

PHOTOGRAMMETRIC STUDY OF STATUES  
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### 1. I n t r o d u c t i o n

The study of monuments and historical centers based on photogrammetric and photointerpretation methods is generally a complicated subject. This subject has particular requirements in countries having a lot of monuments and historical centers, as Greece.

It is necessary the relevant abilities of different photogrammetric and photointerpretation methods, for air photographs and terrestrial takings to be searched through.

In an effort to approach systematically the problem, we have studied various relevant subjects ( 1 - 9 ).

The present paper, concerning the study of statues, continues this effort. The study of statues is of great interest, especially for works of art of remarkable value. However it presents multiple particularities mainly concerning complicated forms. The complication introduces difficulties which increase as the forms become more complicated and the requirements of the study stronger.

Several photogrammetric methods (analogical, orthophotography, analytical), in combination with the existing equipment, could be used for the study of statues.

This paper concerns the study, by analytical methods, on Heniochos (charioteer) statue, a work of remarkable importance in the Museum of Delphi, Greece.

### 2. M e t h o d o l o g y

The photogrammetric takings of the statue were done by stereocamera Wild C40, with its basis almost parallel to the front side of statue's pedestral.

\* I wish to express my thanks to Halkias Th., Lazaridou M., Prevedouros P., for their help in this study.

The statue was photographed at night under regular lighting of the hall (Fig. 1). After that the photogrammetric takings took place under the lighting of a usual projector, which projected a thin square grid of points at the statue (Fig. 2).

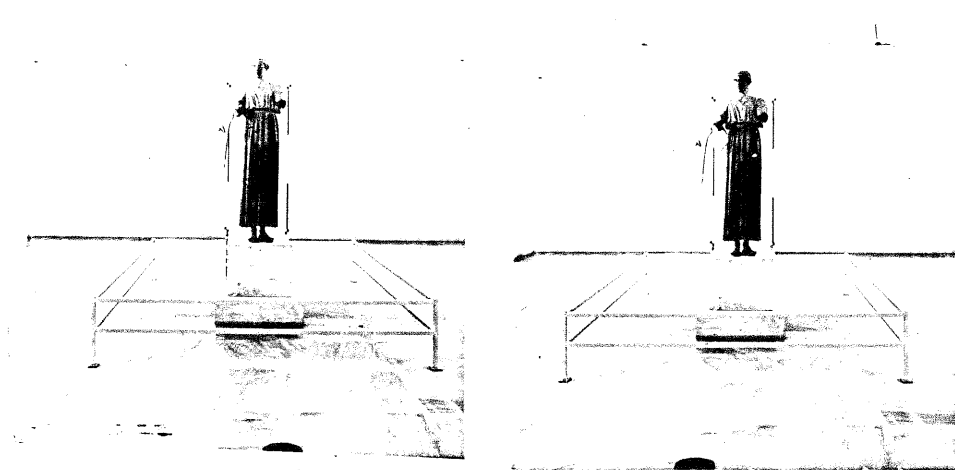


Fig. 1 Stereoscopic pair of Heniochos statue (Delphi, Greece) under normal lighting.

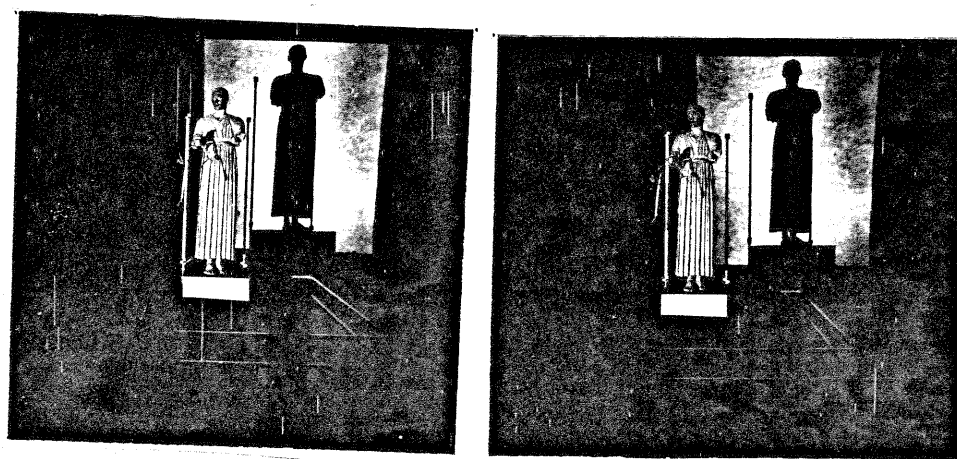


Fig. 2 Stereoscopic pair of Heniochos statue (Delphi, Greece) under the lighting of a projector, which projected the grid.

