基于LiDAR的路面沉降检测应用研究

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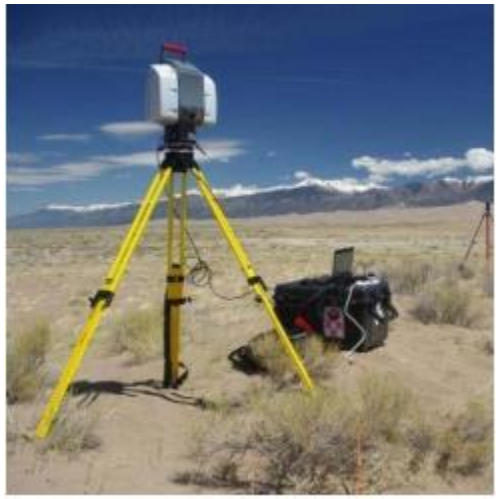
LiDAR

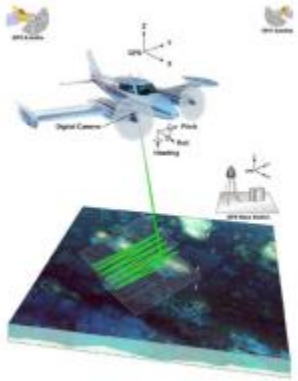
Light Detection And Ranging (LiDAR)

