AI FACTORY FOR RAILWAYS (AIF/R)

Spatial data analytics

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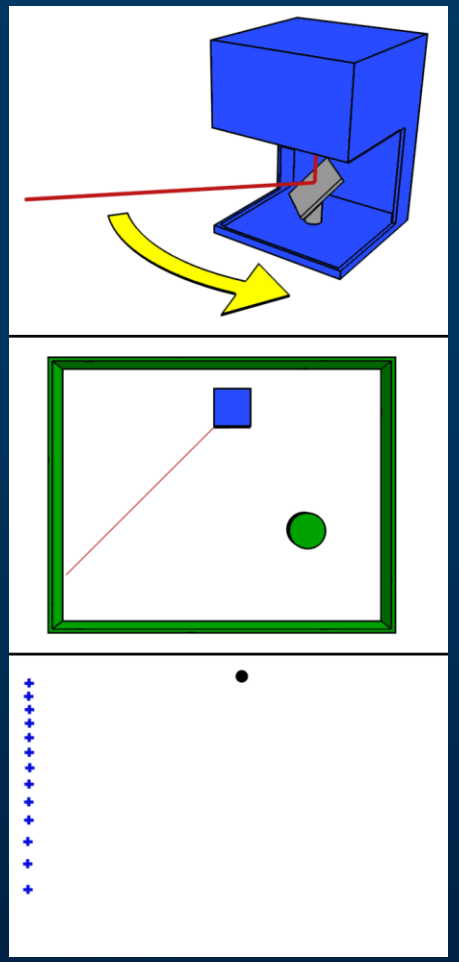
LIDAR WORKING PRINCIPLES

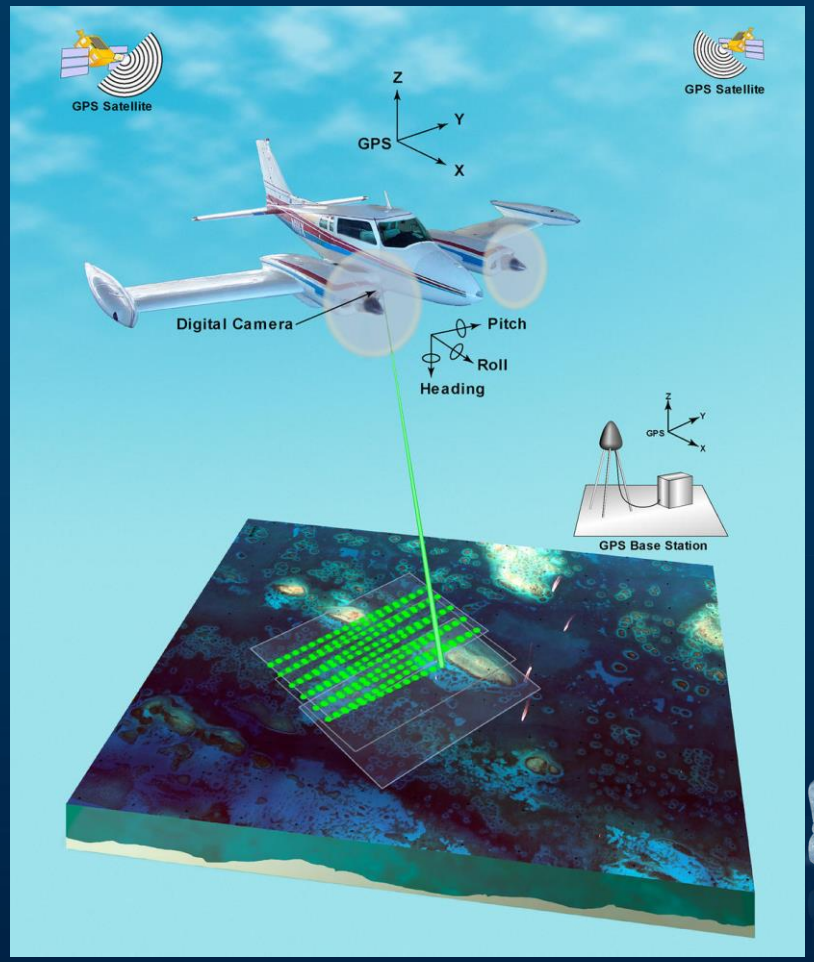
Light detection and ranging

- Transmit LASER beam
- Scanned by rotating mirrors
- Reflection sampled
- Time of flight to measure distance

