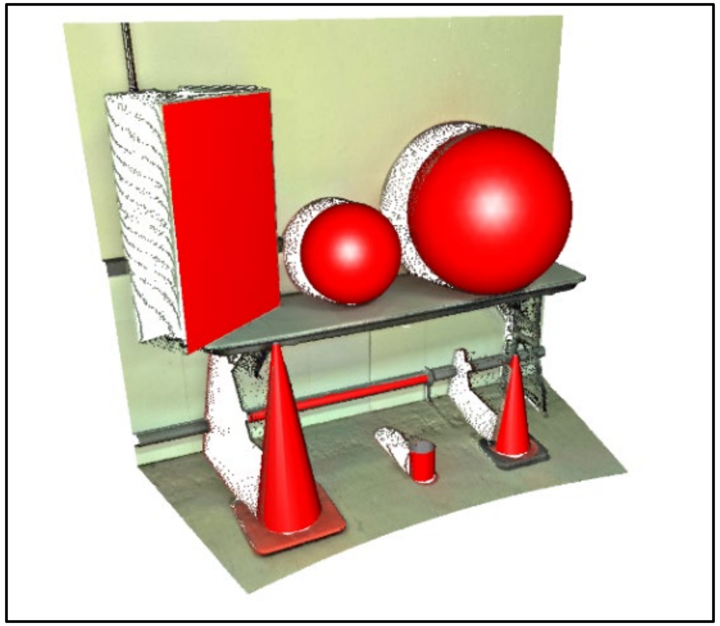
- Groups points with similar attributes
- Supports feature extraction, classification, modeling, analysis…



Point Cloud



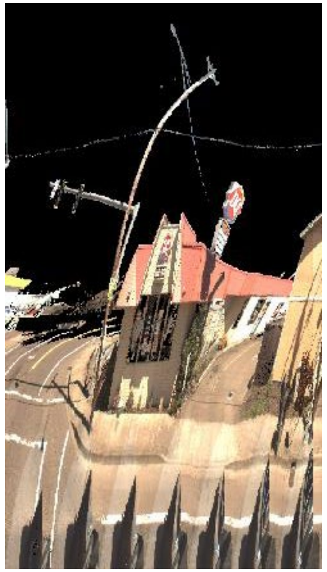
Segmentation

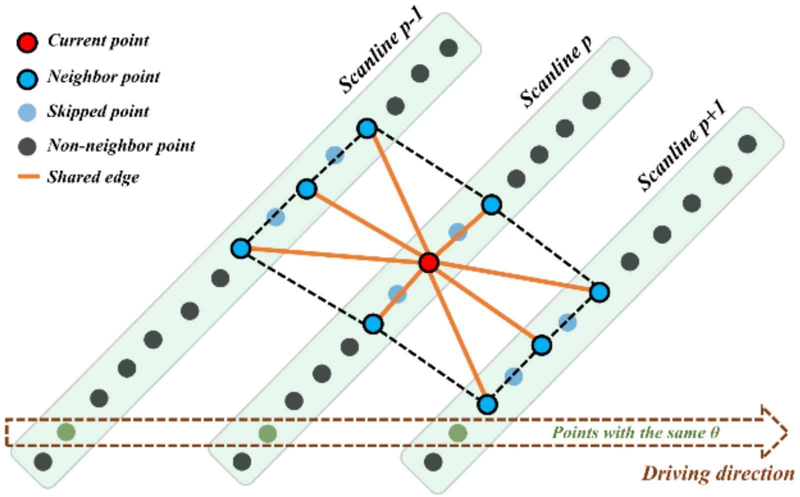


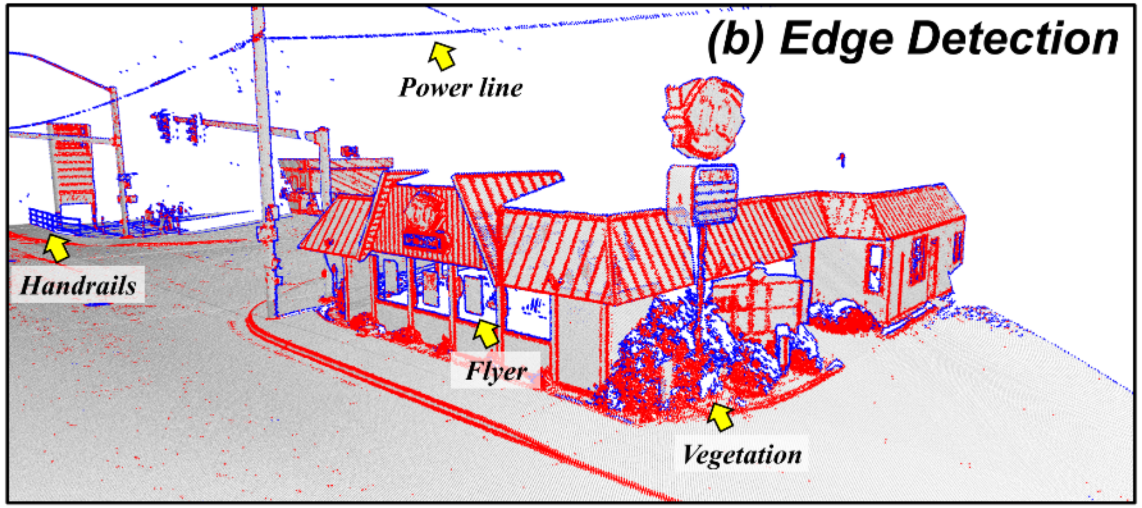
Modeling

(Che & Olsen, 2018)

