UNIVERSITY OF TWENTE.

Detection of Temporary Objects in Mobile Lidar Point Clouds

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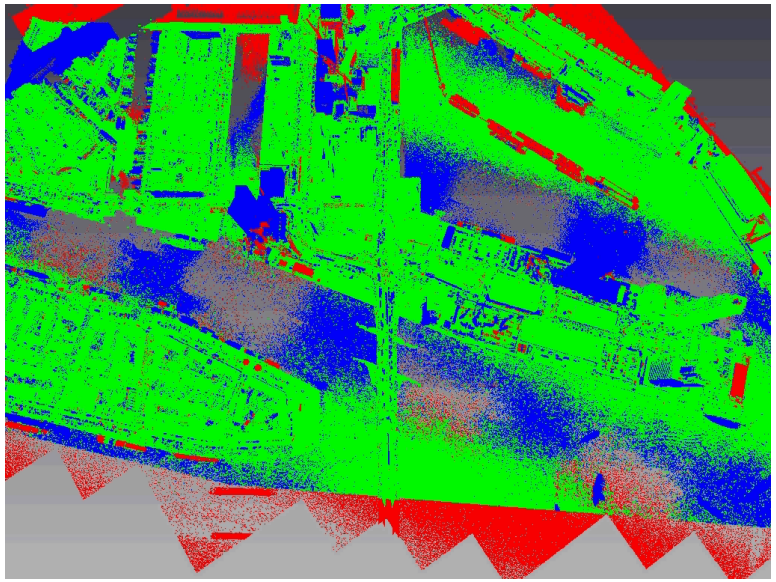
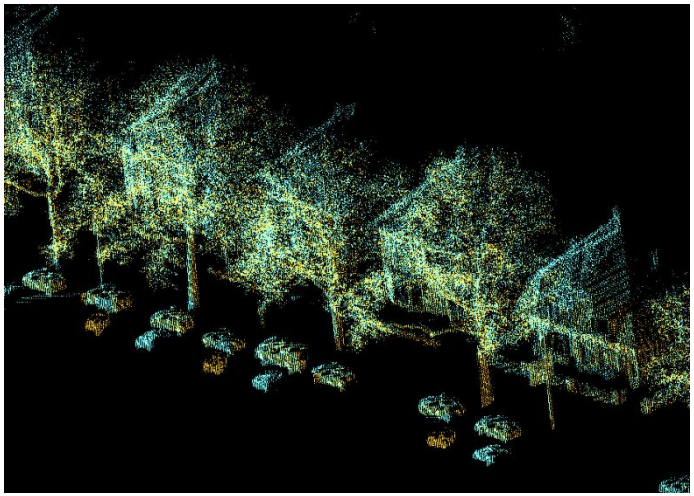
BACKGROUND

- Mobile laser scanning provides an accurate recording of road environments useful for many applications;
- Usually only permanent objects are of interest;
- Temporary objects can hamper the analysis of permanent ones;
- Example: change detection using multi-epoch data where temporary objects appear as (false) change signals.



APPROACH

- Temporary objects: { Static / Moving }



- Static temporary objects:

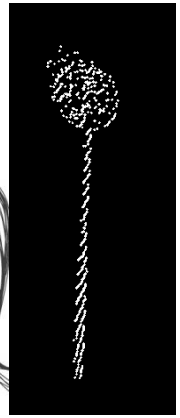
  → segmentation + classification based on shape features

- Moving temporary objects:

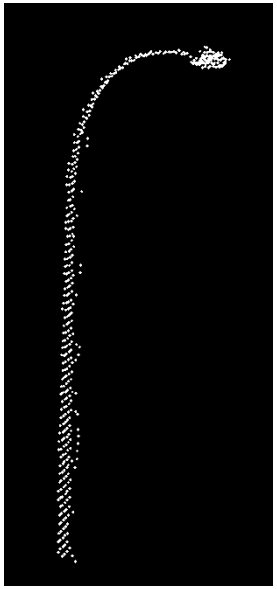
  → segmentation + closest point analysis in two sensor data

STATIC TEMPORARY OBJECTS

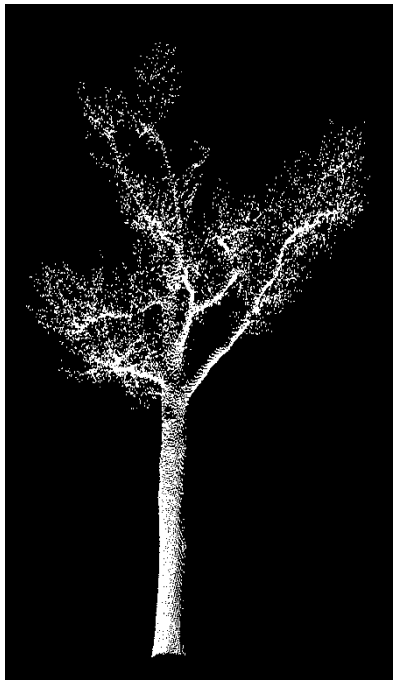
- Classification based on shape features:



