# BALOON PHOTOGRAMMETRY FOR ARCHAEOLOGICAL SURVEYS

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**ABSTRACT:**

A special platform has been recently constructed from Topotech Surveys, GREECE (www.topotech.gr) as a Recording Method for Monuments. This photogrammetric bundle performs mini aerial photogrammetric acquisition over Archaeological Monuments with high accuracy and image analysis. This type of mini-aerial-photogrammetry was proved to be valuable in excavations, site recording and monument conservation. Five case studies and two future plans are discussed. The construction of a large Unmanned Air Vehicle is also discussed here.

## 1. INTRODUCTION

### 1.1 Overview

This special platform was mainly constructed from Topotech Surveys, GREECE (www.topotech.gr)for the recording of the Greek Culture Heritage. The result of this work was very promising. Topotech future plans include the full integration and implementation of an Unmanned Aerial Vehicle that will do the full 3D recording of the monument. Five case studies and two future plans are discussed in this paper. The author emphasizes that his research work presented in this paper was fully privately funded, and no public, or governmental organisation contributed by any economical means in the progress of his work.

Image 1: Topotech's Aerial Platforms

### 1.2 History of Topotech

Topotech was the first in 1996 to use a patented Reflector less Laser Total Station in Greece for the recording of the monuments. That was the first in-house development for the recording of the Greek monuments.

Image 2: First integration-development of GTS 211 D REFLECTORLESS total station with Disto laser in 1996.

The large experience gained in Greek archaeological surveys realised that the top of a monument or an excavation is usually inaccessible by land surveyors. For example, ancient walls were constructed as a hostile environment in order to avoid warriors to overpass them. Special equipment is therefore necessary for the lonely surveyor in order to record the top of the monument. Moreover the required type and level of detail needed for the production of a diagram on top of the monument makes photogrammetry an ideal application to record it as a diagram or orthophoto-mosaic.

## 2. SYSTEM DESCRIPTION

### 2.1 Description of System (sensors, parts, etc.),

The special set constructed in 1999 for the acquisition of images on top of the monuments or excavations survey. It consists of a Ball or Zeppelin type balloon, a 3- axis servo-base and a 25-ressau metric Hasselblad camera.

Image 3: Ancient walls were constructed as a hostile environment in order to avoid warriors overpasses them.

The special set consist of the video telemetry system, the balloon, the 3-axis radio-controlled base the balloon and the gases fuelling cylinders. The 3-axis base is placed between the balloon and the metric camera and controls the Omega,Phi,Kappa placement of the camera. Camera operation and rotation is fully controllable from the ground due to a video link that transmits the acquired image to the ground. Therefore stereoscopic and monoscopic image acquisition is highly accurate, avoiding random image acquisition.

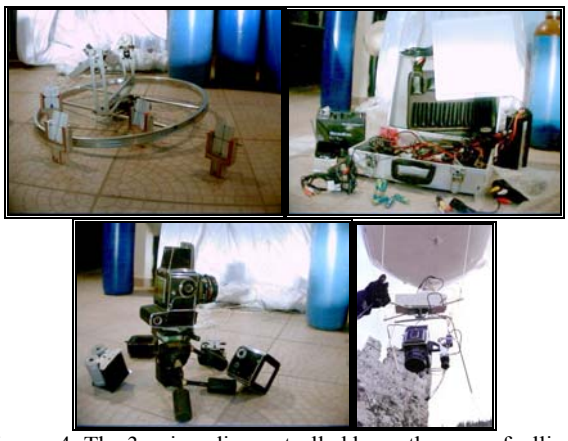


Image 4: The 3-axis radio-controlled base, the gases fuelling cylinders, the video telemetry system, the semi-metric Hasselblad 25-ressau camera and the balloon.

### 2.2 System Transport

The system can be easily transported to a medium sized car, therefore allowing a 2-person survey crew to easily and economically access the Greek mainland and Islands.

Image 5: System is easily transported to a medium sized car

## 3. PHOTOGRAMMETRIC APPLICATIONS

### 3.1 Usual Orientation Triangulation and Photogrammetric Procedures

The balloon is now used from Topotech Surveys, GREECE as a platform for the acquisition of metric aerial images used for photogrammetric triangulation, stereo plotting, orthophoto, 3d Modelling & Virtual Reality Modelling & Creation. Five case studies are discussed were all kinds of photogrammetric products (Diagrams, Orthophoto, Elevations, Profiles, Contours and 3D-views) were produced.