Mo-Norvana Segmentation

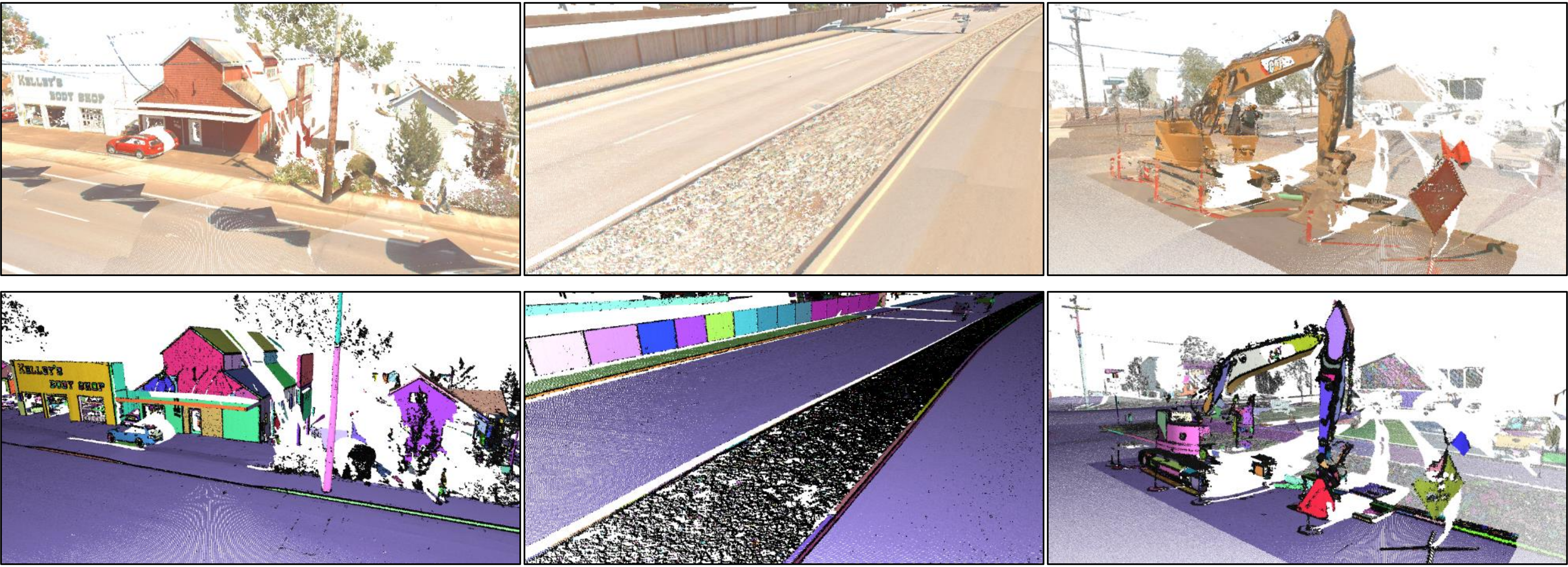






(Che & Olsen, 2019)

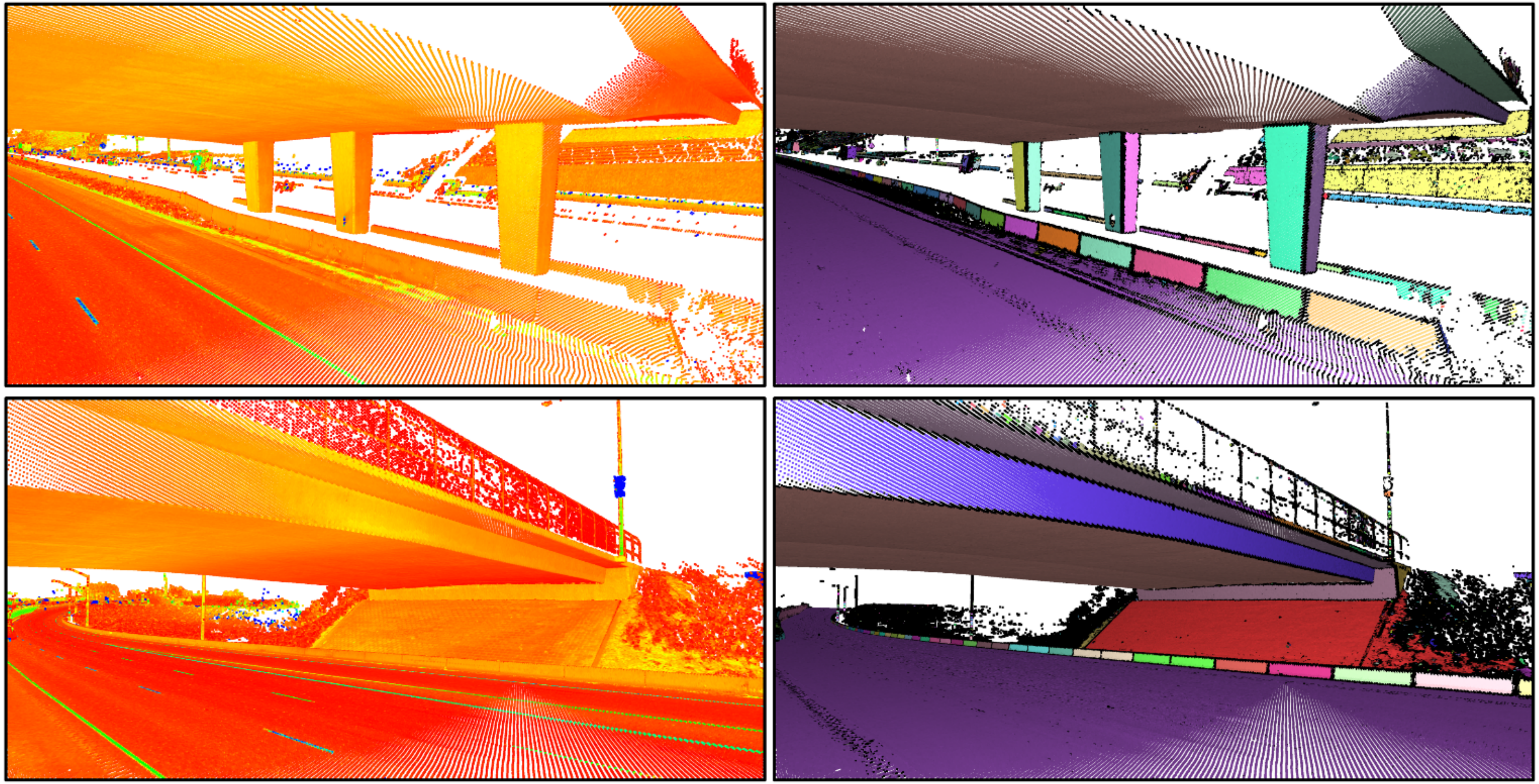
Segmentation Results



(Che & Olsen, 2019)

