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3D MODELING OF BUILDINGS USING DRONES

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Abstract

The Unmanned Aerial Vehicle (UAV) technology has gained great attention in recent years. It is viewed as a low-cost alternative for local large scale aerial mapping and other applications requiring the modeling of a relative small area only. In this paper we present the eBeeX UAV from SenseFly used in acquisition of aerial images and the Pix4DMapper software for data processing for generating a 3D model of a hotel from Spain. The data used in this project are available on https://www.sensefly.com/education/datasets/.
Data management in cases where the number of images is high is also very important. The use of UAVs is also advantageous because it may be used for tasks requiring quick response, including in the case of the inspection and monitoring of buildings.
It is demonstrated that the UAV system for low altitude aerial photogrammetry can be used in the construction of 3D building production, and the technology solution in this paper offers a new, fast and technical plan for the 3D expression of the city landscape, fine modeling and visualization.

Keywords*:3D reconstruction, eBee SenseFly, photogrammetry, Pix4D software, UAV*

INTRODUCTION

Virtual globe visualization software such as Google Earth is becoming increasingly popular, both on desktop and mobile platforms. It enables many applications in the fields of navigation, tourism, but also city and land planning. In addition of displaying detailed 2D vectorial and raster maps on top of digital elevation models, modern virtual globes have the ability to render 3D building models (Kung et al., 2018).
Aerial photography has a long history of applications in cartography. It has a very large range of applications and can be used to minimize work on the ground. Photogrammetry in turn is a standard tool often used for large scale mapping applications. This technique enables the user to obtain 3D data of the zone of interest, and eventually may also be used to produce orthophotos. Photogrammetry has also seen an increase in the use of UAVs (Unmanned Aerial Vehicles) for smaller scale cartography. Their use is also advantageous because it may be used for tasks requiring quick response, including in the case of the inspection and monitoring of buildings (Murtiyoso et al., 2017).
Three-dimensional simulation and virtual reality are two forms of "digital city" and in the building forms both of them are required establishing 3D model. Building modeling method is mainly divided in two ways, which are high precision and fast modeling for building group and fine modeling for one building to update the building area. Nowadays, the advanced technology of remote sensing and photographic measurement technology is an important means of 3D building modeling (XieFeifei et al., 2012).
Because of the limitation of flying high, photography posture and timeliness, fixed orbit satellite remote sensing and mannedaerial photography in middle and high altitude can only get the information of the height and top textures of some buildings, which are hard to meet the requirement of 3D data rapid access and update for city building (Wu , 2003; Li Chengming, 2008, Popescu et al., 2017).

MATERIALS AND METHODS

The area near Playa Bonita was once used by the U.S. Army as a military base, but in recent years has undergone a surge of development. The beach itself is somewhat rocky but borders a calm section of the Pacific Ocean. This dataset was collected in a single flight by an eBee X (Figure 1) carrying a senseFly S.O.D.A. 3D camera (Figure 2).

Figure 1. eBee X UAV by SenseFly

The eBee X is a fixed-wing drone designed to boost the quality, efficiency and safety of data collection, it has a camera to suit every job, the accuracy and coverage to meet every project's requirements, and can work virtually every type of site.

The eBee X can meet the exacting requirements of every project. Its unique Endurance Extension unlocks a maximum flight time of 90 min—for vast coverage of up to 500 ha (1,235 ac) at 400 ft*—while its High- Precision on Demand helps you achieve absolute accuracy of down to 3 cm (1.2 in), without GCPs.

The eBee X suits every job thanks to its range of groundbreaking cameras. These include the new senseFly S.O.D.A. 3D, for stunning 3D reconstructions of vertical environments, the best-in-class senseFly Aeria X RGB photogrammetry camera and the senseFly Duet T for creating geo-accurate thermal maps.

The senseFly S.O.D.A. 3D mapping camera is a unique innovation - a professional drone photogrammetry camera that changes orientation during flight to capture three images (2 oblique, 1 nadir) every time, instead of just one, for a much wider field of view. It is optimised for quick, robust image processing with Pix4Dmapper.

Figure 2. 3D mapping camera by SenseFly

Specifications of the camera: Sensor: 1″, RGB lens: F/2.8-11, 10.6 mm (35 mm equivalent: 29 mm), RGB resolution: 5,472 x 3,648 px (3:2), Exposure compensation
±2.0 (1/3 increments), RGB shutter: Global Shutter 1/30 – 1/2000s, White balance: Auto, sunny, cloudy, shady, ISO range: 125-6400, RGB FOV: Total FOV: 154°, 64° optical, 90° mechanical.

RESULTS AND DISCUSSIONS

As Technical data of resulting fight: the ground resolution was 4.5 cm (1.77 in)/px, the coverage was 1.19 sq. km (0.38 sq. mi), the flight height was about 170 m (557.7 ft) and the obtained number of images was 550 (Figure 3).

