

POINT CLOUD MANAGEMENT AND STORAGE

(PONTFELHŐK KEZELÉSE ÉS TÁROLÁSA)

TKP WORKSHOP 2022

SUMMARY FOR THE PERIOD JANUARY 2021 – MAY 2022

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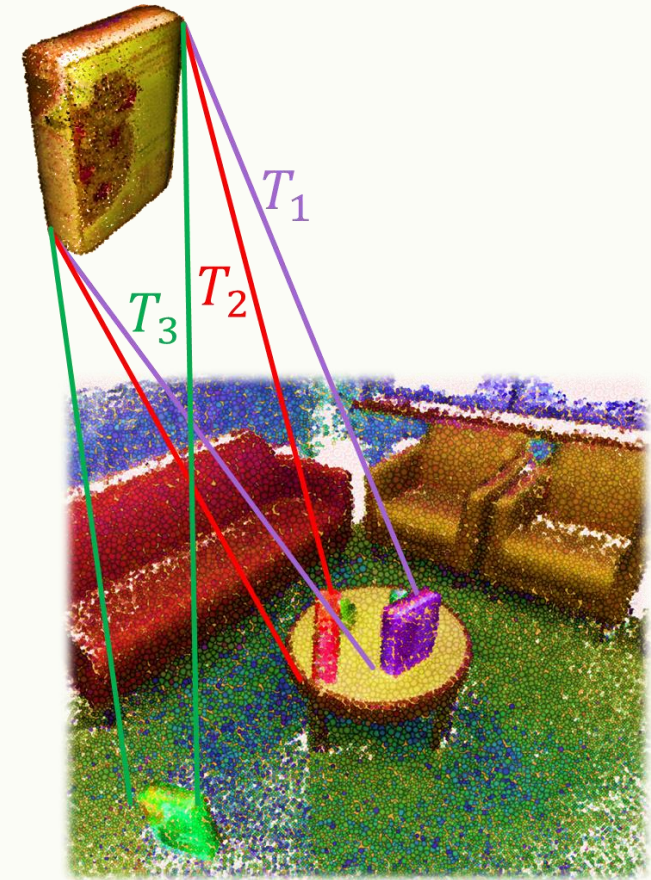
Motivation

- 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



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

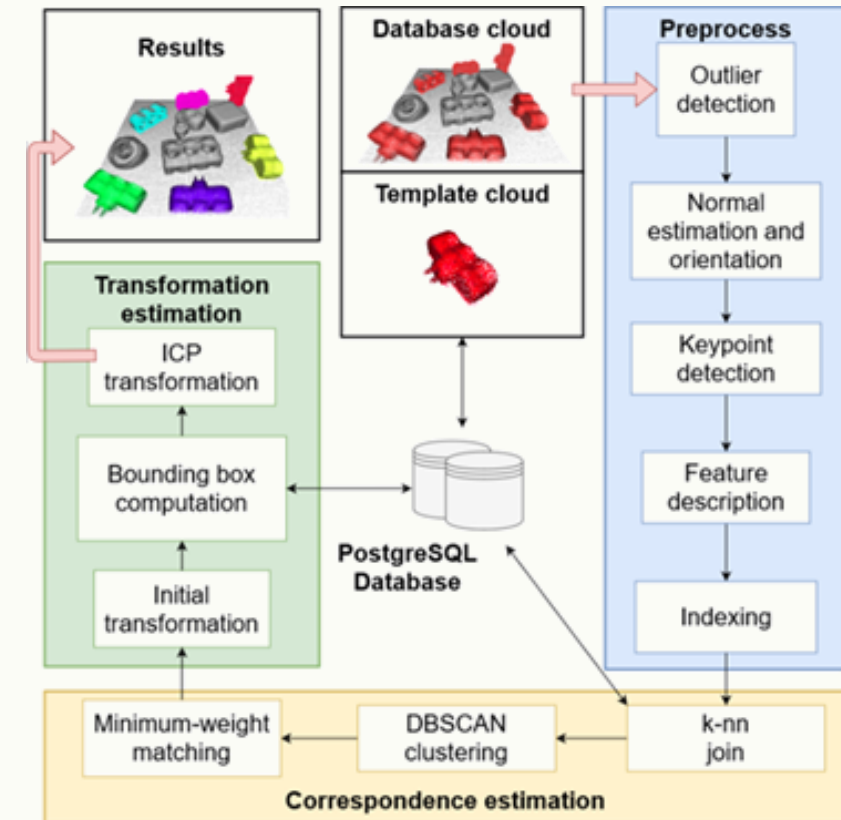


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Pattern matching in large-scale LiDAR point clouds