- **Faster measurement speed**
- **Sufficiently accurate distance measurement**



Ground LiDAR

Mobile LiDAR



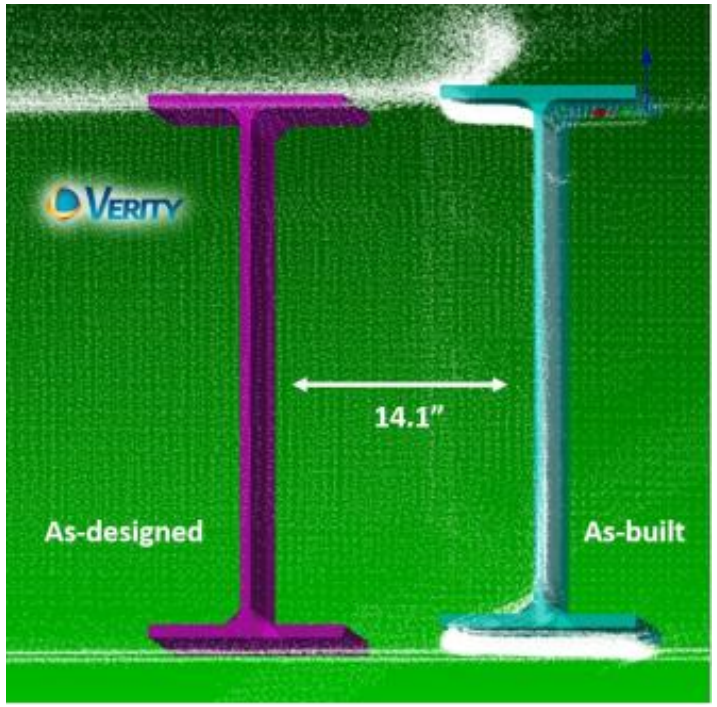
Air-borne LiDAR

Robot-mounted LiDAR

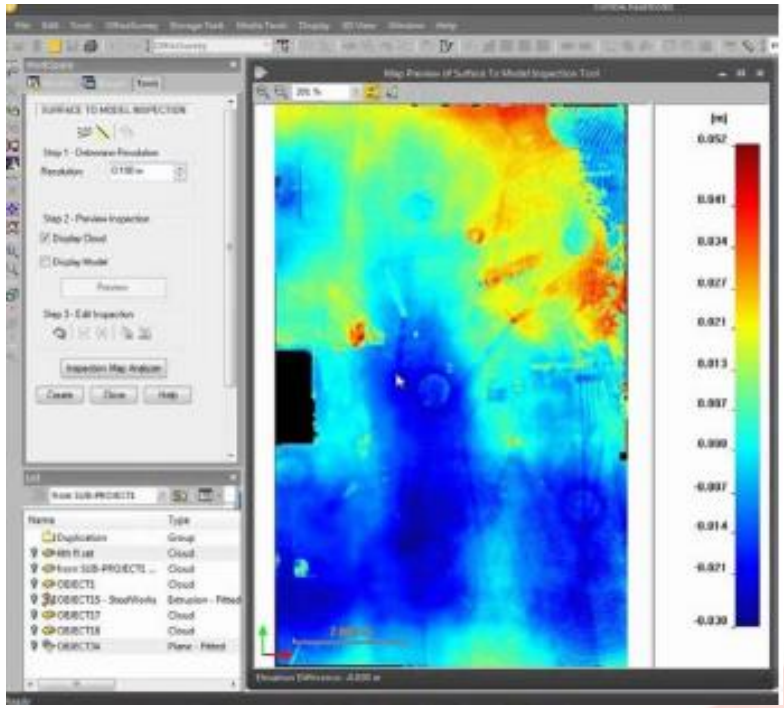
Application of Point Cloud

- **3D documentation**
- **Geometry quality inspection**

3D documentation



As-built location



Surface flatness

Application of Point Cloud

- **Bulk excavation volume estimation**
- **3D model reconstruction**

Excavation progress monitoring

Scan to BIM

Settlement monitoring

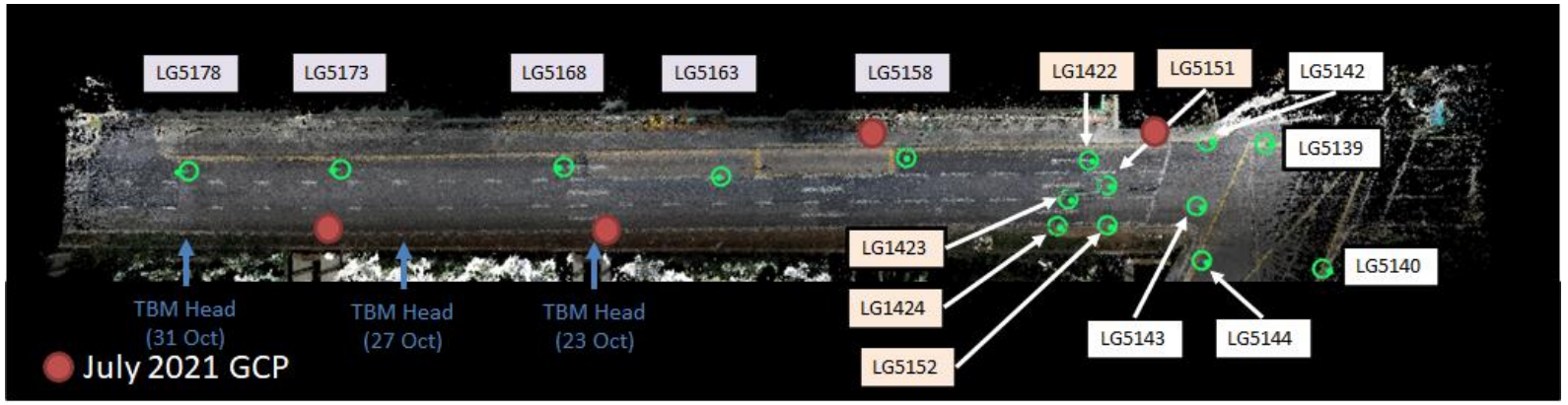
