AN ARCHITECTURAL PHOTOGRAMMETRIC APPLICATION: SURVEY OF THE CHURCH WITHIN SNAGOV MONASTERY ROMANIA

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The Church within Snagov Monastery - an historical monument from the 14-th century- requires some restoration works. Having this aim in view, a survey has been carried out both for its architecture and mural paintings. Classical and semi-automatic technologies carrying out this survey, using digital photogrammetry within an integrated developing and drawing system are presented in this paper.

Key Words: Analog, Analytical, Archaeological, Architectural, Terrestrial

INTRODUCTION

Snagov Monastery is located on an island in Snagov lake at the North-East from Bucharest, at about a 50 km distance. An old convent and a voivode's church, it was also a Romanian orthodox cultural centre. In the 14-th century, during the reign of Dan I Voivode (1383-1386), it was mentioned for the first time; further mentions were made both in Mircea cel Bătrîn's documents and in the 15-th century Chronicles regarding Vlad Tepeş Voivode (1456-1462) among its protectors.

Owing to its strategic position, and based on some archaeological investigations that island has been considered as a monachal place beginning from the 11-th century.

During 1512-1517, in the reign of Neagoe Basarab Voivode, the Church within Snagov Monastery was re-built; in 1563, Petru cel Tînăr Voivode together with his brothers Radu and Mircea ordered the church inner side painting.

In the days of Antim Ivireanu Abbot (1694-1705) that monastery became an important panorthodox centre, as many Romanian,Greek, Slavonic and Arabic sacred books were printed.

Snagov Monastery was also a prison, especially, for unfaithful boyards and even some voivodes. Within the pronaos, there are to be found nine tombs where the boyards "beheaded" by Mircea Ciobanu, Alexandru Mircea and Mihai Viteazu Voivodes had been buried. Vlad Tepeş, seen as the church protector, according to the old past chronicles, was buried in a tomb within the naos.

As all the orthodox churches,that one built within Snagov Monastery has a cross-shaped appearance, divided into three parts: pronaos, naos and altar.

THE BUILDING DESCRIPTION

The Pronaos is a former church porch walled in among its pillars. Its inner vault is supported by four octhogonal pillars using both a circular arc leaned upon the external wall and a pendentive system supporting the square base of the tower cylinder with a semi-spherical dome on its top.

The naos: A semi-cylindrical apse along the transverse axial plane, one in the South and the other in the North sides, and two windows each are to be found in it. The hanging roof is supported by four cylindrical pilasters sustaining the arches; an axial bow starts from the central part and ends into the altar. The bows outside the pilasters are extending to the "proscomidia", in the North, and "diaconicon" in the South. The square tower cylinder base with a semi-spherical dome on its top lies upon them.

The altar is divided into three apses, i.e. the central apse called the altar, the Northen one called "proscomidia", and the Southen one called "diaconicon". In the Northen and Southen apses, there is a cylindrical tower having a semi-spherical dome on its top; it is supported by a square base.

Inward the church, there are mural paintings from the 16-th century all over its walls. Owing to the earthquakes and the bad weather peelings, they must be repaired, as soon as possible. The same thing must be said about the church re-building, especially the pronaos.

A PHOTOGRAMMETRIC SURVEY - A PREREQUISITE CONDITION

Considering the state-of-art of the Church within Snagov Monastery, as we have mentioned above, its survey is absolutely required. It is focussing on both its architecture and mural paintings. The architectural survey allows to investigate the building itself, viewing to study the preservation and restoration concerns, as well as, to identify and locate improvements to be done,

especially, in pronaos where cracks and damages are spreading everywhere.

Mural painting and picture survey allows the painter to remove these damages having appeared as a result of water washing after the dome fell down during 1977 and 1986 earthquakes.

This special survey has established the measuring procedure and the working programme.

MEASURING PROGRAMME

A unique X,Y,Z reference plane establishing a network of points transferred inward the church and all around it has been envisaged to make survey.