- 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

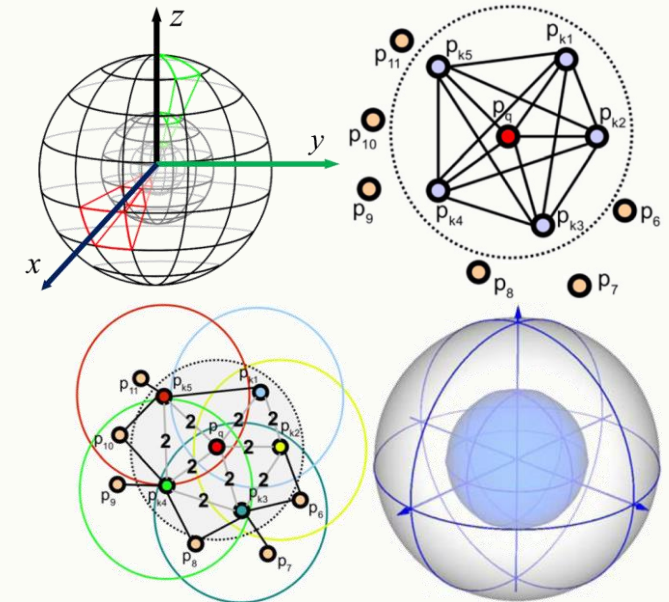


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Feature descriptors

- 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

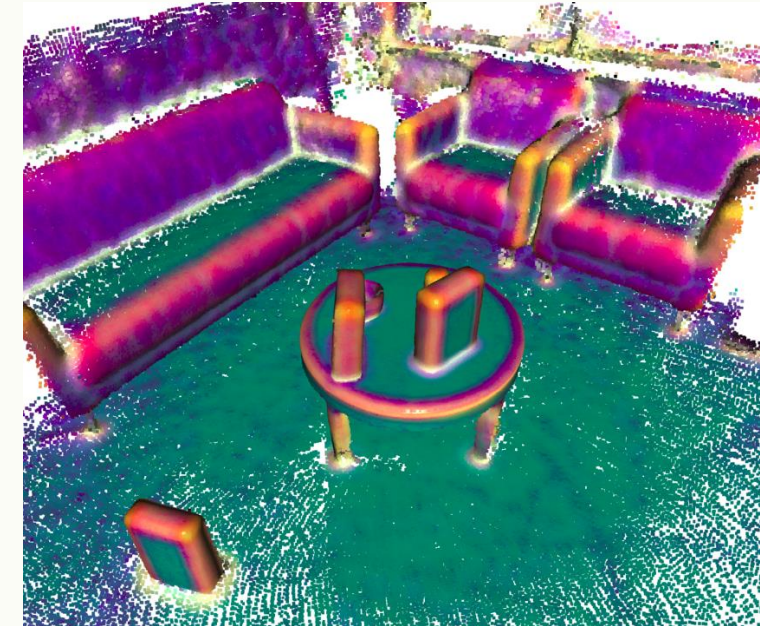


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Feature descriptors

- 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.



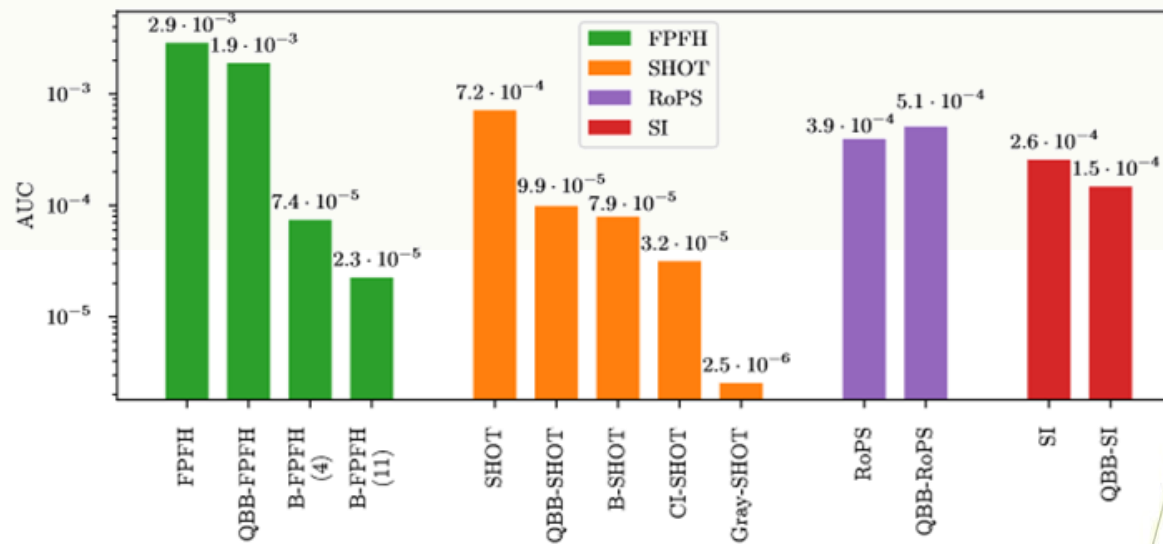
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Feature descriptors