Monitored locations

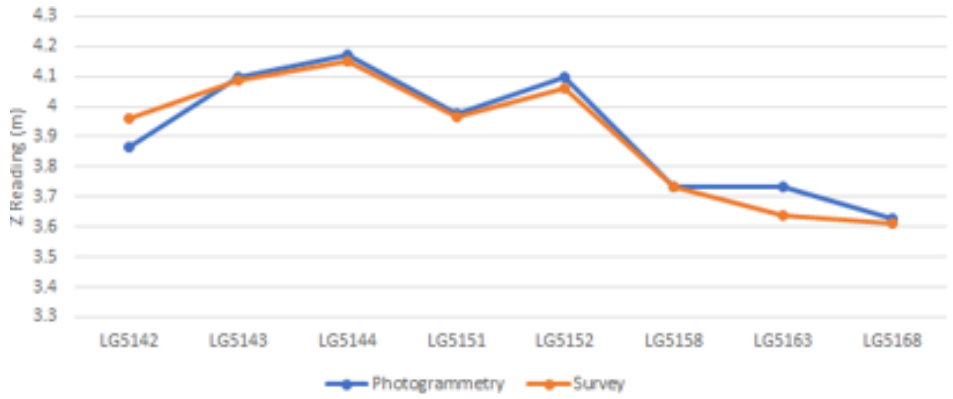
Settlement monitoring

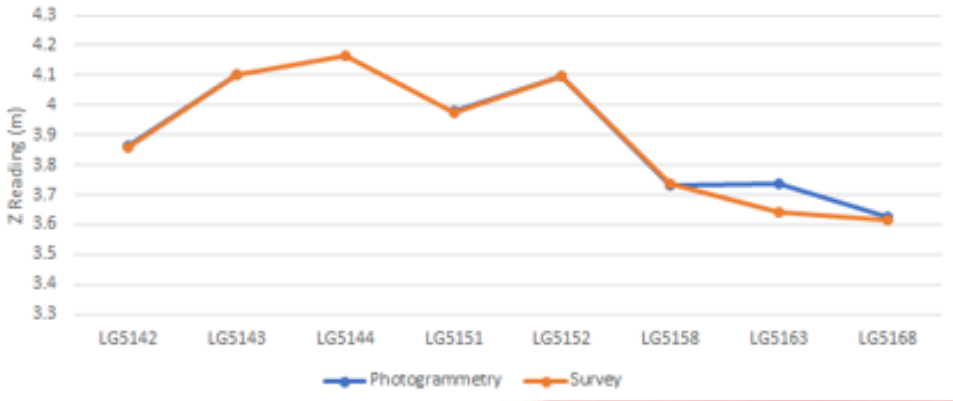
Scanned by ground LiDAR

Settlement monitoring

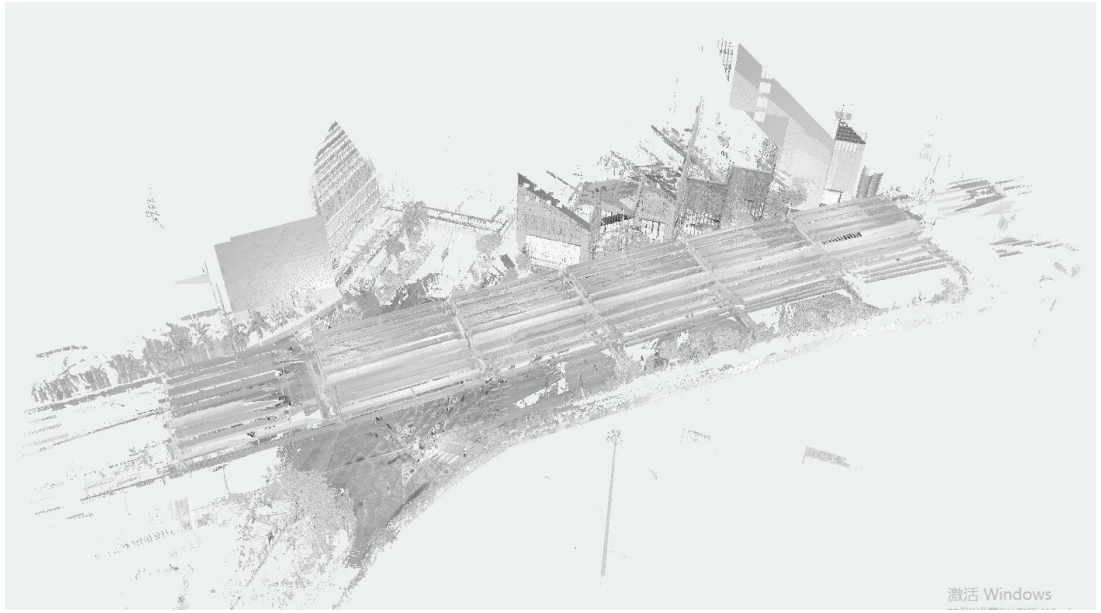
- **By Terrestrial Photogrammetry**

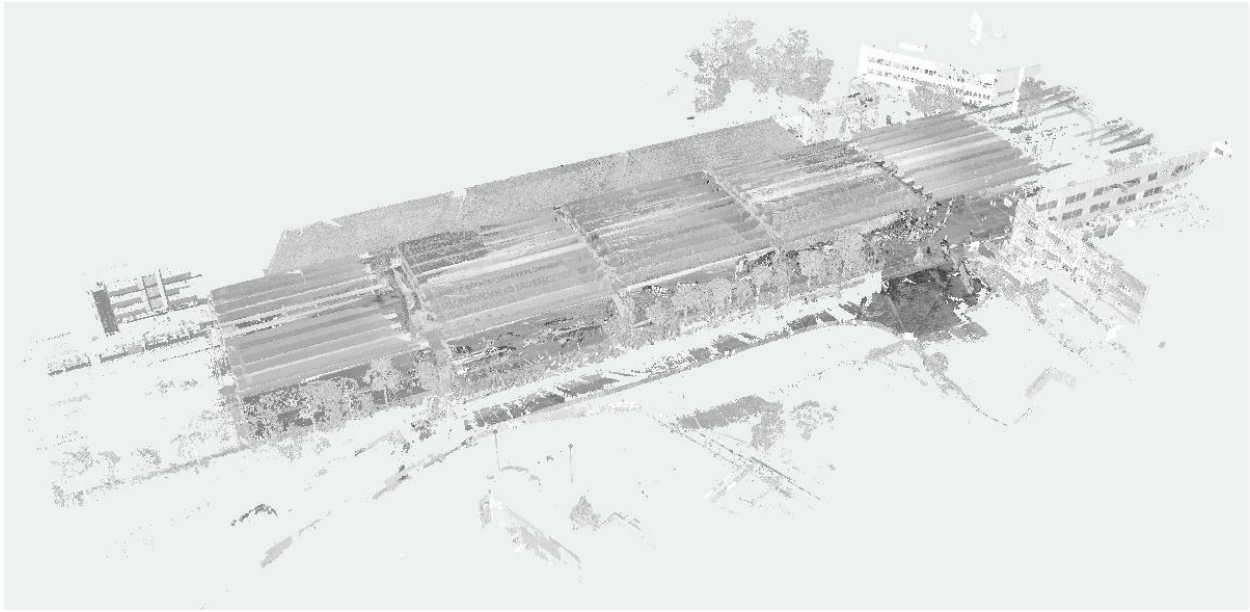


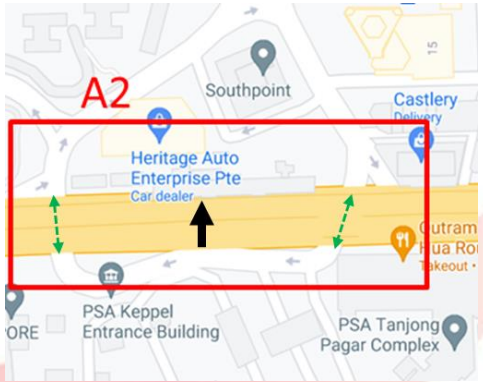




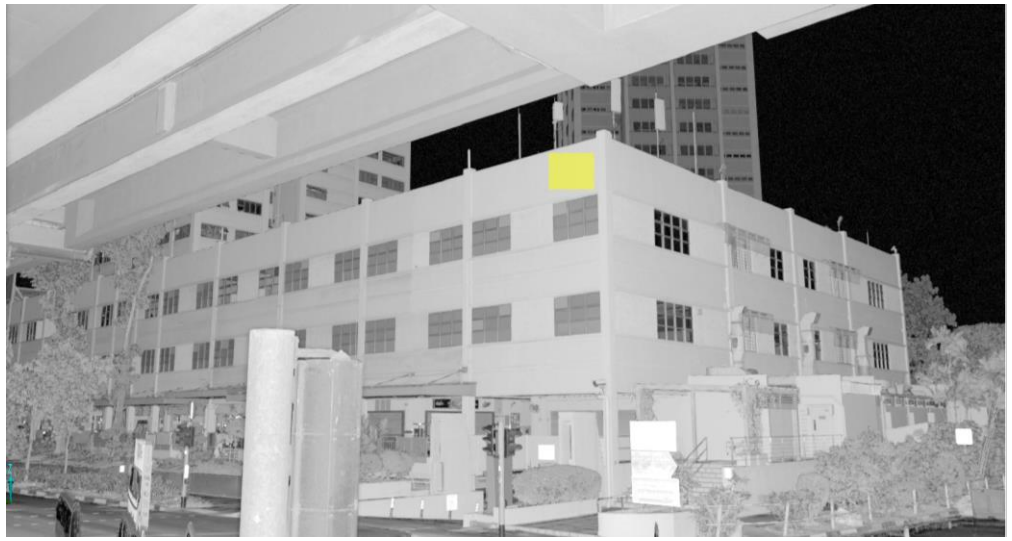
Settlement monitoring

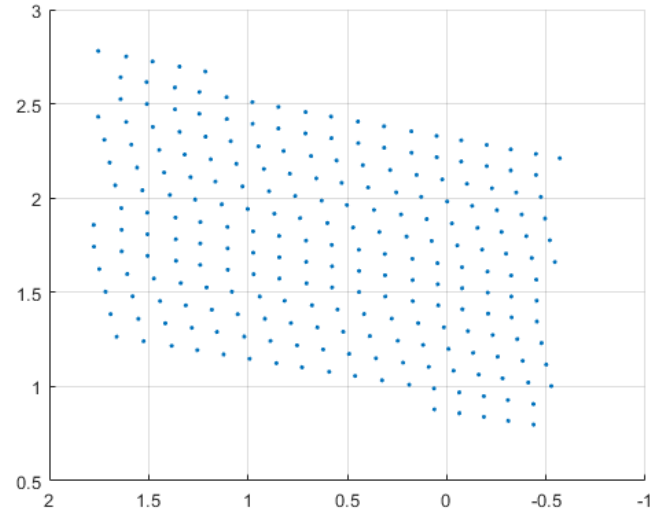




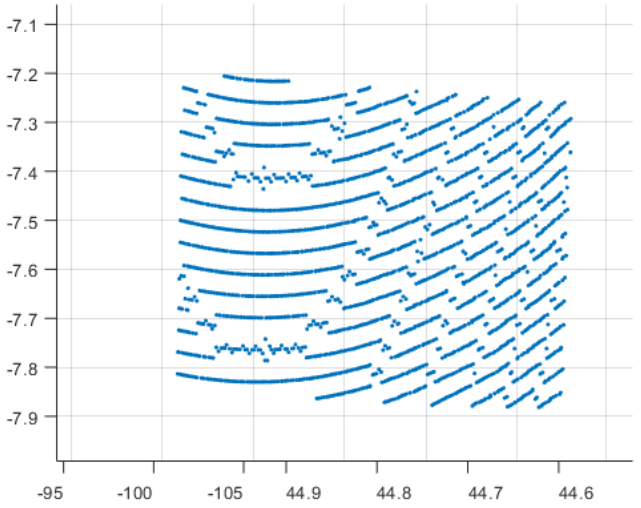


Scan quality



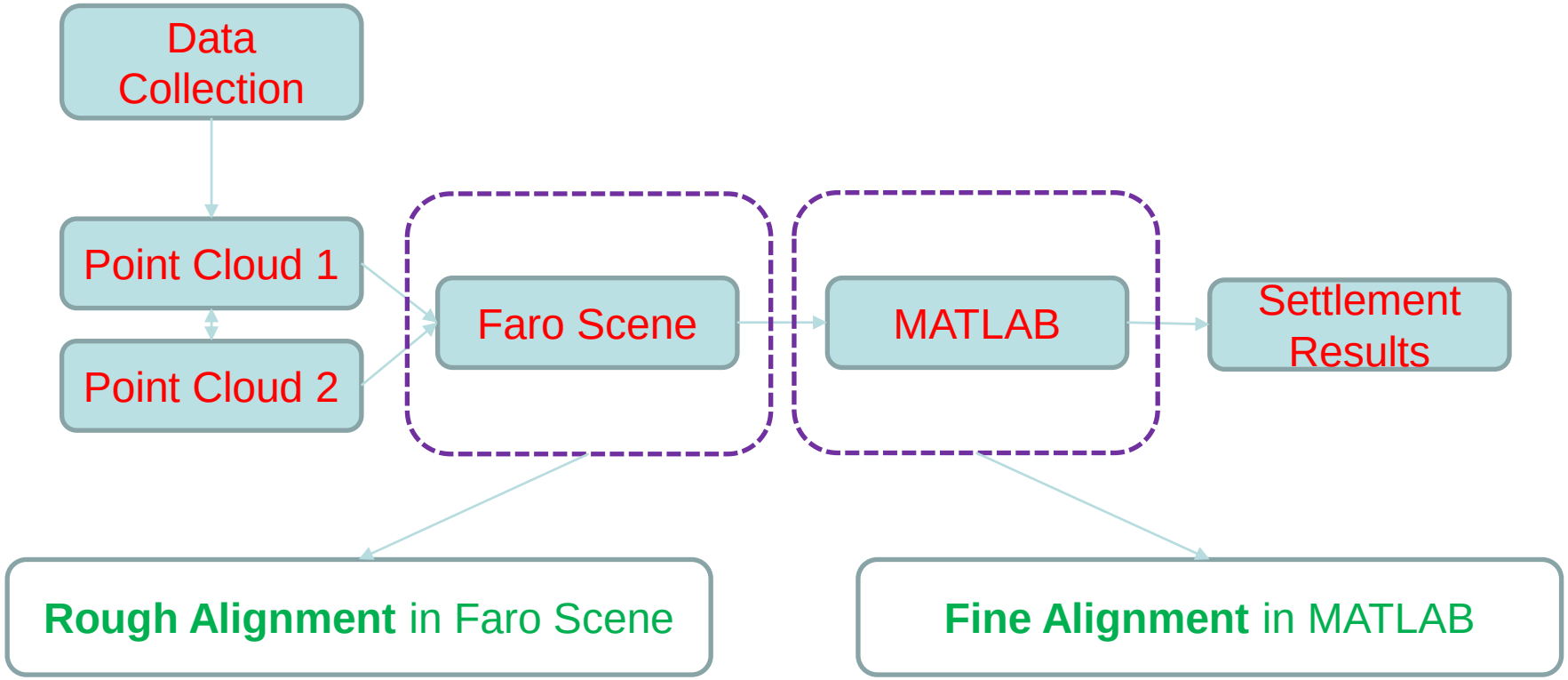