For the triangulation of images special targets are used. Thus the resulting accuracy and reliability is very high. Following are triangulation results.

| Parameter | X | Y | Z | XY | |
|---|---|---|---|---|---|
| RMS | Control | 0.005 | 0.006 | 0.012 | 0.005 |
| RMS | Check | 0.010 | 0.014 | 0.018 | 0.017 |
| Mean | Std | Dev | 0.010 | 0.009 | 0.012 |
| Max | Residual | 0.015 | 0.018 | 0.023 | |
| RMS | Image | 4.6 | 5.0 | | |

Table 1: Artificial Ground Control Special targets guaranty high accuracy and reliability.

Network Adjustment is rarely required by project specifications. On the contrary sectioning, elevation drawings and stereoplotting is the most commonly used technique for this kind of applications.

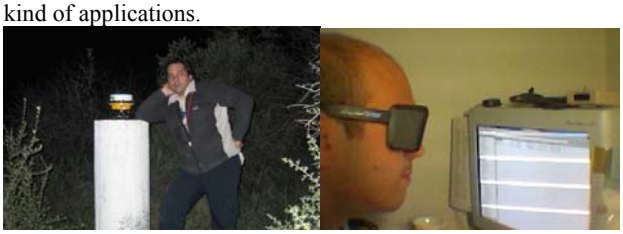


Image 6: Techniques used

### 3.2 Case Study 1: *Mistras (Peloponissos)*

The excavations of the *Gate of Nafplio* were recorded in mosaic & diagram. Also 2243 meters of cobbled roads were surveyed by RTK GPS and reflector less Total Stations.

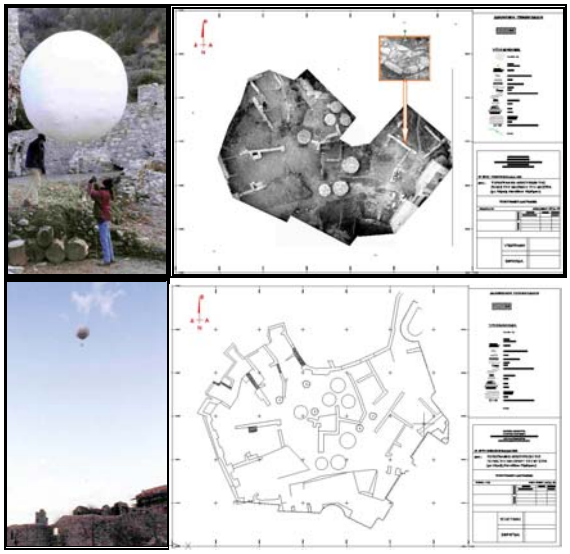
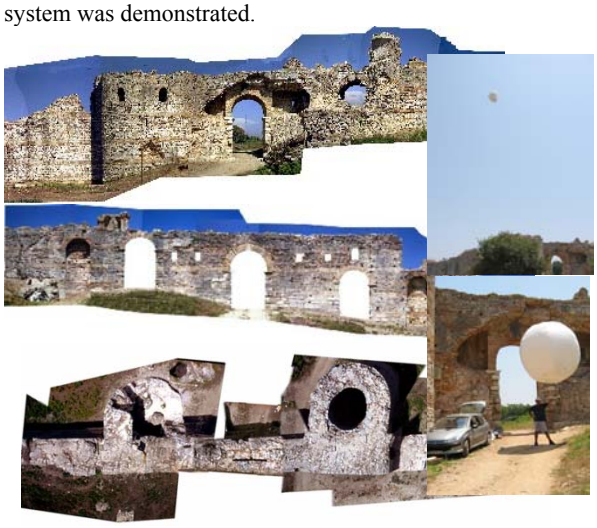


Image 7: Project: *Mistras*

### 3.3 Case Study 2: *Nikopoli, Preveza (Ipiros)*

The ancient wall of the *Gate of Arapoporta* was recorded in mosaic & diagram. Another set of 30 orthophotomosaics, elevations and plan views. was also developed by reflector less Total Station. Ground survey (Plan diagrams) was overlaid over the rooftop orthophotomosaic. Thus the high accuracy of the system was demonstrated.