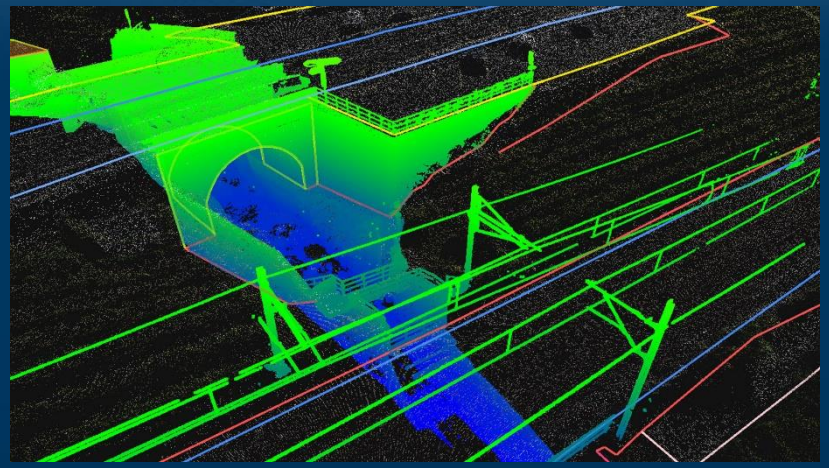


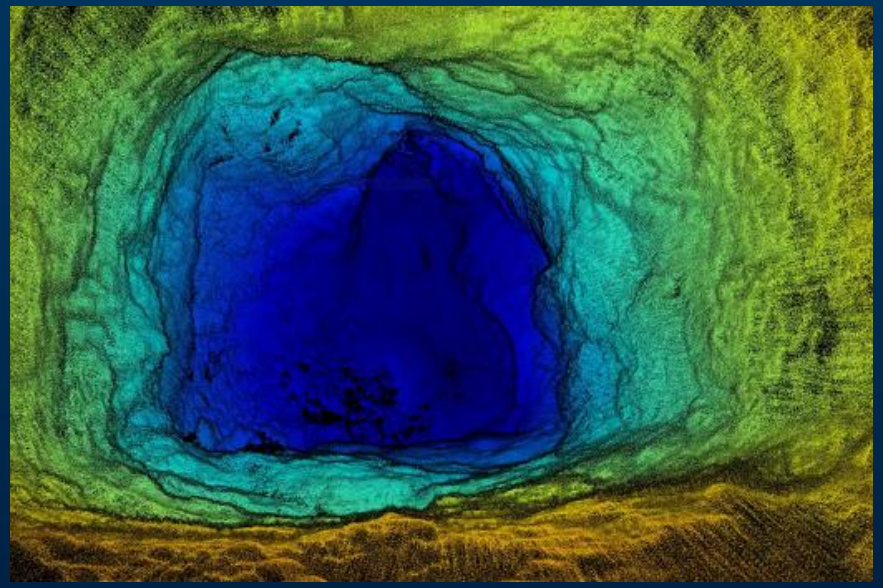
AERIAL LIDAR

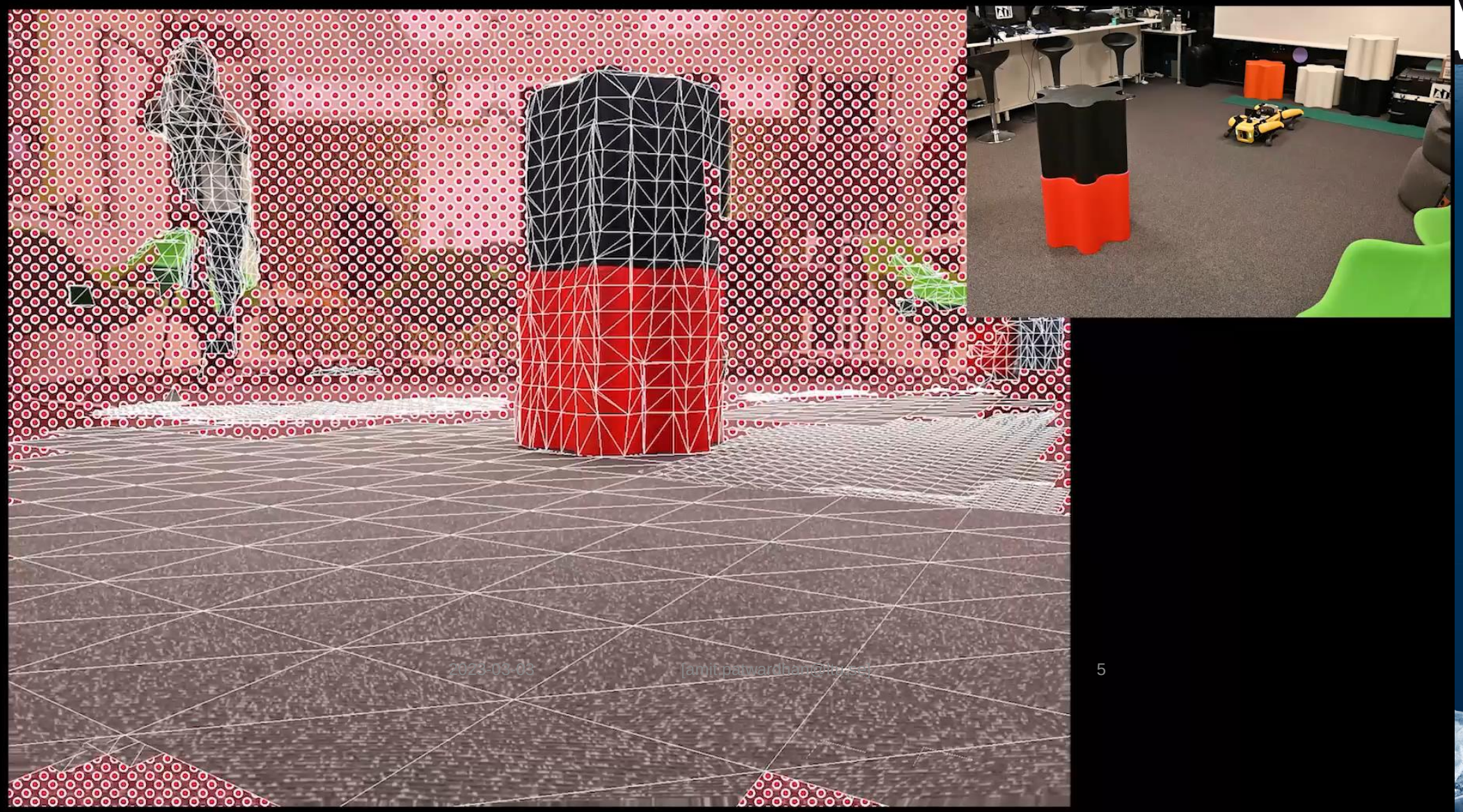
- Aerial vehicle equipped with Lidar, GPS, Accelerometer and Gyroscope
- GPS provides location and altitude
- Accelerometer + Gyroscope provide yaw, pitch and roll of ariel vehicle
- Lidar scans the ground in a zig-zag manner
- Point values are translated based on GPS + Accelerometer + Gyroscope readings
- X, Y and Z coordinated for each point are stored