Linear & short

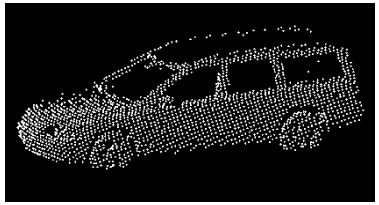


Linear & tall



Volumetric & tall

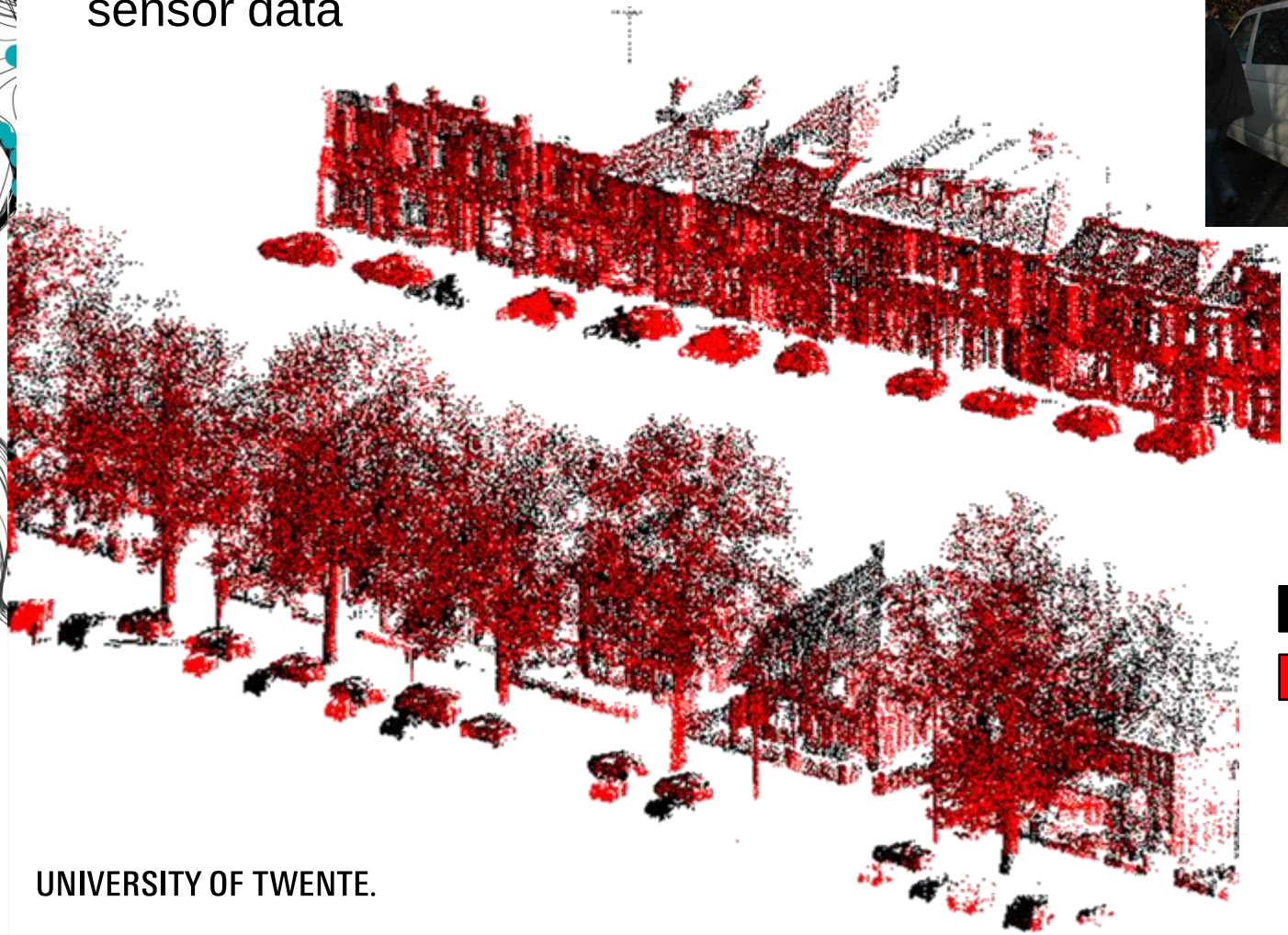
Planar



Volumetric & short

MOVING TEMPORARY OBJECTS

- Detection based on closest point analysis with two sensor data



Sensor 1

Sensor 2

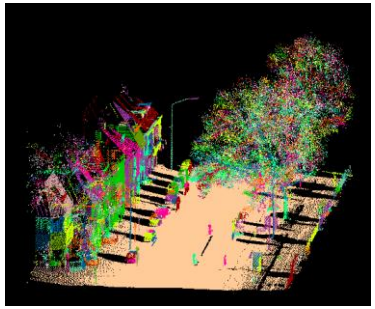
METHODS

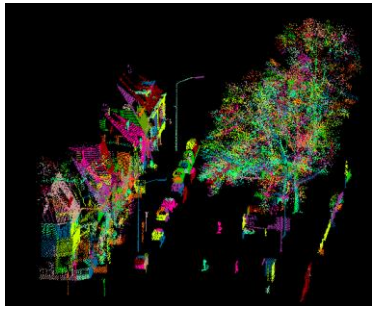
1. Ground removal
2. Connected-component segmentation
3. Static temporary objects:

