Mapping a Serious Collision via UAV Photogrammetry using GCPs

Background

In July, 2018 a Canadian Police Investigation Unit used a UAV/drone to map a serious traffic accident scene. The incident occurred on Highway 19, south of Courtney, along a stretch of highway in the district of Comox Valley, British Columbia. A Dodge Challenger (referred to as vehicle one) was negotiating a gradual counter clockwise curve (left-hand bend) as it crossed the Trent River bridge, when it compromised lateral traction and lost control. Vehicle one then began to spin in a counter clockwise direction, which caused an over-steering action. Vehicle one then entered the center median and crossed onto the northbound side of the highway.

A Dodge RAM pickup pulling a fifth wheel trailer (referred to as vehicle two) was traveling northbound when vehicle one slid sideways through the center median into vehicle two’s path. Vehicle one struck vehicle two in a frontal orientation causing the truck and camper to deflect to the right where it left the highway on the eastbound road shoulder, rolling onto its side. Vehicle one was accelerated backward from maximum engagement, coming to rest in the center median of the highway.

The occupants of vehicle two were taken to hospital suffering from life-threatening injuries, whereas the driver of vehicle one, sustained less serious injuries.

The Police UAV crash scene mapping:

For the aerial mapping, the Police Investigators used a DJI Inspire 1 drone with Pro XS camera. The UAV camera had been pre-calibrated using iWitnessPRO™. The software APP DJI GS-Pro, installed on an iPad, was used at the site of the crash to plan the autonomous flight mission, the configuration comprising overlapping strips of images, both in the direction of the road and diagonally across the road, as indicated in the top-down view within iWitnessPRO’s workspace in Figure 1.
The DJI Inspire 1 acquired 134 nadir-looking images from a flying height of 36m (118 ft) AGL, the flight time being about 12 minutes. *iWitnessPRO*’s automatic two-stage photogrammetric data reduction process for network orientation and dense 3D point cloud generation took 78 minutes to complete on a standard laptop computer with i7 processor and 32Gb of ram.

Ground control was provided by eight Propeller Aeropoints, which are image-identifiable targets with inbuilt survey-grade GPS positioning capability. They provide the coordinate reference system for the photogrammetric network, along with accurate scale. Both the final orthoimage map and the 3D point clouds and mesh can then be directly output as KMZ files for direct overlay on Google Earth imagery. Figure 2 shows the positions of five of the Aeropoints, which require manual measurement within a sufficient number of overlapping images.

As mentioned, the two-stage photogrammetric processing by *iWitnessPRO* is fully automatic. However, in cases where ground control points (GCPs) are utilized, the 3D network coordinates of these requires that the operator undertake a traditional manual referencing process in order to obtain triangulated coordinates of the GCPs. This process is made simple in *iWitnessPRO* via a function termed GCP-Assist, which allows semi-automatic image point referencing, thus greatly speeding up the 3D point determination for GCPs. Figure 3 shows a screen grab of the GCP-Assist process.
Once the 3D network coordinates of the GCPs are measured, the coordinates of all photogrammetrically determined feature points can be transformed into the desired reference coordinate system via the Aeropoint GPS data. The provision of more than three GCPs affords an integrity check on the consistency of the photogrammetrically determined and GPS-measured GCP coordinates. In this instance, the two data sets were in quite acceptable agreement, to an accuracy level of 1.1 cm (.036 ft.) RMS.

The outputs of the dense image matching stage for the 134-image network in iWitnessPRO were a colorized digital surface model comprising 22.5 million points, along with an orthoimage, as shown in Figure 4.
Figure 5 shows the resulting orthoimage map (in KMZ format) overlaid upon the image base of Google Earth PRO. This figure illustrates the visualization utility of displaying accident scenes spanning 100s of meters within Google Earth.

Summary

The automated photogrammetric processing of images from UAVs/drones by iWitnessPRO affords law enforcement and emergency responders a fast and safe means to record 3D scene evidence for diagramming purposes. In regard to the choice of a 3D reference coordinate system for the photogrammetric network, it is often adequate to utilize the GPS positions included in the image metadata. However, when more precise absolute positioning is required, for example for the generation of KMZ files for visualization purposes, the use of GCPs is warranted. The provision of the GCP-Assist tool within iWitnessPRO greatly simplifies the GCP processing, leading to faster and more accurate 3D feature point coordinate generation, and thus faster production of digital surface models and orthoimage map data.

Photogrammetry, and especially iWitnessPRO, has been proven by numerous applications in law enforcement, traffic accident reconstruction and forensic analysis to be a low-cost, accurate and reliable mapping tool, irrespective of whether the images are captured by hand-held cameras or by cameras mounted on UAVs.