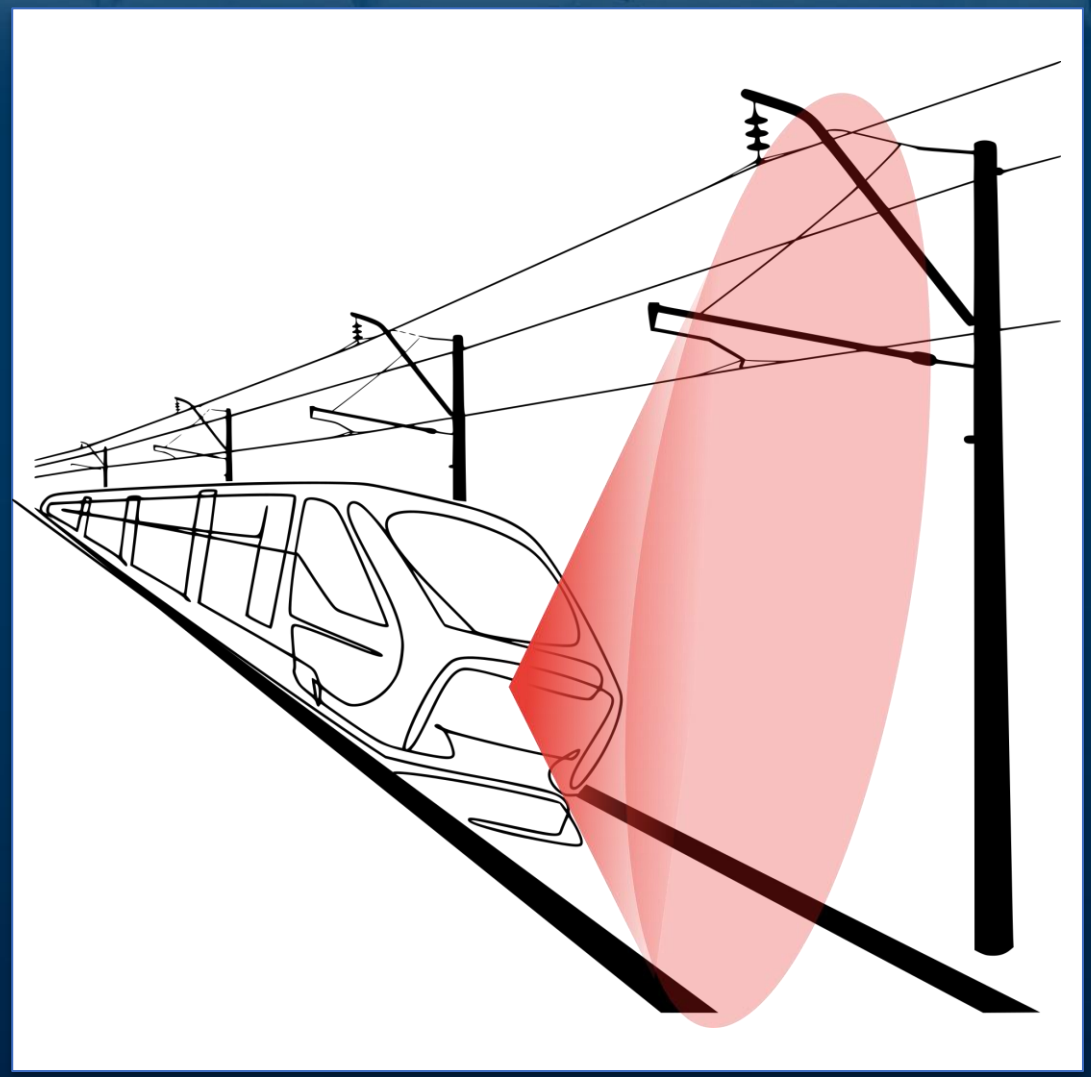
LIDAR APPLICATIONS

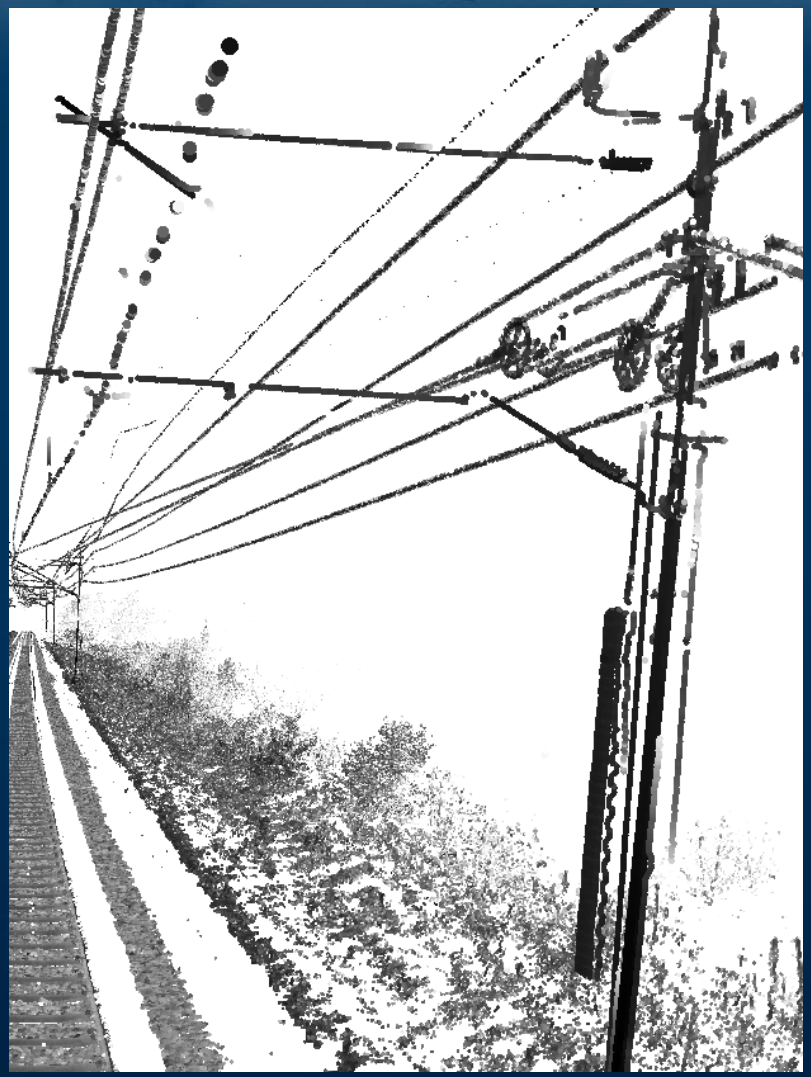






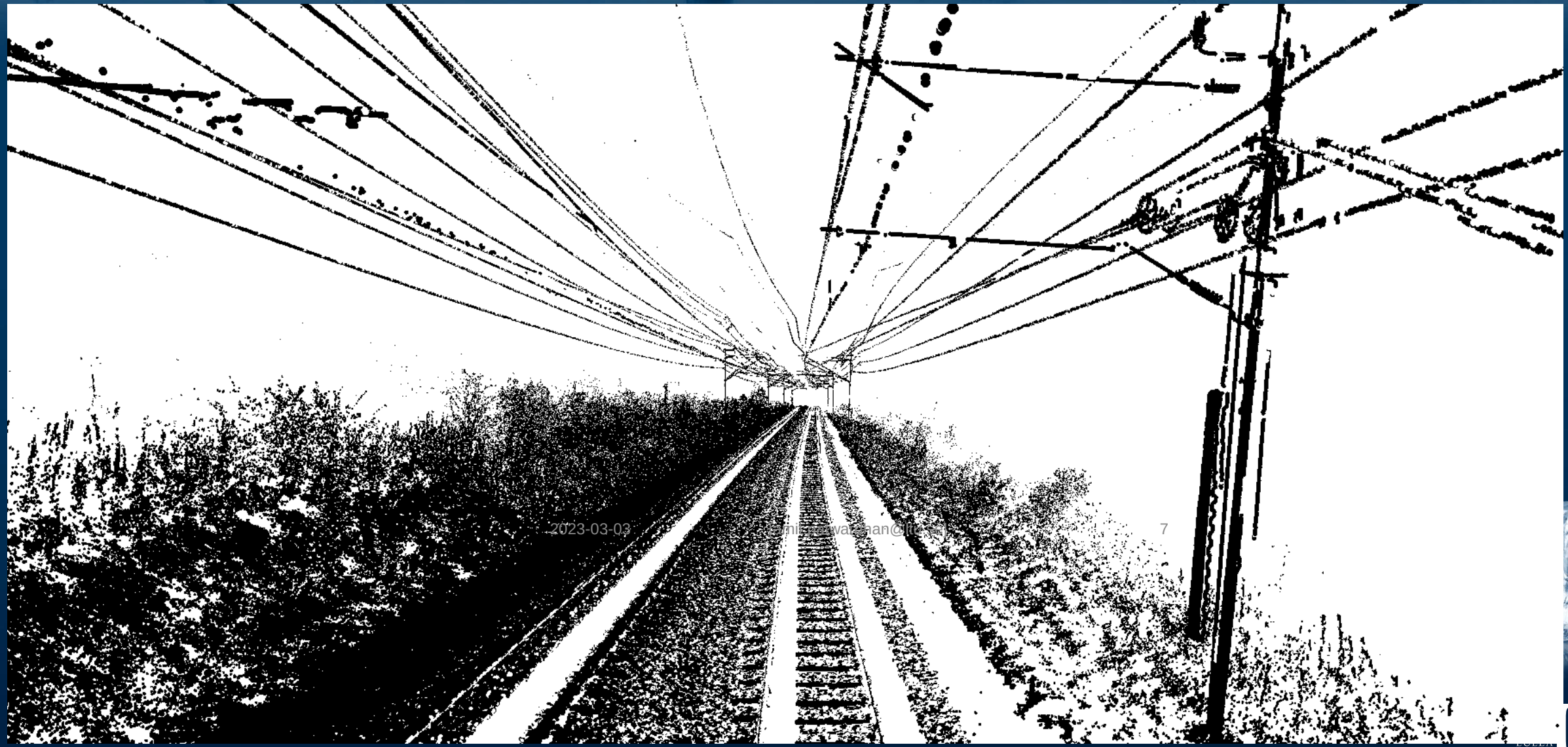
LIDAR INSPECTION



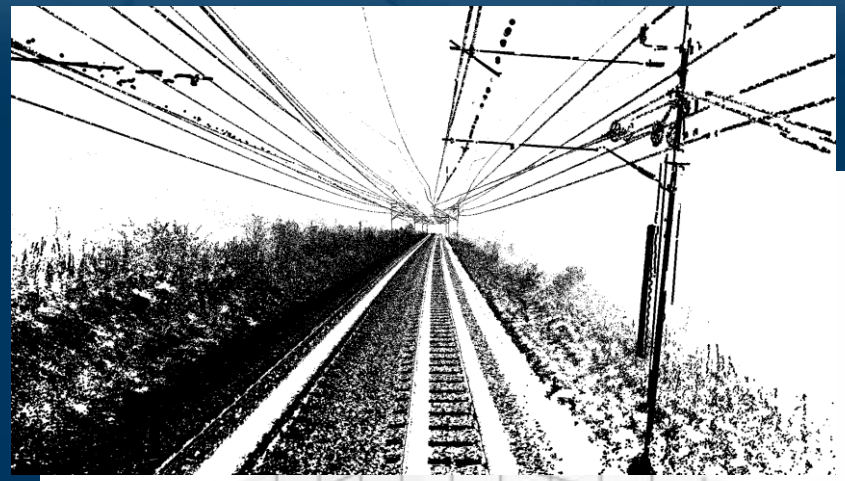


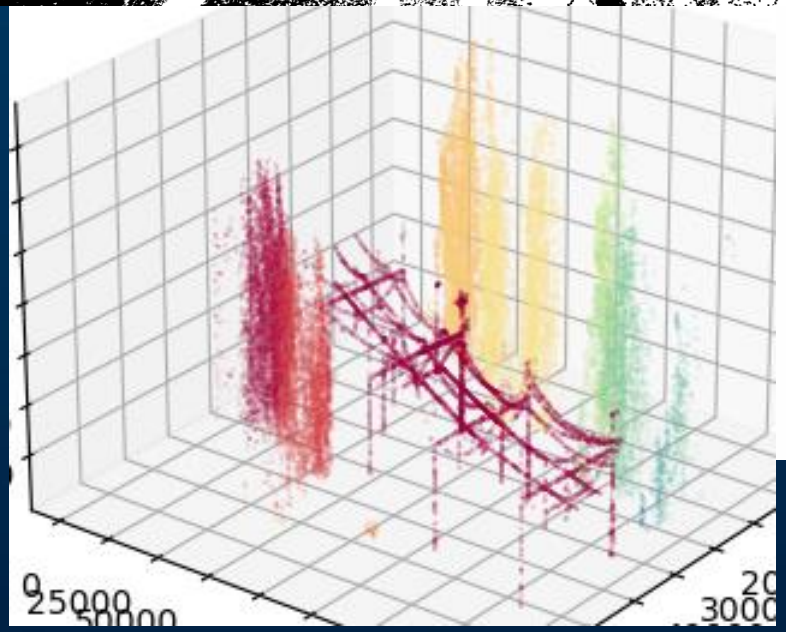
Light Detection And Ranging

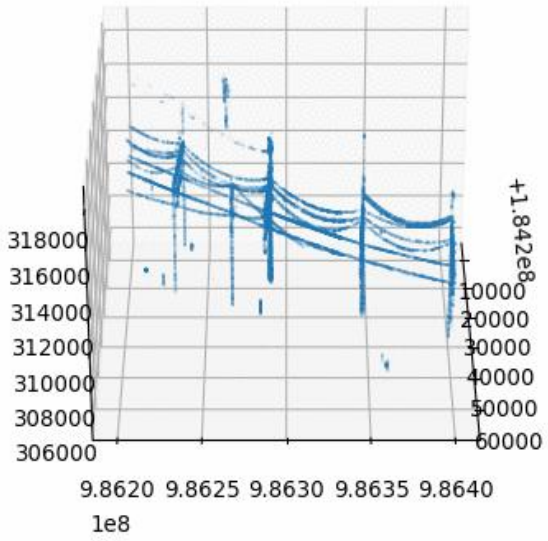
LIDAR SCAN

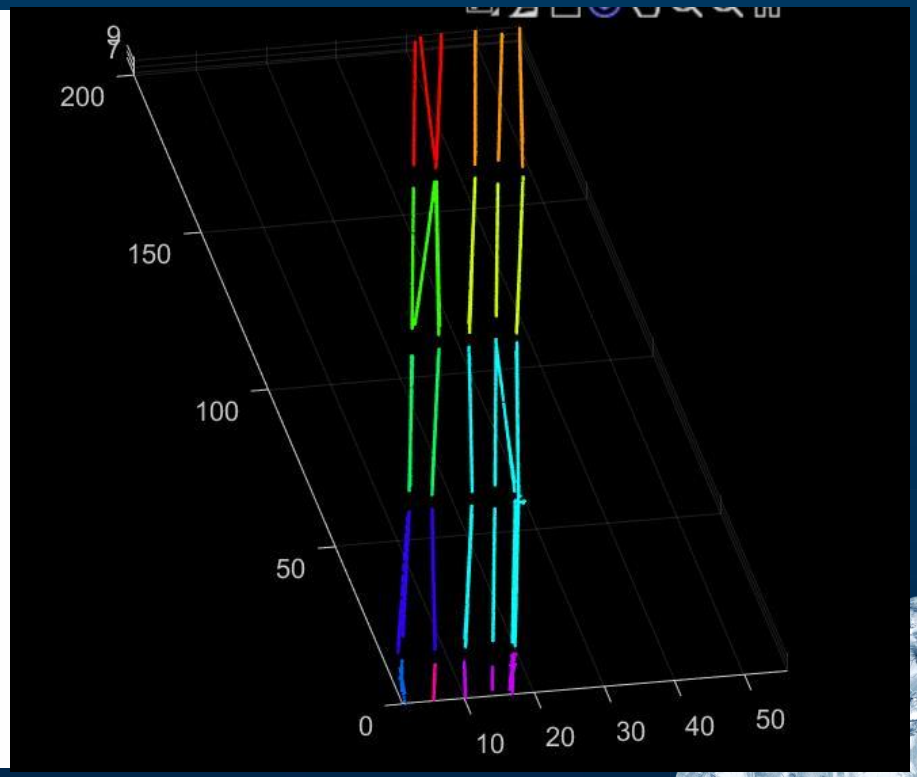


PROCESSING






318000
316000
314000
312000
310000
308000
306000
9.8620
9.8625
