

Randomized Generation of Road Networks and 3D Visualization of Traffic Scenarios in Gazebo

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Motivation

Randomized Road Generation

CommonRoad XML

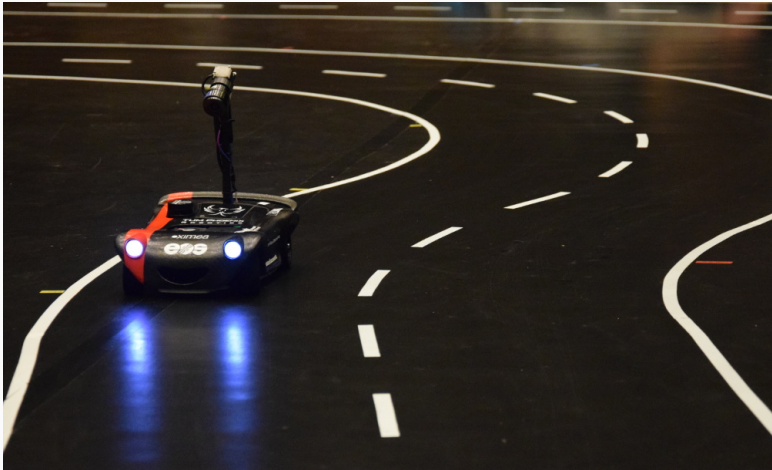
3D Visualization

Conclusion & Future Work

Motivation



Source: Hans Kirchner, 2017-02-08



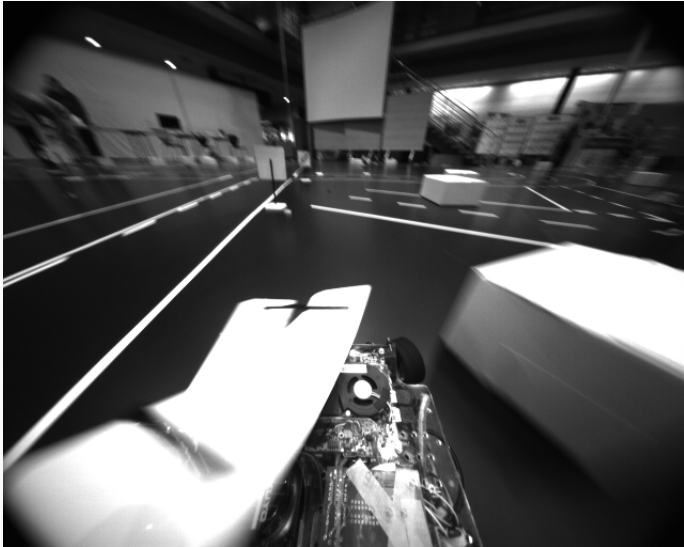
Source: Hans Kirchner, 2017-02-06

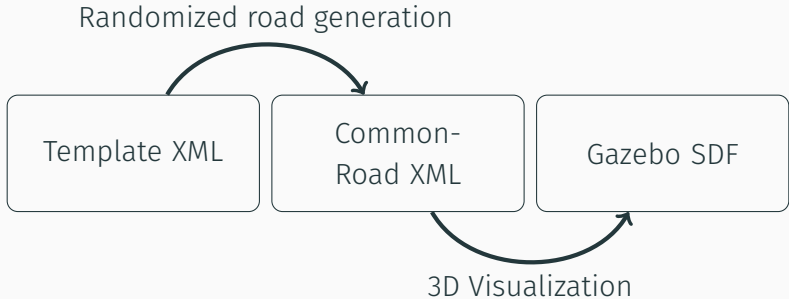
- Student's competition
- Autonomous 1:10 scale cars
- Custom hardware & software concept
- Three challenges:
 - Parallel Parking
 - Driving
 - Driving with Obstacles
- Extended mode:
 - Zebra crossings
 - Complex intersections
 - Blocked areas
 - Traffic signs