RMSE (mm) = 1.8



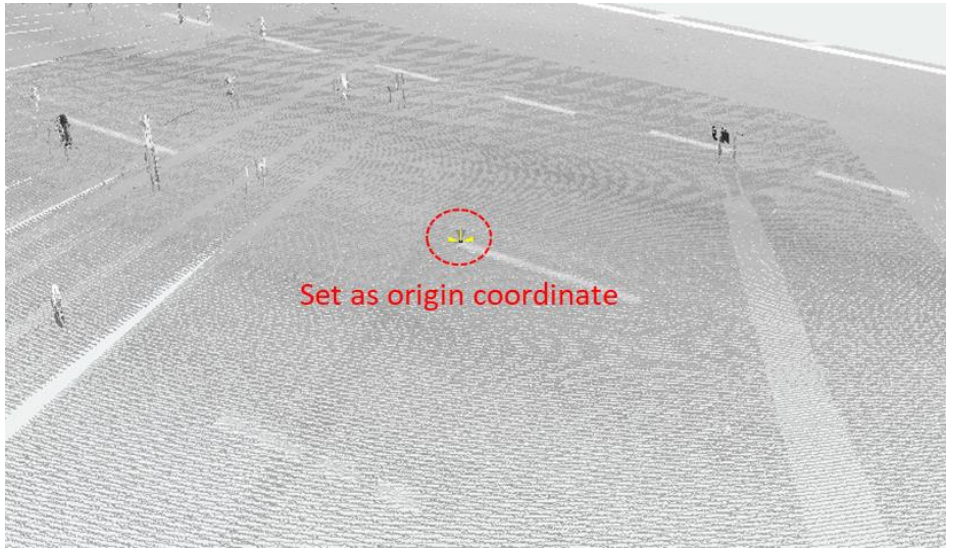
RMSE (mm) = 1.9

Settlement monitoring - Method



Alignment for Non-settlement region

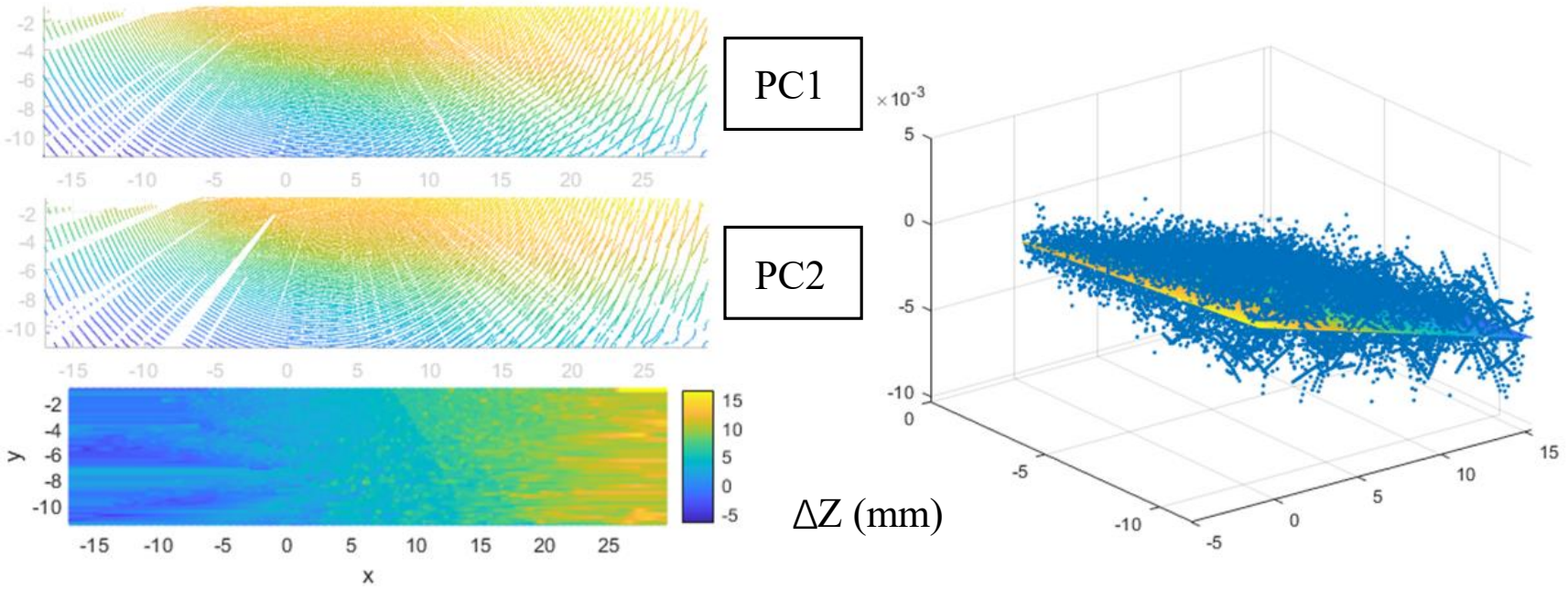
Rough alignment



Steps:

- **Find very closet point in two point-clouds to set as origin coordinate**
- **Find a same plane in two point-clouds to align with same direction**

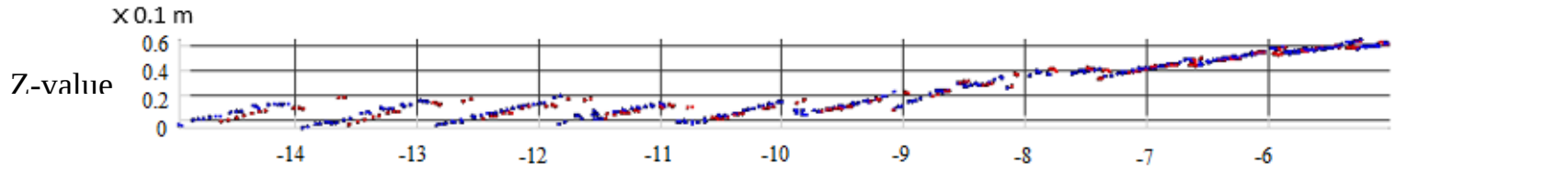
Fine alignment



Steps:

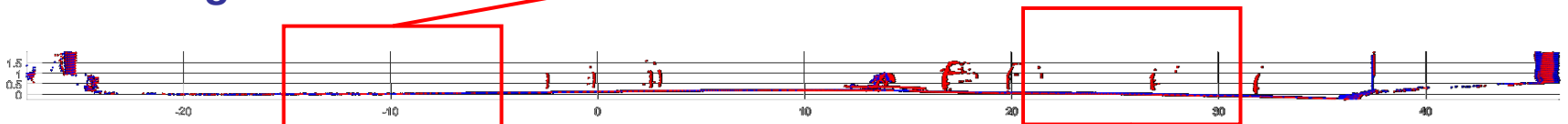
- **Pick out an identical area in settlement-free region**
- **Plane fitting with adjustment**