9.8630
9.8635
9.8640
1e8
+1.842e8
10000
20000
30000
40000
50000
60000


200
150
100
50
0
10
20
30
40
50

POINT CLOUD DATA PROCESSING

Scanning

- ❑Raw Point Cloud
- ❑Registration

Pre-Processing

- ❑Filtering
  - Noise
  - Ground Plane
- ❑Down-Sampling

Processing

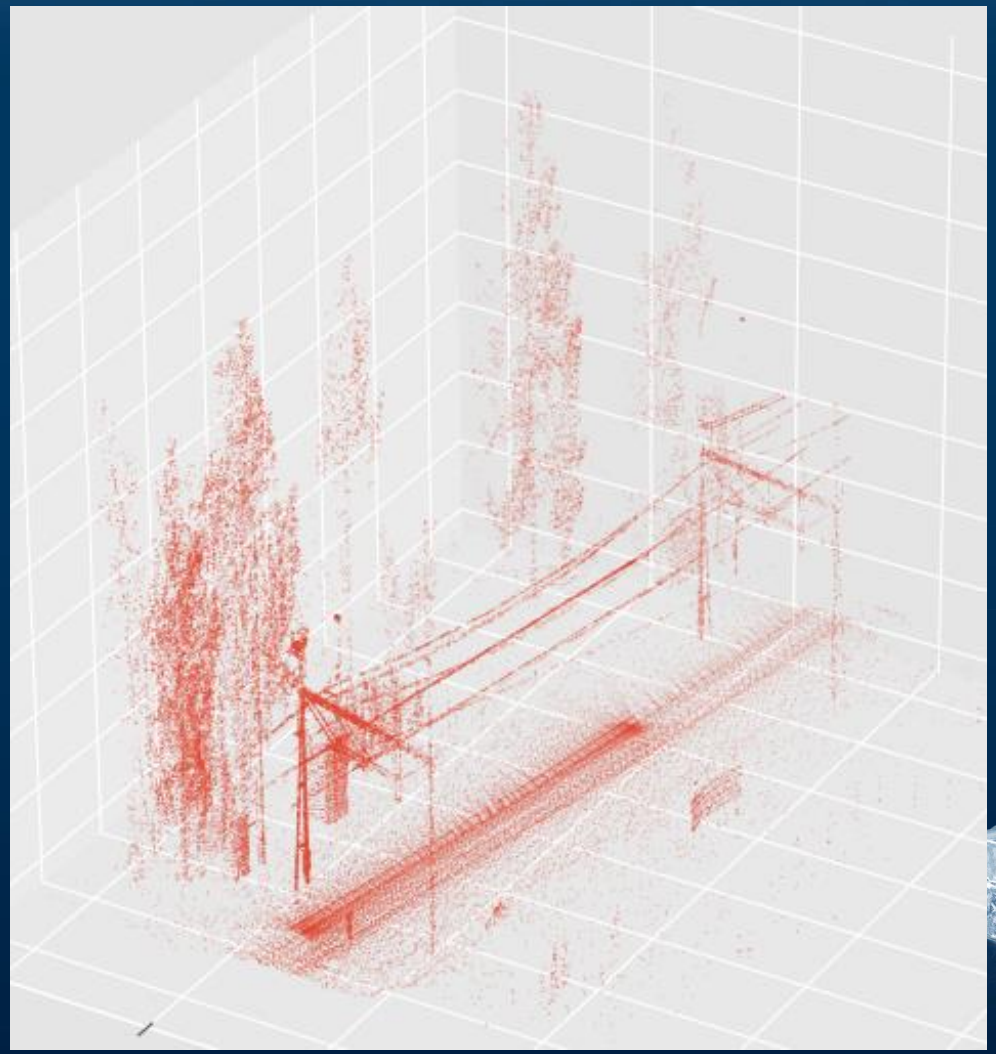
- ❑Cropping
  - Region of interest
  - Asset properties
  - Statistics
- ❑Clustering
  - Asset properties
  - Data features
- ❑Segmentation
  - Extraction