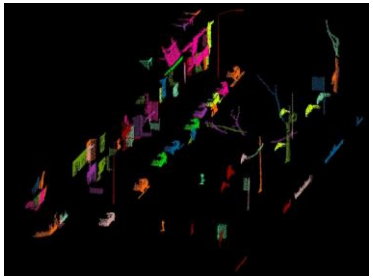
   → feature extraction + classification

4. Moving temporary objects:

   → closest point analysis + classification

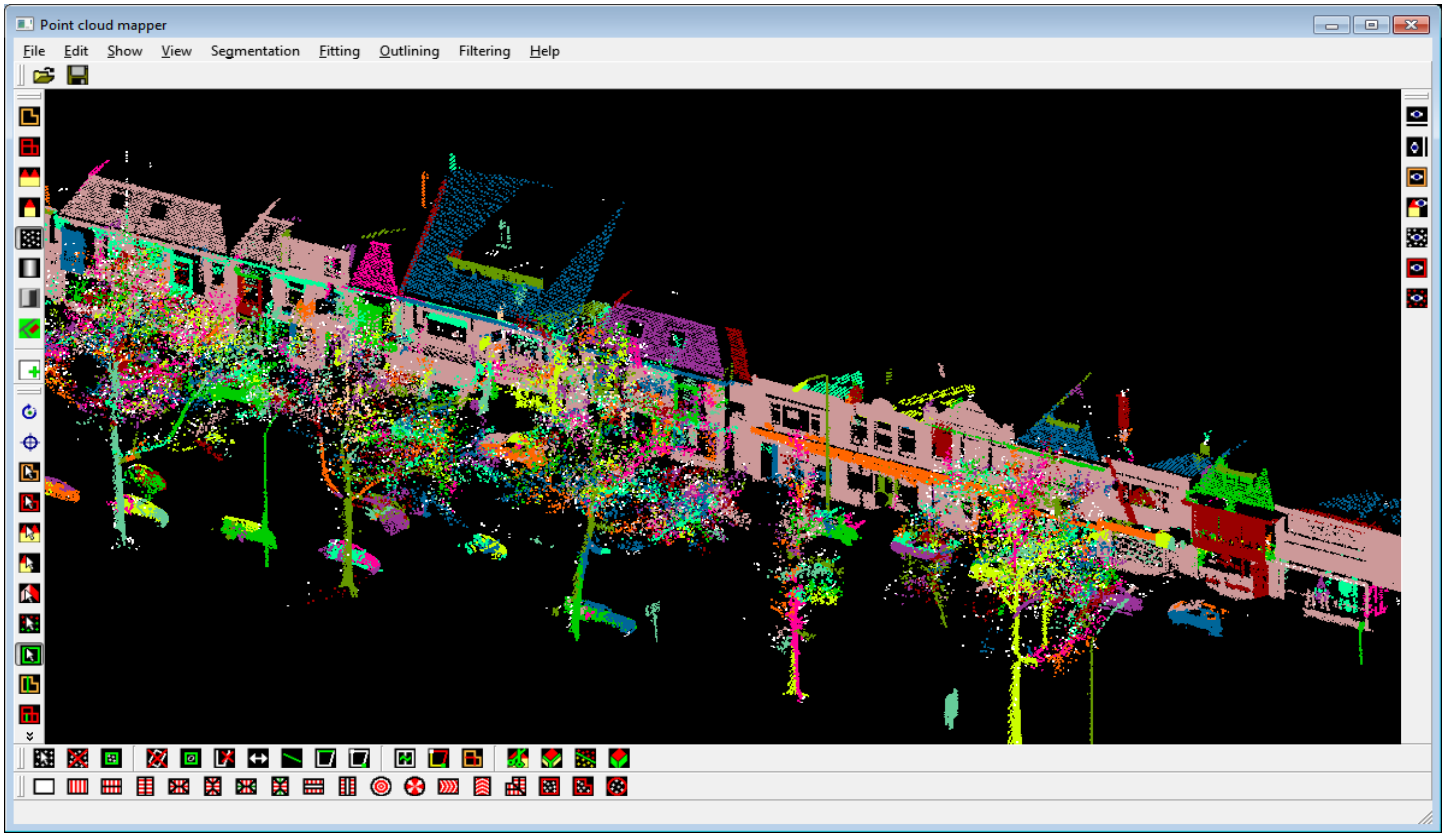






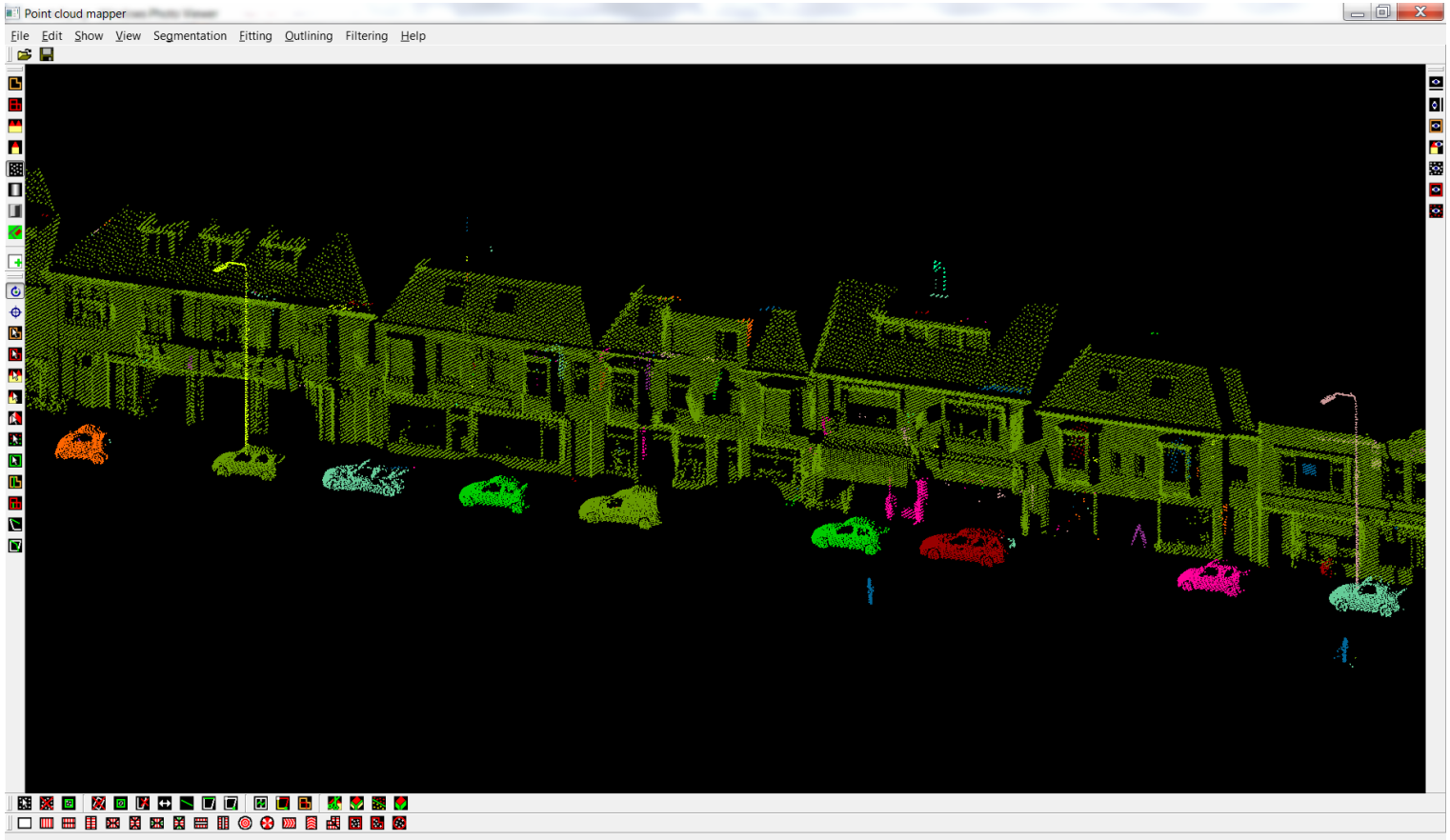
GROUND REMOVAL

- Plane-based segmentation
- Ground = large & low segment



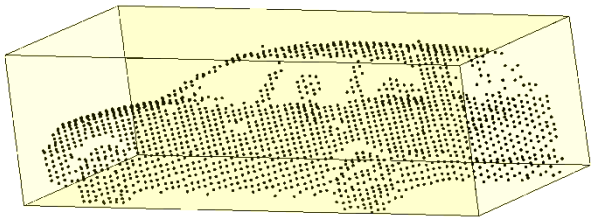
CONNECTED COMPONENT SEGMENTATION

- Points that are closer than a certain distance (e.g. 30 cm) belong to one connected component;

