AN EVALUATION METHODOLOGY FOR INSIDE-OUT INDOOR POSITIONING BASED ON MACHINE LEARNING

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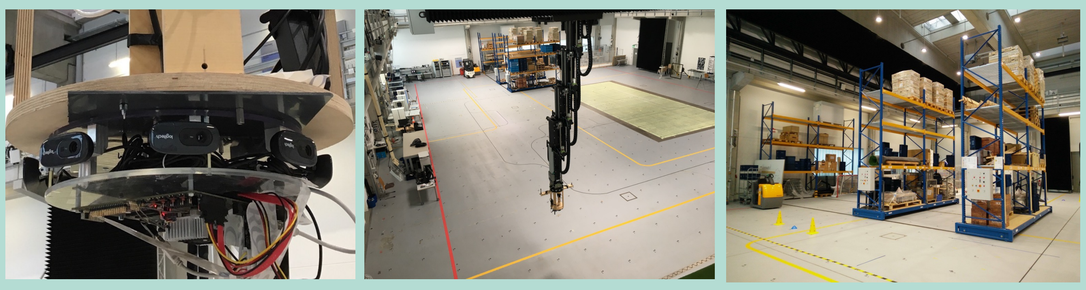
Motivation

Novel methods of camera-based self-positioning using machine learning may soon become a real alternative to more classical approaches.

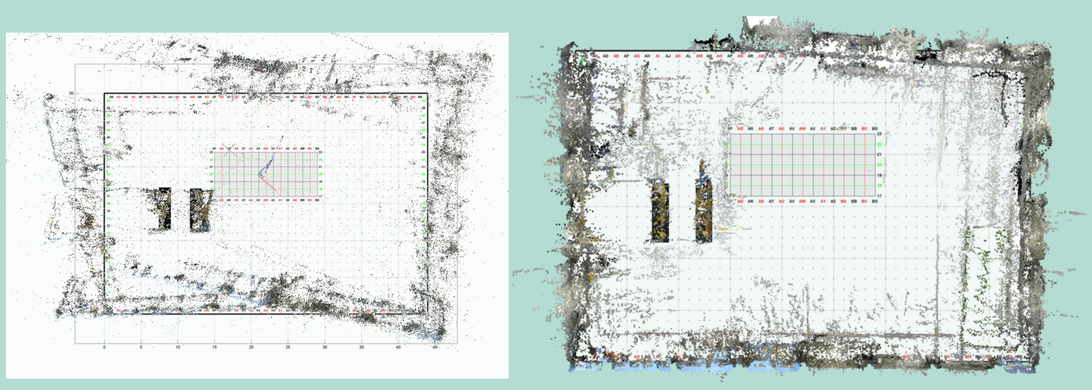
Without the need for hand-crafted optical features like QR-codes, antenna infrastructure and less required storage or computational performance, the potential benefits are considerable.

Goal

For enabling the transfer of data driven methods into real-world applications, we developed an evaluation methodology and dataset for a very challenging warehouse environment.



The data recording platform on the L.I.N.K. 3D Positioning System recorded data in an intra-logistics environment (*Warehouse*).



The *warehouse* environment is very challenging, classical feature-based schemes like Colmap (left) and VSFM (right) fail.

Evaluation Criteria

The methodology evaluates various properties of tested algorithms:

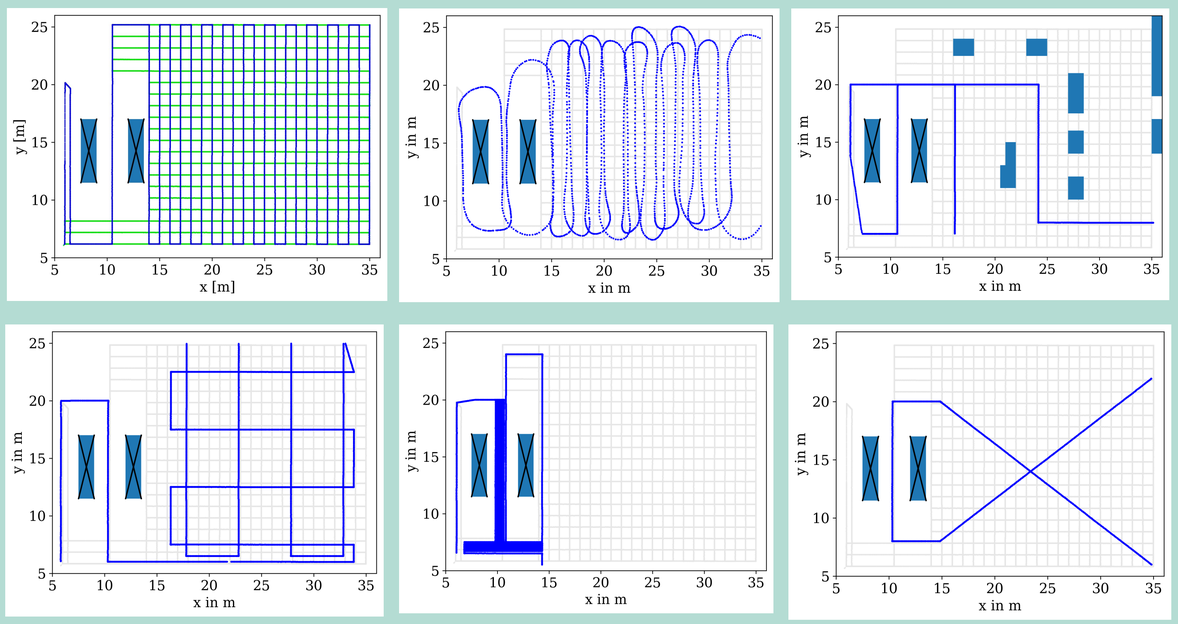
- **Generalization** Can the algorithm interpolate previously unseen positions that are close to already seen positions?
- **Environmental scaling** Does the accuracy differ over area scales?
- **Scale transition** How does the algorithm perform in small or large scale areas?
- **Volatility** How robust is the algorithm against features which are not in the training dataset?
- **Ambiguity** Does the algorithm tolerate ambiguous (i.e., repetitive or untextured) features in environment?
- **Motion artifacts** How do blurry images, unsteady angles or new view points influence the prediction performance?

