3D-PITOTI Newsletter

1st Newsletter 2016

Arrivederci 3D-Pitoti

After three years of successful collaboration and hard work, the 3D-Pitoti does finally come to an end.

The project consortium has produced many different new technologies and tools, such as the 3D-Pitoti Scanner, a novel way of flight planning, segmentation and analysis tools, a database, an app and last but not least a 3D-Pitoti movie and digital exhibition.

The results of the project are available on the 3D-Pitoti webpage for download, as well as 3D-models, newsletter, videos and deliverables.

The consortium is looking forward to apply again for another 3D-Pitoti Mark II project in the future.

Special points of interest:

- Final Conference
- Project Results

Impressions of the final event at Cambridge, UK.

Inside this issue:

Final Conference at Cambridge, UK.

At the first day, the 3D-Pitoti team demonstrated many of the novel outcomes of the project. Also included was a live performance of rock engraving which was then scanned with the 3D-Pitoti Scanner and processed using the 3D-Pitoti Pipeline.

In the afternoon, the team presented an overview of the 3D-PITOTI pipeline from 3D acquisition, through processing and finally presentation to a number of audiences. Introduced by the Project Coordinator, Sue Cobb (University of Nottingham, UK), speakers included Paolo Medici (Centro Camuno Studi Preistorici), Axel Pinz (Technical University of Graz), Christian Mostegel (Technical University of Graz), Markus Seidl (St. Pölten University Of Applied Sciences), Oliver Reuss (ArcTron3D), Alexander Kulik (Bauhaus University Weimar) and Craig Alexander (University of Cambridge, UK).

This was followed by a research screening of the 3D-PITOTI film by Fred Baker and Marcel Karnapke (University of Cambridge, UK) "Pitoti Prometheus" produced to extend the reach of the results to a wider audience.

The second day was a half-day workshop targeted at archaeologists to provide more detail of the research and science behind the pipeline. With extended presentations, the workshop provided the opportunity for more detailed questions and discussion about the future of digital cultural heritage. With extended presentations, the workshop provided the opportunity for more detailed questions and discussion about the future of digital cultural heritage.

The 3D-Pitoti Scanner, a new tool for data acquisition

The 3D-Pitoti Scanner in use in Valcamonica

The 3D-PITOTI Scanner is capable to record at the sub-millimetre scale a faithful digital reproduction of rock-art.

The 3D-Pitoti Scanner does not require ground control points because of its capability of outside-in tracking and scale information. This is accomplished by the combination of tachymeter-based tracking of the scanner, calibrated stereo and structure-from-motion. Two Li-Po batteries allow a constant data acquisition for a full day.

For the acquisition of the colour information, the 3D-Pitoti Scanner is equipped with a custom made flash providing up to 165000 lx.

Each time two pictures are taken, one with flash and one without flash for the further radiometric processing of the data.

Frame differencing of images with and without intense artificial illumination is used to eliminate the influence of ambient illumination and the radiometric surface properties are calculated based on known illumination configuration and radiometric calibration.

Calculating the relations between surface normal, camera pose, and incident light leads to the final result of dense 3D point clouds that represent radiometric surface properties.

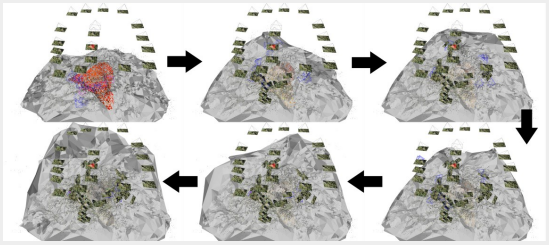
During data acquisition the 3D-Pitoti scanner provides instant user feedback on an external tablet. The especially developed online Structure from Motion algorithm allows an in-field pre-processing of the measurement data, providing the user with different information, such as a sparse point cloud, a mesh and the amount of matched pictures.

3D-Pitoti UAV view planning – a new approach

UAV data acquisition at Valcamonica

To obtain a good and complete 3D reconstruction from the mid-level, the 3D-Pitoti consortium developed a system, which surpasses the tradition definition of view planning. The system closes the loop between acquisition and reconstruction and works completely on-site without any prior model.

Through iteratively updating the geometry, planning and autonomous execution, our system closes the acquisition and reconstruction loop and is able to deal with inaccurate scene estimates as well as imperfect plan execution. One of our key novelties is that we specifically learned the requirements of the final densification step with respect to the camera constellation and the scene characteristics. This novel feature can significantly improve the resulting 3D reconstruction in coverage and accuracy.



Different steps for the reconstruction of the site

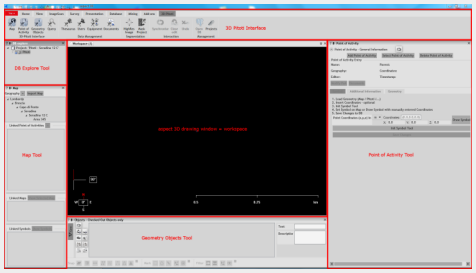
3D-Pitoti Database Module: A database for Rock Art

An archaeological rock-art database was developed. This 3D-Pitoti Module is capable of storing different data, such as survey data, 3D-Pitoti Scanner data, text and all other information necessary for the study of rock art. The 3D-Pitoti module of aspect 3D comprises all the different algorithms developed within this project.