Post-Processing

- ❑Classification
  - Asset properties
  - Statistics
- ❑Export
  - Asset features
  - 3D Model
- ❑Visualisation
  - Point cloud
  - VR
  - AR

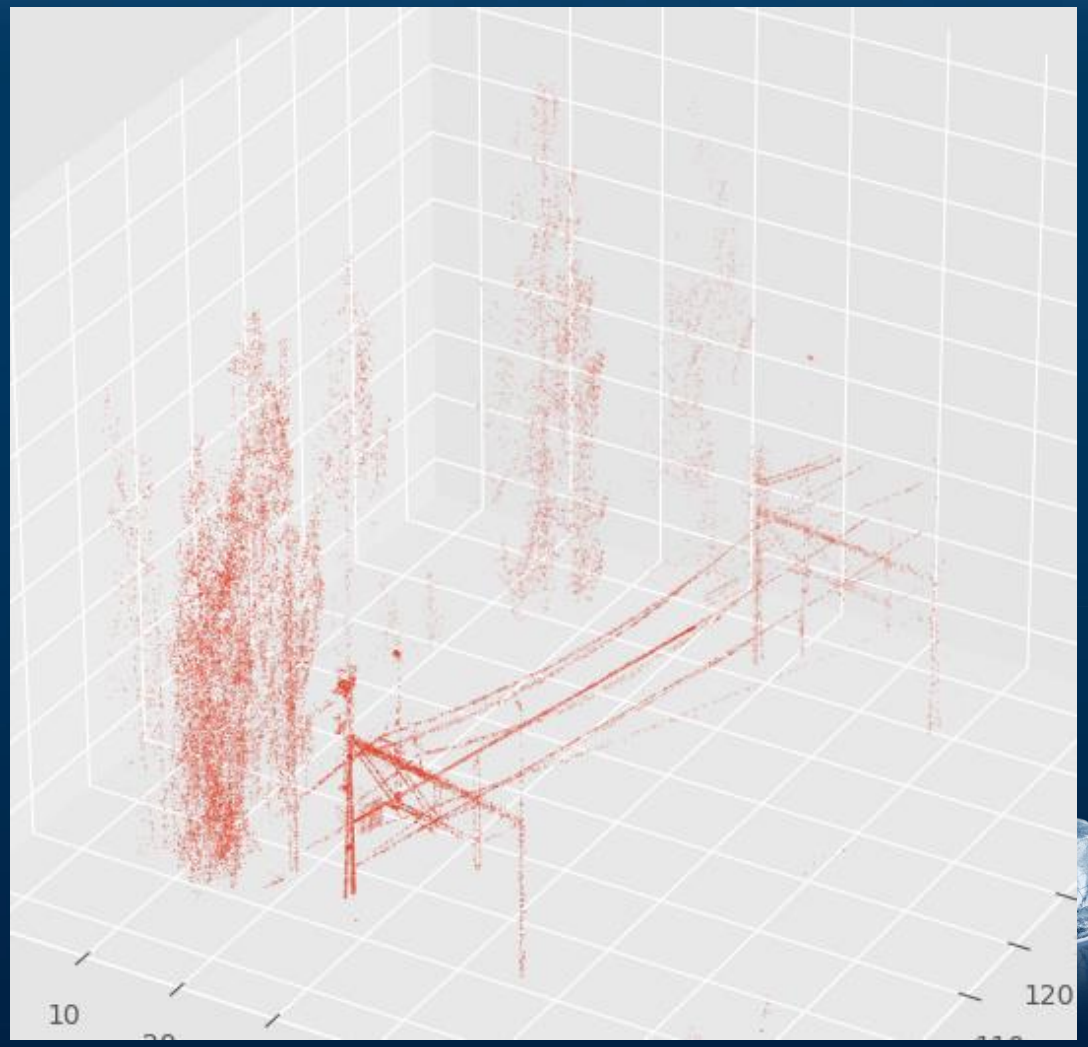
POINT CLOUD

- Reduced density point cloud
- ≈ 72K points
- 70 meter of railway track

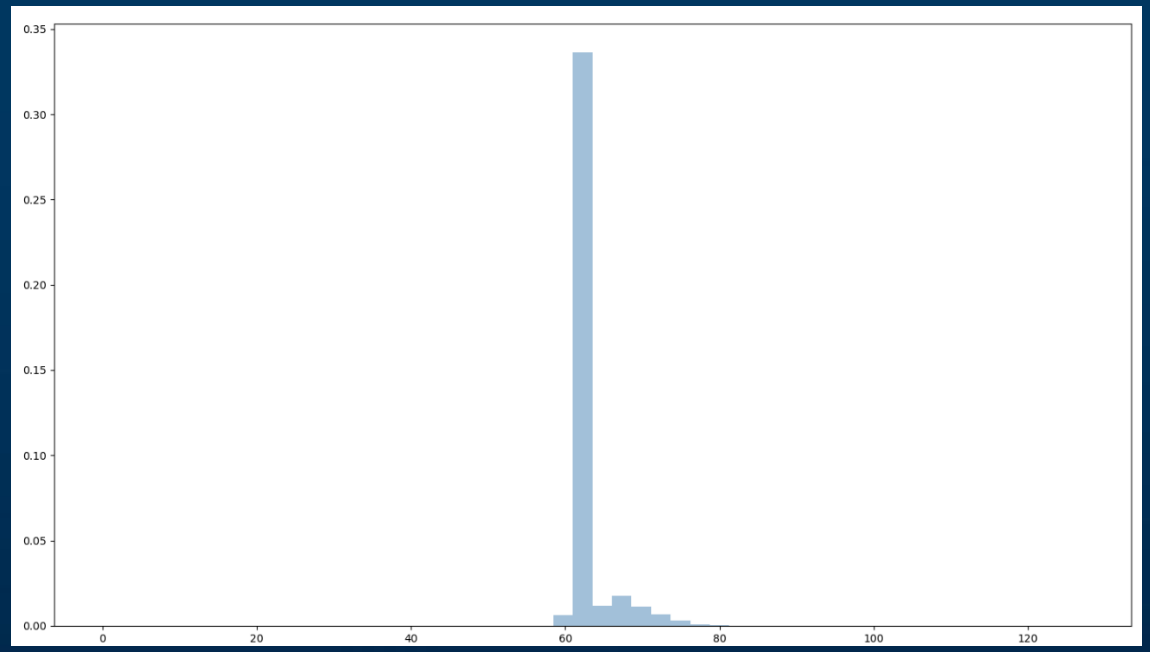


GROUND REMOVAL