It is used to implement control points (Figure 1) on inner and outer walls, at various levels and established in the basic reference coordinate system.

sured on metric and non-metric individual photographs for pilasters and zones difficult of access; they are processed by photorectifying procedures; arches and vaults in an expanding projection are made by computer-assisted processing of the digital data captured for curved surfaces.

Stereo pair of photographs, as well as, metric individual photographs are processed using Carl Zeiss-Jena UMK-10/1318 equipment on ORWO photographic plates, while non-metric individual photographs are processed using a 24 x 36 mm photographic apparatus.

MEASUREMENTS

Stereo pairs of photographs for architectural survey have been taken by photogrammetric bases located outside the church and covering details on architectonic features, cracks and building features. Inside, there have been used various technical solutions considering building state-of-art and damage measurements.

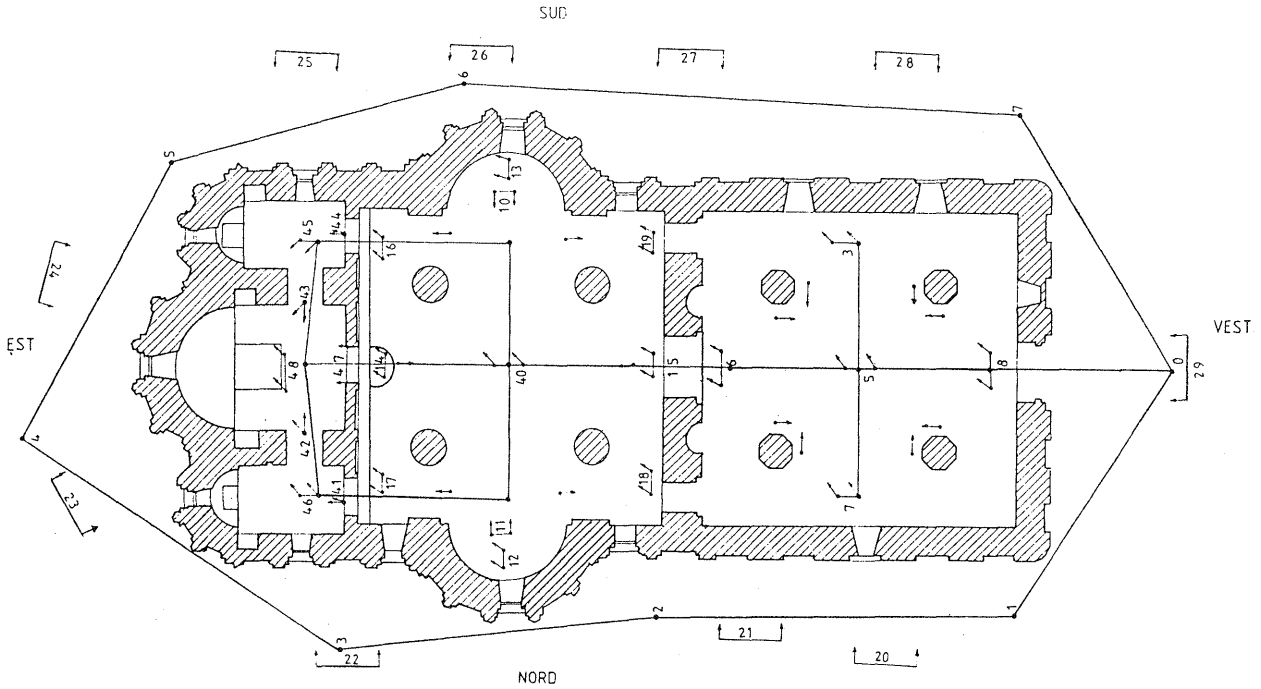

Figure 1. Plan Showing Network Points and Photographing Data

Key :

- Normal base
- Bases with $\omega = 90^{o}$
- Separate photographs
- Vertical bases
- Polygon point

The architectonic survey is to be both measured on stereo pair of photographs analogically, using a Carl Zeiss-Jena Technocart plotter and digitized computer-processed images, employing a DZT plotter to draw them.

Mural painting surveys are generally measured on metric individual photographs taken by stations at a 3 m. height located on axes parallel to the walls. Vaults, towers, arches and apses have been registered on stereo pair of photographs, having their photographing axes either normal or vertical, as when the apses in the altar have been taken.

