POINT CLOUD MANAGEMENT AND STORAGE

(PONTFELHŐK KEZELÉSE ÉS TÁROLÁSA)

TKP WORKSHOP 2022

SUMMARY FOR THE PERIOD JANUARY 2021 – MAY 2022

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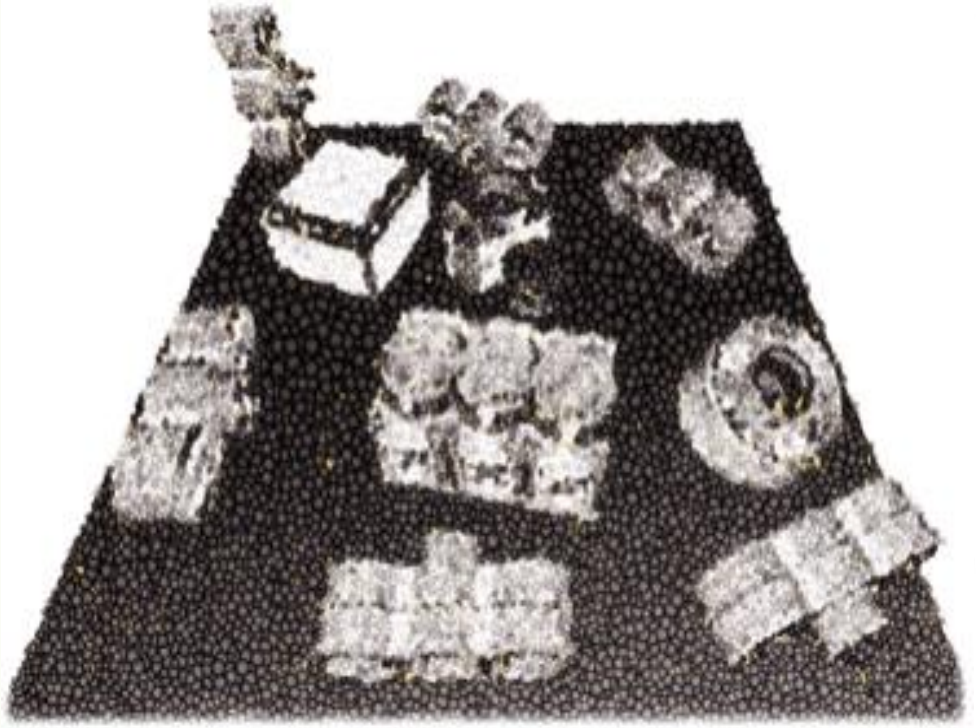
Motivation

- Modern 3D LiDAR scanners → point cloud applications
- E.g.:
  - in the context of self-driving cars, localization
  - stitching together successive scan data to produce a map,
  - pedestrian detection or detection of other non-local objects,
  - for autonomous robots, finding an object in a bin



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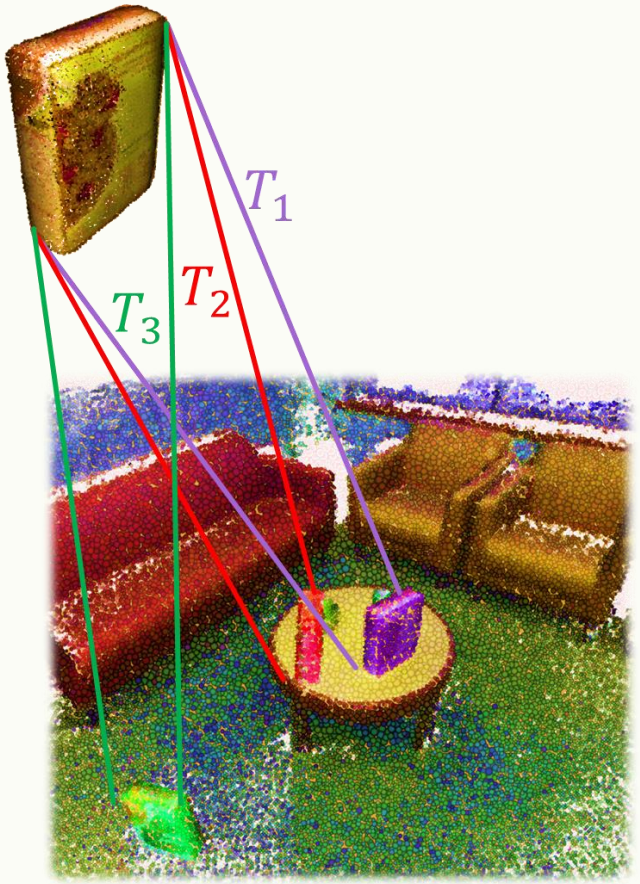
Point cloud registration