- Ground plane may contain upto 70% of the points
- Reduce processing overhead



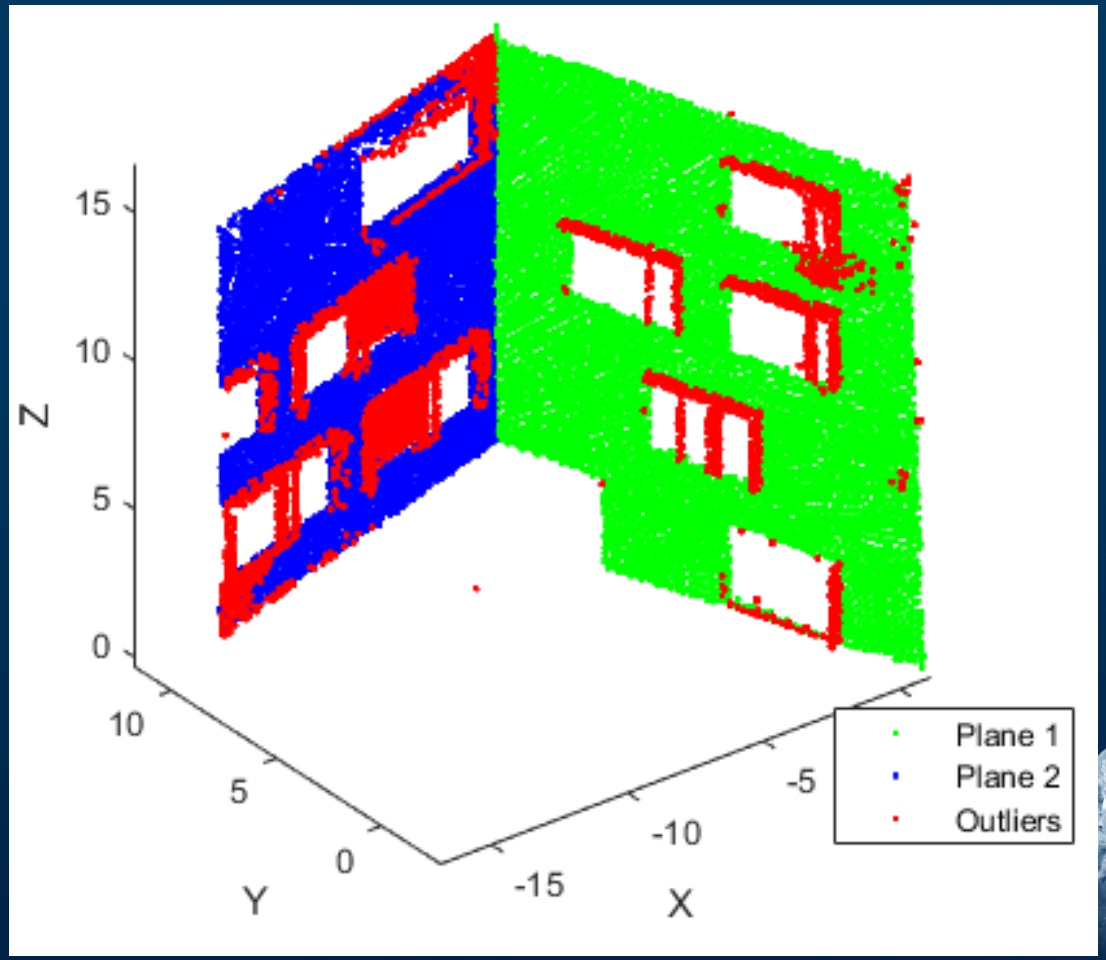
GROUND DETECTION



- Histogram of height component of all points
- The peak represents the mode of the sample
- Mode represents the ground points

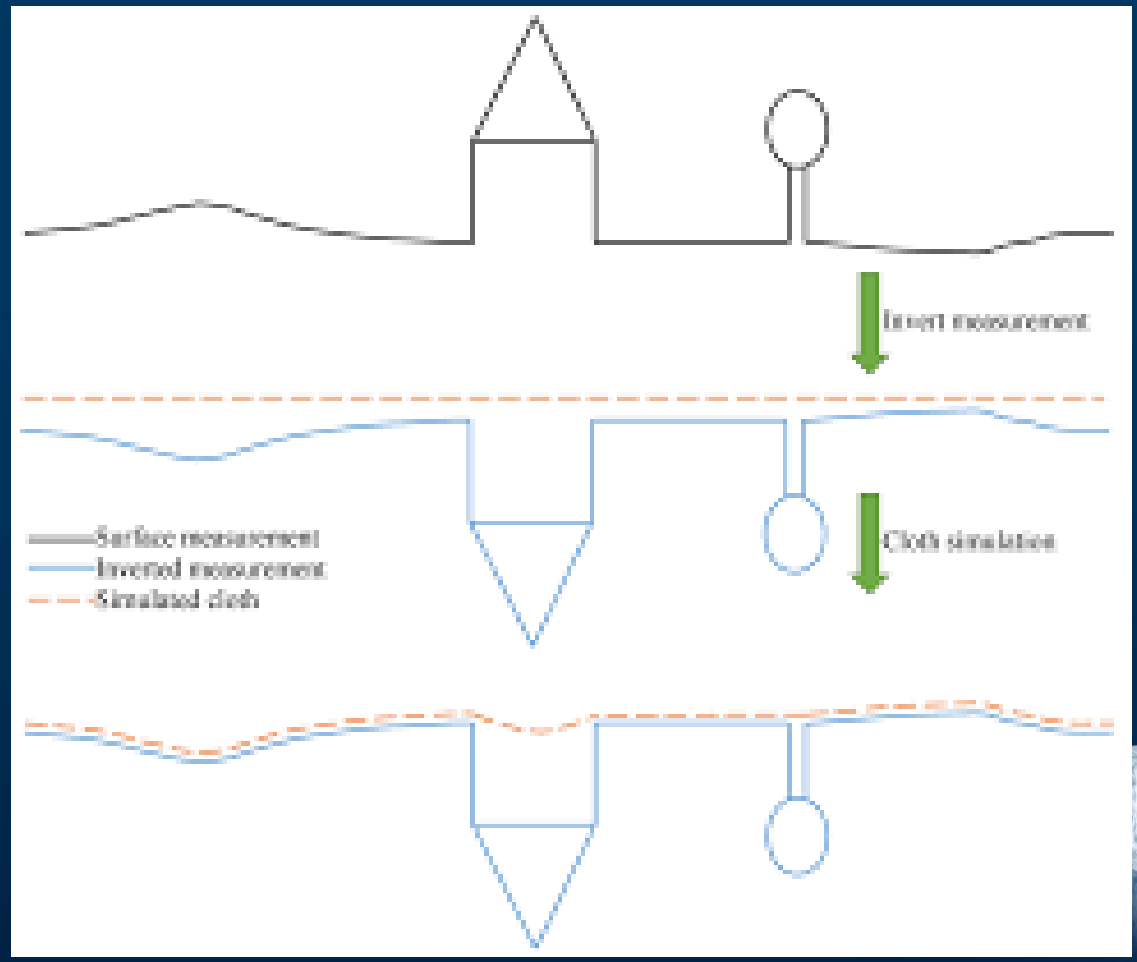
PLANE DETECTION

- Random sample consensus (RANSAC)



