First Experiment of Long-Range Panoramic Images on a High-Precision Geodetic Reference Frame

Author: Peyman Javadi [1] ; Directors: José Luis Lerma[1], Luis García-Asenjo[1]

Programs: Doctoral Program in Geomatics Engineering

[1] Department of Cartographic Engineering, Geodesy and Photogrammetry, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain.

Introduction

Geomonitoring of rock-falls and landslides is increasingly carried out by solutions that integrate different geomatics techniques to provide quickly 3D point clouds or models that are required to be rigorously in the same reference system. Methods based on remote sensing such as terrestrial laser scanning or photogrammetry need precise ground control, which is usually provided by means of geodetic surveys. Geodetic techniques cannot always grant accurate target points optimally distributed within the monitored object, but terrestrial photogrammetry shows clear advantages compared to terrestrial laser scanning. A possible alternative is the use of the panoramic photogrammetry method by using robotic devices like Gigapan along with a systematic collection procedure from stable stations of a reference frame whose coordinates are accurate and well-controlled. This contribution describes an experiment conducted in Cortes de Pallás (Spain).

Objectives

When the area under monitoring is larger than 1 km^2, the topography presents great difficulties. The 3D models resulting present inconsistencies with other high-precision geodetic techniques. General aim in this research deals with the generation of high precision 3D models by optimizing image-based methods and panorama photogrammetry technique for the monitoring of deformations at distances in the range of 1 km. Other goals are also pursued, including:

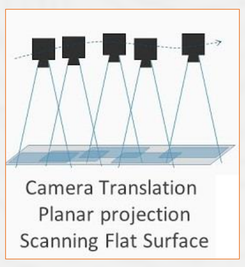
1) Using panoramic images for 3D model reconstruction with photorealistic and high-resolution texture.
2) Utilizing of dedicated algorithms for panorama orientation and restitution.
3) Operating the generated 3D model to optimally reconstruct the geometry.
4) Eliminating refraction error in accurately measuring the distance between control points and target points.
5) Integration of geodetic measurements with panoramic images to identify deformation and displacement.

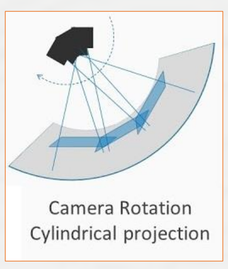
Materials and Methods

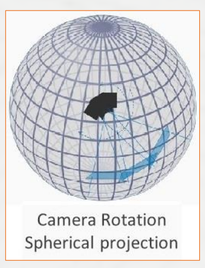
Panoramic Photogrammetry

Panoramic Image

Panoramic photography, also known as wide format photography.
Stitches multiple images together to form a single image with wide view.







Panoramic Photogrammetry

Image Stitching

The biggest challenge with panoramic photography is the proper stitching due to low quality of images, poor image correspondence, or possible parallax errors.

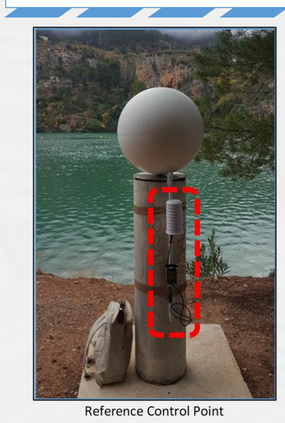
Measurement Setup

Description of the Test Field

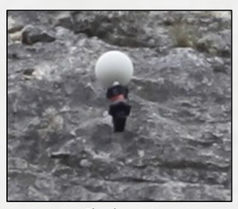
Study site of Cortes de Pallás highlighted in red: top) oblique aerial view; bottom) front view

Measurement Setup

Permanent Points



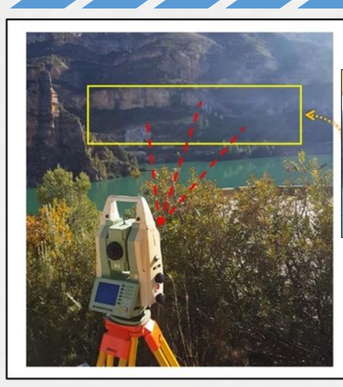
Reference Control Point



Check point

Measurement Setup

Geodetic Survey



Sub-millimetric EDM Mekometer ME5000

Robotic Total Station for automatic CPs observation

Measurement Setup

Photogrammetric Survey

Camera mounted on the Gigapan for acquiring the panoramic images

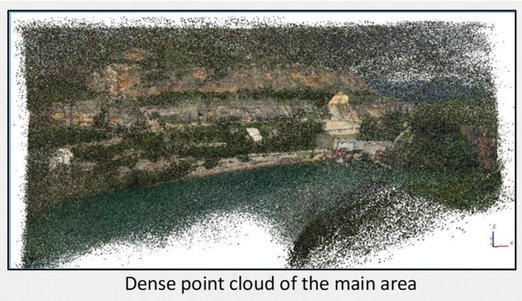
Results

Orientation of the seven partial panoramic images

		Number	
Stations		7	
Photos		37	
Markers		37	
Reference Points	*Control Points*	19	*3*
	Check Points		*16*
Tie Points		1,948,279	

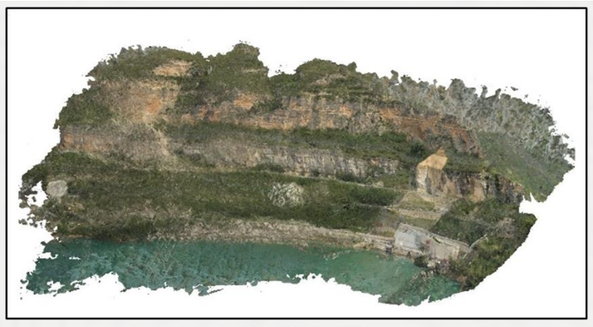
RMSE obtained in the orientation of partial panoramic images

	Error (m)	*Error (pix)*
Control Points	0.028	1.170
Check Points	0.170	1.284



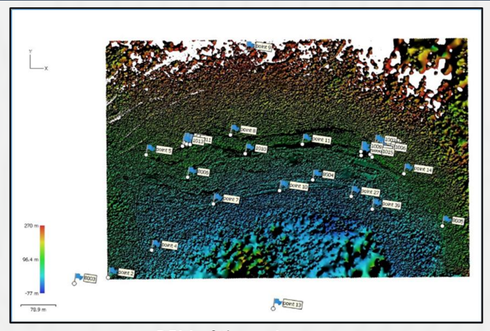
Dense point cloud of the main area

About 2 million points were obtained for surface determination, points cloud production and initial 3D modelling. A dense cloud of points was built in this range, based on only 37 photos taken from different angles.



3D model of the main area

By including the texture of the image, the 3D model of the area is produced to an acceptable level.



DEM of the main area

The tile model is made with a resolution of 5 cm/pix, which ultimately achieves the initial DEM production of the area.

Conclusion

Experience using panoramic images to monitor deformation can be an optimal solution for detecting instability over long distances, that requires a network with the correct geometry. In close-range photogrammetry, it is important to select reference CPs to orient the images. But use of panoramic images from the reference CPs is outstanding. With this method an *accuracy* of *2 cm* was obtained for CPs and about *17 cm* for ChPs.