- Feature-based registration algorithm → initial transformation
- Steps:
  1. Keypoints (e.g. corner or edge points) detection
  2. Feature descriptor computation
  3. Correspondence estimation, filtering
  4. Transformation estimation
- Special case: point cloud-based pattern matching



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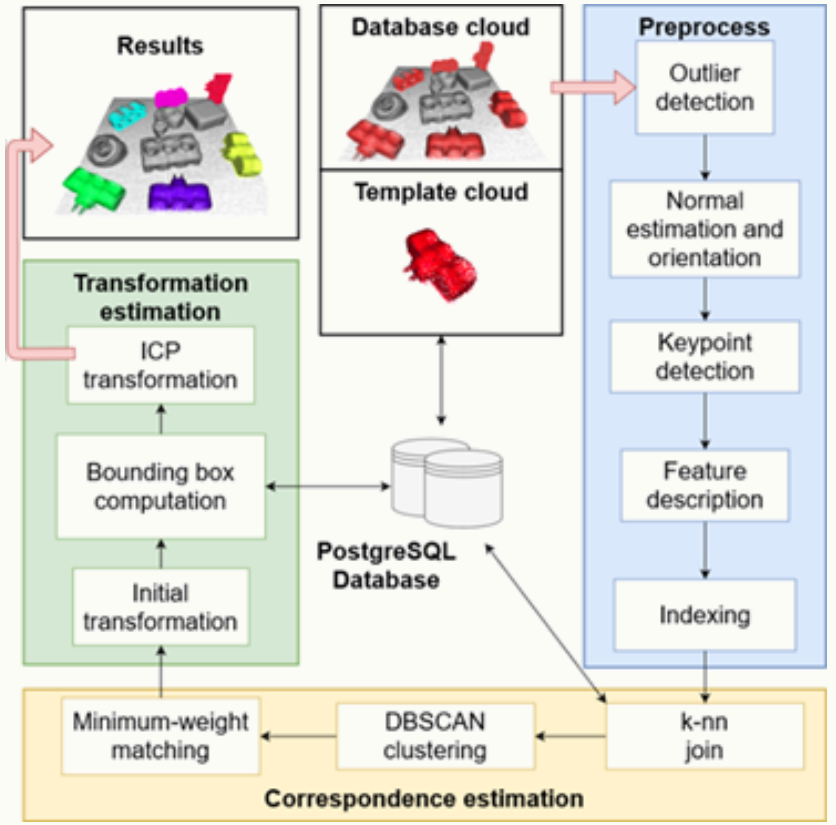
Pattern matching in large-scale LiDAR point clouds

- Large-scale point clouds (e.g. Oxford RobotCar dataset)
- Last year result was a publication on this method:
- Dániel Varga, **János Márk Szalai-Gindl**, Bence Formanek, Péter Vaderna, László Dobos, **Sándor Laki**, Template matching for 3D objects in large point clouds using DBMS, **IEEE Access** journal (Q1), pp. 1–14, 2021, doi: 10.1109/ACCESS.2021.3082848



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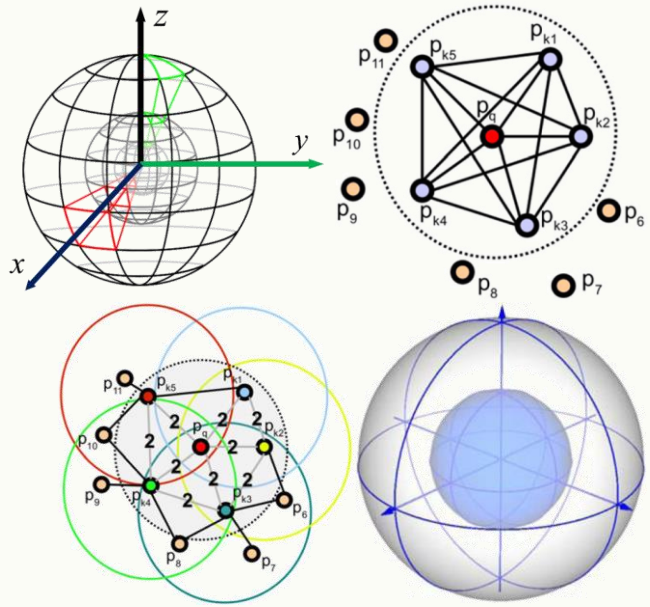
Feature descriptors

