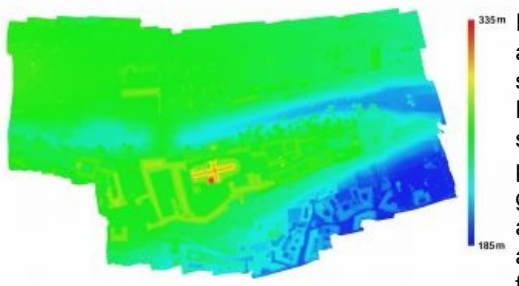
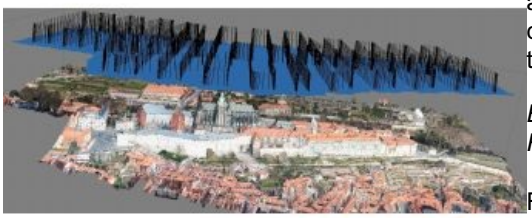
CAPTURING A HIGHLY SECURED SITE FROM THE AIR

Modelling Prague Castle with a UAS





In a recent project to obtain detailed and accurate orthoimages and 3D models to support technical staff in maintaining Prague Castle in the Czech Republic, the site was captured by UAS photogrammetry. Videos and georeferenced panoramic images were also taken as a service to documentalists and to provide the basis for virtual tours for tourists. Prague Castle and its surroundings are heavily secured sites and special permission was required to conduct the air survey. Learn more about this unique project here.

By Jakub Karas, Upvision, Czech Republic

From the 9th century onwards Prague Castle, located on the banks of the River Vltava in the centre of Prague, Czech Republic, was the residence of the country's royal family and since 1918 it has been the residence of the president. At 570m long and 128m wide it is one of the world's largest castles, plus it is the largest ancient castle on the planet. It is a symbol of both the city and the Czech Republic as a whole. Various Czech kings have been crowned and entombed in St. Vitus Cathedral, located within the castle complex.

UAS Equipment

The Prague Castle zone is heavily guarded. Conducting UAS flights over the one-square-kilometre site is strictly forbidden and the fine for doing so can amount to EUR200,000. As the first and largest Czech UAS company registered at the Czech Civil Aviation Authority (CCAA), Upvision obtained permission to fly over the secured area in 2015. The UAS used was the Mikrokopter, a hexacopter built by the company itself and licensed by CCAA for conducting mapping and other commercial aerial missions. The Mikrokopter was equipped with a calibrated Canon EOS 700D camera with a 28mm lens fitted on a servo gimbal. Spherical panoramic photos were taken using a Canon EOS 700D camera equipped with a fisheye lens, also mounted on a gimbal. Video was captured with a Panasonic GH4 affixed to a brushless gimbal for absorbing vibrations. The positions obtained by the on-board GNSS receiver, which acquired both GPS and GLONASS signals, and the measurements from the inertial measurement unit (IMU) were tagged to the images directly during exposure.

Survey

Five flights were carried out in the early morning of a working day when the president was away and the castle was not yet open to tourists. There was little wind and the sky was clear. Each flight lasted around 13 minutes and the entire survey could be finalised within little more than one hour. As the highest tower of St. Vitus Cathedral is taller than 100m, a flight altitude of 150 metres was adopted resulting in a ground sampling distance (GSD) of 2.4cm. High image overlaps – 80% along track and 60% across track – were chosen because of the many tall buildings. The take-off location differed per flight and was selected such that it was in the middle of the area to be covered to ensure that the pilot could maintain sight of the UAS during the entire flight, from take-off to landing. After manual take-off, the UAS was flown in automatic mode. Landing was then performed manually (Figure 1). The flights took place in the presence of soldiers of the Castle Guard. As it would have been inappropriate to paint ground control points (GCPs) on such a historic site, a total of six natural

GCPs were used. For checking purposes five control points, likewise natural objects, were identified. The control points were measured by the real-time kinetic (RTK) technique using TopCon Hiper GGD and processed with TopSurv software.

Processing and Output

The area of nearly one square kilometre was captured by 1,595 images. The amount of geodata collected approached nearly 100 gigabytes. The images, external orientation parameters and flight logs were uploaded and processed with Agisoft Photoscan Pro. During block adjustment, over four million tie points were created. The coordinates of the GCPs were determined with a root mean square error (RMSE) of 5cm. The processing resulted in a georeferenced (Czech coordinate system) digital surface model (DSM) consisting of nearly 400 million points (Figure 2), a mesh model and an orthomosaic with a GSD of 2.4cm (Figure 3). The processing took two days on advanced hardware.

The orthomosaic, in addition to complementing the existing maps and technical drawings of the castle, was draped over the DSM to create a 3D model of the area (Figure 4). The 3D model will not only be used for visualisation purposes but will also serve as a detailed information source in helping technical staff to maintain the historic buildings as well as providing documentation for other projects. The above-mentioned outputs will be integrated in the GIS of the Prague Castle Administration. In addition, the panoramic images were processed to generate interactive spherical views used for the creation of a virtual tour (Figure 5). The video and the virtual tour will be accessible through the Prague Castle website.

Biography of the author

Jakub Karas is co-owner of Upvision, manager and consultant. He has been specialised in photogrammetry and GIS for over 14 years. He also chairs the Czech UAS Association.

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Figure Captions

Figure 1, Manual take-off.

Figure 2, DSM, cross shape: St. Vitus Cathedral.

Figure 3, Part of the orthomosaic and detail (bottom).

Figure 4, 3D model showing a preview of aerial images.

Figure 5, Spherical image in little planet projection.

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