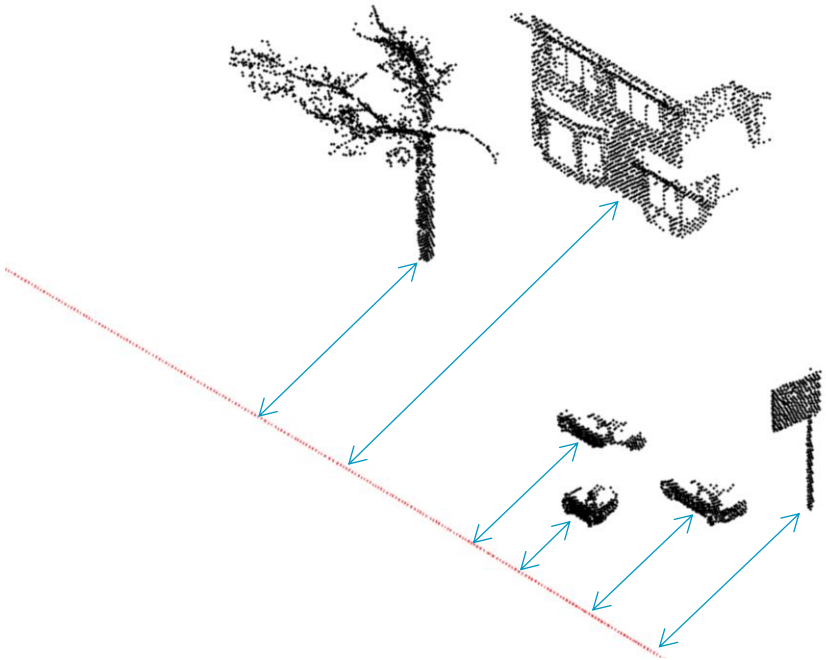


FEATURE EXTRACTION

- Shape features
  - → Size (number of points)
  - → Area on horizontal plane
  - → Mean density
  - → Height of the lowest point
  - → Height



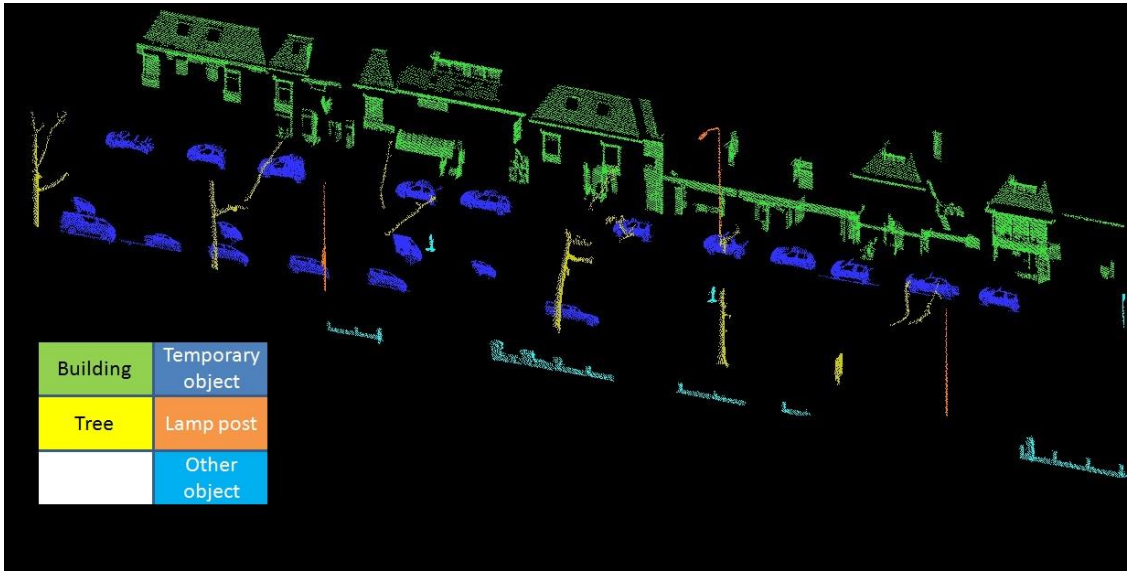
- Contextual feature
  - → Distance to trajectory



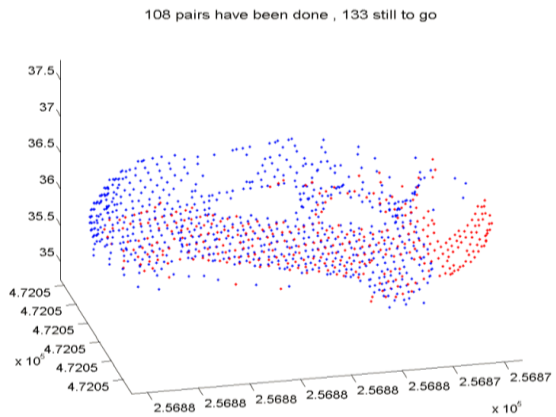
- Eigen-based features
  - → Anisotropy
  - → Planarity
  - → Sphericity
  - → Linearity