Settlement monitoring - Method



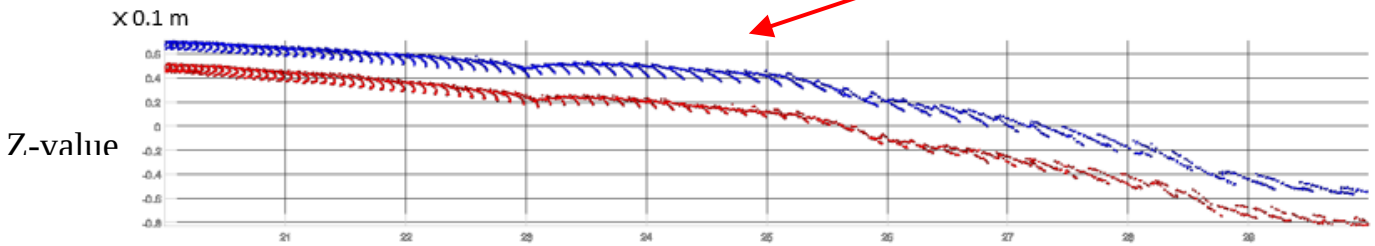
Settlement-free region

Static region is perfectly aligned



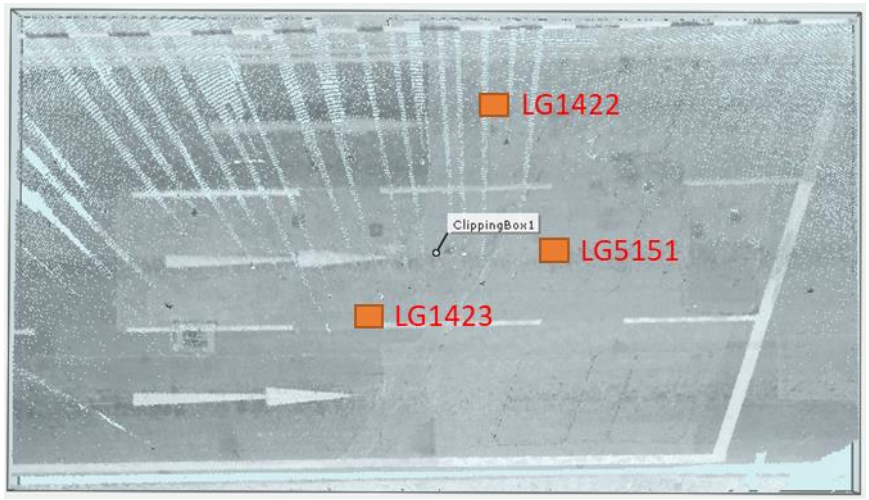
One cross section of Keppel Road:

