Reducing the gap between simulated and real life environments by introducing high-precision data

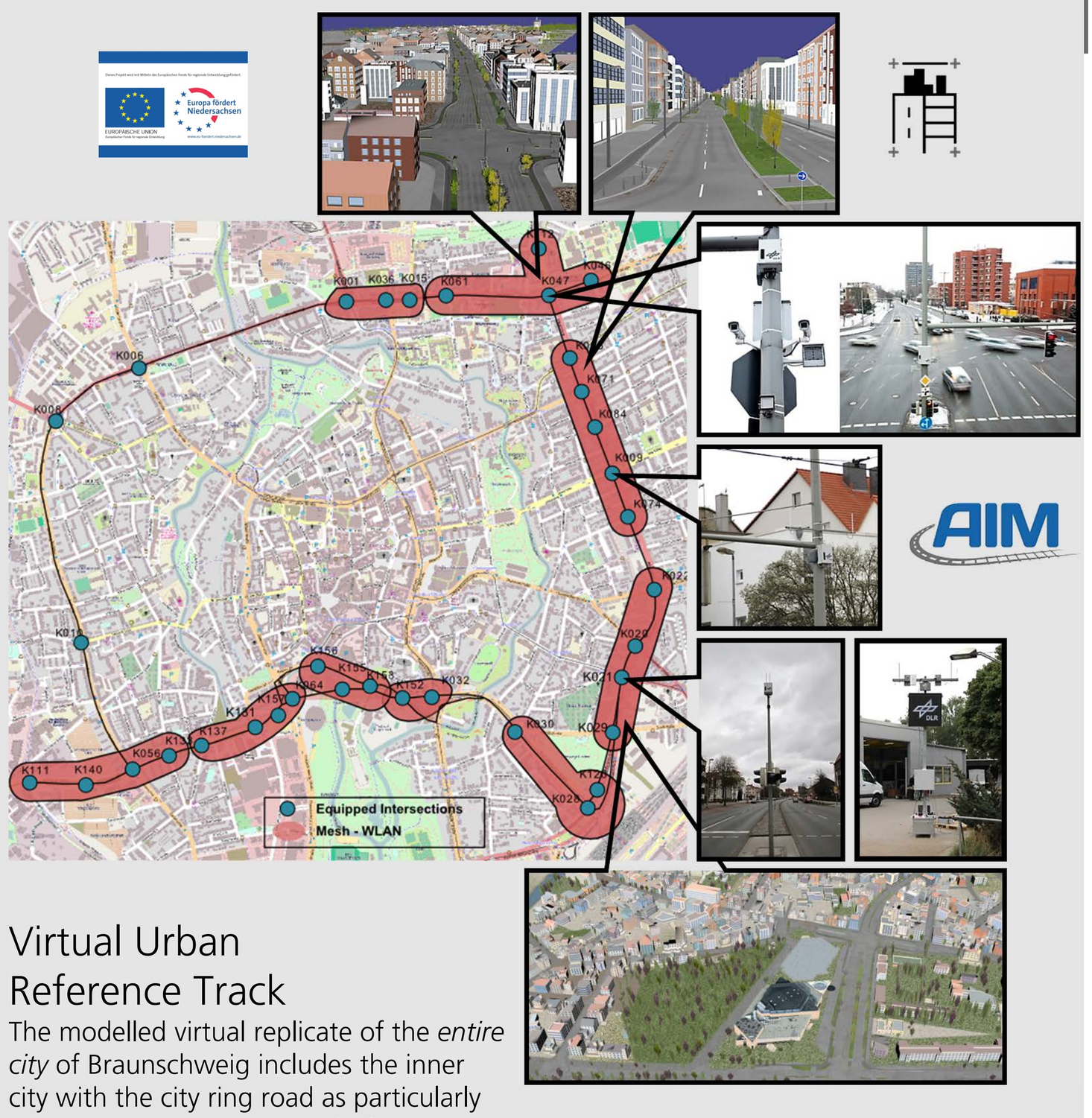
Challenge

The gap between virtual environments and real roads for testing purpose used to be quite huge, especially for the highly complex and demanding urban road networks and urban traffic conditions. Discrepancies often cover the following aspects:

(1) Mismatch between real and virtual street topology and topography, regarding complexity,

(2) Reduced degree of details in simulation (e.g. signs, traffic lights, buildings, etc.) – This decreases the impression of reality and might influence the results of simulative acceptance studies, especially within urban areas and,

(3) Mismatch between simulated (usually simplified or artificial) traffic flow and real traffic flow.



Solution

Facing these challenges, a **virtual urban test track** was generated based on high-precision data of a **real urban reference track**, which is equipped with Intelligent Transportation System (ITS) devices for testing cooperative ADAS. This virtual test track provides a virtual counterpart for simulations. Both, the real and the virtual reference track are part of the large-scale research facility "Application Platform for Intelligent Mobility" (AIM).

Real World Urban Reference Track

An important part of the AIM infrastructure is a reference track on public roads surrounding the downtown area of Braunschweig, which is equipped with *ITS Roadside Stations* (IRS) for Vehicle-to-X (V2X) communication. The interface between ITS Roadside Stations and ITS Vehicle Stations serves as an ad-hoc network connection according IEEE 802.11p whereas the interface between ITS Roadside Stations and other users (e.g. pedestrians) will work according to one of the regular WLAN standards IEEE 802.11b/g/n.
Further, a central *research intersection* on the reference track is equipped with additional sensors for comprehensive data collection. Mobile devices with V2X communication ability comprehend the AIM equipment for real world testing.

Virtual Urban Reference Track

The modelled virtual replicate of the *entire city* of Braunschweig includes the inner city with the city ring road as particularly accurate part. The 3D model of Braunschweig was created with a *tool chain* based on third party applications providing a high degree of automated processes using *heterogeneous geographical data from existing databases*. The overall road network was created based on cadastral data using a computer graphics and geographic information system approach and is described using the OpenDRIVE road description format. The generation of the logical road description and the 3D model is less time consuming and less expensive, but on the cost of precision. In order to reach a higher level-of-detail for the representation of the reference track, *measurements with special high-precision* equipment (max. 2 cm deviation of road surface and road marking positions) have been performed. The obtained detailed information was used to generate an OpenDRIVE description of the city ring, which was then merged with the generated overall road network. Information about *infrastructure objects* as road signs, traffic light and street light positions were obtained directly through the respective operator companies and local authorities and added to the road descriptions as well.

Impact

The benefits of the high-precision virtual reference track using the OpenDRIVE description format are numerous. The significant one's are:

(1) Simulation results are more reliable and comparable due to the usage of real world data.

(2) The high-precision data can serve as a map for intelligent vehicle functions (highly automated driving), for monitoring tools and as basis for local digital maps (LDM) which can be distributed via the IRS or mobile devices.

(3) The very same complete road network can be used for traffic flow analysis as well as for driver-in-the-loop studies in a driving simulator.

(4) The traffic flow simulation (e.g. SUMO) is more realistic due to the adaption of real traffic conditions, measured on the real test track.

(5) The generalized approach for automated road network generation and virtual databases will help to obtain additional realistic road networks in short time and with low costs.

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