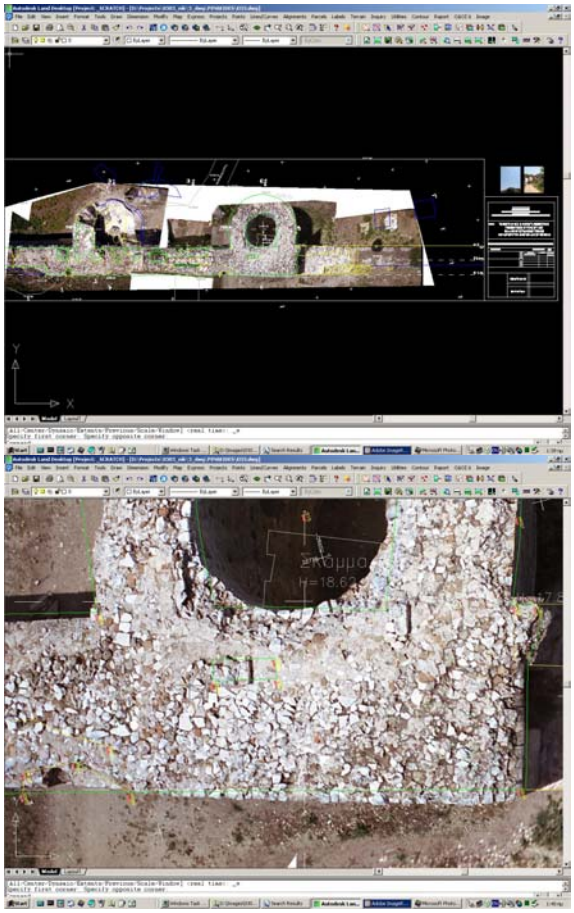


Image 8: Project: *Nikopolis*

### 3.4 Case Study 3: *Acropolis, Athens (Attica)*

A reconstructed theatre at the South East side of the *Acropolis Rock* was surveyed for reconstruction & restoration needs

Image 9: Project: *Acropolis*

### 3.5 Case Study 4: *Polidroso*, Voiotia (Central Greece)

An ancient temple was surveyed.

Image 10: Project: P*olidroso*

### 3.6 Case Study 5: Athens North Ring, *Posidwnos Ave*

The balloon took place in acquiring oblique images of a large road accident survey in an under construction highly trafficked major road.

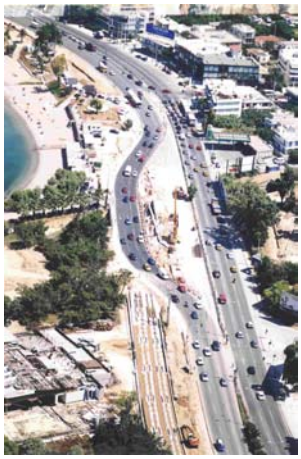


Image 11: Project: Athens North Ring

## 4. FUTURE PLANS

### 4.1 Balloon & Laser Scanning

Topotech in cooperation with Praxilla's (www.praxilla.gr) & Lissippos' (www.lisippos.gr) Mensi GS100 Geodetic laser scanner will act to combine range data (laser scanner) with image data (balloon system). Praxilla is a telecom supporting company and Lisippos is a Consulting Engineering Firm. Both companies are high technology companies. This cooperation aims in the integration of both data sources that will produce high quality and accuracy Virtual Reality Models and Perspective Views in order to promote and advertise the Greek Heritage.
Moreover, until the

Image 12: Praxilla's & Lissippos' laser scanner

### 4.2 Unmanned Air Vehicle

Topotech is also constructing a large (2.5m wingspan) Unmanned Air Vehicle. This UAV, RPV type carries a smart navigation system, transmits telemetry data and images. The characteristics of the final version of this system will be ground pre-programmed, an autonomous flight, manual take-off and landing and will be presented by the end of 2004 in Athens. Flight tests performed were very promising. Two projects regarding provincial road planning were delivered until now. This carries the Hasselblad semi-metric camera but this will change in the near future.

Image 13: The RPV, UAV Unmanned Air Vehicle at the old Marathon Airport.

## 5. CONCLUSION

Topotech's special balloon construction aims in the full 3-D photogrammetric integration of Archaeological Surveys. This photogrammetric bundle performs mini aerial photogrammetric acquisition over Archaeological Monuments with high accuracy and image analysis. This type of mini-aerial-photogrammetry was proved to be valuable in excavations, site recording and monument conservation. Future plans include the full integration of an UAV.