CLOTH SIMULATION FILTERING

- Mass and spring simulation



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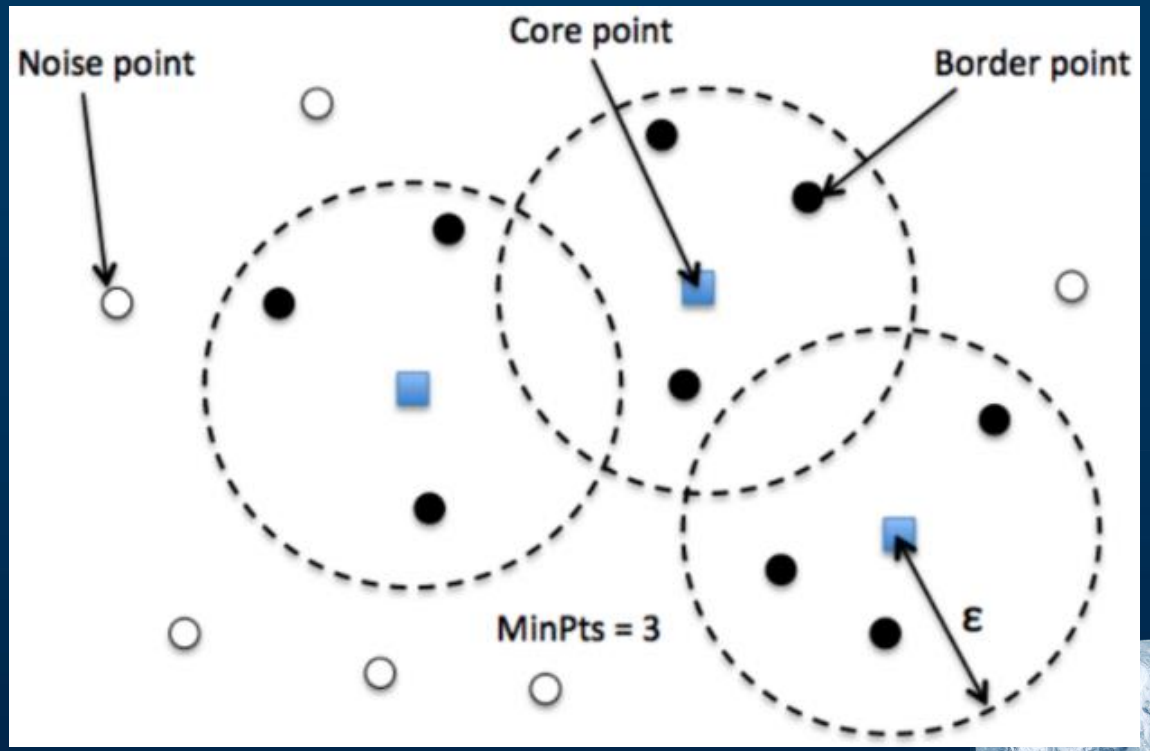
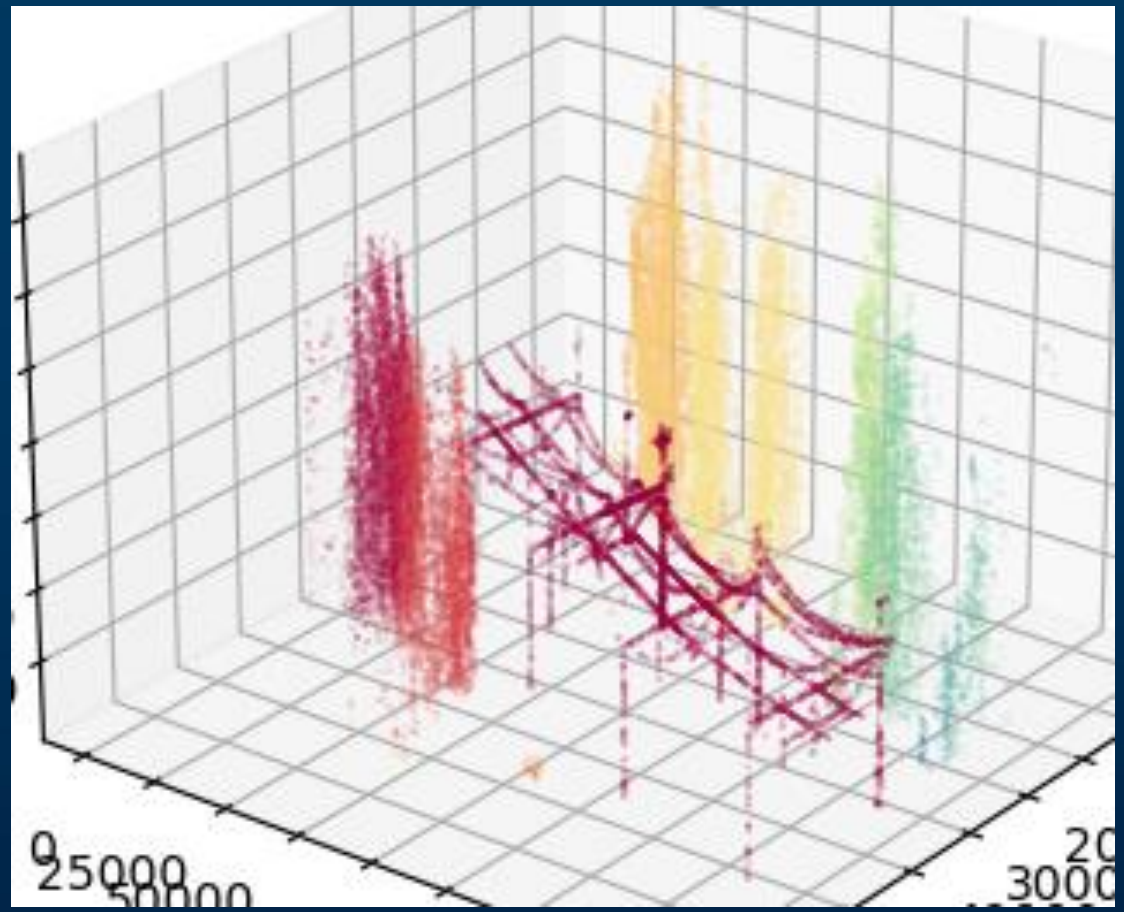
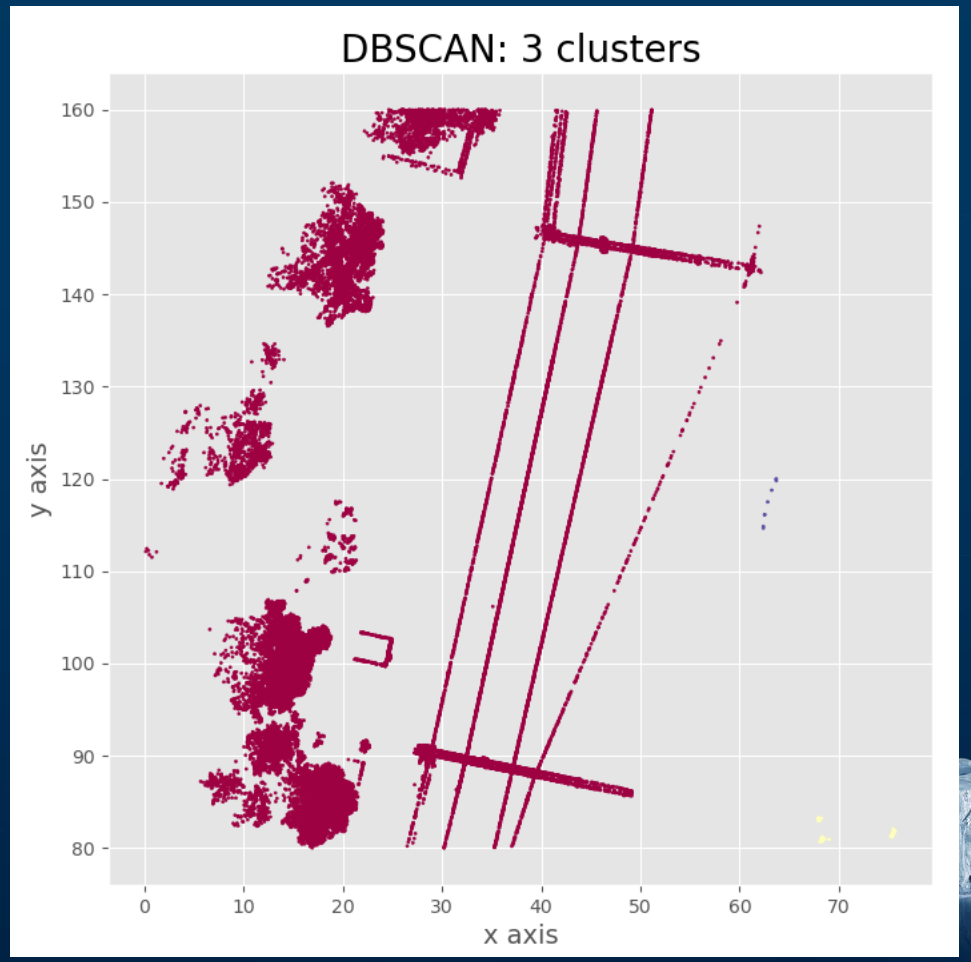
CLUSTERING

