Fraunhofer IPM

3D-AI BIM

Automated generation of semantic 3D building models

AI-based point cloud to model conversion

Automated creation of a 3D model: The measurement data is classified directly in the 3D point cloud, followed by either AI-based or geometry instantiation, depending on the object class.

Combining optical measurement technology with automated data evaluation is a perfect way to optimize construction planning and documentation. Fraunhofer IPM develops multimodal sensor systems for the detection of existing buildings, construction sites and construction areas. AI-based software provides automated data evaluation, which in turn accelerates the scan-to-BIM process – regardless of which detection sensor technology is used.

Multimodal measurement systems

Digital 3D models are increasingly becoming the basis of efficient construction planning and execution. While most new buildings are now planned using 3D models, the advantages of Building Information Modeling (BIM) are not usually applied to existing buildings because this would require the buildings to be measured and modeled.

High-performance sensors can be used to quickly and precisely record both the insides of buildings and facades. Fraunhofer IPM develops multimodal measurement systems with – depending on the requirements – integrated cameras, laser scanners, thermal imaging cameras, stereo cameras and GNSS sensors for position measurement. Inside buildings, we use Simultaneous Localization and Mapping (SLAM) to measure the spatial location of the sensors. Our systems capture the environment in a quasi-static process using handheld devices or mobile robot platforms. To survey large areas, for example in civil engineering, we use drone-based sensors.

Creating object-based, semantically enriched 3D models faster

Fraunhofer IPM offers an automated process for the conversion of large 3D point clouds into a semantic 3D model that creates a BIM-capable model in considerably less time than ever before. Until now, the digital model has been created in a manual or semi-manual process. This is very time-consuming, particularly for large and complex projects because the 3D point clouds captured by the laser scanner are often combined and enriched with RGB image data provided by the cameras. These textured

Automated scan-to-BIM process

- Automated instead of manual processing of large 3D data volumes
- Enrichment with semantic information
- Modeling of existing buildings (facades, interiors, construction sites)
- Independent of detection sensors

From point cloud to 3D model: In an automated process, point clouds are converted to semantically enriched models.

point clouds have a very high data volume and are manually converted to a 3D model and enriched with meta information, e. g. object classes.

BIM-enabled data directly from the point cloud

The automated data evaluation process developed by Fraunhofer IPM significantly shortens the time from measurement to 3D model. Our AI-based approach to automated 3D model generation builds on our extensive experience with data fusion and homogenization, as well as handling huge point clouds. The data is automatically classified in the 3D point cloud, followed by either AI-based or geometry instantiation, depending on the object class. The point clouds can optionally be enriched with RGB information.

One of the first use cases is to reduce the 3D point cloud data to 2D floor plans for room registers, fire protection plans as well as area calculations. We use both geometry and AI-based approaches to detect rooms or other features in point clouds.

Dedicated data set for AI training

The data is semantically segmented in the 3D point cloud by means of an automated process. The segmentation algorithms are based on an artificial neural network (ANN), which has been specially trained for construction applications using a custom, semantically enriched dataset for the classification of different object classes. These include doors, windows, floors, ceilings, stairs, etc.

Highly efficient tool set for point cloud annotation

For every AI solution, the performance of the artificial neural network crucially depends on the quality of the training data set. Generating training data still is a manual process to be done by specifically trained workers and thus proves to be the main cost driver. Compared to 2D data annotation, annotating 3D point clouds is an even more labor-intensive task, as navigating in a 3D space on a flat display is way more challenging for humans and more demanding with respect to hardware. The POLAR (Point Labeling Revision Tool) software by Fraunhofer IPM lends itself to the fast and appealing visualization of point clouds and represents an alternative to currently available tools for point cloud annotation, which are insufficient and cumbersome. POLAR has been specifically designed to make the human-machine interaction for point cloud labeling as intuitive and efficient as possible.

Efficient digitization for efficient construction

The automated, efficient 3D modeling of existing buildings or even building areas (volumetry) can optimize various aspects of construction planning and construction documentation:

- Complete digitization of facades and building parts
- Automated reconciliation of existing buildings and planning models, e. g. for retrofitting existing buildings or for invoicing
- Construction progress control and documentation
- Fitting new buildings into existing infrastructure
- Planning equipment retrofitting in factory buildings or planning new factory equipment
- Precise prefabrication of construction elements (e. g. facade elements) based on 3D models
- Recording historical buildings for the protection of monuments or restoration

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