Photograph processing, control point establishments and element measurements for the horizonthal plane and sections were made at the same time.

Each photogrammetric station location has been established by X,Y,Z coordinates, viewing to support the processing programme.

DATA PROCESSING

(a)Architectural survey was, in fact, a stereoplotting to obtain a 1:20 scale front plane-elevations - giving all architectonic features, especially, cracks and damages. Inside, apses, arches and vaults have been measured, projecting them on the plane and on the expanded plane for each of them.

Some 1:100 scale sections, i.e. a longitudinal section (Figure 2) through the church axis corresponding to X axis of the reference system and transverse ones (Figure 3) through the altar towers have been made photogrammetrically, both inside and outside, representing the building details.

composition and contouring lines at a 1:10 scale, (Figure 4) numbering pictures on lines and columns pertinent to each wall.

Mural painting photoelevation has been made based on the known control points, using a Carl Zeiss Jena Rectimat photorectifier.

Monocular photograph plotting in a Technocart plotter and computer-assisted data digitizing and processing using a DZT plotter for automatic drawing have been applied to get picture elevation showing the main contours (see item 7 b).

Pictures on a curved surface have been projected on an expanding surface plane, using an automatic computer-assisted integrated system (see, item 7 a). Projection in a rectifier has used photographs taken for the apse and vault curved surfaces.

SEMI-AUTOMATIC PROCESSING

An automatic computer-assisted processing using the taken photographs has been made, such as:

Figure 2. Longitudinal Section

A 1:100 scale horizonthal section plane for the church floor containing building details measured photogrammetrically and/or direct topographically has been compiled.
(b)The mural painting survey contains : photoelevation of the mural pictures assembled on the walls and pilasters at a 1:5 scale; tracing pictures by the main

(a) stereo pair of photographs have been plotted using a Carl Zeiss Jena Stecometer coupled to a IBM/PC-AT computer, having a proper "STEKO" software, and a Carl Zeiss Jena DZT plotter, to measure the expanding surfaces of the curved apse, arch, pendentive and vault surfaces.