Randomized Road Generation



Straight roads



Circular arcs



Static obstacles



Traffic signs



Intersections



Cubic Bézier curves



Quadratic Bézier curves



Parking lots



Parking obstacles



Zebra crossings



Blocked areas

- Goals:
 - Generate a single, long road
 - Must be customizable
 - Use randomness to generate different scenarios
 - Top-down evaluation
- Control structures:
 - `<sequence>` - like sequential block
 - `<optional>` - like an if
 - `<select>` - like a switch
 - `<repeat>` - like a loop
 - `<shuffle>` - permutation

`<sequence>`



`<optional p="0.5" >`



`<repeat min="1" max="3" >`





```
<optional p="0.5" >
```



```
<repeat min="1" max="3" >
```

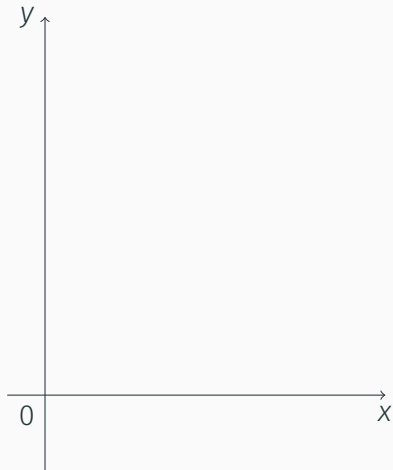




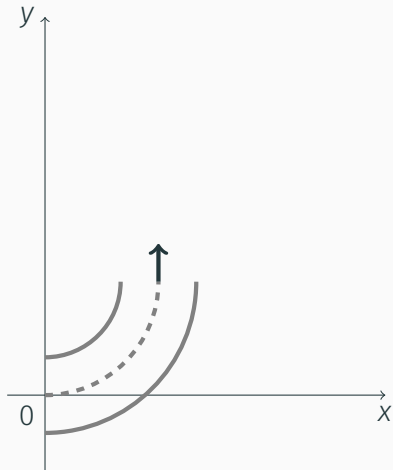
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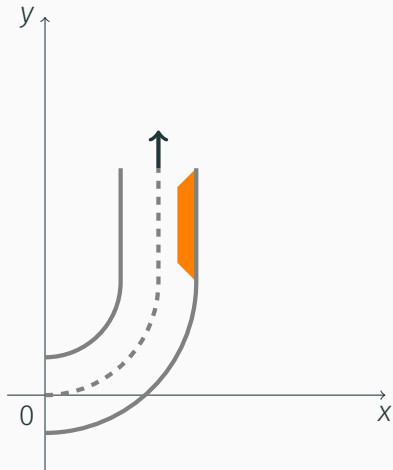




