![Fraunhofer IPM logo]

# 3D-AI Urban
## Automated interpretation of mobile mapping data

### Object recognition in 3D point clouds of urban scenes

*Infrastructure monitoring generates large amounts of data. Interpretation of such data can be enhanced by automatic object recognition.*

Today, high-performance cameras or laser scanners are used for monitoring traffic infrastructure such as roads, tunnels or bridges. They deliver high-resolution images and precise, georeferenced measurement data, which are usually evaluated in a manual process. 3D-AI Urban, a software framework by Fraunhofer IPM, automates the evaluation process, providing a tool for the efficient analysis of 2D and 3D data.

### AI-hybrid approach

The software framework 3D-AI combines two approaches for automated interpretation of 2D and 3D data: artificial intelligence (AI) and 3D geometry-based object detection. While AI-based approaches provide good results in object detection, especially in 2D images, reliability of detection is insufficient in critical processes such as infrastructure monitoring. Purely geometry-based object detection, which is rule- and feature-based, proves to be not robust enough against object variations; AI-based solutions that operate directly in the 3D data are an approach that is increasingly being pursued in science. However, purely AI-based data interpretation does not yet produce results that cover the entire diversity of object classes in urban scenes. Fraunhofer IPM is investigating the use of such 3D AI-based approaches

to enhance specific object types and features in mobile mapping data. Hybrid algorithms as applied in 3D-AI combine the strengths of all these approaches, thus enabling highly reliable recognition in real-world data.

### End-to-end process chain

The 3D-AI software framework is part of a comprehensive end-to-end process chain that allows georeferenced 2D image data and 3D point clouds to be fed into an on-premise or cloud-based system. A fully analyzed data set is provided in the form of a point cloud in which each point is assigned a specific object class. As a result, georeferenced objects are available. Depending on the application, a 2D or 2.5D map can be generated, which includes infor-mation on the height of objects. In addition,

### Advantages at a glance

- Efficiency evaluation of mobile mapping data
- Segmented point clouds including georeferenced objects
- 2D or 2.5D maps according to application
- Processing sequences according to application
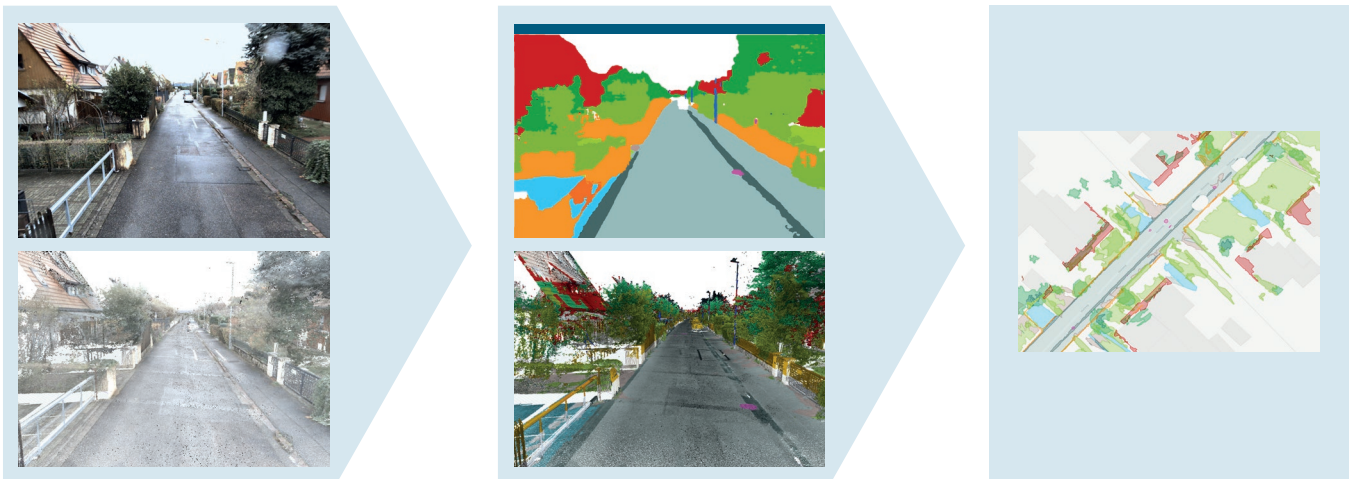
*2D camera data (upper left) and 3D laser scanner data (lower left) depict the infrastructure quickly and efficiently. 3D-AI analyzes the data automatically using smart algorithms (mid). Each color in the point cloud represents a singular class of objects. This data is then transferred to a digital planning map (right) for automated route planning. In addition to the categorized surfaces, this plan contains information on the position of the objects.*

the data can be combined with different maps or GIS solutions according to the specific application.

## Analyzing mobile mapping data

Fraunhofer IPM developed 3D-AI Urban especially for mobile mapping data. In its current version, the software covers up to 30 object classes from urban environment such as different types of pavement, sidewalks, vegetation, posts, etc. The software analyzes measurement data acquired in a full geodetic survey of a small town with a road network of around 200 kilometers within a few hours. The combined georeferenced 2D RGB image data and 3D laser scanning data are analyzed directly using 3D-AI Urban. All object classes are projected into the 3D point cloud. Finally, special heuristics and filters are applied. Several companies employ 3D-AI Urban for classifying and evaluating measurement data. The software has been optimized for cost efficiency, particularly with regard to cloud applications, with the aim of using the existing hardware as efficiently as possible. Optimization includes reducing runtime and making the software more flexible towards the hardware provided.

## Adaptable for specific user scenarios – tools for 2D/3D data annotation

Fraunhofer IPM customizes 3D-AI Urban for specific applications by adding object classes or adapting the software framework to further data sources and data outputs. Object detection can be carried out based on the image data alone or directly based on the 3D data. While tooling for 2D annotation is readily available and can be provided by Fraunhofer IPM based on open-source products, there are currently no commercial or freely available

software solutions for efficient 3D data annotation. The Point Labeling Revision Tool POLAR by Fraunhofer IPM, specifically designed for user-friendly and efficient 3D labeling, fills this gap. Using annotation tools, additional training input for the AI components can be produced, either by the end-user or as a service offered by Fraunhofer IPM as part of a development project. Interfaces of the award-winning 3D-AI software framework are adapted according to customers' requirements. There are several options to make 3D-AI available to prospective end-users, ranging from more generalized solution-as-a-service models with a pay-per-use license agreement to a fully customized bespoke solution for specific use-cases.

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