Warehouse Dataset

The indoor logistics *Warehouse* dataset aims at providing a solid basis for the development and evaluation of machine learning based positioning schemes.

The dataset covers an area of 1,320m^2 and contains 464,804 images of 640x480 pixels. One trajectory was recorded on a forklift, the others using the L.I.N.K. 3D Positioning System. Each image was labeled with a 3D position ground truth that was recorded using the highly precise optical Nikon iGPS system. The dataset includes different scenarios that allow a detailed analysis of positioning schemes based on the evaluation criteria:

- Two trajectories on horizontal and vertical trajectories can be used to train.
- Eight trajectories on various paths through the warehouse.

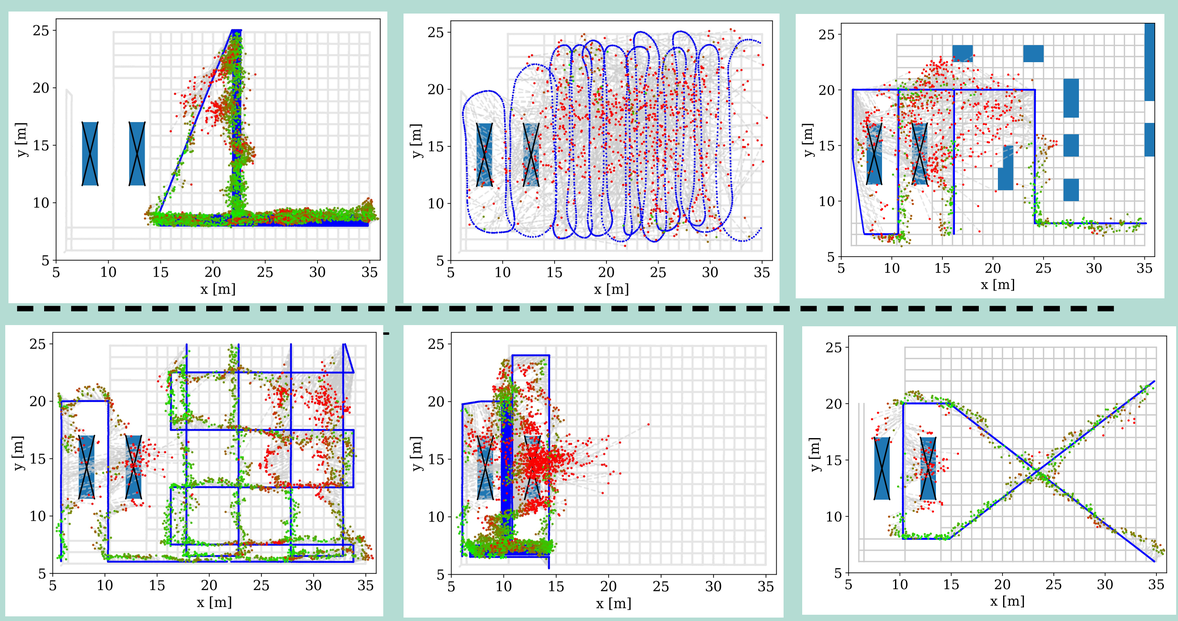


Selection of trajectories from the *warehouse dataset*

Results

We present the representative CNN-based approach PoseNet.

- The evaluated positioning scheme can **generalize** well in **open** and **large scale** environments and has difficulties in narrower and **small scale** areas.
- **Smaller volatile features** added to the environment are tolerated by the scheme, but **larger changes** (e.g., movable shelves) reduce the performance drastically.
- **Ambiguous features** were confused by the scheme.
- As expected, **Motion artifacts** let the scheme fail almost completely.



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