- 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

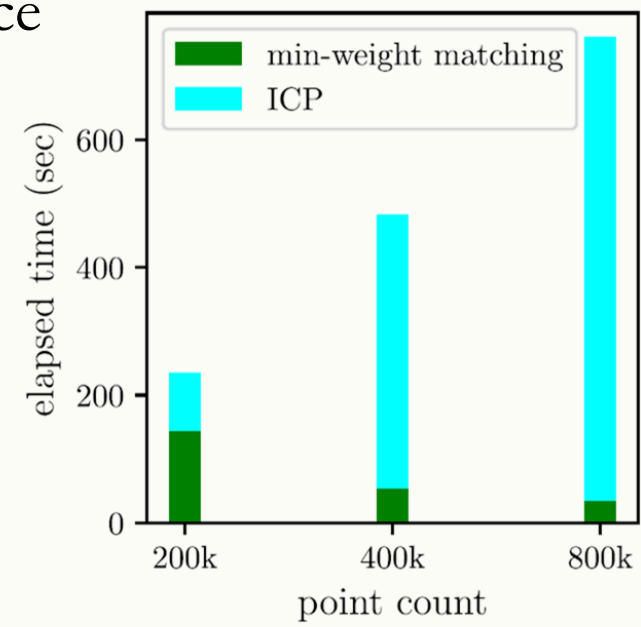
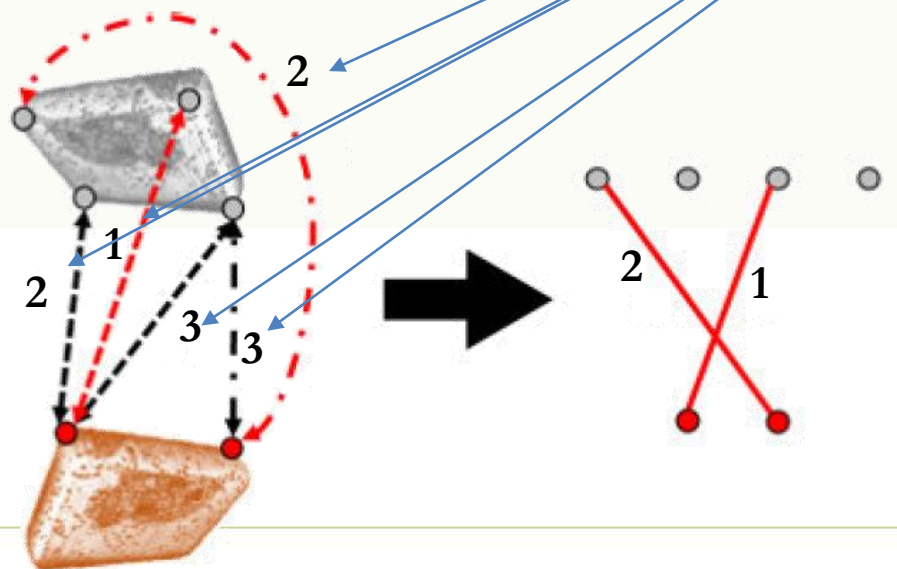