CLASSIFICATION

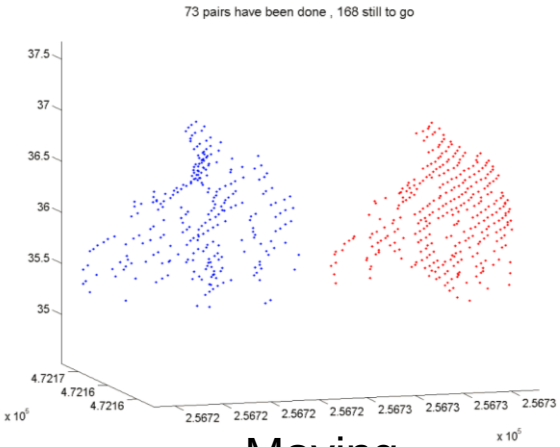
- Ground truth for training and evaluation: manual labeling (115 samples)
- Feature selection
  → Forward Selection (FS)
  → Backward Elimination (BE)
- Classification
  → Linear Discrimnant Classifier (LDC)
  → Support Vector Machine (SVM)



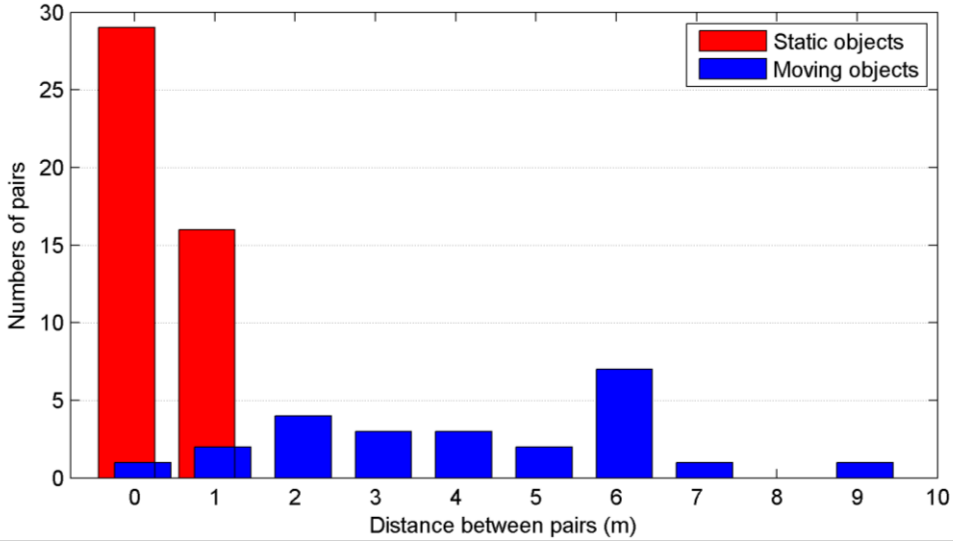