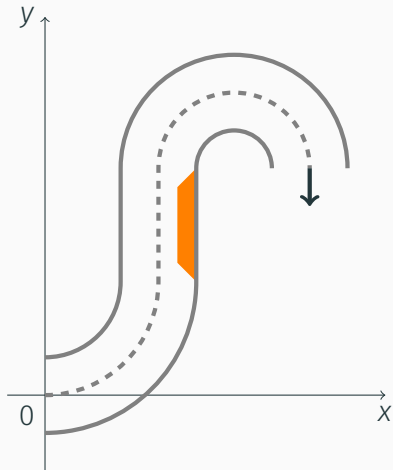
1. leftArc



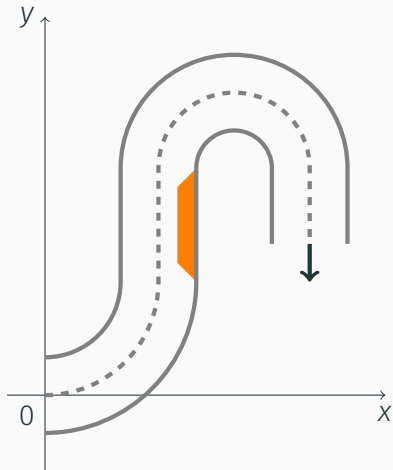
1. leftArc
2. blockedArea



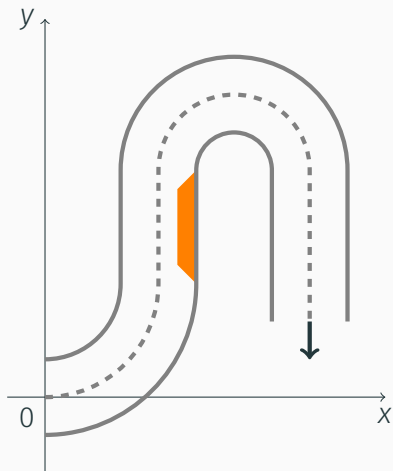
1. leftArc
2. blockedArea
3. rightArc



1. leftArc
2. blockedArea
3. rightArc
4. line

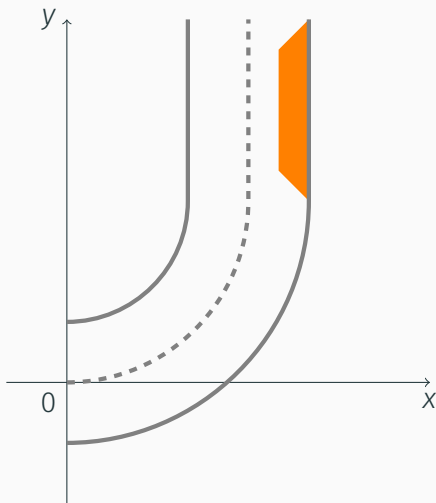


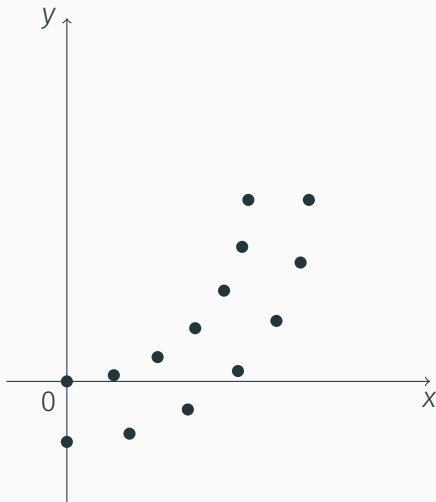
1. leftArc
2. blockedArea
3. rightArc
4. line
5. line

