

# Photogrammetry survey with a UAV and a long distance laser total station on an abandoned quarry

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Author names: Henri Borreill, Christophe Puerto

*Author's affiliations. Exametrics*

**Highlights:** An abandoned quarry is a dangerous place. With a UAV and a long distance laser total station, the survey is accurate and safe. Thanks to some Ground Control Points measured from a distance by a long distance laser total station, the pictures taken by UAV can be located with a very high accuracy

**Key words:** UAV, Photogrammetry, long distance total station, Distance surveying.

### Introduction

For the survey of the abandoned quarry, a team of two persons used a long distance total station and a UAV equipped with a 20 MPixel camera. The surface of 8 hectares with a cliff was measured with only 2 UAV flights from 2 different points and the total time of the complete data acquisition was less than 3 hours. The UAV was always in the line of sight of the pilot and its flight height did not exceed 80 m. The team did not take any risks close the eroded cliff.

With this method, the precision of the 3D point cloud is below 5 cm in x, y and z.

### Data acquisition

#### *Characterisc points*



Figure 1: characteristic point seen from the total station (numbered 29)

A camera is used to take a picture of the characteristic point from the total station. The accuracy of the measure of this characteristic point is less than 5cm (like the rover DGPS)

With the long distance total station, the operator chooses characteristic points that can be seen from the camera flying in the UAV.



Figure 2: Detail of a picture taken by the UAV (80 m high)

### *Characteristic point measurements*

We used a DGPS Leica 1200 DGPS for the georeferencing of the site. The rover georeferencing was based on the RGP computed thanks to Leica Geo Office.

With the DGPS rover, we used 6 real time computed stations and averaged for the georeferencing of the global station.

The characteristic points were chosen at different places on the cliff, and were equally distributed.

We decided to use Ground control points that are used by the photogrammetry software and Check points which purpose are to check if the point cloud is correct.

Some points on the ground – that was not seen from the total station location were also measured thanks to the DGPS rover.

There were 2 locations of total station to cover the whole site of the quarry. The total station locations were georeferenced thanks to 3 fixed points known with a double reversal computation.

This methodology has several benefits. The ground control points measured with the long distance laser total station TCRP1203+ R1000 (1km distance) do not need that an operator go onsite with the DGPS rover. This is a safe and quick way of surveying for the operators.

### *Characteristic point distribution*

The below picture shows the spatial distribution of characteristic points : GCP and check points.