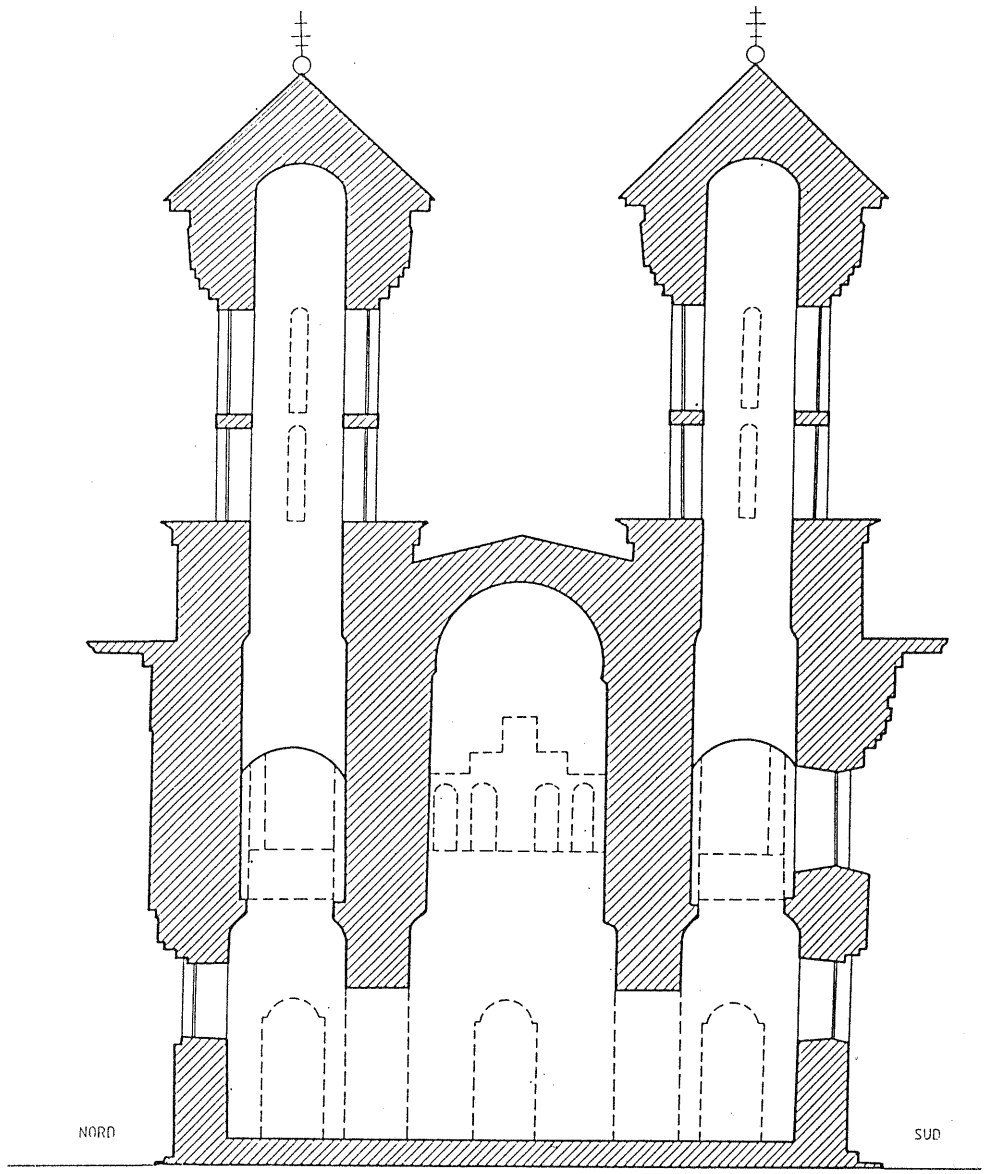

Figure 3. Transverse Section

Programme requires as input data: camera constant, photographing station heights; base value, ω inclination angle, φ deflection angle, X,Y,Z coordinates of the control points. Files of the measured point coordinates and X,Y/X,Z/Y,Z plane,having details plotted to be used in rectifying, drawn on a DZT plotter are output data.

Programme also requires to specify the surface to be plotted, i.e. plane, cylindrical and/or double-spherical ones.

The cylindrical surface has known no restriction in its expanding, as there is a true correspondence between the real and expanding curves. A generatrix of the cylinder and three points along the curve are given to calculate the cylinder radius needed as processing data.

The double-spherical (quadric) surface having two directions perpendicular on various spherical curvatures is established by three marked points on each direction. The expanding surface is a "broken plane support" used to rectify the mural painting photographs.

(c) A "Kalto" programme has been used in an automatic main mural painting contour plotting. An automatic plotting configuration consists of: "Kal A-2/MU" Caltometer coupled to a IBM-XTPC compatible computer, having a driver coprocessor with a minimum 720 KB external storage. That programme uses Kal-A-2/MU hardware facilities digitizing the photograph, establishing U and V coordinates of the four control points with X,Z coordinates. The transforming and rectifying computation programme establishes X,Z coordinates of the digitized points located on the main mural painting contours to be registered into a file. A DZT plotter could be coupled to the system configuration to draw the 1:10 scale plotted contours.That programme has been also checked in the architectural photograph plotting, using any photographing plane as against the object one. The same findings as those ones of the analogical plotting have been got,showing the same detail and accuracy.

3D REPRESENTATION

Cavalieri and isometrical perspectives have been used to represent the church spatially.