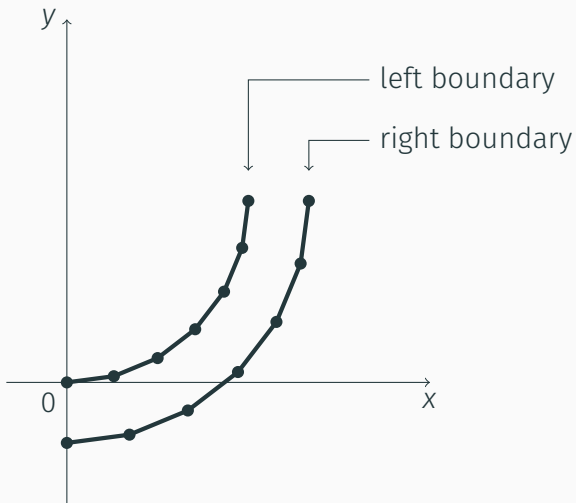


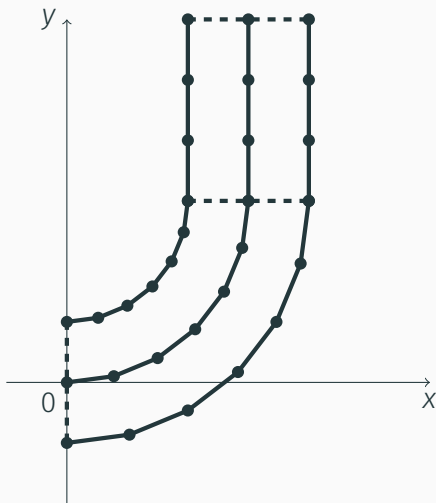
CommonRoad XML

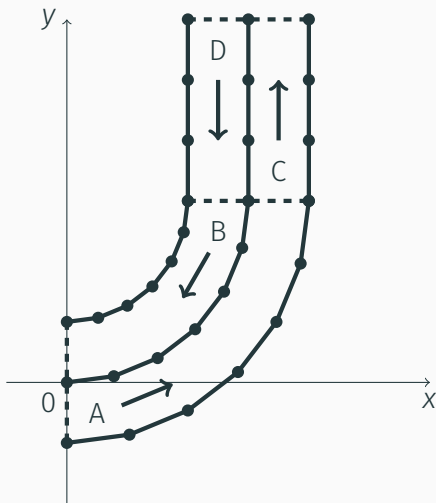
- Goals of CommonRoad XML:
 - XML format to model traffic scenarios
 - Arbitrary road networks
 - Dynamic objects with trajectories or occupancy sets
- Basic objects in CommonRoad XML:
 - Lanelets
 - Static/Dynamic obstacles
 - Ego vehicle
- Extensions:
 - Traffic signs
 - Intersections
 - Parking lots