Freeway Data

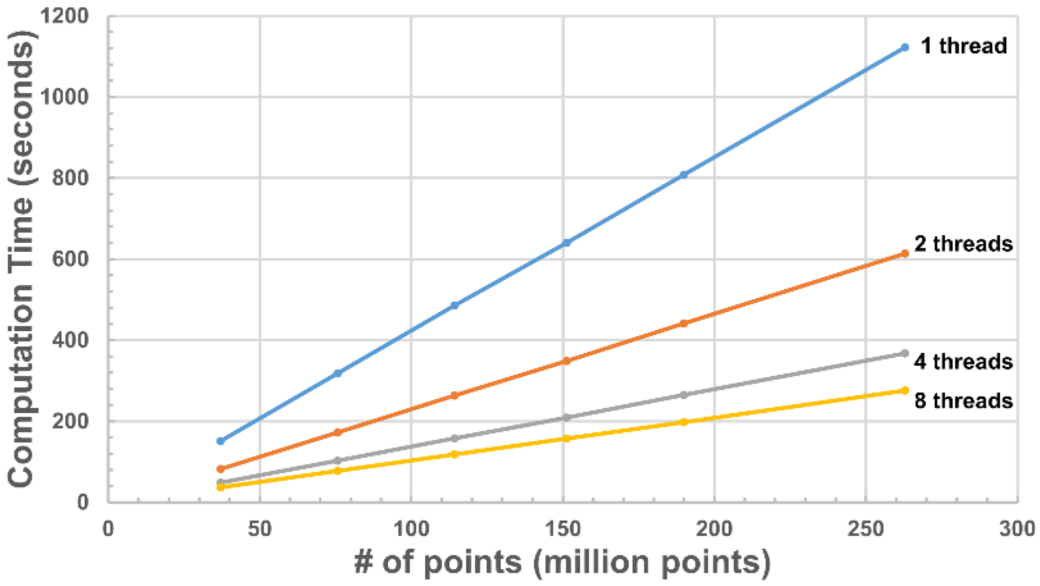
Avg. speed: ***24.7 m/s*** # of pts: ***87,240,616*** # of threads: ***8*** Processing time: ***95.4s***



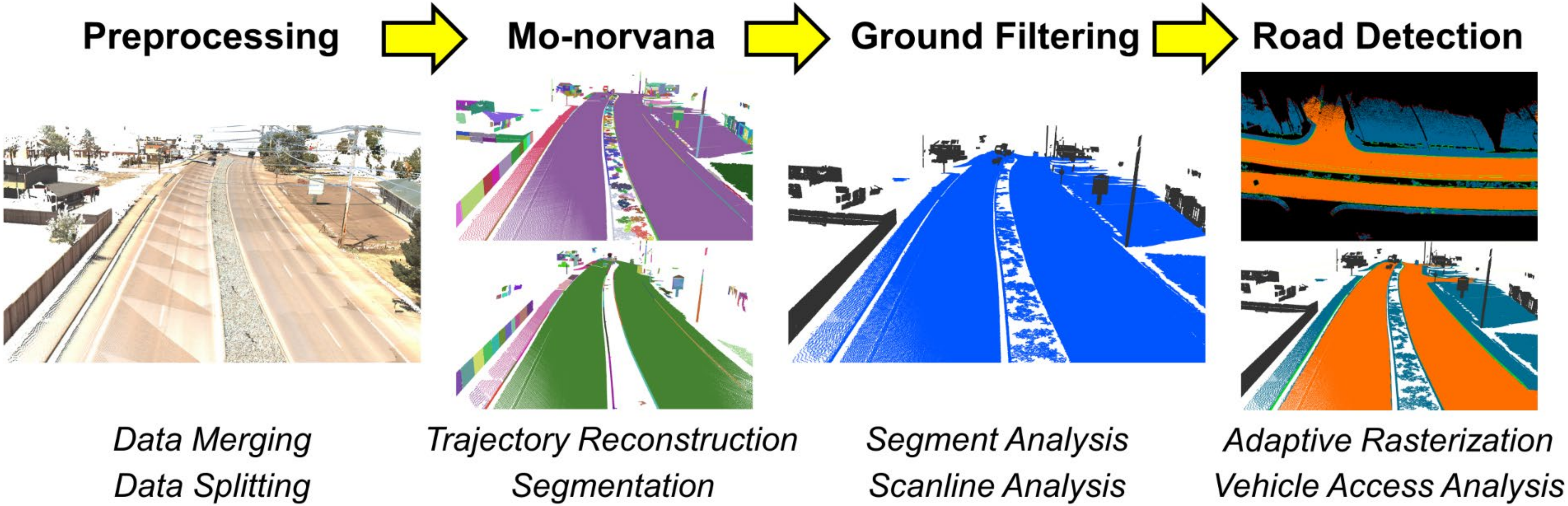
(Che & Olsen, 2018)

Computational Performance

	CPU	# of points	time	pts/sec.
Mo-norvana	Intel Core E5620 @ **2.40** GHz (4 cores, 8 threads)	**263M**	**276s**	**0.953M**
Vo et al., 2015	Intel Core i7-3770 @ 3.40 GHz	**6M**	**38s**	**0.158M**
Xu et al., 2017	Intel Core i7-4790 @ 3.60 GHz	**13M**	**14400s**	**0.001M**
Yang et al., 2013	Intel Core i3-540 @ 3.07 GHz	**105M**	**3241s**	**0.032M**



VROOM Road Detection



(Che et al., under review)

