ContextCapture Creates Precise Reality Model for EUR 23,000 Ridracoli Dam Survey Project

ITALDRON's 3D Model for Preventive Maintenance of Water Supply Dam Proves Accurate within 2 Centimeters

Project Summary

Organization
ITALDRON

Location
Bagno di Romagna - Santa Sofia, Forlì-Cesena, Italy

Project Objectives

- Create a 3D reality model of Ridracoli Dam that can be used as a basis for planning preventive maintenance.
- Test UAV photogrammetry as an alternative to LiDAR survey methods for generating dense point clouds and 3D mesh models of project infrastructure.
- Compare terrestrial and aerial survey results against known geometry to determine a precise delivery method.

Products Used
ContextCapture

Fast Facts

- Romagna Acque selected ITALDRON to conduct the aerial survey using radio-controlled drones.
- ContextCapture's SfM imaging technique aligned the 2D images in a 3D geo-referenced space to create a reality model of the dam site.
- The aerial survey data proved to be accurate within 2 centimeters or less, delivering the precision Romagna Acque needed.

ROI

- UAV photogrammetry proved to be a low-cost source of accurate 3D data for modeling and preventive maintenance of Ridracoli Dam.
- Romagna Acque will use the aerial survey technique to gain access to hard-to-reach areas in a short amount of time.
- Using reality models to predict and prevent deteriorating conditions in infrastructure will help lower risk, improve safety, and avoid high-cost corrective maintenance.

Hydrogeological Risk Assessment

Italian water supplier Romagna Acque required a fast, accurate, and low-cost alternative to the terrestrial surveys the company used to help monitor the condition of its infrastructure. Ridracoli Dam, spanning the Bidente River in Casentino Forests National Park, provided the proving ground for a test of an innovative aerial survey method using radio-controlled drones equipped with cameras. ITALDRON, a local company specializing in aerial data and image acquisition, executed the test survey of the dam and ancillary buildings. The project team used Bentley's ContextCapture reality modeling application, to convert the thousands of images into a 3D model of the dam that was accurate within 2 centimeters or less. Properly calibrated, the model will enable Romagna Acque to predict and prevent deterioration of this vital asset.

Terrestrial Survey Shortcomings

Completed in 1982 by Romagna Acque, Ridracoli Dam provides drinking water for 48 municipalities in the Emilia-Romagna region of Northern Italy. The arch-gravity structure is 103.5 meters high and 432 meters wide, with double-curvature to retain the 33 million cubic meters of water that supplies the Aqueduct of Romagna. To maintain this massive asset, the water supplier augments inspections with periodic surveys. The surveys contribute data for modeling the static and dynamic behavior of the structure, predicting potential deterioration, and planning preventive maintenance. The model also helps anticipate and prepare for the impact of seismic events, thermal fluctuations, and other environmental conditions.

Using the LiDAR survey method allowed surveyors to access hard-to-reach areas of the dam, but the technique was often slow, expensive, and hard to execute. Survey teams were hard pressed to meet the short turnaround times that were often required. Romagna Acque needed a better way to get accurate data for the dam, and its ancillary buildings and abutments. Aerial photogrammetry presented a promising alternative to terrestrial laser surveys, but its accuracy and precision were untested under these conditions. In this EUR 23,000 project, Romagna Acque worked with ITALDRON and the University of Perugia to verify the accuracy of unmanned aerial vehicle (UAV) photogrammetry and build a functional reality model of the dam.

ContextCapture's SfM imaging technique aligned 2D photographic images of the dam and ancillary buildings in a 3D geo-referenced space to create 3D models of the structures.

Unprecedented Access

Based in Fornace Zarattini, Italy, ITALDRON designs, produces, and markets multi-role, high-end remotely piloted aircraft systems (RPAS) for aerial data and image acquisition. ITALDRON's team planned to conduct the aerial survey in a single day to minimize the effects of atmospheric variations on data collection. Advance work involved placing 175 geo-located targets around the dam and surrounding area to delineate the aerial survey zone. To establish baseline data, the project team performed a topographic survey of the dam and ancillary structures using total station, GPS station, and terrestrial laser scanner.

For the aerial survey, ITALDRON sent RPAS on 19 flights – each lasting 15 minutes – to capture 4,600 images. The RPAS reached areas that were previously inaccessible, such as the downstream side of the dam's arch. During post-processing, ITALDRON used ContextCapture's structure-from-motion (SfM) function to reconstruct the dam geometry from the thousands of images. The SfM imaging technique aligned the 2D

"The synergy between the use of unmanned aerial systems (UAS) and ContextCapture produces an ideal and efficient combination for capturing and returning data in 3D."

– Tommaso Solfrini, CEO, ITALDRON

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photographic images in a 3D geo-referenced space to create the 3D reality model of the dam and ancillary buildings.