- Multidimensional feature descriptors
- Search for nearby neighbours
- Intrinsic dimensionality, dimension reduction technique
- Binarization methods
  - Hamming distance
  - Smaller memory footprint and storage space requirement



Guo, Y., Bennamoun, M., Sohel, F., Lu, M., Wan, J., & Kwok, N. M. (2016). A comprehensive performance evaluation of 3D local feature descriptors. International Journal of Computer Vision, 116(1), 66-89. page 69: Figure 1

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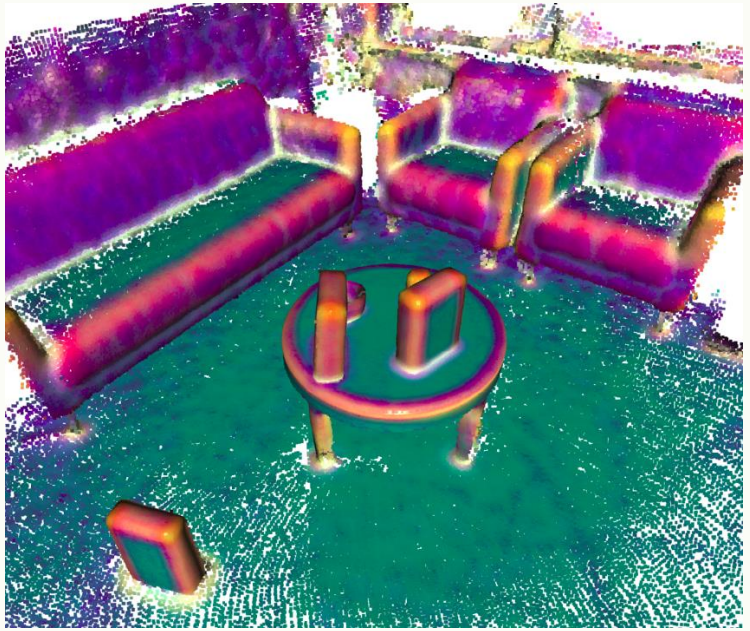
Feature descriptors

- Application of PCA to feature descriptors
- Dániel Varga, **János Márk Szalai-Gindl**, **Sándor Laki**, The descriptiveness of feature descriptors with reduced dimensionality, in European Conference on Advances in Databases and Information Systems. Springer, 2021, pp. 317–322.



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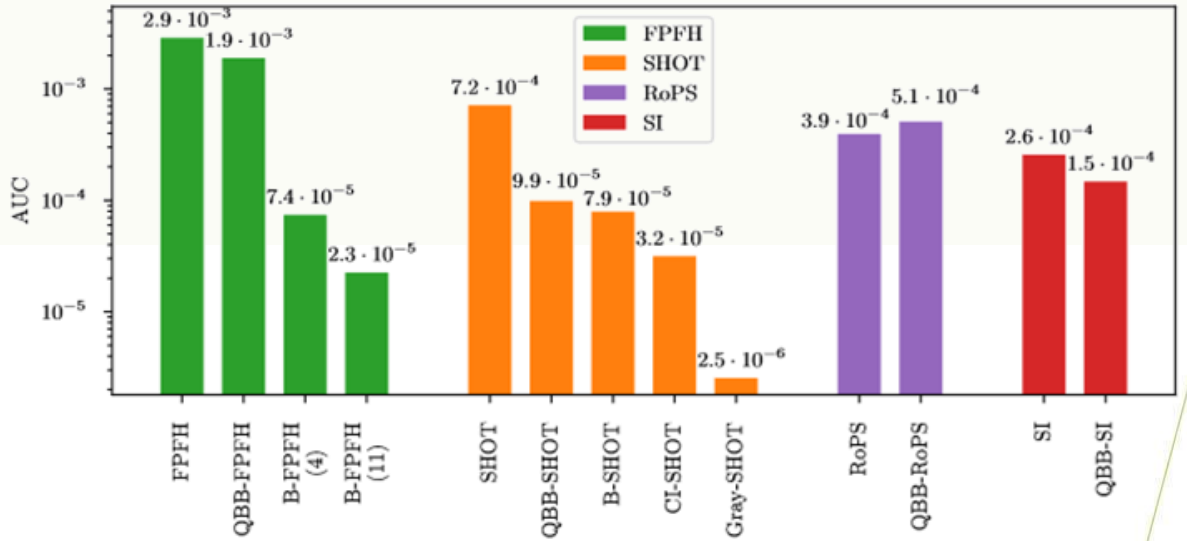
Feature descriptors