Ground filtering

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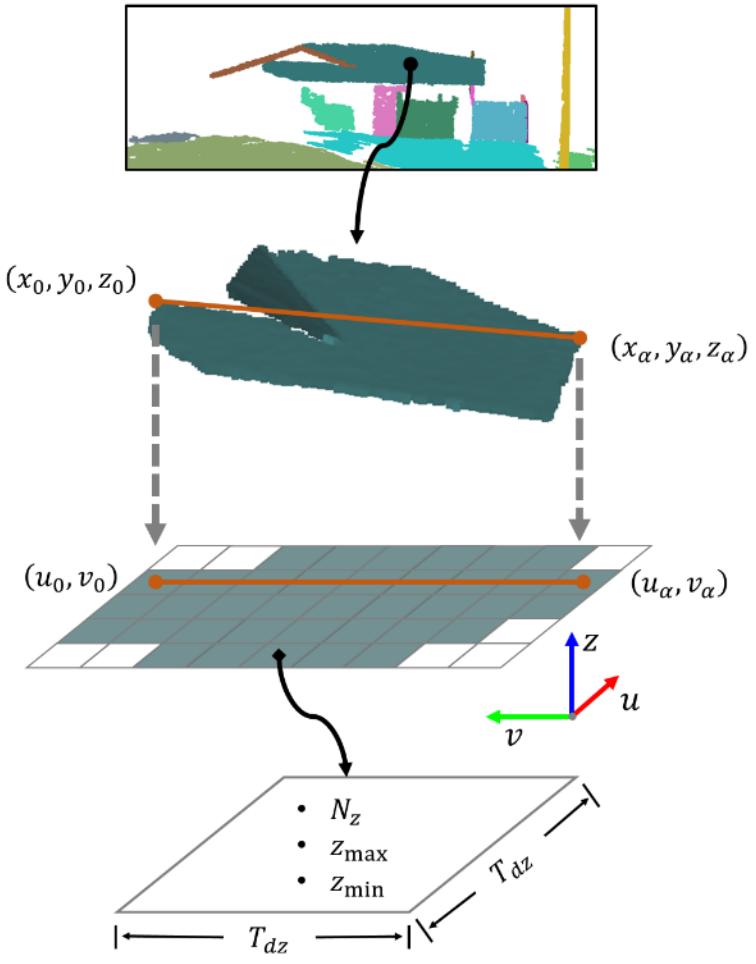
