

THE IMPLEMENTATION OF A VECTOR GIS TO THE SURVEY OF A CASTLE

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Abstract

In this paper the utilisation of a modern vector GIS package in the survey of a large medieaval castle is being described. The survey was carried out by modern geodetic and photogrammetric equipment, using specialised methodology.

The fieldwork has been planned and carried out in such a way, to exploit the capabilities of the package and ease the phase of on-screen restitution. All data was directly transferred to the package and the whole restitution was carried out using a computer (processing, editing, plotting etc.).

The results of the survey and its integration to the package are evaluated in terms of accuracy, cost and effectiveness.

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1. Introduction

St. George's castle in Argostoli, Cephalonia is a unique example of early 14th century defensive architecture. The castle was built in several stages by the various conquerors of the island, mainly the Venitians. It served as the main defensive construction of the island against all invaders, as it controls the entrance to the large natural harbour of Argostoli. It also has a unique view over almost all the southwestern part of this large Ionian Island.

It is situated on top of a very steep hill about 10 km southwest of Argostoli. The main outer wall as it stands today encircles an area of approximately 20.000 sq.m. The outer wall features three impressive towers, one at the northwest corner, over the harbour, one at the north side, where the hill is less steep, and the third and biggest at the east corner, controlling the one and only gate to the castle. The actual height of the outside wall varies from 7 m to 14 m above the ground surface.

Inside the wall there are various constructions the main of which are smaller, and probably older internal walls and numerous buildings. There are several ammunition stores, a couple of churches, houses, defensive constructions etc. Most of them are in ruins, but there are a few that are still in good condition today. The last time the castle was used as a defensive construction was by the Nazi occupation during World War II. Today the inside of the castle is almost totally covered by 20 m high pines and other kinds of lower wild vegetation, which make an eventual survey even more difficult.

2. Fieldwork

The survey was carried out on behalf of the National Archaeological Fund. The requirements of the survey were a 1:100 plan (Fig. 1), several horizontal and vertical cross sections mainly through the dungeons and the elevations of one of the defensive towers at a 1:50 scale (Figs. 2,3).

A combination of geodetic and photogrammetric techniques were implemented during the survey. For the geodetic measurements an electronic theodolite (WILD T1000) was used, together with a Husky recording unit with PanTerra field system and a WILD DI1000 EDM. In appropriate situations, where the points of interest were inaccessible, or for the cross sections, a WILD DIOR 3002 (EDM without reflector) and laser beam (GLZ1) combination were employed. The advantage of this instrumentation was the possibility of assigning special codes to the points measured, in order to facilitate the restitution in the GIS package later. The points were divided into the following main groups:

- a. Detail points, which included points on buildings, walls and other structures.

b. Detail points, belonging to and defining cross sections.

c. Spot heights, including trees and subdivided to points that would take part to the DTM calculation later and those that would not.

A feature code was attached to each of these points, characterising the string to which each of these points belonged. This code assignment to points was followed during all geodetic measurements as well as during the photogrammetric restitutions with the help of the relevant facility of ADAM MPS-2 3D digitizing software.

Two main traverses were established, one encircling the castle from the outside and the other inside it. The co-ordinates of the 67 stations were determined by triangulation in the National Network. The determination of the station heights was carried out by double run levelling using height control points of the National Network. Thus all plans would refer to the same reference system, a fact which would enable the eventual interpretation of the plans by the users.

The photogrammetric instrumentation comprised a WILD P31 metric camera, a 60x60 mm² non-metric one and an ADAM MPS-2 analytical plotter. Stereo coverage of the cone shaped defensive tower was taken, mainly with the metric camera. Details that would not appear on the main photography were later covered using the non-metric camera. The analytical stereo restitution instrument allowed for stereopairs with different principal distance at the cameras. This was very convenient for this case as the new pairs did not need the determination of new control points.

For the compilation and construction of the three dimensional model of the castle and the surrounding area (a zone of 20 m width around the outer wall) approximately 6000 detail points were observed and measured (including the small number of control points for the photogrammetric survey), 1500 of which belonged to the horizontal and vertical cross sections.

The execution of the whole project took about 25 days and 5 nights of fieldwork for a survey party of three persons. Sometimes it was necessary to work after sunset (20:00 hrs) for improving the visibility of the laser beam. During these hours the DIOR 3002 and GLZ1 laser measurements were performed for the cross sections. The mean daily duration of the fieldwork was 10 hours. A back up of the measurements was performed on a daily basis using the Oracle back up unit connected directly to the Husky. As a further safe guard the data were also transferred to a PC.