- New binarization method:
- **János Márk Szalai-Gindl**, Dániel Varga, Márton Ambrus-Dobai, **Sándor Laki**, QBB: Quantile-Based Binarization of 3D Point Cloud Descriptors
  - Submitted to ACM SIGIR 2022 conference → rejected
  - Submitted to **IEEE Access (Q1) journal** → encouraging first round review results



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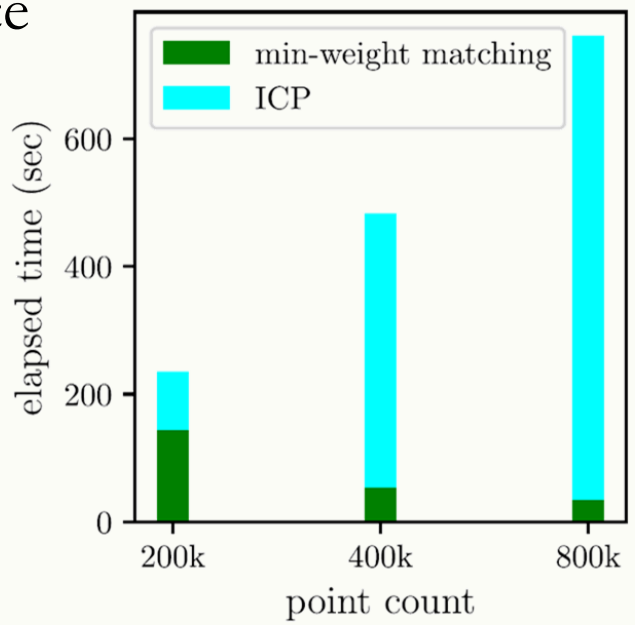
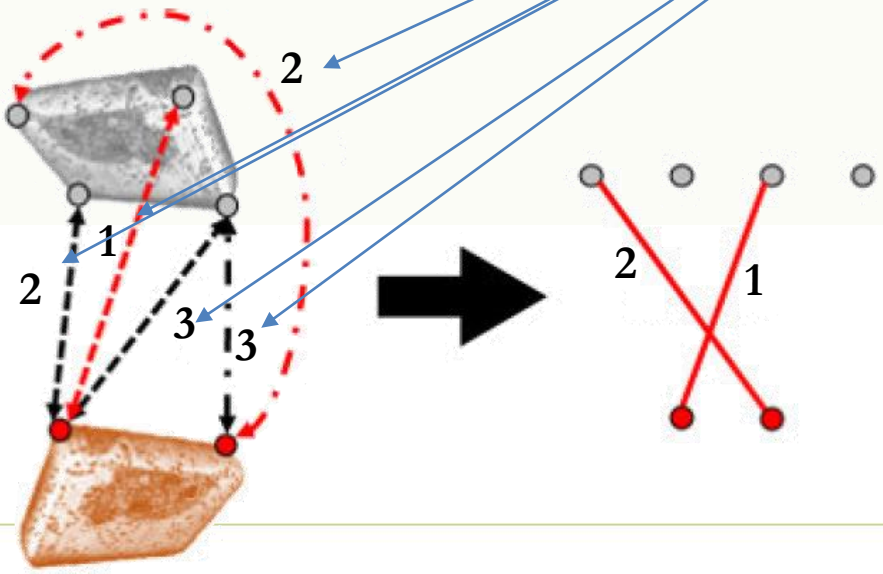
Correspondence estimation

- Previous approach:
  - K-NN join between feature descriptors → correspondence candidates: $\{(dfeat_i, sfeat_j, nn_{idx}), \dots\}$
  - DBSCAN clustering → occurence candidates
  - Filtering of correspondence candidates (minimum weight matching)