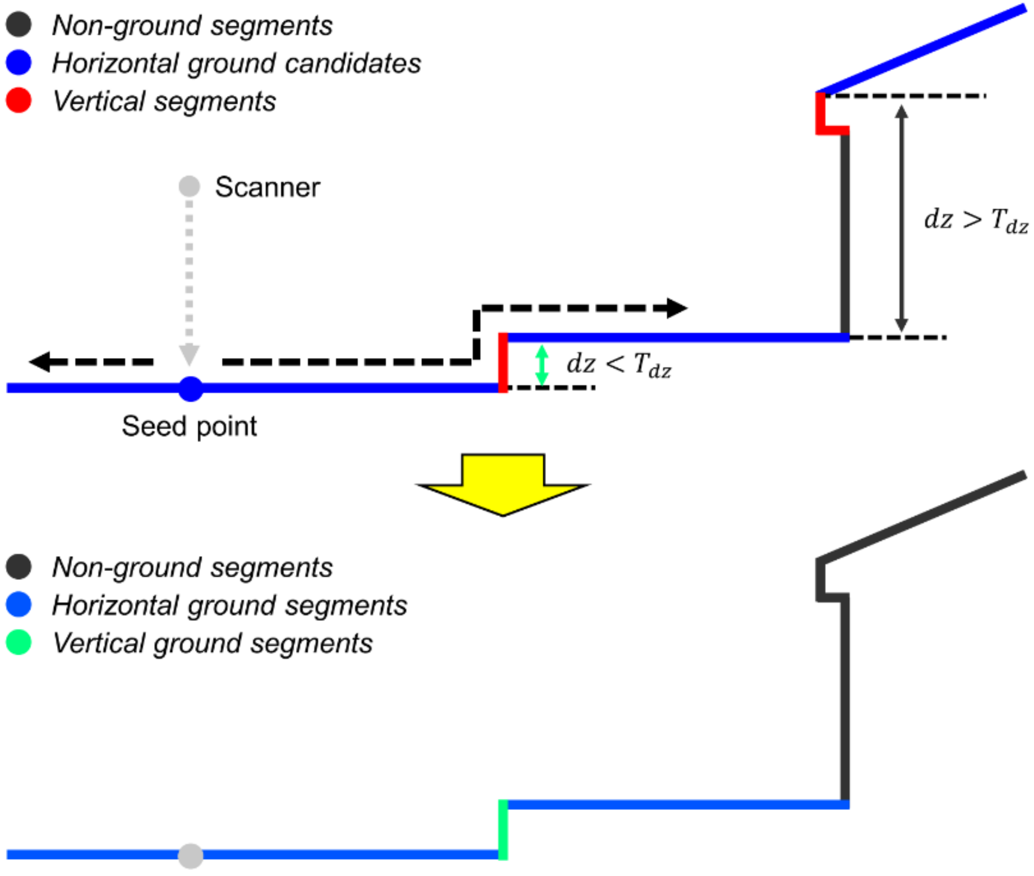
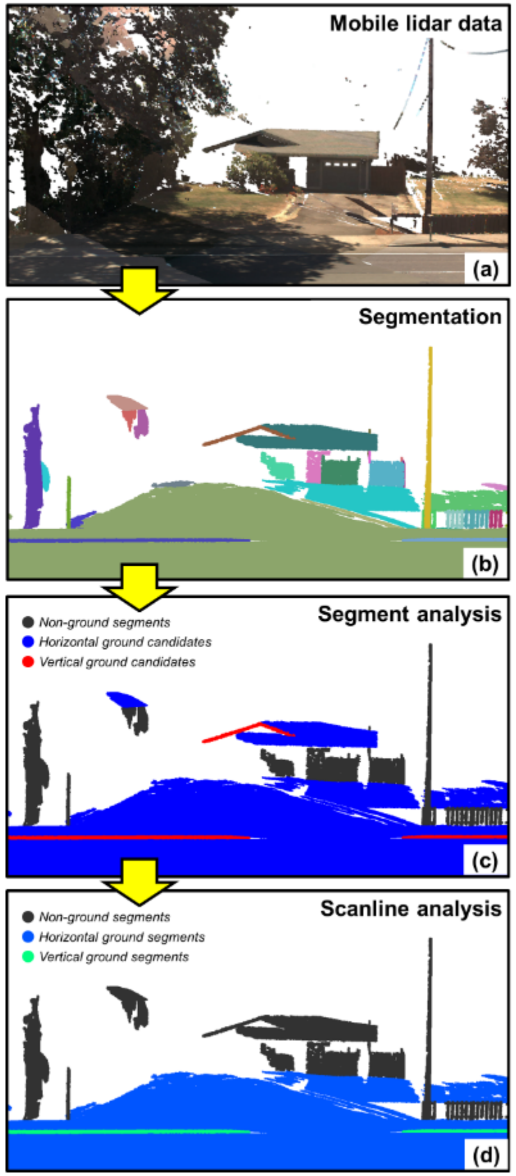
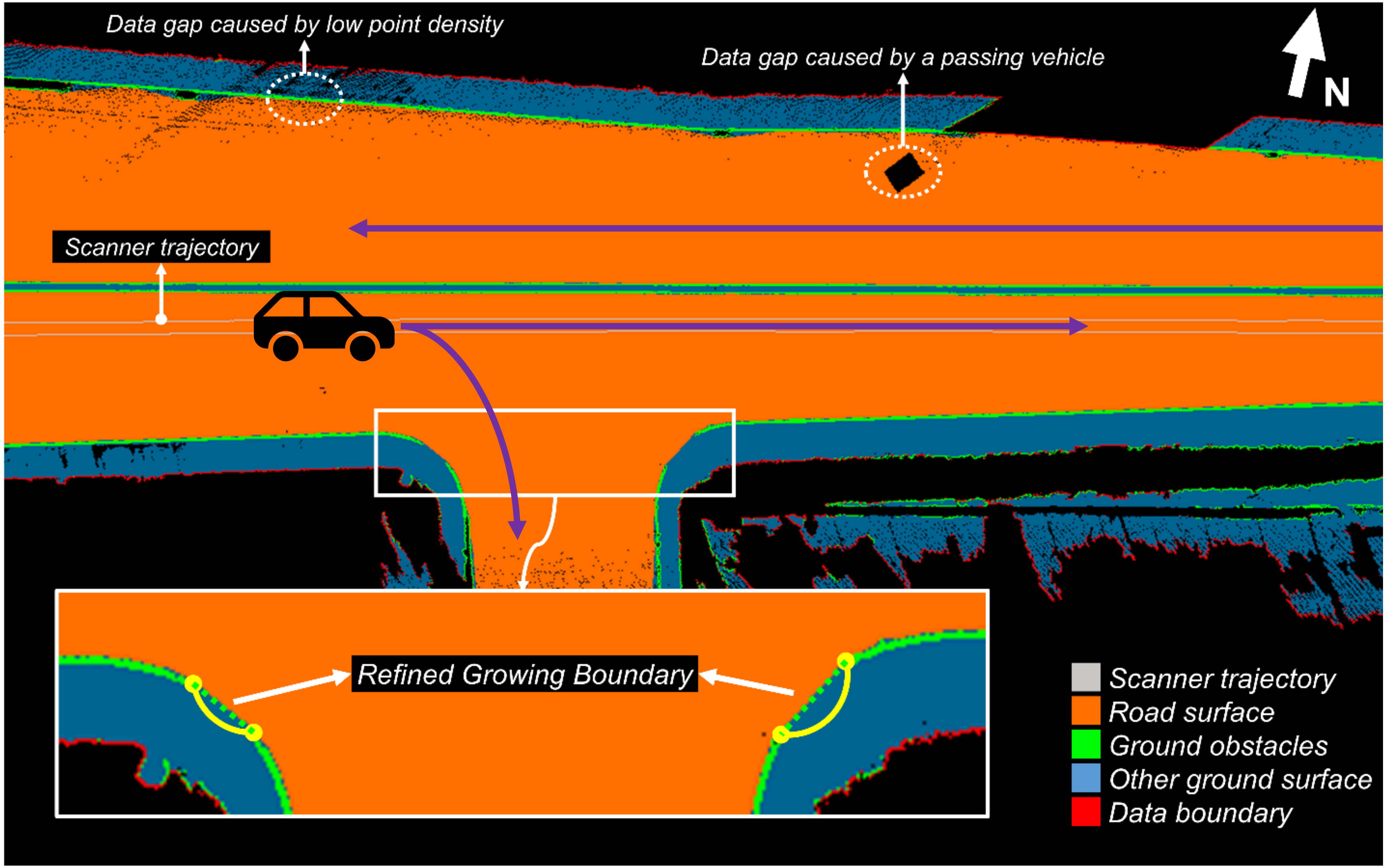