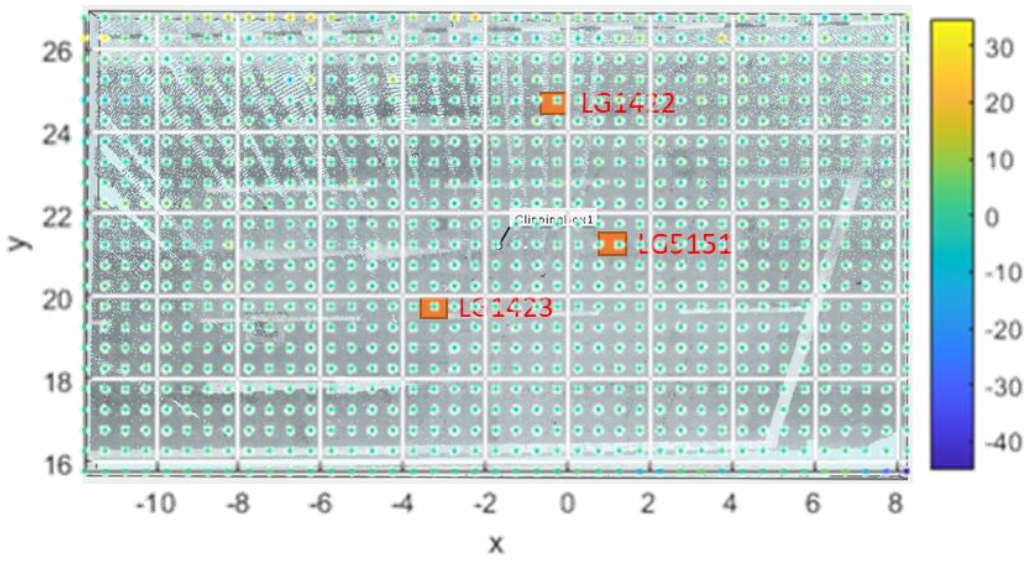
Settlement region



Settlement is significant in settlement region

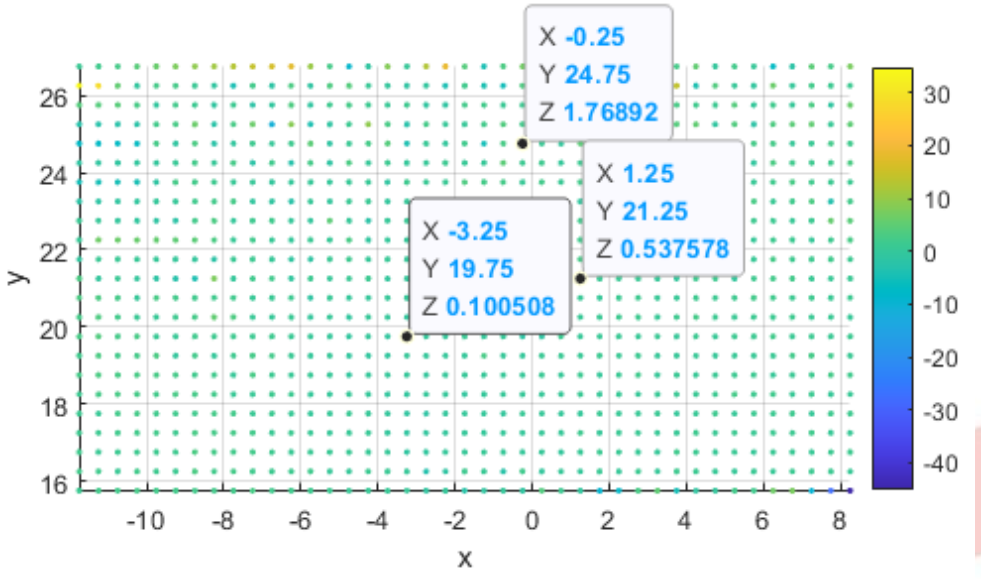
Results



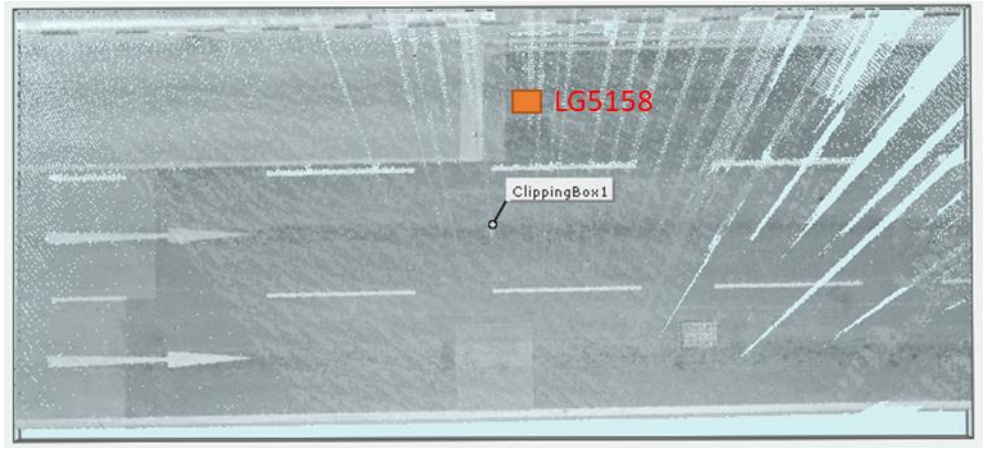


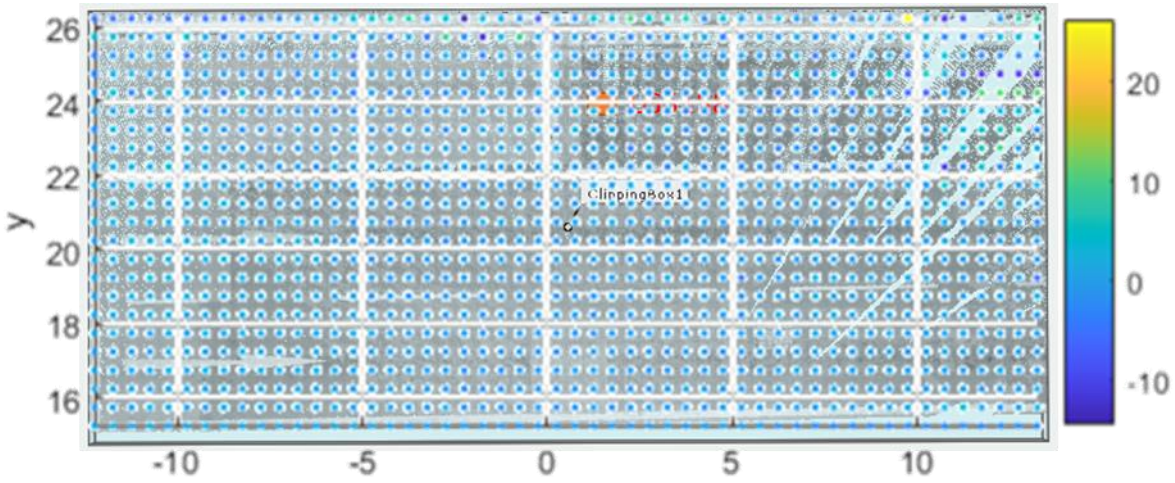
Settlement value calculation

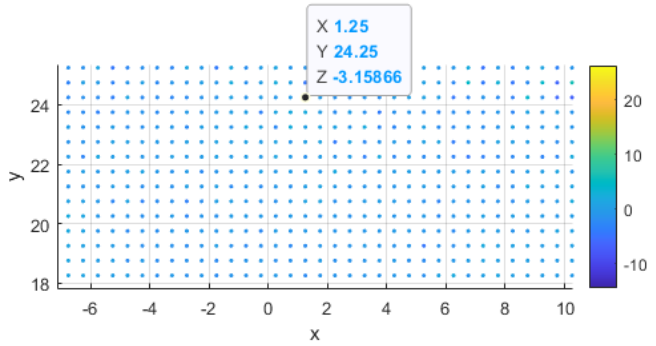
- Attach the heat map of ΔZ on point cloud with land markers
- Read the corresponding value