The module includes the following tools:

- Automatic detection of the cameras and camera calibration data
- Automatic detection of total station data
- Creation of OrthoDepth Images for Automatic Segmentation
- Manual Segmentation on point clouds
- Creation of DSM for further use in GIS
- Retexturing of meshes for better texture quality

The principles of the database are single Point of Activities. They link the pure 3D geometry with the regular data such as jpgs, films, txt but as well with the information about the point. The later include predefined tables, which are unique to every Point of Activity.



3D-Pitoti Database Interface

3D-Pitoti Segmentation, Classification and Peckstyle Analysis

Different techniques for the (semi-)automated computational analysis of petroglyphs have been developed. Processing the high-resolution scans involved developing new techniques such as (semi-)automated segmentation of the rock surface in pecked and non-pecked regions, the automated classification of Pitoti shapes and the investigation of pecking style similarity.

For the investigation of pecking style similarity, different approaches have been developed, using different input spaces and different types of sampling.

For the automated shape classification of Pitoti into types of different typologies we developed the automated typing of Pitoti figures and clearly enhanced and make more productive the classification work of a rock-art researcher. In addition, automatic and semi-automatic segmentation tools for the extraction of petroglyph shapes from 3D reconstructions have been developed.

The method clearly outperforms 2D colour-based segmentation on photographs and yields a high generalization ability. This segmentation method bridges the gap that exists between 3D reconstruction of rock surfaces and higher-level shape analysis of petroglyphs.

Different peck styles of two Pitoti figures

3D-Pitoti Scientists' Lab

The 3D-Pitoti Scientists' Lab is a prototypical visualization infrastructure for the collaborative exploration and analysis of large and complex 3D scanning data. Its core elements are two multi-user 3D displays, a real-time rendering system for large 3D point clouds, and a suite of collaborative 3D interaction techniques.

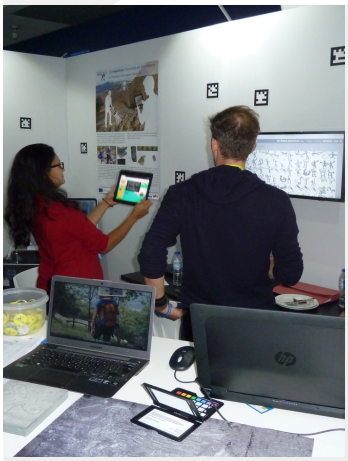
The system is based on multi-user 3D projection technology that provides individual stereoscopic image pairs for multiple users. All involved users perceive the shared 3D scene from their own physical viewing position.

As a result, the physical interaction space of multiple users and the displayed 3D scene merge to a coherent mixed reality. The two physical screens and additional virtual views complement each other and support frequent transitioning between closely and loosely coupled cooperation.

All viewing devices support multiscale 3D navigation through dedicated controllers or multitouch input. A virtual torch allows users to highlight the geometric structure of Pitoti figures through the effects of light and shadow on the rock surface.

Discussing point clouds in every detail

3D-Pitoti Storytelling App



Playing with the 3D-Pitoti App

A story-telling app was created with school children and teachers from the UK and Italy to make the results of the project more engaging. The 3D-Pitoti story-telling app provides information about the rock art in the valley of Valcamonica with explanations and interpretations of different archaeologists.

However the highlight of the app is the augmented reality (AR) "Create" part which uses AR markers to enable the user to see animated Pitoti figures and to record their own Pitoti storyline. The resulting story can be explained in a short spoken story and shared with other people.

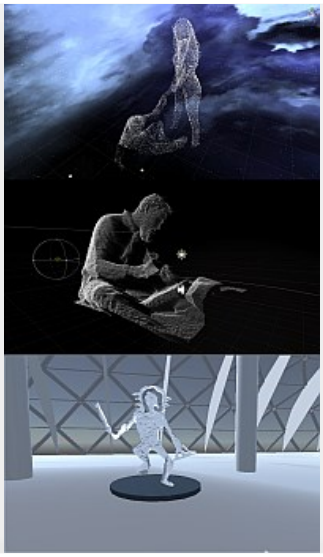
The app will be in use at the tours of Archeocamuni.

3D-Pitoti Pitoti Prometheus and digital exhibition

The 3D-Pitoti Prometheus

A 3D film called "Pitoti Prometheus" is one of the outputs of the 3D-Pitoti project. This film tells the story of Goethe's Prometheus using the setting of Valcamonica and the Pitoti figures. The actors are 3D point clouds, recorded at the Interactive Performance Lab at the Bauhaus University at Weimar.

In addition a virtual 3D Pitoti exhibition can be visited. The three dimensional scans have been made with a specially created scanner and processed with the 3D Pitoti Pipeline. In our display the digital 'puppets' start to move, when the visitor gets close enough.



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3D-PITOTI is an EU FP7 funded project which started in 2013 and finished in February 2016. The Human Factors Research Group at **University of Nottingham** are project coordinators.

Other partners are:

- **Graz University of Technology**
- **ArcTron 3D GmbH**
- **University of Cambridge**
- **Centro Camuno di Studi Preistorici**
- **Bauhaus-Universität Weimar**
- **St. Pölten University of Applied Sciences**

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Find out more at www.3d-pitoti.eu