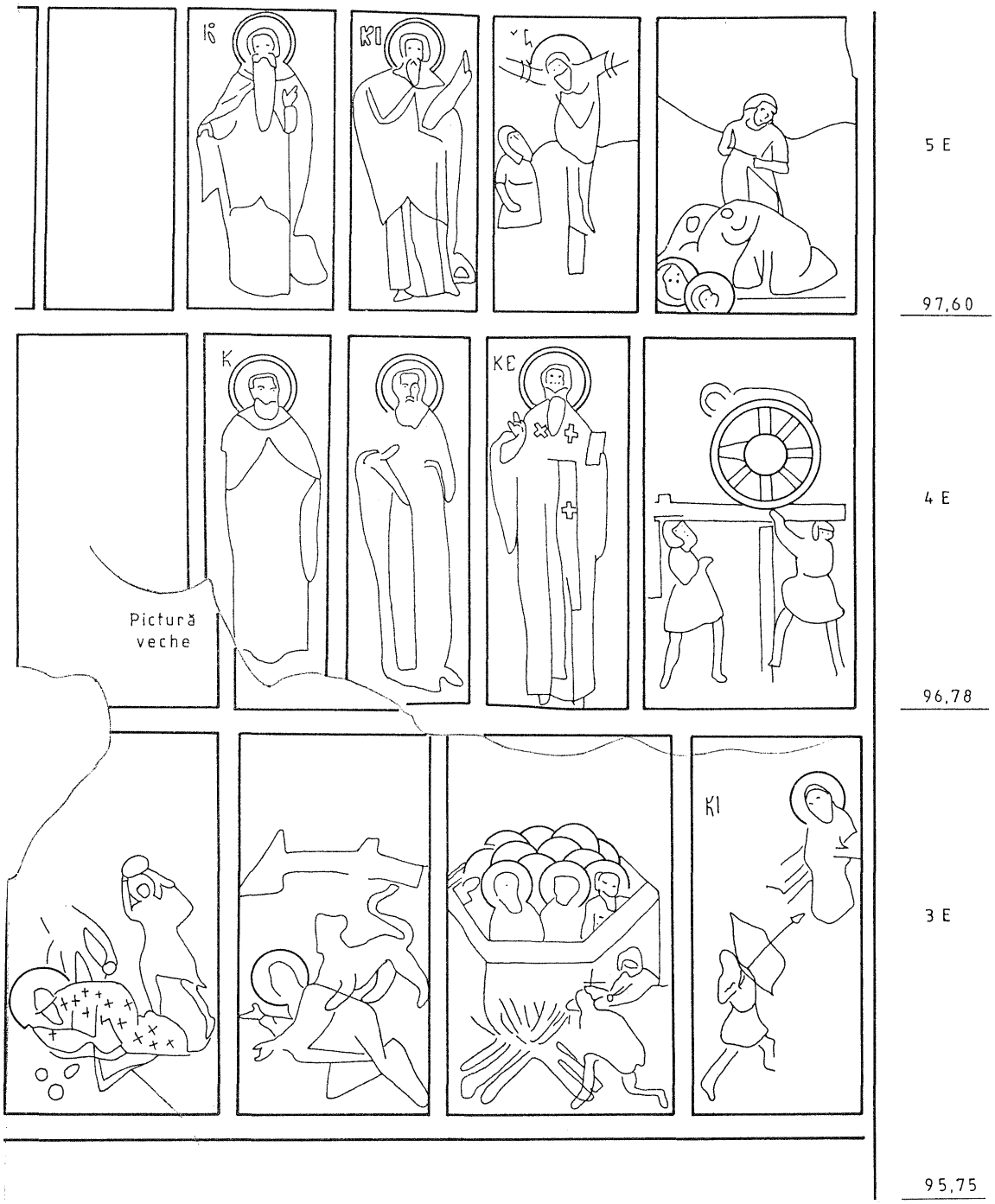

Figure 4. Elevation with Mural Painting Contours

Cavalieri perspective has two equidistant view points, having a 155^{0} wide angle in the azimuthal plane in the three coordinate axis origin.

That perspective has been used to represent pronaos, naos and altar three-dimensionally for each one, and the outside architecture (Figure 5) and the building together with its inner side, on the whole (Figure 6), as well.

3D representation, in isometrical perspective, has been tested on a computer, in a semi-automatic manner. A P-3D/2D programme has been developed. That semi-automatic programme has suggested the possibility to make a point file after X, Y, Z coordinates had been measured, to establish an object space, such as: measurements on digitized documents carried out by Kar-A2/MU Cartometer; measurements on stereo pair of photographs, using a Stecometer; input the measured point coordinates, using a keyboard.