Bentley's reality modeling software generated dense point clouds and 3D mesh models. ITALDRON tested these results for density, points, lines, and surfaces using traditional topography as a reference. This comparison of the aerial survey results vs. terrestrial survey results made it clear that the UAV survey was just as accurate as the LiDAR survey, as deviations ranged from 2 centimeters to less than 1 centimeter.

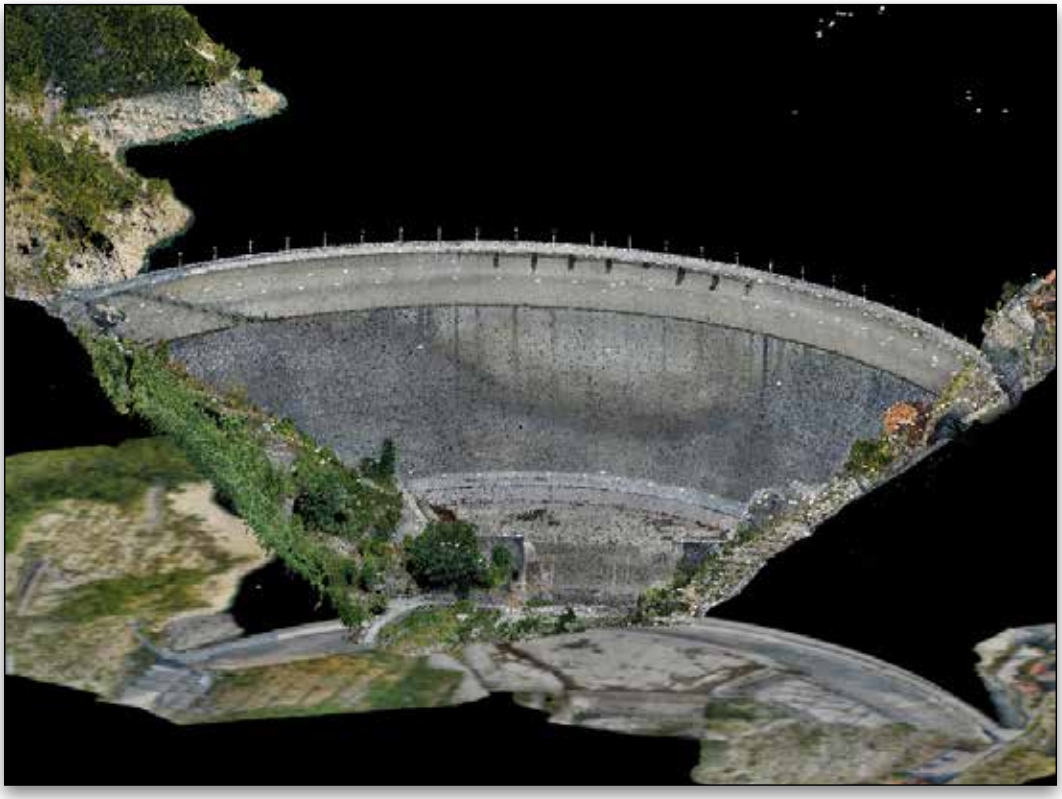
The field test demonstrated that aerial photogrammetry processed with Bentley's ContextCapture software could produce the highly detailed 3D reality models that Romagna Acque needed for its preventive maintenance program. Validating the results against known design geometry proved that the technique delivered an accurate, realistic representation of the dam's current condition.

The reality model was integrated with pre-existing data from the owner's design documentation and regional technical papers. Digitized records dating back to 1974 provided a comprehensive basis for comparison of old and new data. The integrated point cloud became the basis for a robust model with structural and mechanical properties. Once this model was calibrated with appropriate material properties and static and dynamic loads, it became a valuable tool for real-world forecasting of the dam's structural condition over time.

ContextCapture Provides Low-cost Alternative

Compared to the other survey results, the UAV survey data exceeded expectations. The accuracy of UAV photogrammetry not only compared favorably to terrestrial LiDAR but also had the advantage of providing better coverage at a lower cost. The innovative technique provided an economical solution for acquiring 3D data within a short time frame. Properly calibrated, the up-to-date model will provide better insight into the dam's response to environmental conditions, especially earthquakes.

Together, UAV photogrammetry and reality modeling provide a powerful solution for proactive asset management. The method allows companies like Romagna Acque to predict conditions that will require maintenance and take action before problems escalate to a safety risk. The methodology vetted in this project has potential application for any organization whose assets include large-scale infrastructure. ContextCapture produces 3D models of existing conditions for infrastructure of all types.



An integrated point cloud became the basis for the model providing structural and mechanical properties.

Bentley Advancing Infrastructure