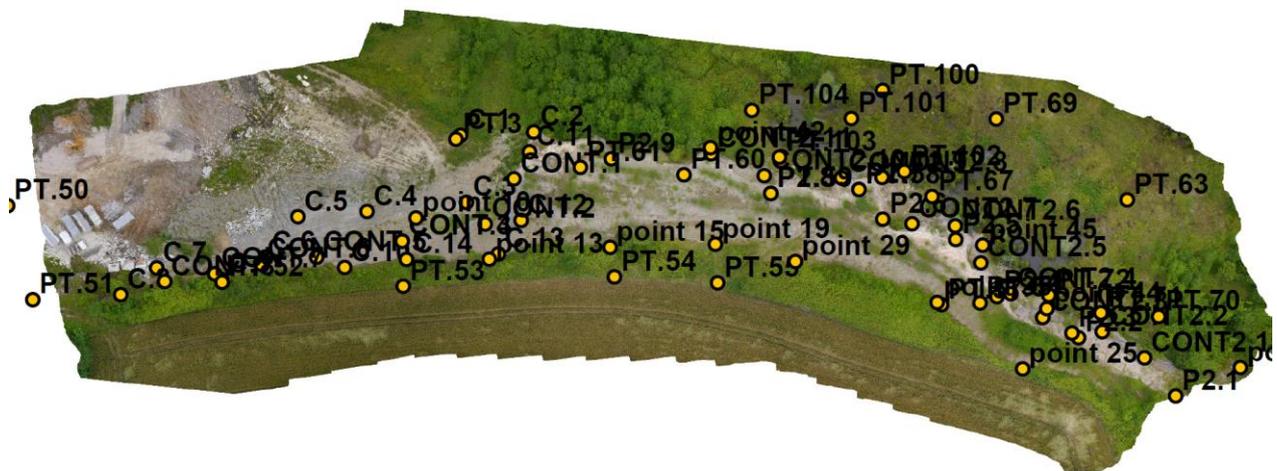


Figure 3 : Spatial distribution of characteristic points

Most of the characteristic points measured by the total station were taken on the cliff at different heights. The other points measured by the rover DGPS were on the ground.

Almost 40 CGPs and 40 checkpoints were used.

### *UAV*

The pictures are taken with a 20MPixel camera at 80 m above the ground. The pixel size is less than 2.24 cm. The camera is in nadir position. The flights are partly programmed, and the pilot also flew manually the UAV to take pictures of the cliff with an oblique view. Each flight is less than 10 minutes long.



Figure 4: UAV flight: first programmed with a nadir position camera, then manually with an oblique view

For each flight, the camera took around 120 pictures, but the surveyor team finally chose only 50 pictures in total for the photometric process.

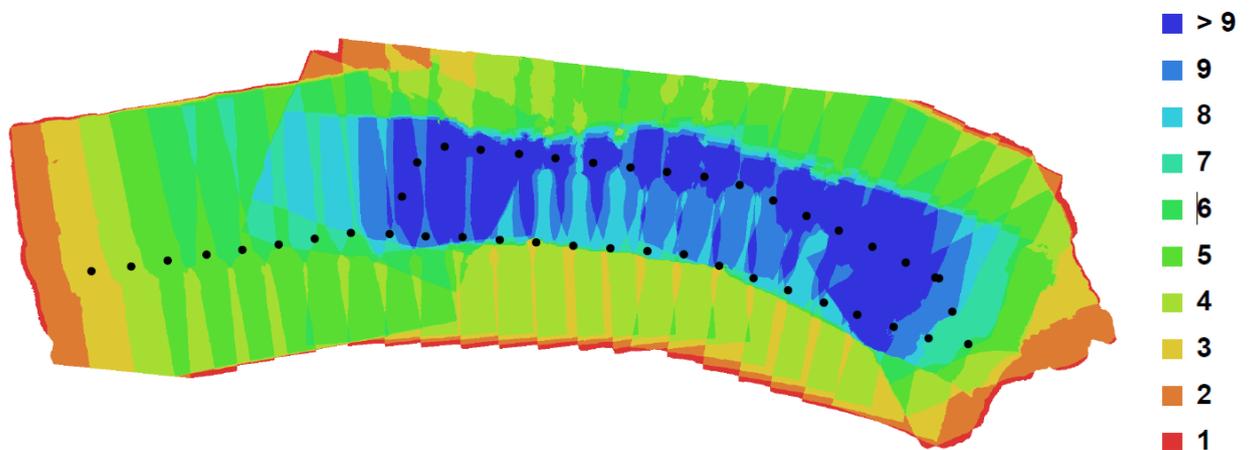


Figure 5 : Overlapping pictures

The above figure shows the pictures locations and the overlapping parts used for the 3D model creation.

## Data Processing

### *Photo calibration*

Each photo was calibrated and rectified thanks to Agisoft Lens.

### *Photogrammetry software*

The software Agisoft Photoscan was used as 3D modeling software.

The Ground Control Points are used to georeferenced the 3D points cloud. The check points are used to control that the model is also accurate where the GCP are not used.

The process duration of the 3D model build-up last less than 2 hours.

## Result

With this method, the precision of the 3D point cloud is below 5 cm in x, y and z.

## **Conclusion**

For the survey of the abandoned quarry, the long distance laser total station and the UAV is a safe, quick and accurate solution. The surface of 8 hectares was measured with only 2 UAV flights from 2 different points and the total time of data acquisition was less than 3 hours.