The projection of the grid on statue's surface was distinguished at the photographs, taken under these conditions (Fig. 3).

The study of these pictures and the relevant measurements were done by Stereocomparator Wild STK 1 (magnification X6 for the figure and XII for the mark that was a point in a surrounding circle).

The traces of the projection of the grid were guides for the measurements at different areas of the statue. Relevant experience was obtained by the particularities of each area.

The results of the measurements (430 in 32 rows) are presented for the head area which is the most difficult because of fine and complicated characteristics.

Calculations were based on the equations for the normal case of terrestrial photogrammetry,

$$X = \frac{B}{P} x' , \quad Y = \frac{B}{P} f , \quad Z = \frac{B}{P} z'$$

The coordinates  $X, Y, Z$  refer to a rectangular system of axis starting at the projection center  $O_1$  of the left camera. Axis  $X$  is horizontal as basis  $O_1O_2$ , axis  $Y$  follows the axis of the camera and axis  $Z$  is vertical.

These resulting digital data may either be used at the above mentioned system or be somehow transformed in order to representatively present the result.

Among various abilities, measurements were considered to be useful, because of simplicity and representative, to refer to a vertical plane, parallel to plane  $XZ$  passing by the point with the largest  $Y$  coordinate (Point 0, Fig. 5).

All the points (430 in 32 rows) were reported in scale 1:1.

The document with this form may then be useful in many ways (graphically, numerically, e.t.c).

Therefore it is, for example, possible to have contour lines. Some characteristic of them are indicatively presented in Fig. 4, (the numbers express distances from the reference plane in mm).

We can also consider characteristic points, as those indicatively presented in Fig. 5, based on a simple sketch for their location (the numbers express distances from the reference plane in mm).

### 3. D i s c u s s i o n - C o n c l u s i o n s

The abilities of analytical photogrammetric methods in the study of statues, were searched through, in this paper.

Using Stereocomparator we are interested in the recognition between corresponding points on the pair of photographs, in order to place the mark on these points in accordance with the procedure of measurements at Stereocomparator.

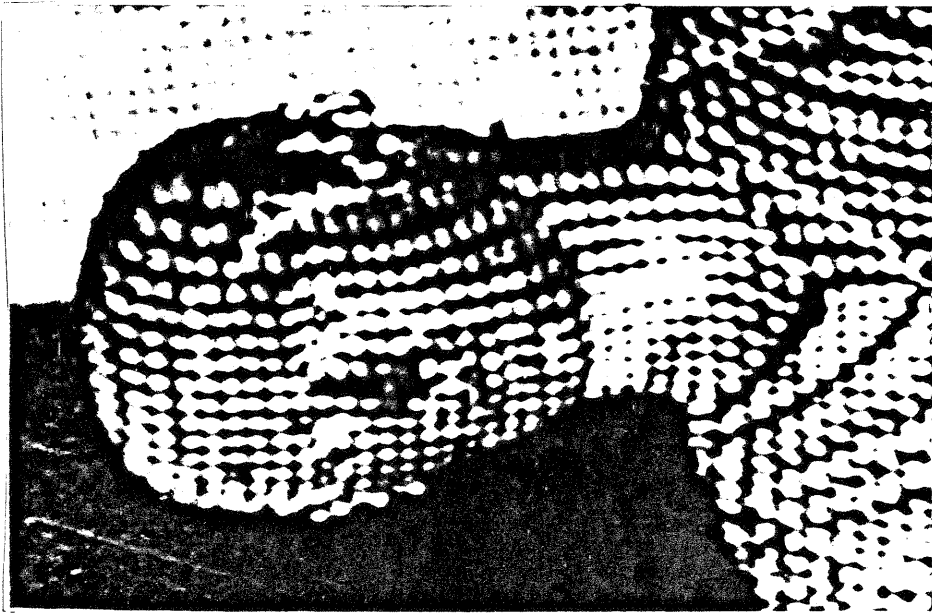


Fig. 3 Appearance of the grid at the statue.

