
Driving Simulator Conference 2016 VR
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Development and Evaluation of Driver Assistance and Automation Systems using Driving Simulators
Need for Re-creation of Complex Urban Environments in Driving Simulators
Urban Road Networks in Driving Simulators: Solution 1
Surveying of the Original

• by specialist companies
(ResultOverlay)
Urban Road Networks in Driving Simulators: Solution 2a
Transforming of Cadastral GIS Data...

- fusion of different sources such as:
  - road topography
  - road axis
  - elevation model
  - land use
  - ...

[Maps and diagrams related to urban road networks and cadastral GIS data]
Urban Road Networks in Driving Simulators: Solution 2b

...and fusion with Road Operator Data

- fusion of different cadaster regarding location and orientation:
  - road signs
  - road signpost
  - traffic lights
  - street lighting
  - catenary
  - ...
Urban Road Networks in Driving Simulators: Solution 2c
Transforming Cadastral CAD Data

- only visual database, road signs as images and no logical correlation
Urban Road Networks in Driving Simulators: Solution 3 Using Crowd-Sourced Data

- such as OSM, including:
  - lanes
  - traffic rules
  - traffics signs
  - street furniture
  - ...

[Image of a detailed urban road network with various markers and signs indicating traffic rules and street furniture.]
Urban Road Networks in Driving Simulators

Summary

• **Solution 1:**
  - high precision road survey can be conducted by specialist companies delivering the results in driving simulator formats
  - Drawbacks are a high amount of time and cost for data transformation, not suitable for large-scale road networks

• **Solution 2:**
  - automated generation of large-scale road networks based on GIS data using a combination of computer graphics GIS approach is possible (see “Virtual World” project – DOI: 10.1177/0037549716641201)
  - Drawbacks are generalized intersection layouts and less accuracy, both depending on input data

• **Solution 3:**
  - crowd-sourced data is (more or less) free to use and widely available
  - Drawbacks are a lack of lane level details and heterogeneous data quality and a poor accuracy
Urban Road Networks in Driving Simulators

Goal

• Having a solution 1 + 2: high precision data that is widely available and automatically transformable (to reduce time and cost effort).

• Therefore:
  • cities should provide their data in a “machine-understandable” way
  • store information in a simplified way, thus everybody is able to gather the data with only few pre-processing effort
  • store the data in a way that requirements of public authorities and driving simulators are met
  • guidelines should support every surveyor how to pre-process the data

• Solution:
  • join forces in the project “Road2Simulation” to create and test such guidelines and disseminate them
Road2Simulation
Just a new “Standard”?  

- http://xkcd.com/927/

- More than just a standard: “Road2Simulation” includes a data model and description how to pre-process the data (format, spatial reference, topological integrity, etc.) and also guidelines, how to model the data for different scenarios, etc.
Road2Simulation
simplified Data Model

- linear objects as WKT/WKB LineString Z
- punctual objects as WKT/WKB Point Z
- areal objects as WKT/WKB Polygon Z
- data source description including absolute and relative accuracy in XY and Z, etc.
Road2Simulation
Guidelines for Modelling of Roads

• how to model different types of roads:
Road2Simulation
Guidelines for Modelling of Roads

- how to model different types of roads:
  - course of the road
Road2Simulation
Guidelines for Modelling of Roads

- how to model different types of roads:
  - course of the road, lane borders
Road2Simulation
Guidelines for Modelling of Roads

• how to model different types of roads:
  • course of the road, lane borders, road marks
Road2Simulation
Guidelines for Modelling of Roads

- how to model different types of roads:
  - course of the road, lane borders, road marks, linear and punctual objects
Road2Simulation
Guidelines for Modelling of Roads

• how to model different types of roads:
  • course of the road, lane borders, road marks, linear and punctual objects, areal objects
Road2Simulation
Guidelines for Modelling of Intersections

• how to model different kinds of intersections:
  • north
Road2Simulation
Guidelines for Modelling of Intersections

• how to model different kinds of intersections:
  • north, east
Road2Simulation
Guidelines for Modelling of Intersections

- how to model different kinds of intersections:
  - north, east, south
Road2Simulation
Guidelines for Modelling of Intersections

- how to model different kinds of intersections:
  - north, east, south
Road2Simulation
Guidelines for Modelling of Intersections

• how to model different kinds of intersections:
  • north, east, south, west
Road2Simulation
Guidelines for Modelling of Intersections

- how to model different kinds of intersections:
  - north, east, south, west, inner parts
Road2Simulation
Guidelines for Modelling of Complex Intersections

• how to divide complex intersection in multiple simple intersections
Road2Simulation
Guidelines for Modelling of Complex Intersections

• how to divide complex intersection in multiple simple intersections
Road2Simulation
Guidelines for Modelling of Punctual Objects

• how to model:
Road2Simulation
Guidelines for Modelling of Punctual Objects

• how to model:
  • traffic lights
  • road signs
  • infrastructure
  • street furniture
  • ...
Road2Simulation
Road2Simulation
Applying the Guidelines

• reference track is a test track of a car magazine in Stuttgart downtown

• contractor was selected by public tender
• price is roundabout one third of an offer delivering data in driving simulator format

• contractor was able to adopt the guidelines easily, no logical issues arisen

→ Now, data conversion has to be improved for all exceptions reality has ready…
Road2Simulation
Applying the Guidelines
Road2Simulation
Applying the Guidelines
Urban Road Networks in Driving Simulators

Summary

• No data format is available that meets requirements for public authorities and driving simulator operators.

→ Thus, exchange of real world data is complex (but nevertheless possible) and there are no synergies for data acquisition (experience of surveying companies, data usage, etc.).

• Project “Road2Simulation” developed guidelines on how to pre-process and how to store the road data to meet cadastral and simulation requirements:
  • simplified data model with included meta data for transformation
  • suggestions and examples for typical road situation
  • guidelines are available free of charge

• Guidelines is tested with a reference track in an urban environment.
• Currently results are looking very promising…
The Surveyor's Guide to Automotive Simulation
available for free at: http://www.dlr.de/ts/road2simulation

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