Focus on smart cities

A mobile sensor box, installed on public transportation or service vehicles, provides real-time geodata for urban digital twins.

Urban digital twins are increasingly becoming essential tools for urban planning. Building, road, and utility line construction, the prevention of hazards caused by heavy rain and heat, and route planning for construction sites and events – all these scenarios and many more can be planned, visualized, and simulated using digital 3D city models. Citizens also benefit from this, as digital models make it easier to participate in municipal decisions, for example, by making construction projects interactively accessible and tangible.

Data is the raw material for digital city models. Indeed, the quality of the model depends on the quality of the data fed into the virtual image and how recent it is. The basis of an urban twin is formed by georeferenced data – i.e. measurement data that is located in space. It comes from various sources, such as digital city maps, aerial photographs, or surveys conducted using vehicles equipped to measure the city area using laser scanners and cameras. The point clouds generated by laser scanners form a three-dimensional virtual image of the environment in which each measuring point is uniquely located in space. Using the spatial coordinates, a wide range of additional information – such as climate and traffic data or even socioeconomic information – can be linked to the survey data, creating an urban digital twin that can be used to address various urban planning issues.

Digital data – closely monitored and provided in real time

As part of the MuSiS* project, funded by the Baden-Württemberg Ministry of Economic Affairs, Labor and Tourism as part of the Invest BW funding program, Fraunhofer IPM has implemented a new concept for data acquisition and data analysis for urban digital twins. It creates the conditions for closely recording high-precision digital infrastructure data and makes it instantly available for digital city models. Instead of conducting regular surveys every one to two years, sensors are mounted on buses, garbage trucks, taxis, or trams, recording the environment on a daily basis as they circulate through the city.

Inside the box – robust sensors in a compact space

The MuSiS research team has succeeded in housing the necessary complex measurement technology in a compact container that is not much larger than two shoe boxes. The “Mobile Urban Mapping System MUM mini” can be attached to the roof of vehicles using suction cups. The robust box, which weighs around 20 kilograms, contains two laser scanners, several cameras, a positioning unit, computing and storage media, and the power supply. All components are carefully calibrated so that the data from the camera and laser scanner can be accurately merged.

Real-time data, analyzed using AI

Continuously measuring urban spaces only serves a purpose if the measurement data is available in real time. To this end, the data is preprocessed and reduced while it is still on the vehicle. This is necessary because the sensors of a single survey vehicle record several gigabytes of data per kilometer as it travels

“Plug & Measure”: The MUM mini mobile sensor box can be installed on any vehicle.

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through the city. All measurement data is automatically anonymized before being stored locally and then immediately transmitted to a geographic information system via the 5G network. AI-based algorithms semantically enrich the data streams and create the necessary data models for the digital twin.

After two years of development, MUM mini is ready to hit the road – the multimodal measurement system is collecting geodata in various cities as part of several pilot projects. The sensor box has already been tested on garbage trucks in Heidelberg. From spring 2025 to the end of 2026, it will be used in the city of Wuppertal to collect data for the development of its "**DigiTal Zwilling**" digital twin. The city of Freiburg is also planning measurement trips for digital urban development.

The data will be made available via apps or web portals in the future, tailored to specific use cases and user groups. Two smart city projects we are also working on show just how specific the goals can be. In collaboration with the city of Freiburg, we are developing a software prototype that automatically derives street width from mobile mapping data, thus providing valuable information for parking space management (see p. 28). In the future, we will use a multispectral laser scanner to record the vitality of trees as we drive by – for greater safety on traffic routes (see p. 29).

**MuSiS (multimodal digital twin for a safe and sustainable city)*

> With our sensor box, we continuously record data from the surrounding environment. It's almost like a smartwatch, but for cities."
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> *Prof. Dr. Alexander Reiterer, Head of Department*

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