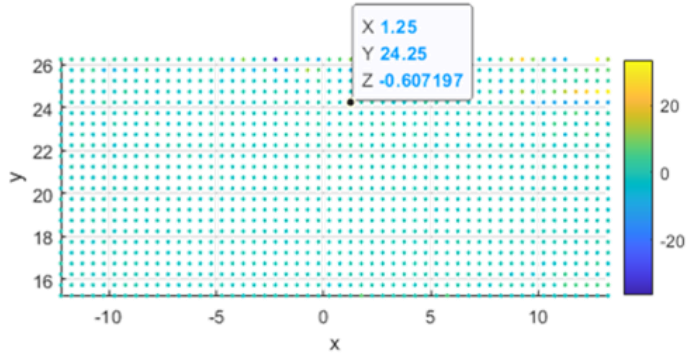
Results



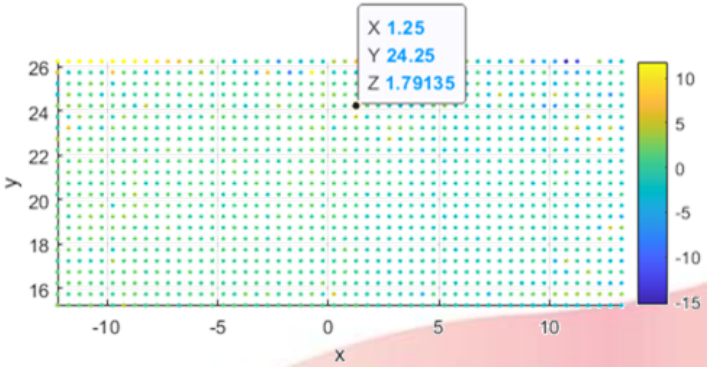




Day 2 vs. Day 1

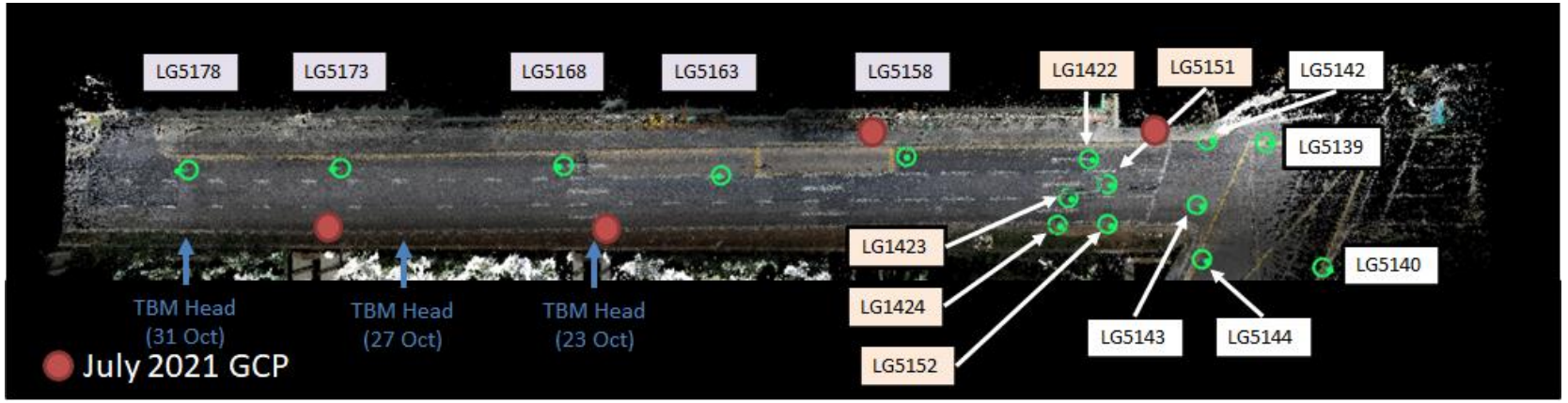


Day 3 vs. Day 1



Day 4 vs. Day 1

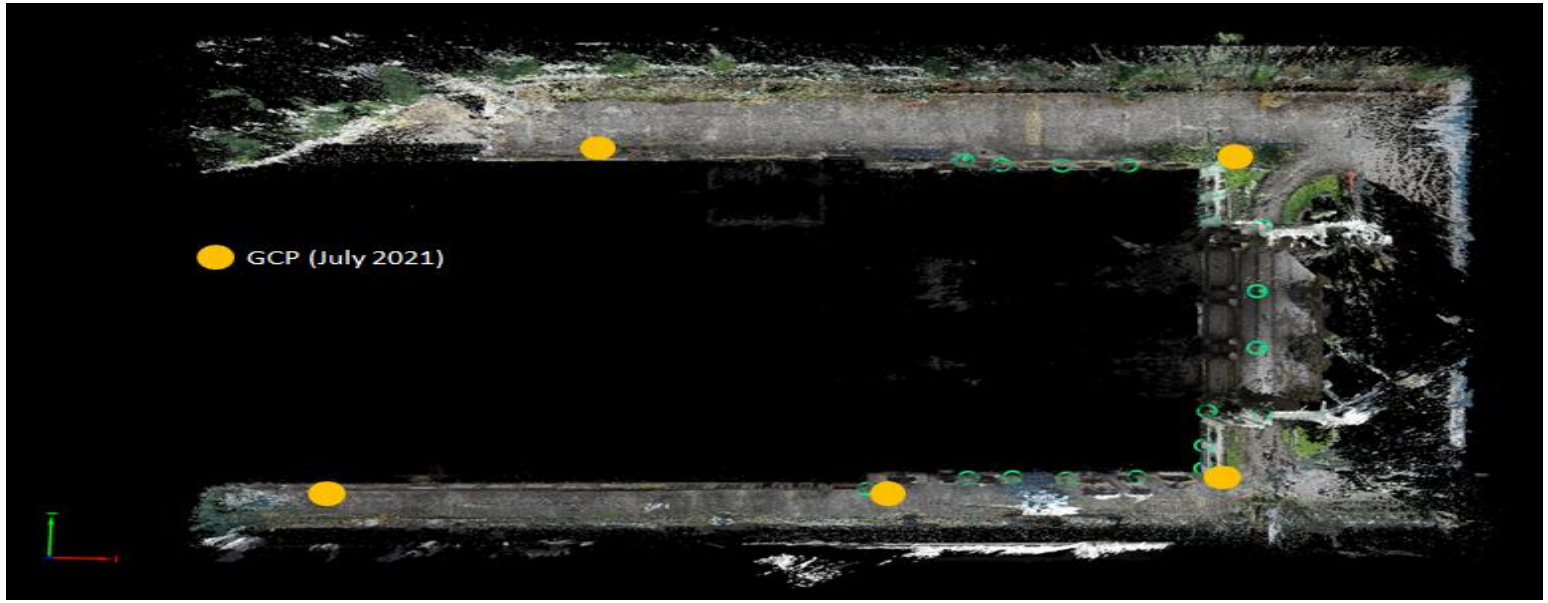
Results



	LG5142	LG5143	LG5151	LG5158	LG5168	LG5173
Day 1	Baseline					N.A.
Day 2	0.7	1.7	1.0	3.6	2.2	Baseline
Day 3	N.A.	N.A.	N.A.	0.5	1.0	4.6
Day 4	N.A.	N.A.	N.A.	N.A.	2.7	4.2

Mean error = 2.2 mm

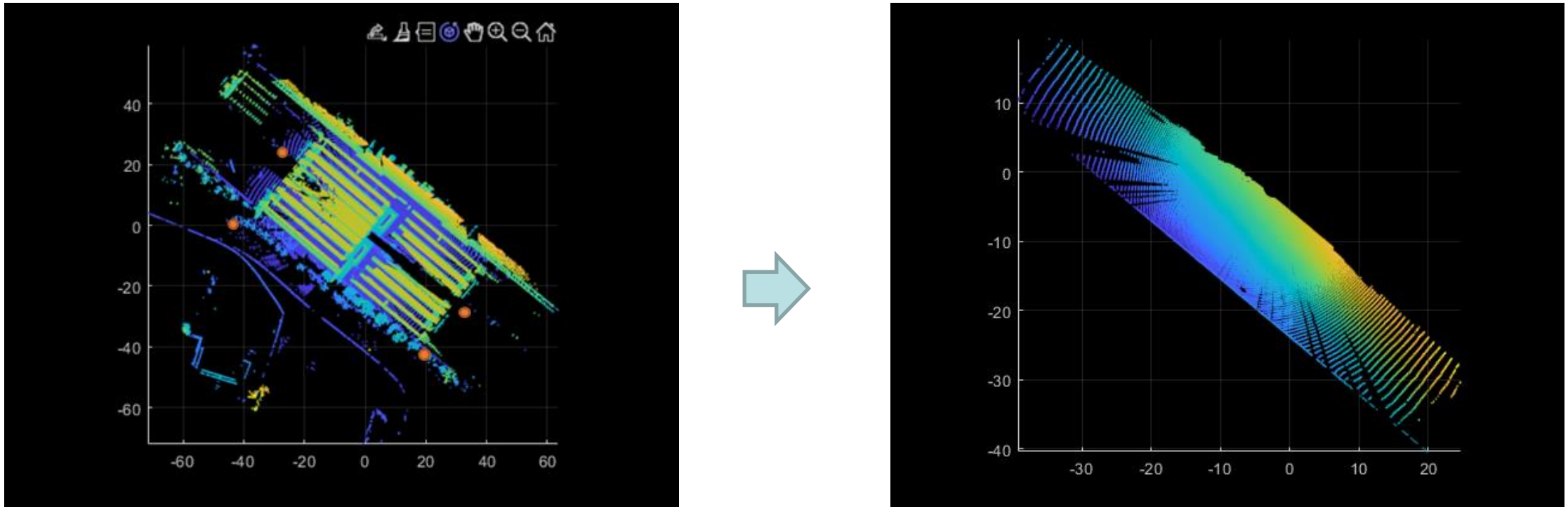
Results



	LG9173	LG3741	LG3706	LG3707	LG3704	LG3705	LG3732	LG3742
Day 0	Baseline							
Day 1	1.0	4.8	1.3	1.4	0.5	1.1	0.6	0.2
Day 2	4.9	1.6	1.0	0.9	1.2	0.7	0.9	0.4
Day 3	6.6	0.2	1.4	0.5	1.1	2.3	2.5	3.5
Day 4	2.6	1.2	0.4	0.7	4.1	4.4	1.5	3.6

