Topographic and Photogrammetric Survey of the Altamira Cave

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Key words:

ABSTRACT

The Altamira cave located in the municipality of Santillana del Mar, in Cantabria (Spain), was discovered by chance in 1869 and it was not until 1902 that the discovery received international recognition and became known as the Sistine Chapel of Paleolithic Art. In 1985 it was declared part of our Human Heritage.

The topographic and photogrammetric surveys of the Altamira cave, carried out by the Instituto Geografico Nacional, have permitted construction of a life-size replica (scale 1:1), of the entrance-kitchen and the polychromatic chamber.

The special environmental conditions (low temperature, absence of luminosity and a 98% humidity level), together with the restriction of not being able to physically disturb the medium we wished to measure, radiometrically (low intensity and always reflected light), together with the very high precision required, implied that the methodologies and instrumentation for data capture and data processing had to be specific and unique.

The topographic methods used were esentially radial lines from stations that had been previously defined and had poligonal coordinates and in the majority of cases coordinates obtained by multiple inverse intersection and angular measurement of distances to a series of fixed points on the chamber perimeter. In this way we avoided short sided polygons which would have caused large angular errors. The coverage using these stations formed a mosaic of quadrangles covering the ceiling, walls and floor. All the panels were measured using a motorized theodolite with a visible light laser that performs measurements without a prism. The walls were used as reflectors and the instrument was programmed so that it operated even at night.

Once the coordinates of the points had been calculated, classified and filtered using a local reference frame, we calculated the cave volume by forming a polyhedron made up of thousands of triangular faces with an approximate side length of 5cm and about 500.000 vertices.

The conditions for taking the photographs used to construct the photogrammetric model of the ceiling of the polychromed chamber were critical. The surface area was approximately 150 m^2 and the distance between the floor and the ceiling ranged between 0,80 and 2,20 metres. The survey was designed taking into account these physical limitations and with the objective of achieving stereoscopic coverage of the entire ceiling. The survey was covered with 56 nadiral

photogrammes which were distributed over four passes. It was necessary to position the camera on the floor on a levelled platform for a number of photogrammes

To perform photogrammetric control, we selected 70 distinctive points such as cracks, the ends of markings and other identifiable points. The aerotriangulation was performed at the office and the entire block of photogrammes was adjusted in order to obtain a digital model of the ceiling with a grid spacing of 5mm and a total of 5,800,000 points which will permit building a replica of the celing using a lathe specially built for this application.
The 56 photogrammes were rectified using the digital model and the fusion of the geometric and radiometric data generated the digital orthoimage (800 MB) with a pixel size of 1mm.

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