The main difficulties encountered during the fieldwork were

- a. The heat (temperatures in July 1990 reached high 30's in the shadow),
- b. The thick and wild vegetation, which obstructed theodolite sights, camera angles and party movements,

- c. The steepness of the ground, which at places reached over 100% and finally
- d. The huge number of scattered ruins that could not be distinguished and interpreted very easily from the natural ground features.

Solution could only be provided for the last difficulty, by on-site interpretation of the various features. Hence knowledge of the history of the castle and of its various construction phases was of utmost importance at the time of the fieldwork.

3. The PanTerra System

For the phase of computations, restitution and evaluation of the field measurements the PanTerra System was used. PanTerra is a really 3D ground modelling system which includes GIS facilities. The hardware requirements of the package are:

- a 386 based PC with maths co-processor
- 2Mb of RAM and a Hard disk
- one alphanumeric and one graphic monitors with high resolution (eg. Hercules + VGA, or NthEngine + VGA respectively)

The system accepts data from plain Surveying, Photogrammetric surveys, digitizing or plane ASCII files produced by other data collection systems. Data output may be either plotted, printouts or ASCII files, which may be used by other restitution systems.

PanTerra's graphical Data Base includes the following features:

- point: name, X,Y,Z co-ordinates and feature code
- link: a live link that connects two points, with the feature code and the shape of the link in the horizontal and vertical planes as attributes
- node: a point through which more than one links pass, with feature code as attribute
- string: a serial connection of two or more links, with name and feature code as attributes
- parcel: a closed area, the boundary of which is defined by links from the same or different strings. Its attributes are name, area, perimeter, region, strings involved, class and type
- text: which automatically attaches to the above items
- family: grouping the above elements according to similar properties

The graphical Data Base has the important facility of layering and holding up to 251 surfaces. Managing information between the layers is also possible. The attribute Data Base of the system is structured in fields that may be combined with files and the input and output screens.

The two Data Bases are in constant interactive mode, hence geometric properties may be connected directly to qualitative attributes. Hence queries based on either the attribute or the graphical Data Base may be executed.

4. Implementing the GIS package to the field measurements

The raw field survey observations were transferred directly from the Husky to the PanTerra. All geodetic calculations, including triangulation adjustment, intersections, traverse adjustments, levelling and reduction of individual point observations, were performed entirely with the relevant facilities of PanTerra. This resulted to the determination of X, Y and Z for all points observed, while at the same time the field coding was taken into account. On the other hand ASCII files produced by the ADAM MPS-2 3D digitizing software were also imported to the PanTerra System. Hence a first model of the castle was produced on the screen. Using the editing facilities of the package the graphical result was refined and the final form of the model was completed.

At this stage the DTM option was executed for the calculation of the natural ground model. Only points coded accordingly during the stage of field measurements and that of the photogrammetric restitution took part in this calculation.

The 3D model of the whole castle with the surrounding zone surveyed was thus possible. For the operations with the PanTerra, ie. the computations, the refinement of the model and the DTM calculation, a week's work for two persons was necessary. The PanTerra package provides the possibility of producing user defined perspective views, profiles through the DTM and the model strings, display of selected elements of the model for further investigation (eg. display of only the fallen or semi-covered walls, in order to interpret and envisage the initial structure). Many more GIS facilities are also offered by the package, which when efficiently exploited may contribute decisively to the study of today's situation, but also to the detailed and accurate documentation of a site like St. George's Castle in Cephalonia.

Following a detailed interpretation of the graphical output, qualitative attributes were assigned to selected geometric entities of the graphical Data Base. Such properties included construction date, building material, use of the object, current structural situation etc.

It was established that for the most efficient execution of such a project, perfect organisation and co-ordination as far as code assignment is concerned, is of utmost importance. Electronic equipment for recording of field measurements enable this task and it remains to the user to exploit their abilities to the full.

5. Conclusion

All required plans were produced by appropriate projections of the model on pre-defined planes. The accuracy achieved was that required for the 1:50 plans.

The fact that all measured points form part of the Data Base constitutes a major advantage for eventual future usage. The Castle is now fully documented, both geometrically and historically, in the GIS package. This fact may form the basis of a General Archive for all monuments of our country.



Figure 1