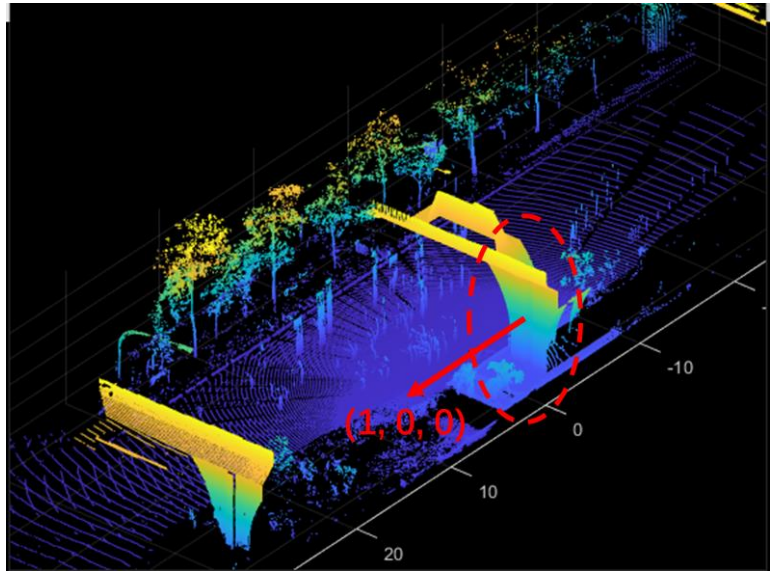
Mean error = 1.8 mm

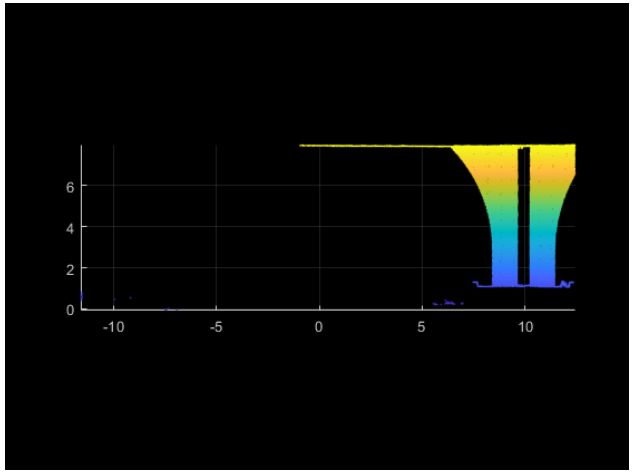
Automation

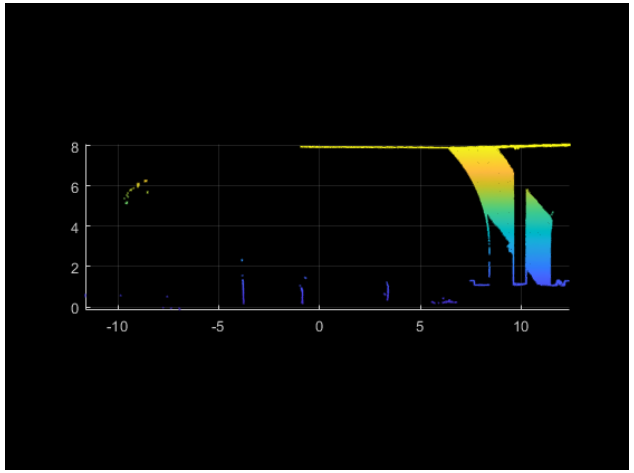


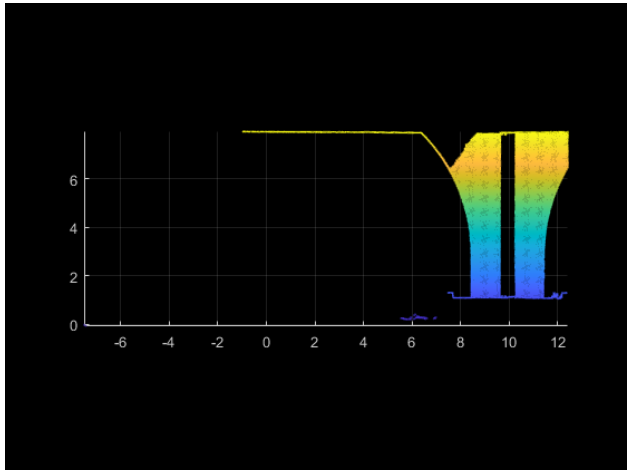
Road extraction from point cloud

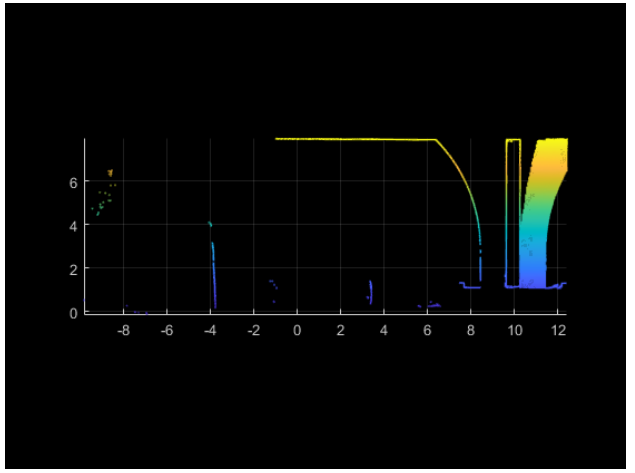
Automation





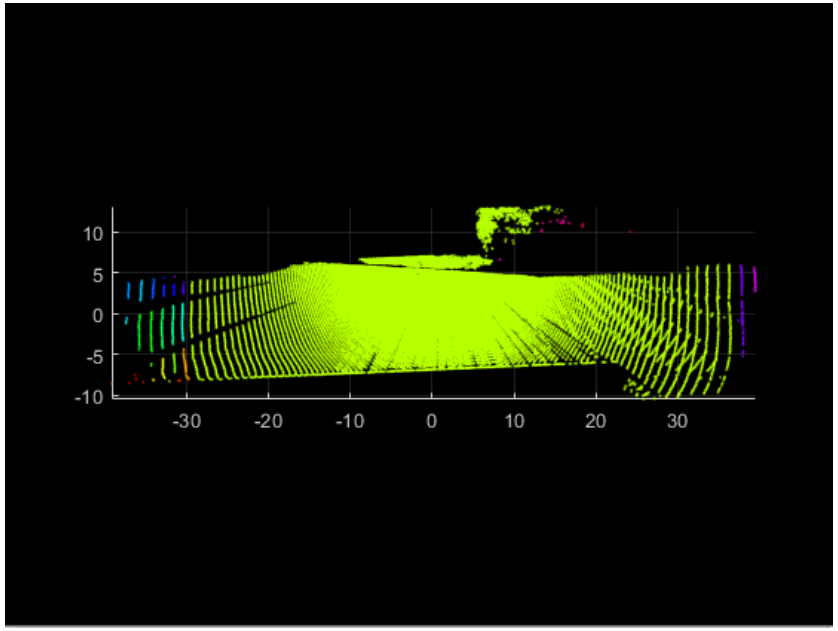


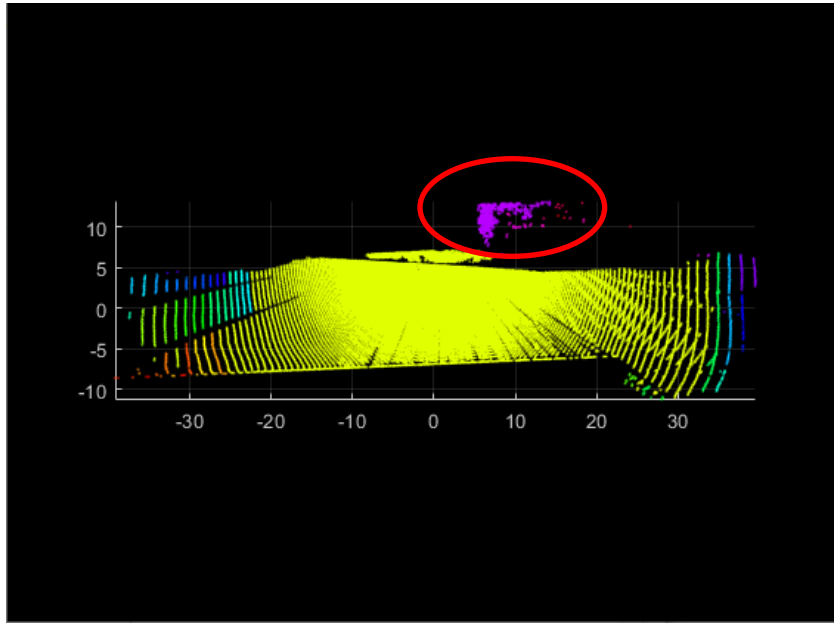




Plane detection

Automation





Noise removal

谢谢！

Questions/Comments:

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