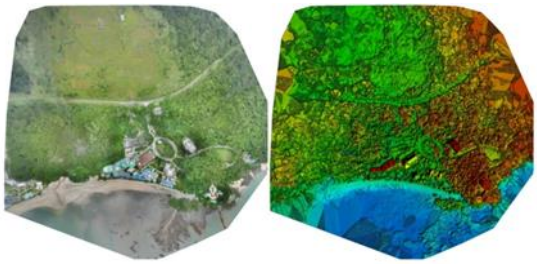

Figure3. Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

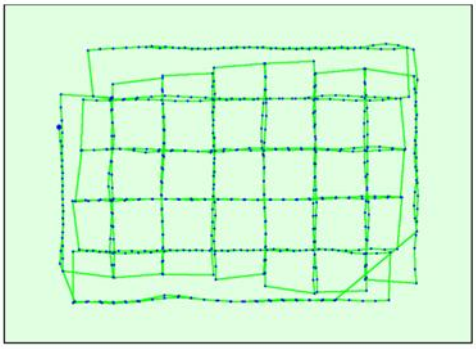

Figure 4. Top view of the initial image position.

The green line follows the position of the images in time starting from the large blue dot.
Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images. Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result (Figure 4).

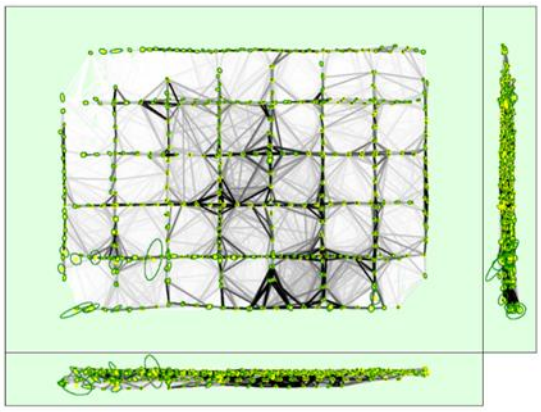

Figure 5 The network of vectors

Computed image positions with links between matched images.
The darkness of the links indicates the number of matched 2D key points between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty of the bundle block adjustment result (Figure 5).

Figure 6. 3D view of vectors grid model

In figure 6 we can see the grid model of vectors which joins the center of every pixel.
In the next picture (Figure 7) it can be seen the vertex of every center of the images.

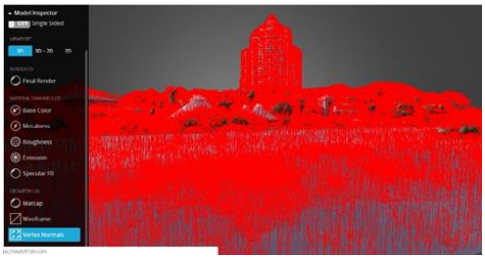

Figure 7. 3D view of vertex

Picture number 8 shows the 2D and 3D shows the place of every image and each pixel that was used in composing the 3D model of the area.

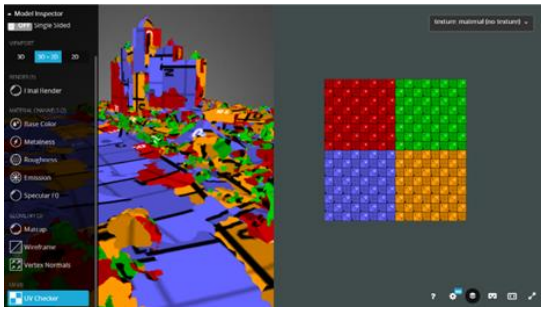

Figure 8. 2D and 3D view of pixel position

As a final result it can be seen in figures 9 and 10 in sketch fab*. It is a platform where you can upload 3D models to publish and share.

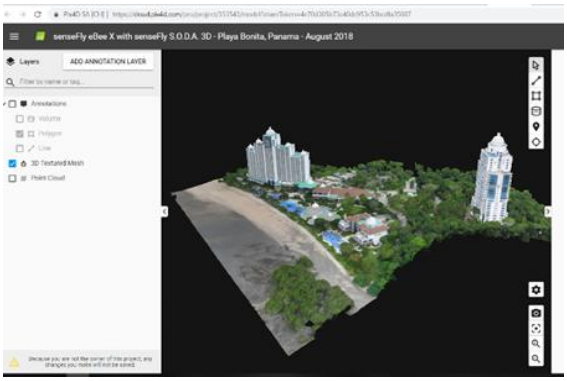

Figure 9. 3D view of the area Playa Bonita

This view it is available on Pix4DCloud

Figure 10. Final 3D view of the area Playa Bonita

CONCLUSIONS

It is important to know that UAV photogrammetry is emerging as an alternative method of acquiring photogrammetry data to the traditional systems using full-size manned aircraft (Erghelegiu et al., 2018).
The UAV is nevertheless a suitable solution for the surveying and recording of historical buildings because it is able to take images from points of view which are normally inaccessible to classical terrestrial techniques (Murtiyoso et al., 2017).
The Pix4D offers a 15-day free trial, after which a monthly subscription can be made. The image processing is made in a cloud, after which the orthomosaic can be downloaded as a .tiff image or other format.
The composition of the orthophotomap can be made in many softwares, but the fastest is Pix4D's cloud-based processing online, making it very accessible because it is not necessary to have a computer with high-performance features such as a plaque video dedicated to very expensive.

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*https://sketchfab.com/3d-models/3d-mapping-sensefly-ebee-x-soda-3dbbbca401b18349178f6abf9f322fc682