Correspondence estimation



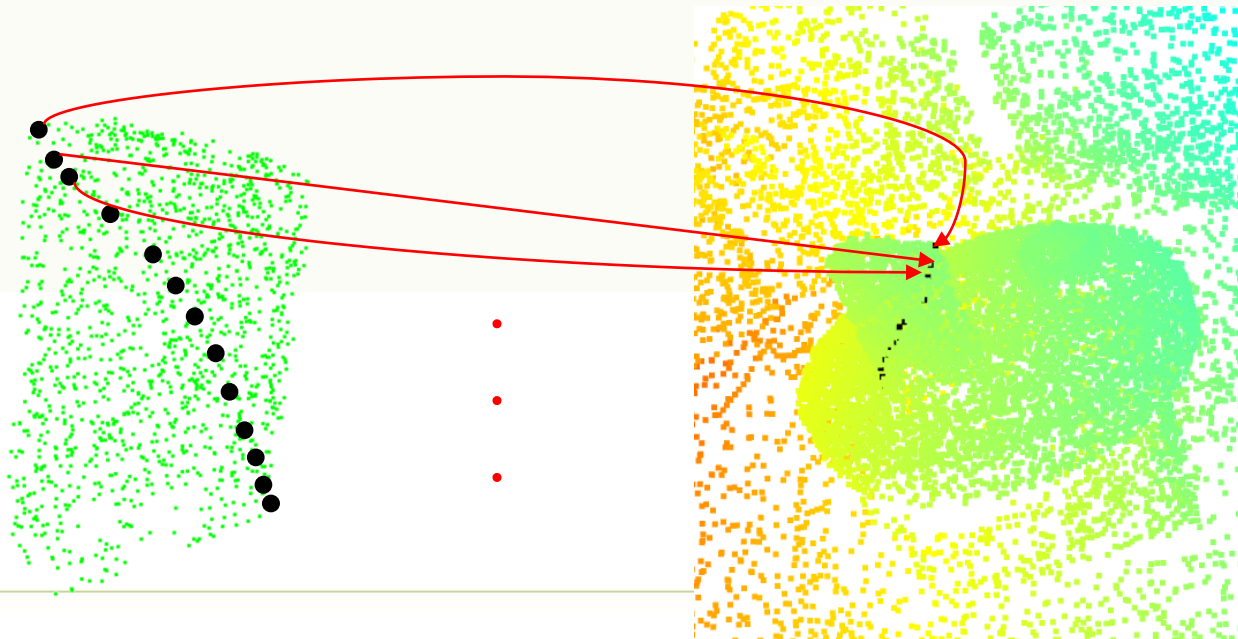
- Previous approach:

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

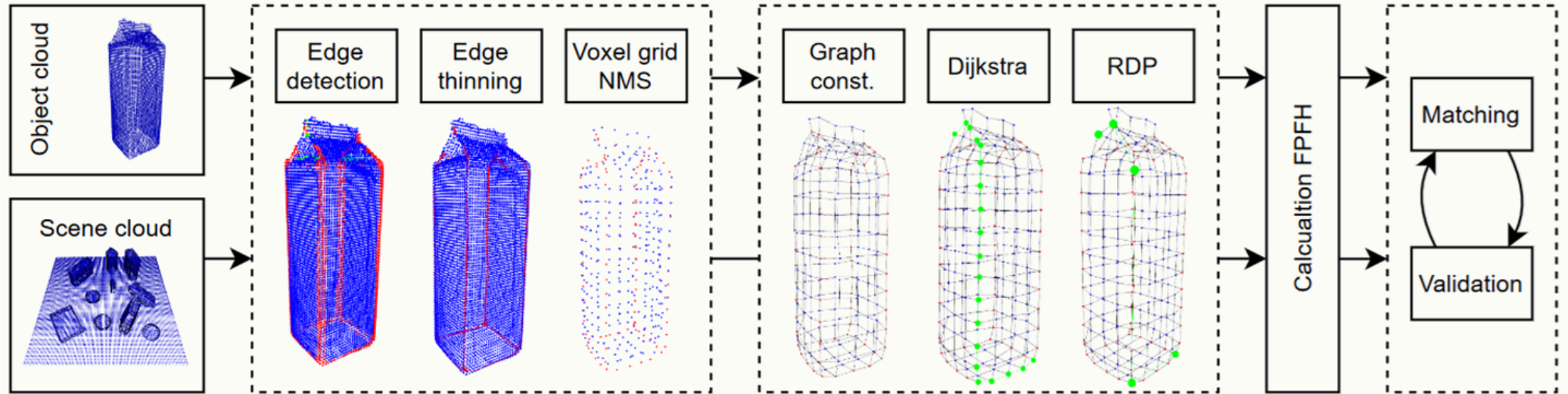


Correspondence estimation – catenarian matching

- 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



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)

LiDAR data

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

The screenshot displays the 'ELTE lidar car dataset' web interface. At the top, there is a navigation bar with links for 'Home', 'Data collection', 'Data processing', 'Data sample', 'Downloads', and 'About'. A language dropdown menu is set to 'English (en)' with an 'ok' button.

The main content area is divided into several sections:

- Data collection:** A sidebar on the left with the heading 'Data collection' and a sub-heading 'Bellantaguo id nizi risus. Nulla bibend'.
- Map:** A central map showing a street layout with a red line indicating a data collection path. A 'Demo' button is overlaid on the map, with 'From' and 'To' buttons next to it. A black arrow points from the 'Demo' button to the 'Sample data' section.
- Filters:** On the right side, there are input fields for 'From*' (500) and 'To*' (999), and a 'Sensors' dropdown menu with options 'cam0', 'cam1', and 'cam2'.
- Sample data:** A section titled 'Sample data' with two tabs: 'Lidar pointcloud' and 'Images'. Under the 'Images' tab, there are five camera view images labeled 'Front-left', 'Forward-facing', 'Front-right', 'Back-left', and 'Back-right'.

THANK YOU FOR YOUR ATTENTION!

www.elte.hu

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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