CLOSEST POINT ANALYSIS



Static



Moving

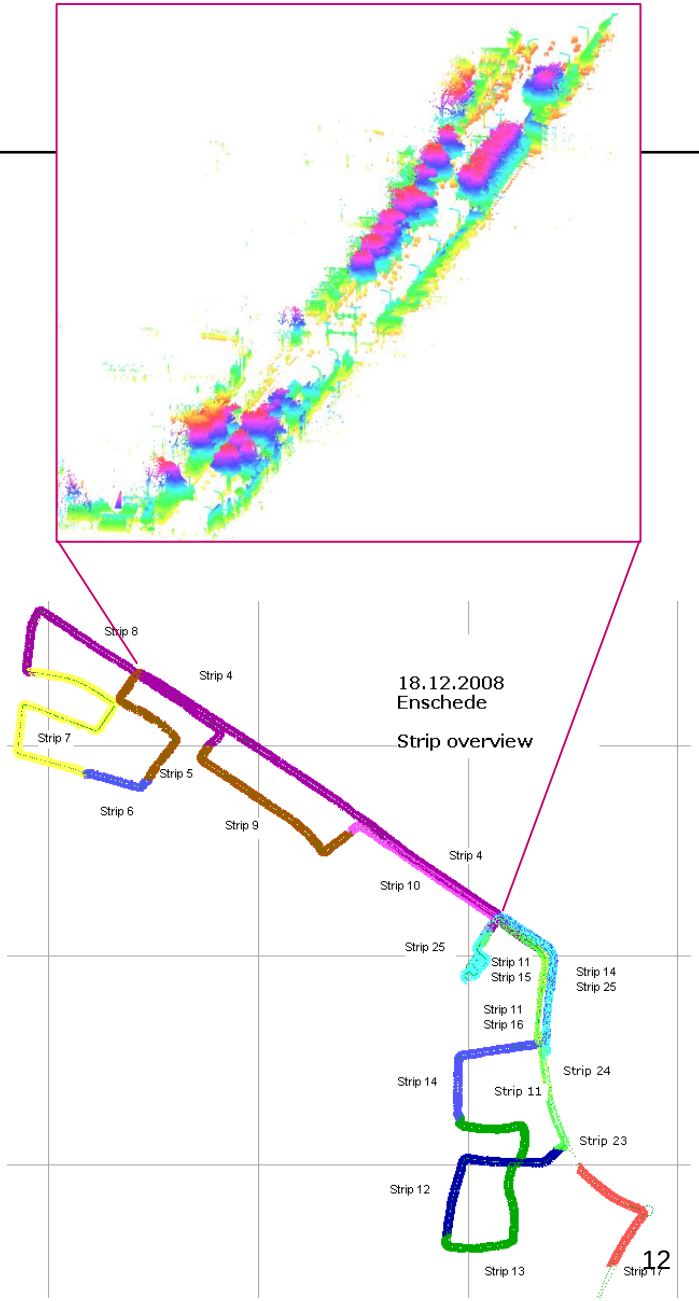


	Static objects	Moving objects
Number	45	24

EXPERIMENTS

- Study area
  → Enschede, urban

- Data
  → TopScan MLS
  → One strip: ~20 mio points



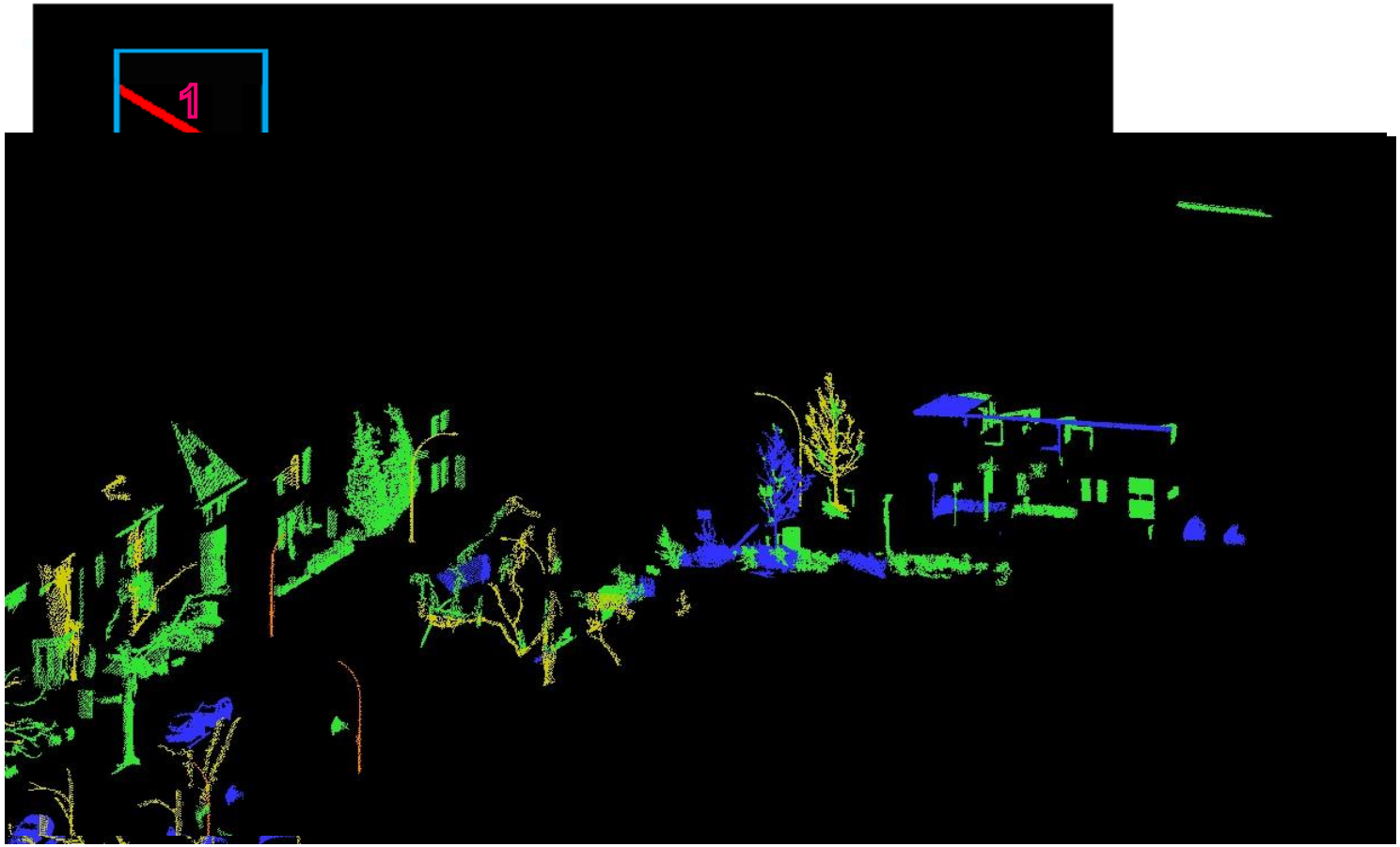
RESULTS

- Detection results for static temporary objects (test set):