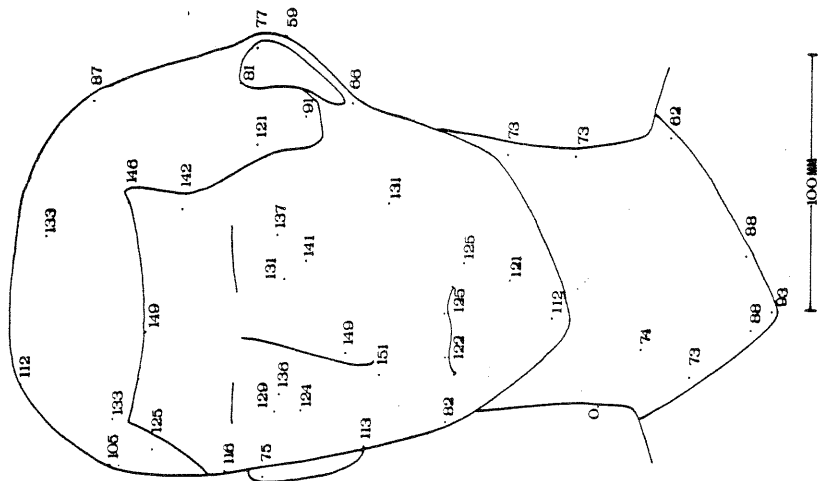


Fig. 5 Indicative points with their distances (in mm) from the selected reference plane. (reduction from original scale 1:1).

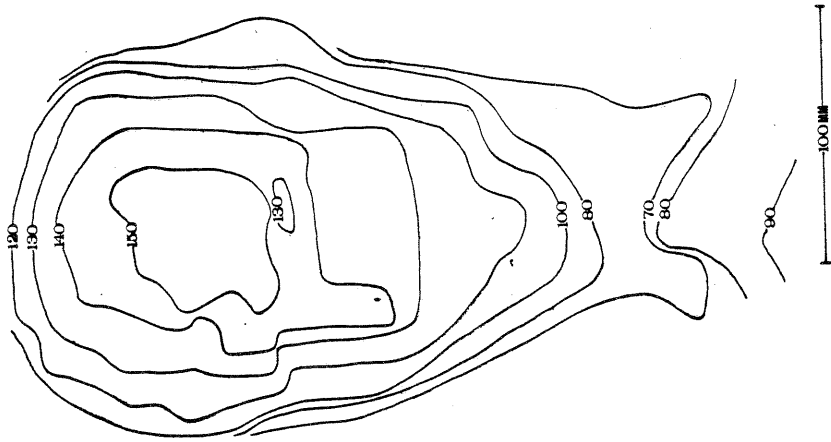


Fig. 4 Indicative curves referring to the selected vertical plane. (reduction from original scale 1:1).

This recognition of corresponding points is difficult in the case of complicated forms, as statues, especially when a detailed study is required.

The use of suitable targets causes several practical problems in the case of complicated forms and detailed study.

The proposed methodology faces the relevant difficulties.

All the measuring requirements were effectively satisfied, combining the following,

the whole picture of the grid on the photographs (a result of the suitable grid and of the general condition of the taking),

the selected magnifications to be used in Stereocomparator,

the kind of the mark that was used (a point in a surrounding circle), in combination with the measuring procedure in Stereocomparator.

The density of the grid can vary so that, combined with geometrical conditions of taking, any requirements will be satisfied.

Digital data, coming from measurements, can be used at the system of the left camera or transformed to any other system that thought to be useful for "symmetrical" appearance of forms or any other reason.

The reference plane, which was chosen in this study, was thought as simple and useful selection. A small inclination of the head to the right, influences the form of the curves.

Digital data effectively serves the requirements of the study of statue, because it can be used to take any metric element we want, be the basis of studies of forms for the specific statue or comparatively to others and to have valuable elements for archives.

Digital data can give graphical documents (curves, sections, e.t.c ) by methods with different automatism.

We could also have forms for different places of observation, orthophotography, combine digital data or the resulting curves with photograph or use it to make a statue similar to the original.

All the above and further abilities present the contribution of the proposed methodology to the photogrammetric study of statues and generally to the whole problem of making photogrammetric archives of monuments and historical centers.

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