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The Heidelberg LiDAR Operations Simulator HELIOS as a Supporting Tool for Capturing and Preserving Cultural Heritage

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Zusammenfassung

3D geodata are of high value for documentation and preservation of cultural heritage. Based on 3D geodata captured with methods such as LiDAR, models of heritage objects and sites can be provided to a wide audience, allowing for their virtual exploration. In addition to realistic visualizations, 3D models can be furnished with additional archaeological information. Finally, by capturing an object in 3D, a documentation of the object's current state is available, providing a basis for the detection of changes or restoration.

We present the Heidelberg LiDAR Operations Simulator HELIOS (Bechtold et al. 2016), a software package for interactive simulation and visualization of terrestrial, airborne and ground-based mobile laser scan surveys. It is written in Java and freely available under the GLP v3 open source license (https://github.com/GIScience/helios). Due to its modular architecture and flexible XML configuration system, HELIOS can be easily adapted and extended to support a wide range of applications. Possible use cases are teaching and training of laser scanner operations, generation of artificial point cloud data for algorithm development, or survey planning.

The HELIOS code base consists of a core and multiple extension modules. The core contains classes that represent virtual scenes, laser scanners and scanning platforms - the fundamental components that are required to simulate a laser scan survey. Extension modules contain supporting functionality like loading of simulation assets (i.e. scene geometry and scanner/platform definitions), playback of survey definitions and interactive 3D visualization and editing of surveys. By combining the core with a set of extension modules, customized applications for different use cases and operating modes (e.g. graphical editor, command line tool or web service) can be built.

The data that define a simulation are loaded in the form of XML files. This includes the technical specifications of the used scanner and platform, the description of the virtual environment (scene) which is to be scanned, and the description of the survey (scanning positions or mobile/airborne platform track, and scanner settings for each position or waypoint). The only input data that are not provided in XML are 3D triangle meshes and texture images which represent the geometry and visual appearance of the scene. These 3D models are provided as Wavefront Object (.obj) files.

A complete virtual survey is defined by specifying a scene, a platform, a scanner and a set of waypoints / scanning positions with scanner settings for each waypoint. Scanners are defined by selecting one of currently four available beam deflector types (rotating polygon mirror, oscillating mirror, palmer scan or fiber array) and setting up other scanner parameters like pulse rate, scan rate and range error. Additional scanners can be implemented in Java.

The platform is specified in the same way, with currently four supported platform types: A stationary platform (e.g. tripod), a simple physics model of a ground vehicle and a multicopter, and a platform that moves the scanner along linear path segments between waypoints, which can be used to approximate the movement of other ground-based and airborne platforms like fixed-wing aircraft. Just like with scanners, new platform models can be added by extending the provided platform base class.

The XML scene description format allows users to compose a scene by placing one or multiple 3D models within the virtual environment. For each model, position, scale, rotation and other parameters can be specified. While scene part 3D models must currently be loaded from static 3D model files, the XML scene description format and other aspects of the system's architecture are designed to also support the use of procedurally generated geometry in future versions.

While scanner, platform and scene descriptions currently are created with a text editor, scanning positions or waypoints and associated scanner settings can be manipulated through visual controls in the same interactive 3D environment that is also used to visualize a running simulation.

Regarding cultural heritage documentation, we see great potential for HELIOS in the planning of laser scan surveys. If at least a rough 3D model of the object or area of interest is already available (either captured in a previous real-world survey or created manually based on photographs, maps or drawings), this model can be used together with HELIOS to simulate a survey before deployment of the real scanner in the field. By checking viewshed coverage and achieved point density for different scanner positions and settings in the virtual environment, better real-world scan results can be achieved in less time.

Furthermore, algorithms for automatic computation of optimal scanning positions for terrestrial laser scan surveys were already tested with HELIOS and might be available for production use in the future.

REFERENCES:

Bechtold et al. 2016: HELIOS: A Multi-Purpose LiDAR Simulation Framework for Research, Planning and Training of Laser Scanning Operations with Airborne, Ground-Based Mobile and Stationary Platforms. In: ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. III-3, pp. 161-168.

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