Classifier	Completeness	Correctness
LDC - all features	0.90	0.86
LDC - FS (8 features)	0.90	0.79
LDC - BE (8 features)	0.95	0.91
SVM - all features	1.00	0.91
SVM - FS (9 features)	1.00	1.00
SVM - BE (11 features)	1.00	0.95

RESULTS

- Classification results for the whole strip :



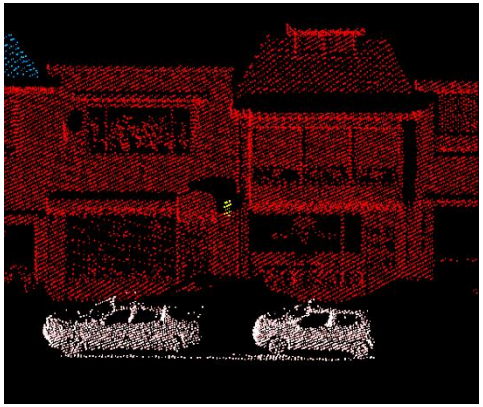
RESULTS

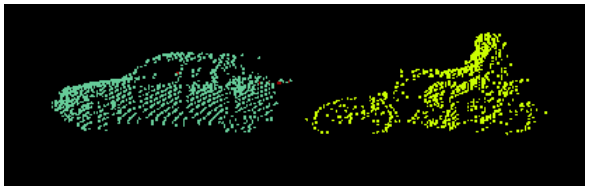
- Detection results for moving objects:
  → Total 64 samples
  → 4 false positives
  → 6 false negatives

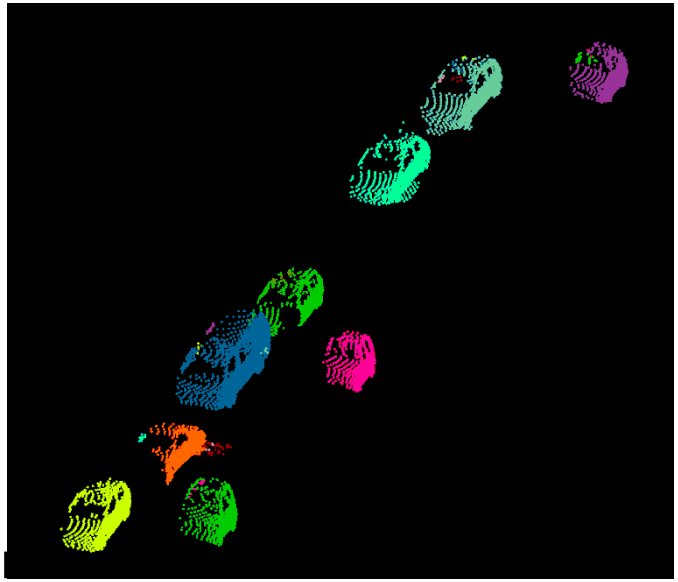
	Sensor 1	Sensor 2	Sensor1 + Sensor2
Completeness	0.93	0.86	0.90
Correctness	0.90	0.96	0.93
Overall Accuracy	0.84	0.83	0.84

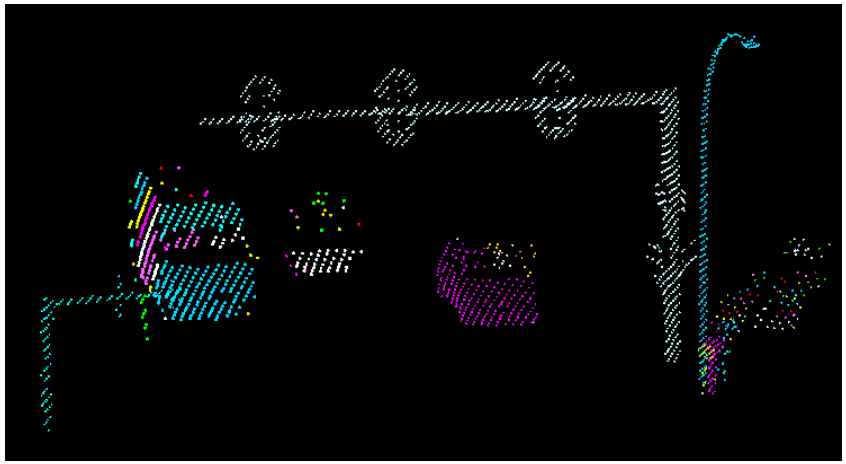
LIMITATIONS

- Occlusion;
- Overgrown and undergrown segments;
- Shrunk or elongated shapes due to movement.
- Variable shape and size of vehicles.









SUMMARY

- Object-based approach: obvious choice as we are dealing with objects not points;
- Connected component segmentation of objects works well (but not perfect!);
- Shape features are suitable for classification of static temporary objects; Accuracy > 90%.
- Distance between closest points is a useful measure for detecting moving objects; Accuracy > 80%
- Occlusion: objects seen by one sensor but not the other = problem for moving objects.

THANK YOU!