- Density-based spatial clustering of applications with noise (DBSCAN)



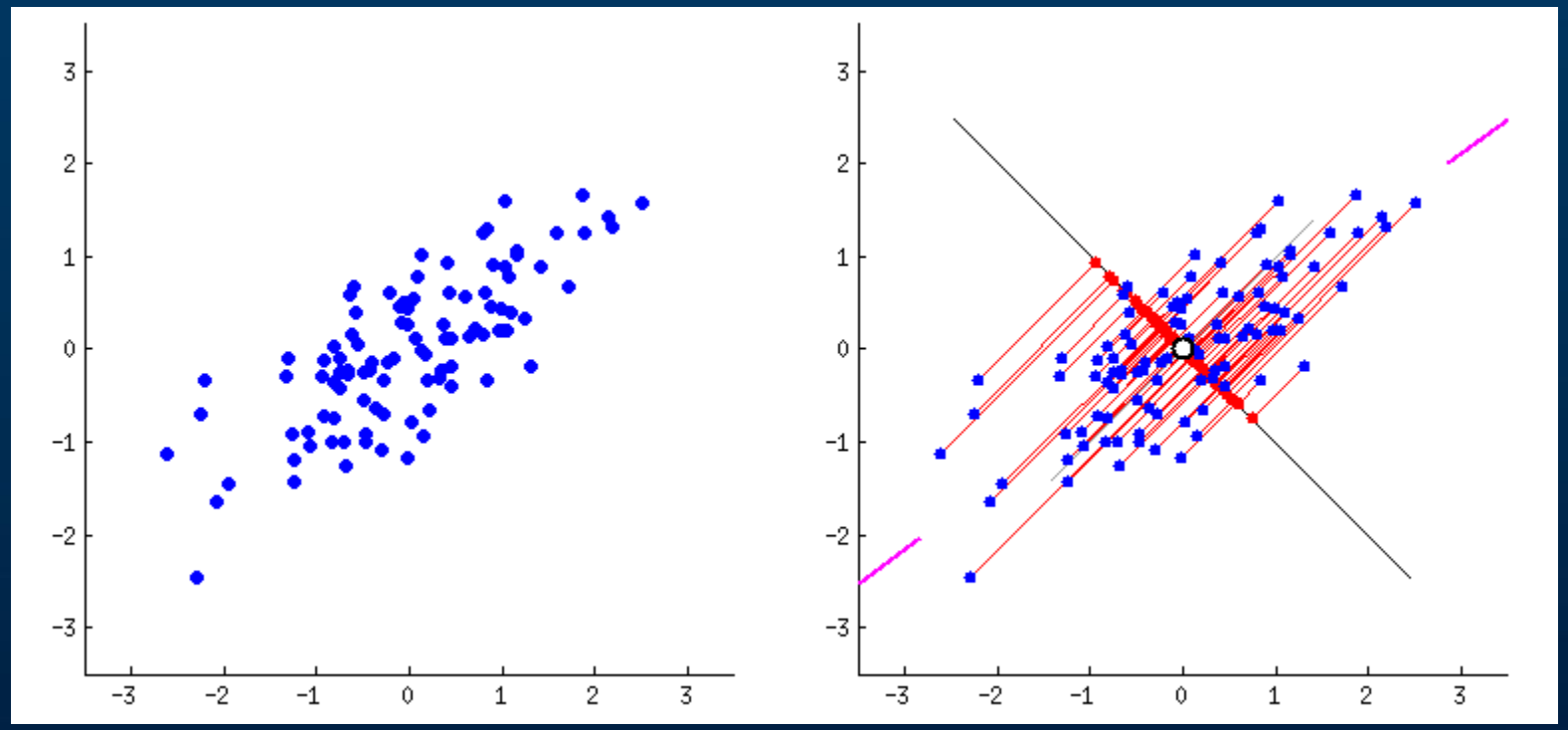
CLUSTERING




DBSCAN: 3 clusters
y axis
x axis
160
150
140
130
120
110
100
90
80
0
10
20
30
40
50
60
70

SEMANTIC ANALYSIS

- Classification of Terrestrial Laser Scanner Point Clouds: A Comparison of Methods for Landslide Monitoring from Mathematical Surface Approximation



FEATURE EXTRACTION

Feature nb	Feature Name	Formula
1	Linearity	$\frac{\lambda_1 - \lambda_2}{\lambda_1}$
2	Planarity	$\frac{\lambda_2 - \lambda_3}{\lambda_1}$
3	Scattering	$\frac{\lambda_3}{\lambda_1}$
4	Omnivariance	$\lambda_1 \lambda_2 \lambda_3$
5	Anisotropy	$\frac{\lambda_1 - \lambda_3}{\lambda_1}$
6	Eigenentropy	$-\sum_{i-1}^{3} \lambda_i \ln \lambda_i$
7	Sum of eigenvalues	$\lambda_1 + \lambda_2 + \lambda_3$

Feature nb	Feature Name	Formula
8	Change of curvature	$\frac{\lambda_3}{\lambda_1 + \lambda_2 + \lambda_3}$
9	Mean Z	$\sum_{i-1}^{k_n+1} \frac{Z_i}{k_n + 1}$
10	Z variance	$\sum_{i=1}^{k_n+1} \frac{Z_i - mean\,(Z)}{k_n + 1}$
11	Maximum Z difference	$Z_{max} - Z_{min}$
12	PCA1	$\frac{\lambda_1}{\lambda_1 + \lambda_2 + \lambda_3}$
13	PCA2	$\frac{\lambda_2}{\lambda_1 + \lambda_2 + \lambda_3}$
14	Roughness	d_r
15	normal vector x	n_x
16	normal vector y	n_y
17	normal vector z	n_z
18	Density	$\frac{k_n + 1}{4/3 r_{max}}$
19	Verticality	$1 - n_z$

THANK YOU