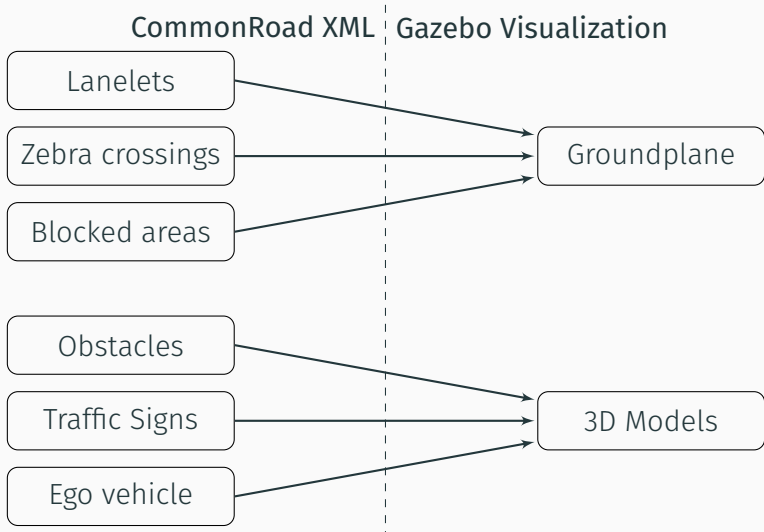


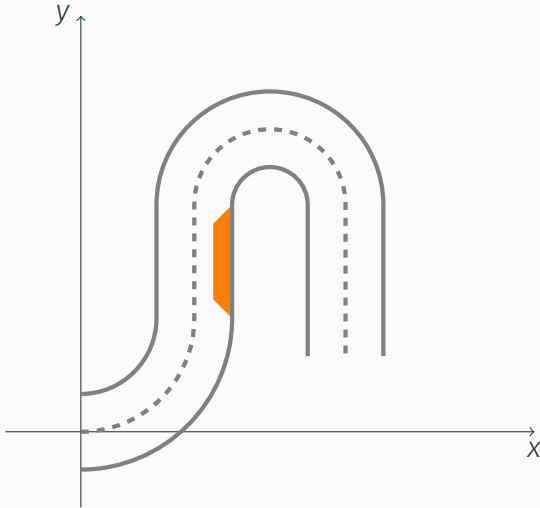


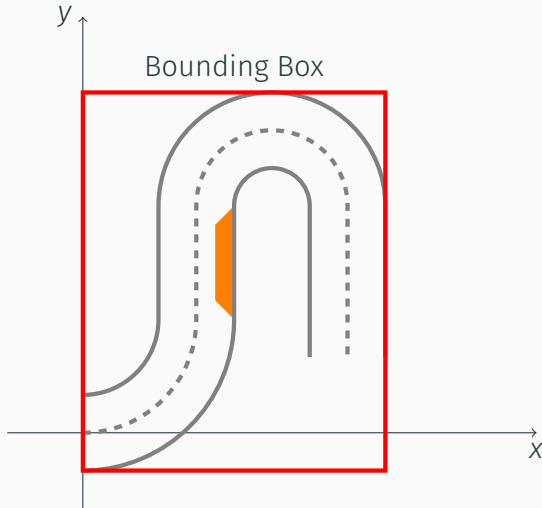


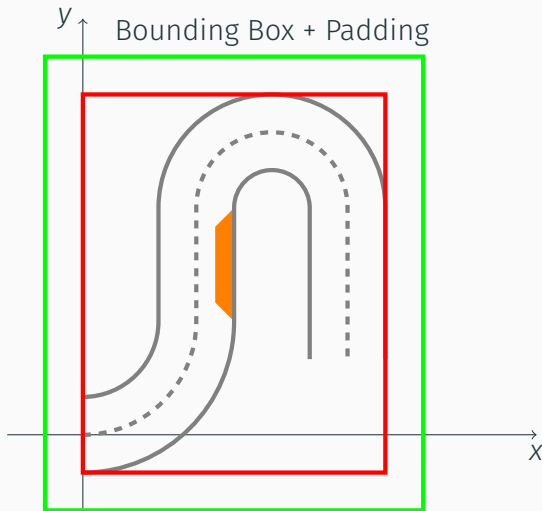
3D Visualization

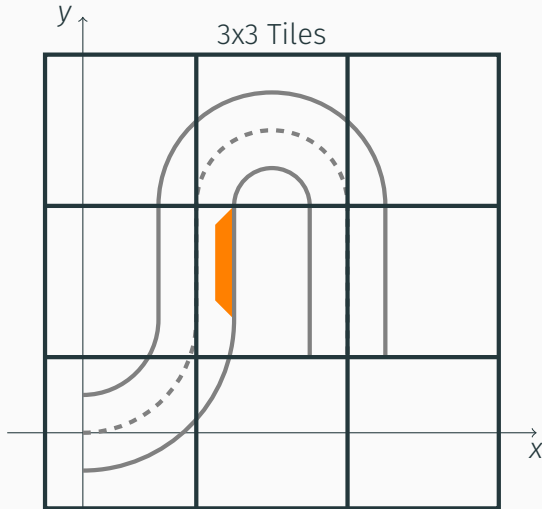
- Environment simulator for robots
- Open source
- 3D engine based on OGRE
- Physics engines: ODE, Bullet, Simbody, DART
- Sensor data from cameras, laser scanners, ...
- Applications:
 - DARPA Robotics challenge
 - Multicopter simulations
- Integration with ROS
- C++-Plugins