An IBM-AT/386/486 Super WGA, Maus computer coupled to a print or a plotter is processing file data. That programme has been firstly tested in two-dimensions and then in three-dimensions;these results are related

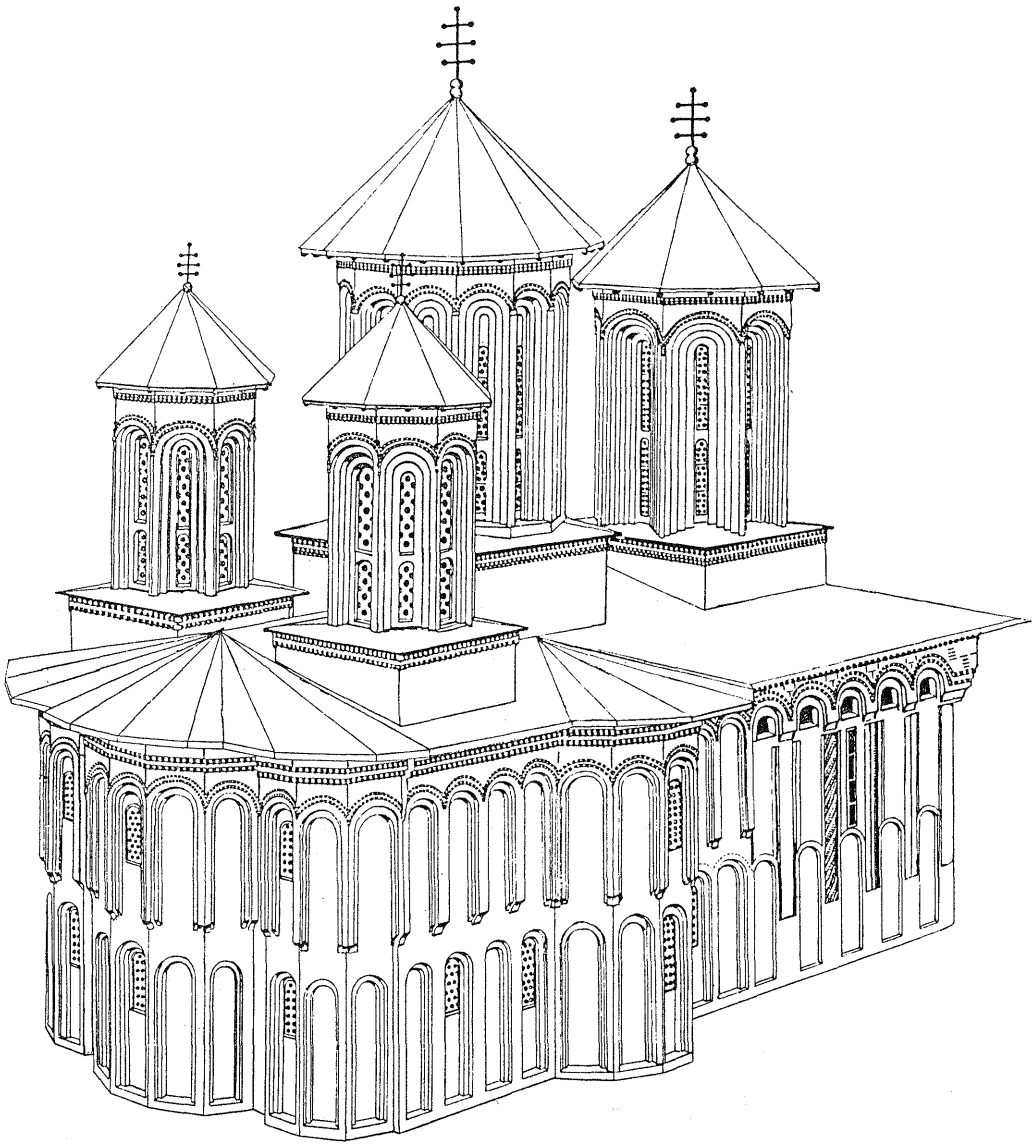

Figure 5. Outside 3D Representation

to the computer and peripheral efficiencies.