(Che et al., under review)

Road Detection



(Che et al., under review)

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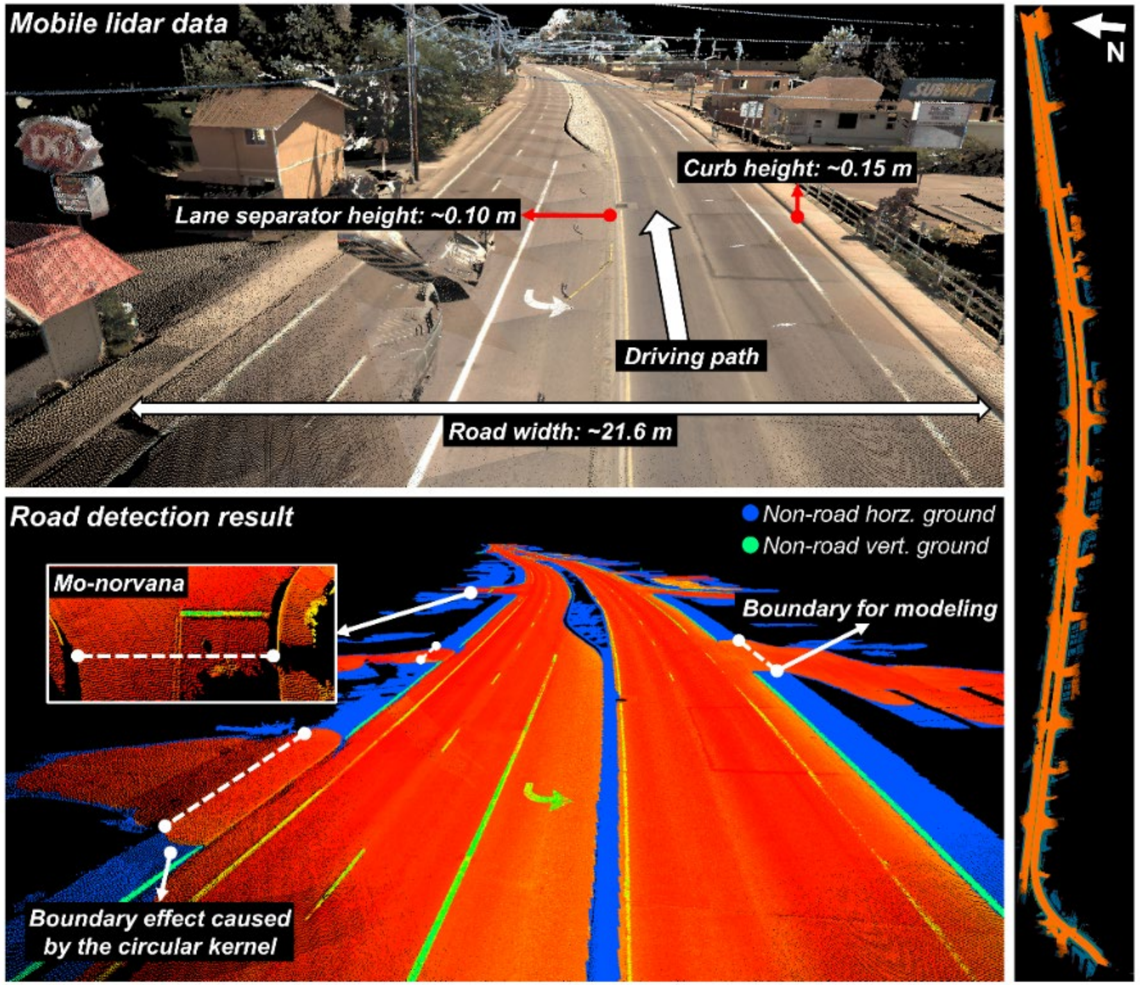
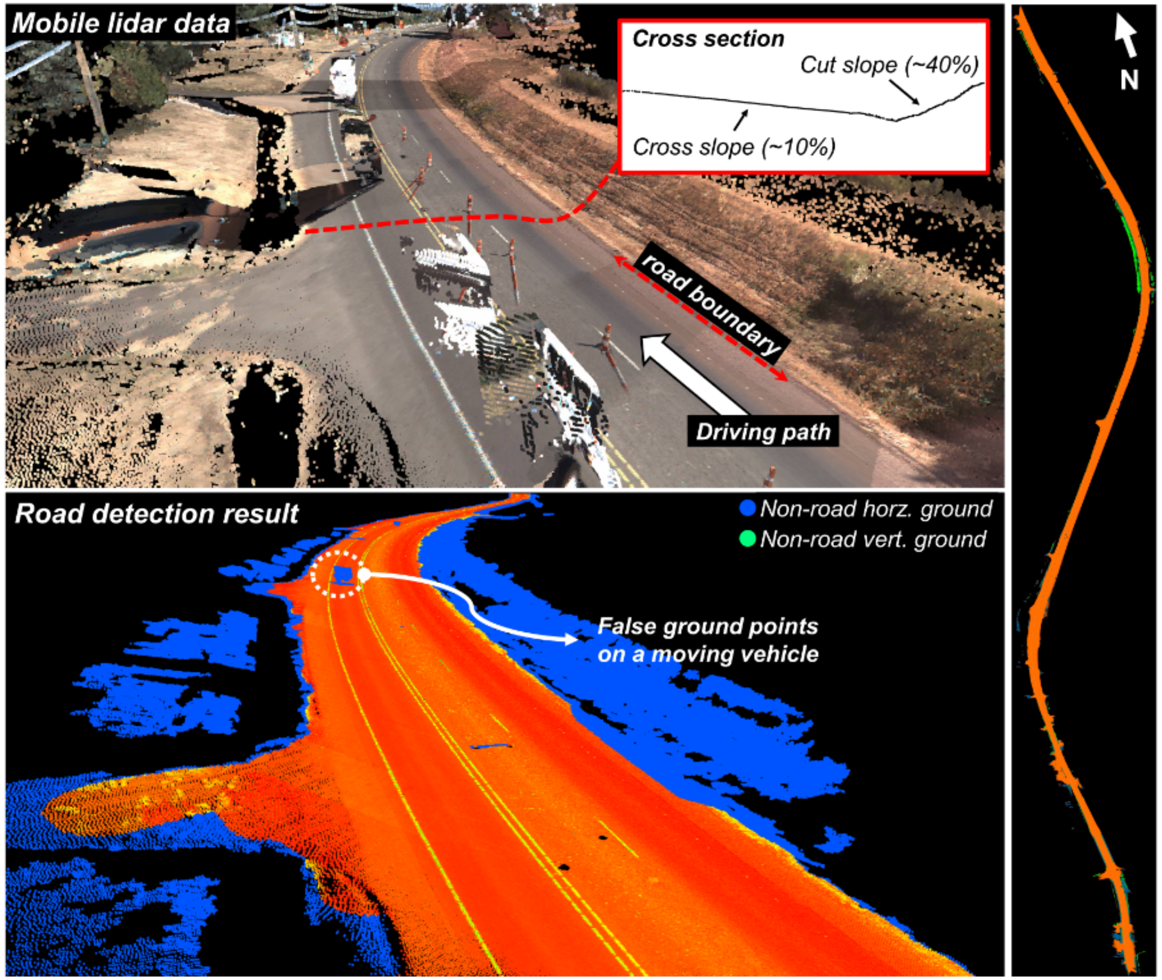
Road Detection Results

