

Building cities using UAV



by Martin Schwall and Benjamin Busse

The twin cities of Waldshut-Tiengen, Germany, have approximately 22,000 inhabitants and are located on the beautiful Upper Rhine in Baden-Württemberg near the Swiss border. The local municipal planning and building control office needed an up-to-date planning framework for the newly planned city construction projects and urban development in the two districts. After being reviewed, the documents were simply not accurate enough, even though they had been existed in 3D format. This was due to an insufficient level of detailing, also referred to as LoDs (Level of Detail). A block model (LoD1) and standardised roof shapes (LoD2) were insufficient. The municipal planning and building control office needed a more accurate 3D model as a basis. How could the exact data of complex roof shapes be obtained without the risk of walking on steep roofs or being forced to hire a company to carry out aerial photography by airplane or helicopter?

The IngenieurTeam GEO GmbH has successfully employed an Aibot X6 from Aibotix for several years and was commissioned by the city of Waldshut-Tiengen with UAV flights for aerial surveying and data processing to create geo-referenced ortho-photos, coloured point clouds and 3D models. The project included obtaining the roof geometries as well as eave and ridge heights. The data obtained was then further processed by Autodesk programs – right up to 3D modelling.

Providing a better basis for decision-makers with 3D modelling

The municipal planning and building control office sought to create an accurate 3D model to visualise the striking new building projects in the centre of Tiengen and in areas of the city Waldshut prior to construction planning. In contrast to plans presented on paper, 3D modelling has the power to truly depict reality and convince the public and the decision makers.

IngenieurTeam GEO's aerial surveying services were already well known. Thus, the idea for using an



ortho-photo to supplement existing LGL (State Agency for Spatial Information) data with current aerial survey data to increase accuracy was the next logical step.

Convenient and secure data capturing

The flights for the aerial survey of the 70,000 square metres (753,500 square feet) of land comprising Waldshut and Tiengen were carried out in May by employee and certified Aibot pilot Benjamin Busse. Aerial surveying of the inner-city requires a special permit and adherence to certain requirements.

The raw data was evaluated with Agisoft Photoscan Pro software. Prior to the aerial survey flights and for the subsequent calculations required to ensure accurate results, control points were measured, marked and signalled using a Leica TPS1200 total station and a Leica Viva GNSS system. Adhering to the principle of surveying “no measurement without control” and to ensure consistent position and height data within the range of ± 5 centimetres (± 2 inches), control measurements were also carried out using the total

station at individual buildings during establishment of the control points.

The Aibot X6 UAV system offered many advantages during this project. The system's quick implementation and high resolution 16.2 megapixel images delivered the accuracy required for the project. An exact recording of the roof types, ridge heights and eave heights would not have been possible with conventional measuring methods due to the close proximity of the buildings in the affected areas. The roof ridges would not be visible due to excessively steep sights.

A picture is worth a 1,000 words

The real benefit, however, lies in the data gathered. This data provides the client with a high level of added value, a textured 3D model, a coloured point cloud and ortho-photos with ground resolution of 1 centimetre (0.4 inch) for optimal representation of the planning area.

Partner company Bytes & Building GmbH, which advises the town of Waldshut in the area of Auto-



Level of Detail (LoD)

Level of Detail (LoD) refers to the various levels of detail in the presentation of virtual worlds. LoD concepts are also used in 3D landscape and city models. Depending on the application, different levels of detail are required.

The City Geography Markup Language (CityGML) is an application schema for storing and sharing virtual 3D city models. CityGML has been a standard for the Open Geospatial Consortium (OGC) since August 2008 and is the basis for many city models in Germany.

The following levels of detail have been specified for CityGML:

- LOD 0:** Regional model, 2.5-D footprints
- LOD 1:** Block model, building block (extruded footprints)
- LOD 2:** 3D model with standard roof structures and simple textures
- LOD 3:** Detailed (architectural) building models
- LOD 4:** LoD 3 building models with interior features

CAD systems, were responsible for the visualisation. Bytes & Building GmbH provides comprehensive solutions in the fields of architecture, building and infrastructure and occupies a leading position in Germany in the construction industry and building information modelling (BIM). When Bytes & Building submitted the 3D models and a 3D animation of city areas there was nothing but praise and enthusiasm from the head of the Civil Engineering Office, Uwe Kopf.

“We are thrilled! The data and information provided have literally given the planning and control office a whole new perspective,” explained Kopf. “Since the visualisation goes beyond 2D floor plans and 2D building facades, the current high-resolution ortho-photos and 3D modelling have immense value for us. This greatly simplifies the decision making process further down the road.”

The perfect complement to classic measurement methods

The use of the UAV system and more than 30 projects implemented by the IngenieurTeam GEO GmbH prove that the UAV system delivers excellent results for surveying in the area of engineering services. The as-built documentation and the creation of ortho-photos as seen in this project are merely two possible areas of application. Other applications are

quite possible in the future. For example, building and property inspections as well as large-scale monitoring and inspections are also conceivable. It is also possible to carry out flights in GNSS-denied areas for aerial surveys, such as in large halls.

Similar to laser scanning, the processing of data and the resulting point cloud allow for diverse finishing processes and optimally complements classic methods of surveying.

Due to substantially improved software programs in the field of photogrammetry like Agisoft Photo Pro, one can certainly speak of a renaissance in the area of photogrammetry. Large amounts of data can be collected and analysed in a short time, quickly delivering 3D data to the client and simplifying the decision-making process much more effectively than a large piece of paper with plotted content, which gives only a crude depiction of what actually exists on the ground.

Despite upgrades in computing capacity, such as larger memory and powerful graphic cards, the processing of very large amounts of data is currently a problem due to longer processing times. The quantity of data and dimensions submitted to the customer should be discussed in advance and pre-established



■ **Client requirement fulfilled: exact geometries of the roofscapes, captured with the Aibot X6.**

as much as possible. Ultimately, the end customer and user must be able to use their data according to their needs and applications.

In future projects, the use of UAV and photogrammetric data processing for obtaining 3D data will efficiently and effectively complement traditional methods. The rapid development of UAV systems is supported by the principles of surveying and geoinformatics.

As professionals in the geo-industry and in order to provide clients with maximum added value, surveyors are committed to provide clients with the best advice

possible, to perform work with the highest-quality sensors and methods, and to optimally analyse and to refine the data. ■

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IngenieurTeam GEO GmbH

The surveying office is headquartered in Karlsruhe and offers services in engineering surveying and hydrography (water measurement). Since 2014, the company has supplemented this offer for a further future-oriented business field, the survey with UAV systems. IngenieurTeam GEO GmbH sees the

enhancement of data collection using UAV systems as the right decision for future success. The engineering office is equipped with the latest measuring and data processing systems.

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