Close-Distance Scenarios
// Challenges

Localization

Blueprint vs digital map from sensor

Understanding parking space

Longitudinal control (NVH, curb, uphill)

Mixed environment
Localization

- Odometry - improve filtering
- Ego-Motion and radar Doppler-signal
// Solutions II

Digital Map
- Conversion of blueprint map using OSM-format
- Improved localization
- Map-based trajectories
Solutions III

Understanding Parking Space

- Object classification with radar
Groundtruth map generation when no apriori map available

- Structured environment
- LiDAR-based
- Feature-based approach

Occupancy grid map based on pure odometry

Occupancy grid map based on corrected position
Path Planning
- Based on OSM-map
- Incorporates lane-network from map to obey traffic rules in parking garage
- Is used for automated valet parking

Without infrastructure information (driving the wrong way)

With infrastructure information (obey the driving direction)
//Key achievements I

- Digital map generation
  - OSM format extended for parking scenarios
  - Convert blueprints to digital maps
  - Lidar for online mapping as groundtruth

- Path planning algorithm
  - Trajectory planning between drop-off and selected locations
  - Push / Pull your car
Key achievements II

- Localization with digital maps
  - Orientation with fusion of map features
  - Spot selection and drive via smartphone

- Localization without maps
  - SLAM implementation and adaptation
  - Loop closure with 10cm accuracy

- Implementation
  - Three demonstrators at RWTH garage
Demonstrator

Trajectory learning
Trajectory replay
Longitudinal Control
Driver inside

Trajectory learning
Trajectory replay
Driver inside

Automated valet parking function
Choose parking spot via smartphone
Driver outside
Outlook

- Level 2 parking automation is reality
- Level 3 needs further development
  - Home parking
  - Dedicated garages
- Level 4
  - standards
  - V2I
  - Valet parking
  - Driver outside?
Thank you.

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