Avg speed: ~25 mph
# of points: ~104 million
Processing Time: 238 s

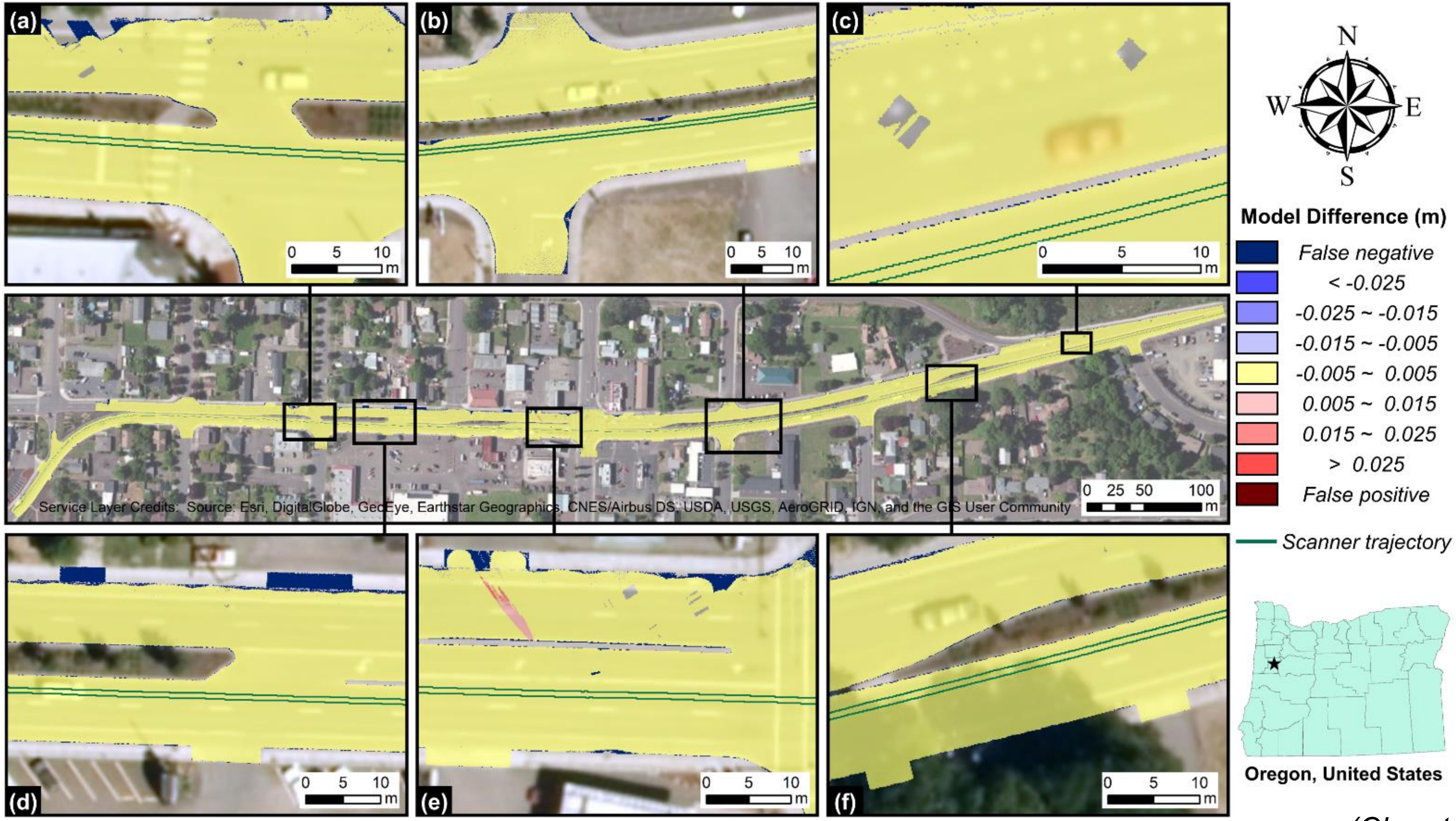


Avg speed: ~40 mph
# of points: ~111 million
Processing Time: 243 s



(Che et al., under review)

Accuracy Analysis



Cell size: *0.15 m*

Class

Recall: 99.31%
Precision: 97.01%
F1 score: 98.14%

Model

Min: -0.032 m
Max 0.033 m
RMSE: 0.003 m

F1 score: Harmonic mean of precision and recall

(Che et al., under review)

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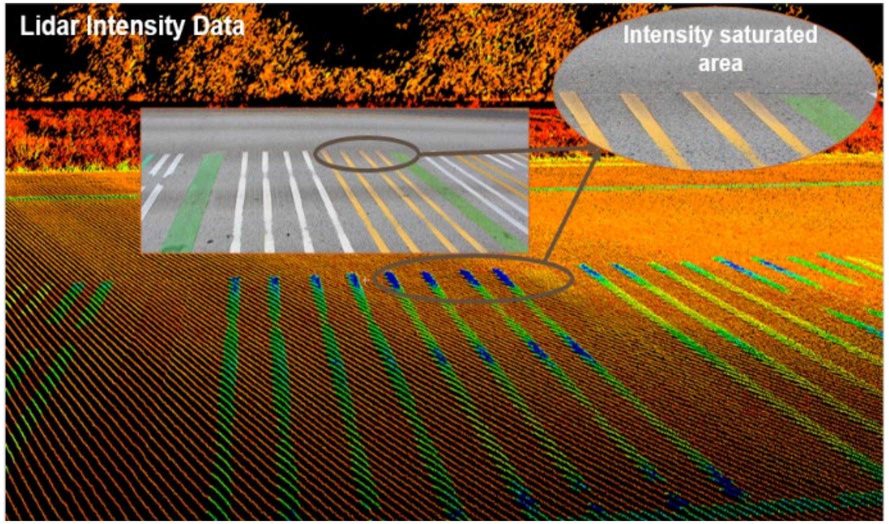
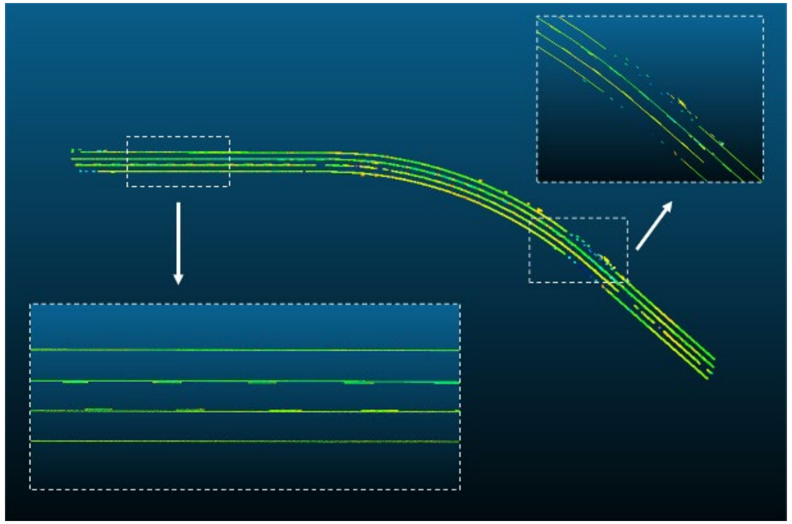
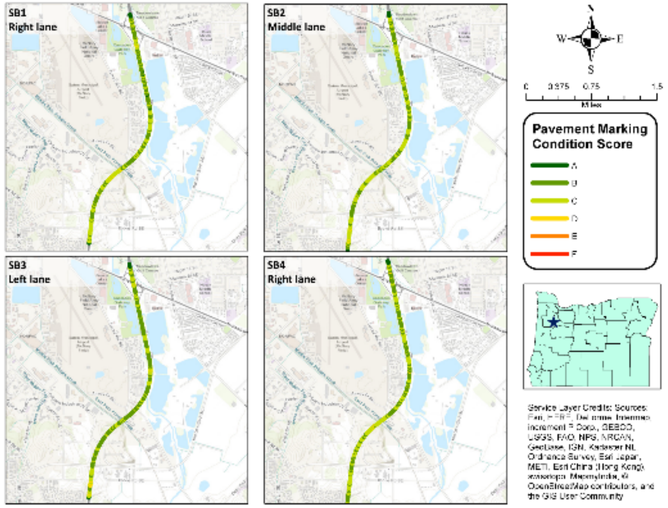
More Applications