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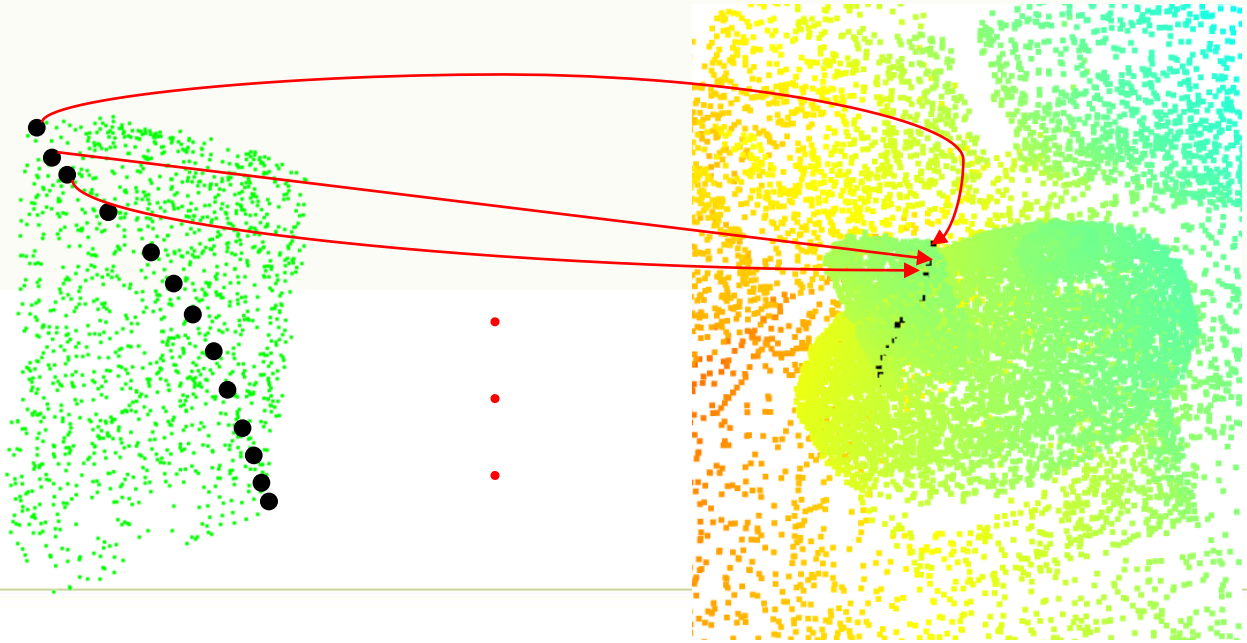
Correspondence estimation – catenarian matching

- Instead, a 'point chain' at the object point cloud
  - Search this in the database point cloud
  - by feature descriptors and geometric constraints
- → Not only search for nearby points in the feature space, but also 3D positions of points



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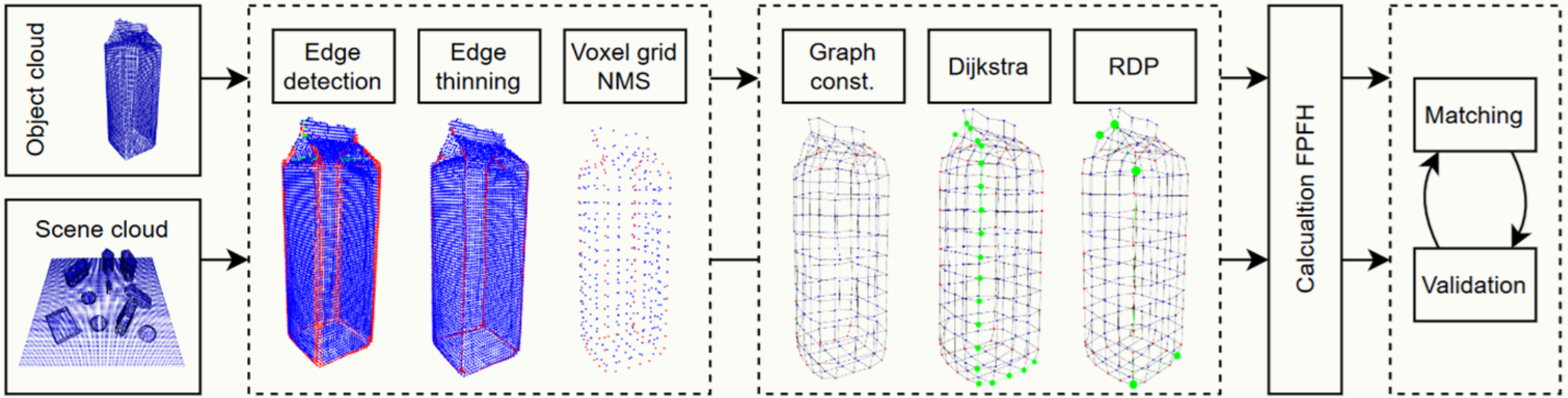
Correspondence estimation – catenarian matching