Should the programme being improved and more data on all building elements being at our disposal, obviously, the results would become compatible with the classical ones.

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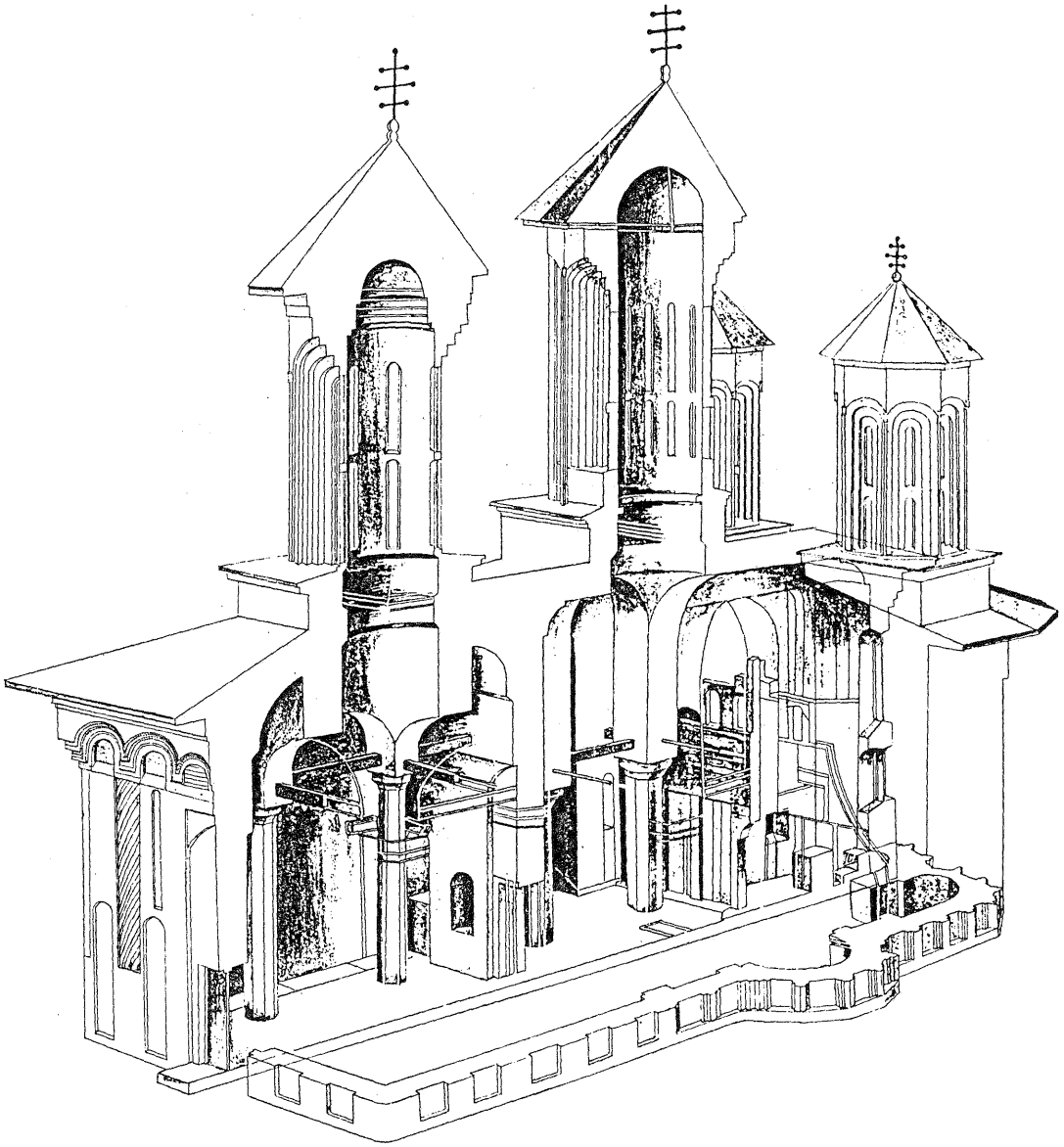

Figure 6. 3D Representation of the Church General View