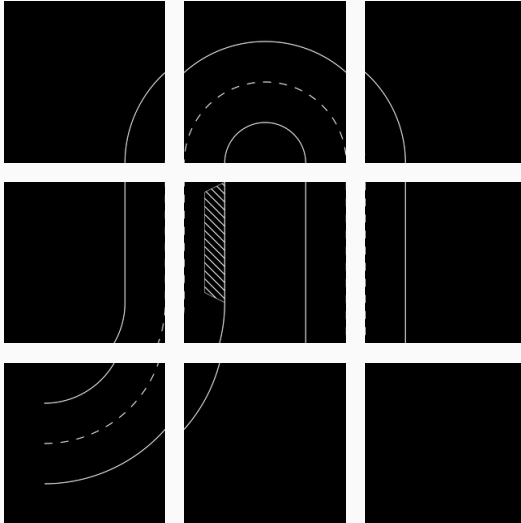


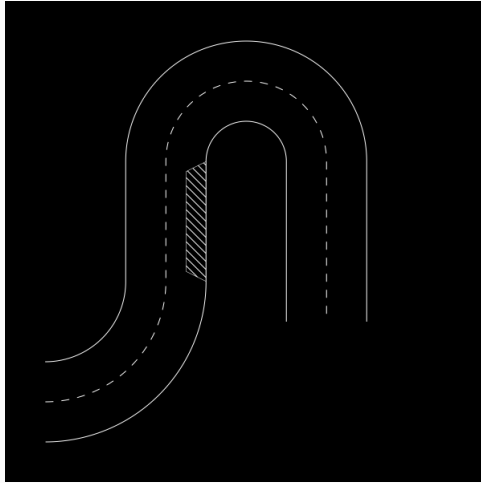


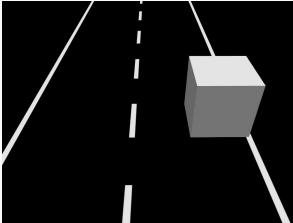








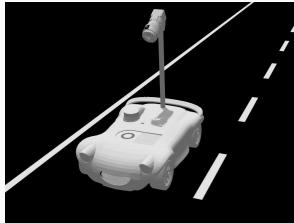




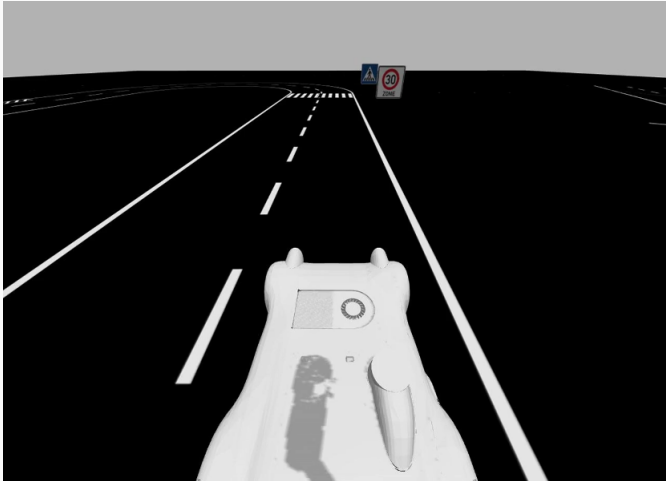
Static obstacle

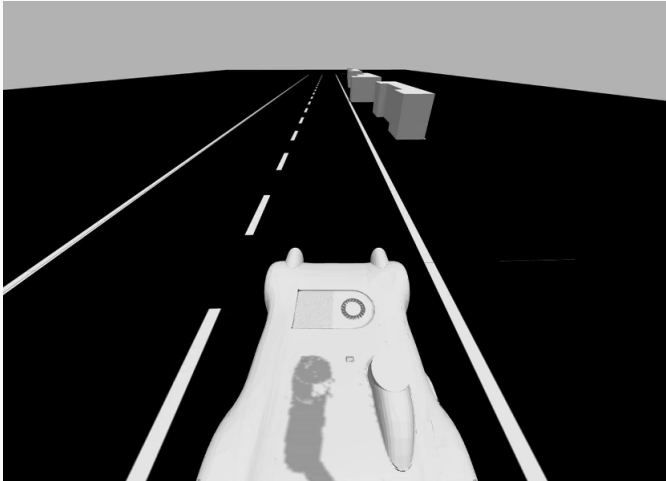


Traffic sign



Ego vehicle





Conclusion & Future Work

- Conclusion
 - Generate different scenarios from a simple Template description
 - Visualize any CommonRoad XML in 3D
 - Applications:
 - Software-In-The-Loop with ROS
 - Generate image data for ML
- Future work
 - Unit testing
 - Generate scenarios with *real* road networks
 - Improve dynamic obstacles with trigger zones
 - Reduce groundplane memory usage

- Papers and web sources:
 - Bender et al., *Lanelets: Efficient map representation for autonomous driving*
 - Althoff et al., *Composable Benchmarks for Motion Planning on Roads*
 - Carolo-Cup Regulations 2017, https://wiki.ifr-ing.tu-bs.de/carolocup/system/files/Regelwerk_2017_20161016_en_0.pdf
- Images:
 - https://commons.wikimedia.org/wiki/File:Zeichen_208.svg
 - https://commons.wikimedia.org/wiki/File:Zeichen_276.svg