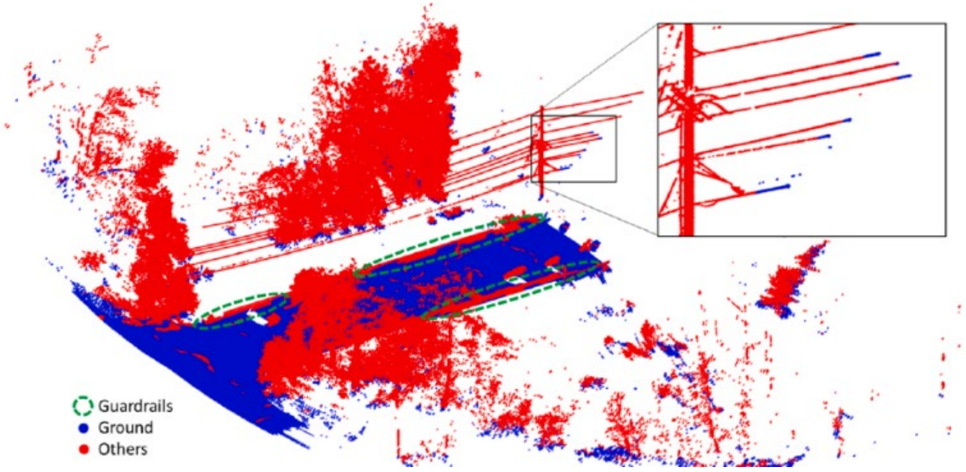
Road Marking Extraction (presented by ODOT last year) and Retroreflectivity Assessment

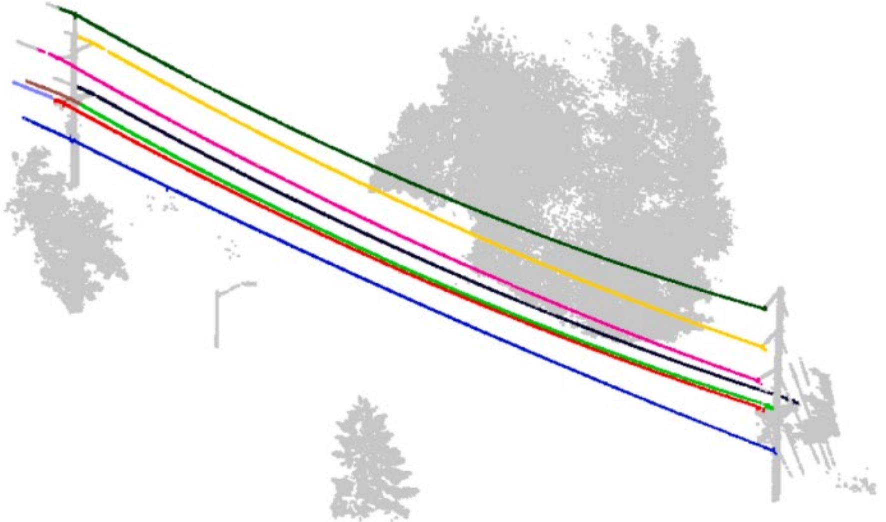






Powerline Extraction





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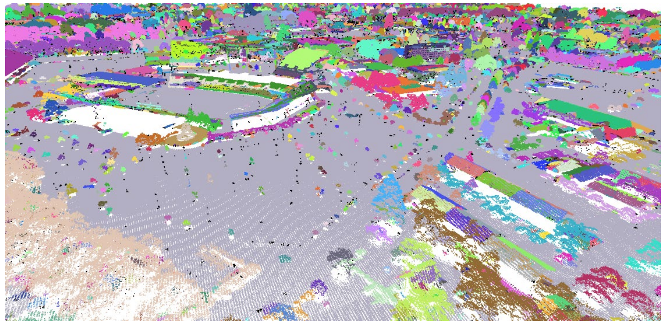
Final Takeaways

- LidarTools
  - Easy to use
  - Fast & automated
  - High Compatibility
    - (LAS/LAZ extra bytes)
  - Much more to come



1 Data Acquisition

2 Registration / Georeferencing

3a *Standard "Top-down" Workflow*

Inflexible Data Management | *Limited QA/QC* | *Manual Data Cleaning* … *Manual Data Cleaning* | *Single Feature Extraction #1* … *Single Feature Extraction #N*

Data/metadata management
- Absence of metadata
- Mostly done manually
- Largely user-dependent

QA / QC
- Done with a few check points
- Only considering global accuracy
- Not available downstream

Data cleaning & feature extraction
- Tedious and time-consuming
- Extracting each object separately
- Not using all data.

3b *LidarTools "Bottom-up" Workflow*

Trajectory-driven Data Management | *Per-point QA/QC* | *One-time Segmentation* | *Automated Feature Extraction*

Saved Time & Labor

Data/metadata management
- Reconstructs trajectory
- Done fast and automatically
- Provides more intelligence

QA / QC
- Reporting accuracy at each point
- Including both global and local accuracy
- Used for reporting product quality

Data cleaning & feature extraction
- Automated and fast processing
- Saving segmented data for re-use
- More info from point-based features

4 Modeling

5 Analysis / Applications

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Acknowledgement

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Sign up for Beta Testing:

https://lidartools.com/join-beta-testing/

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