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Towards Local Dynamic Maps: Automatic Validation and Correction of Road Map Features

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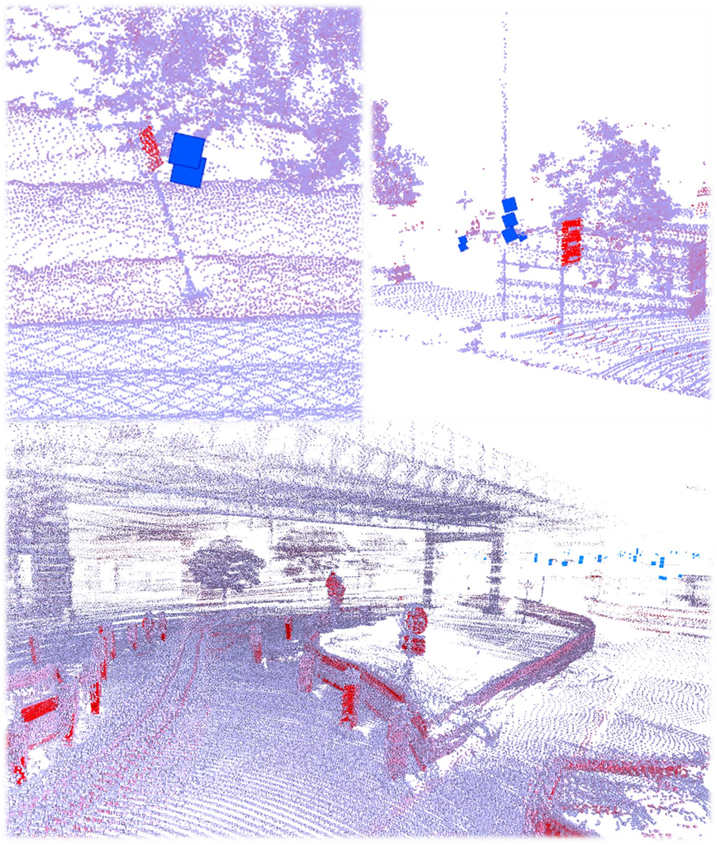
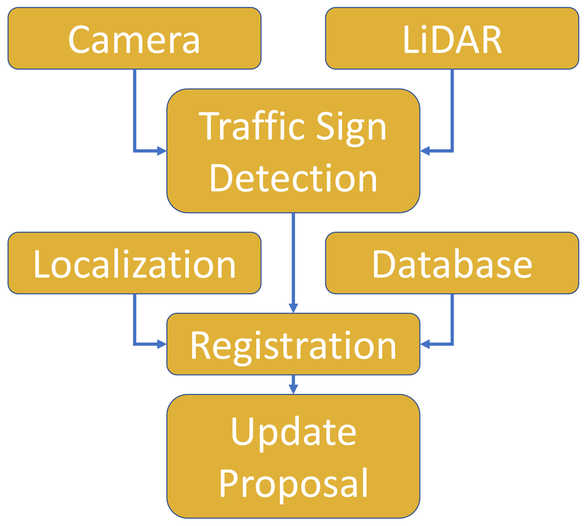


Traffic Sign Ground Truth (blue squares) can be wrong, because of destruction (e.g. accidents, top left), replacement (top right), construction (bottom), and various other reasons. Automatic detection enables automated registration of new ground truth.

Problem Statement

The creation and maintaining of traffic sign databases requires a lot of manual effort. On the one hand, those databases are necessary for various use-cases including landmark-based localization, risk assessment [1], traffic management / speeding ticket. On the other hand, those databases require updates on a regular basis because of changes in the real world, e. g., due to vandalism, construction work, or accidents. For these reasons, databases are usually not up-to-date and contain a lot of inconsistencies w.r.t. the real world.

Our goal is to automate the process of updating traffic sign databases using mobile sensor platforms.

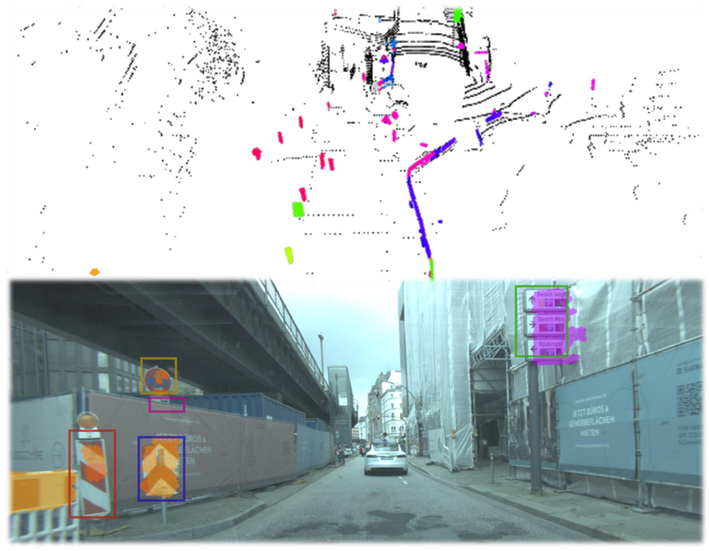


Basic processing pipeline for traffic sign pseudo label generation.

Solution

Our solution is to verify and correct the database on the fly leveraging the vehicle‘s ability of localization and perception [2]. To that end, we set up a complex modular processing pipeline.

- A highly accurate geo-referenced localization (e.g. via fusing GNSS + IMU + LiDAR + geo-refenced maps) is required to register database’s elements against the perceived object.
- (For the same reason, a highly accurate calibration of the sensors within the car is necessary.)
- We process the LiDAR data to filter traffic-sign point clusters via classical and modern AI technology.
- A camera-based object detection further enables the classification of the traffic sign
- We register the perceived traffic sign clusters against the existing traffic sign database.
- Registration mismatches yield proposals for adding, removing, or correcting the database’s traffic signs.
- These proposals enable automatic or human-in-the-loop database updates.



Traffic sign detection on synchronized LiDAR- and Camera data enables generation of pseudo labels.

Contribution

- We provide a solution for automatically creating and maintaining traffic sign databases leveraging modern sensors in future cars.
- We verified our solution against the TAVF and 3DHD CityScenes database.
- Our solution increases reliability of traffic sign databases, which increases the robustness of use-cases that depend on it.
- We enable further research in the active research area of Urban Dynamic Maps.

Future Work

- We are working towards a mathematical foundation for concurrent updates of Urban Dynamic Maps.
- We want to create a benchmark dataset for quantitative evaluation and fine-tuning of the pipeline.
- We want to extend the processing pipeline to handle more dataset formats and more sensor setups to have a more versatile solution.

[1] Leich, A., Fuchs, J., Srinivas, G., Niemeijer, J., & Wagner, P. (2022). Traffic Safety at German Roundabouts—A Replication Study. Safety, 8(3), 50.
[2] Schäfer, J. P., Schmälzle, P., Böker, C., Andert, F., & Lapoehn, S. (2022). Fighting Unreliable GNSS with LiDAR: Autonomous Driving. In The Project KoMo:Dnext.