- Máté Michelisz, Dániel Varga, **János Márk Szalai-Gindl**, CatMat: 3D Object Recognition Using Catenarian Matching
  - Submitted to **CITDS 2022** conference
  - Accepted/presented
- TDK 2th place (→ OTDK)

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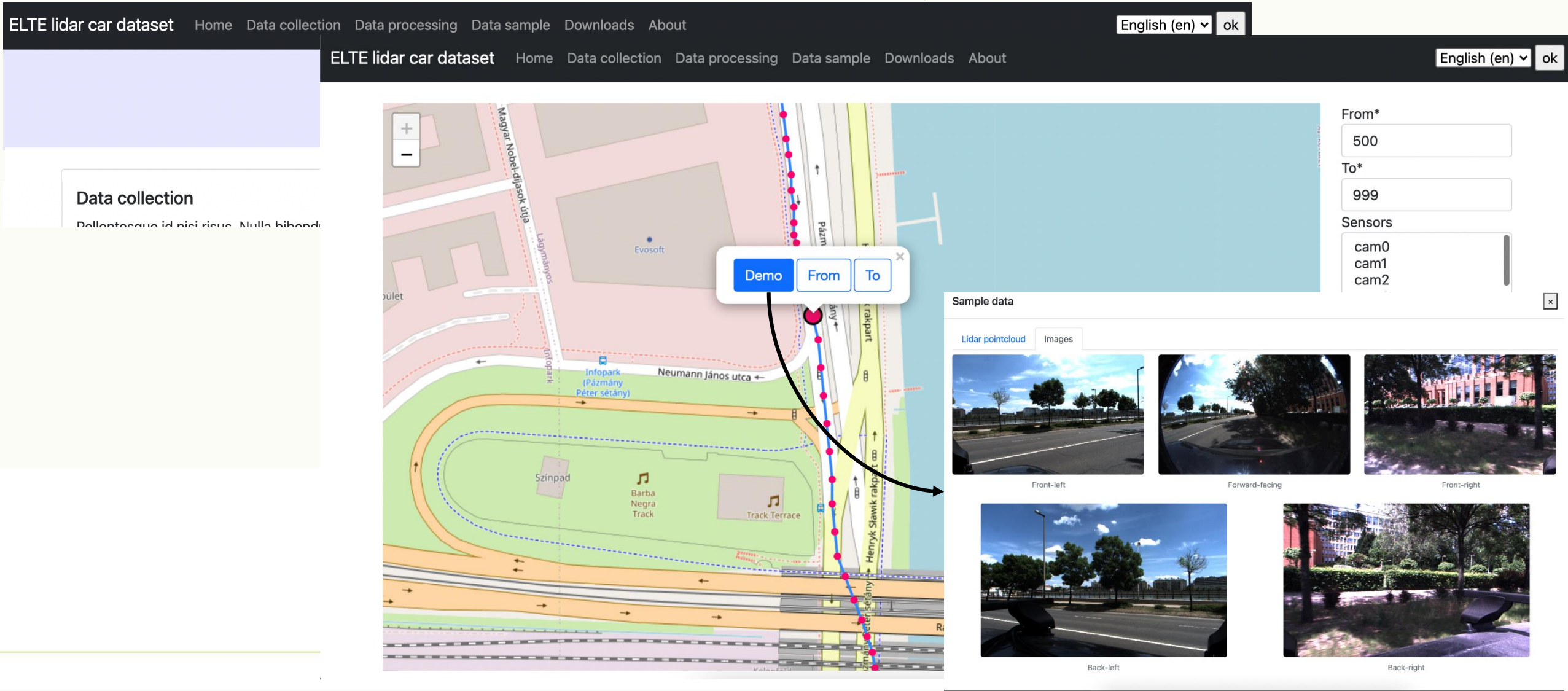
LiDAR data

- Processing and making available LiDAR data from Levente Hajder's group
- Web interface, data visualisation



THANK YOU FOR YOUR ATTENTION!

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Az Alkalmazásiterület-specifikus nagy megbízhatóságú informatikai megoldások című projekt a Nemzeti Kutatási Fejlesztési és Innovációs Alapból biztosított támogatással, a Tématerületi kiválósági program (TKP2020-NKA-06, Nemzeti Kihívások Alprogram) finanszírozásában valósult meg.

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