

## SPECIAL CASES OPERATING PHOTOGRAMMETRY 3D MODELING-OF HISTORICAL MONUMENTS

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**Abstract:** *This paper presents a reconstruction method for viewing objects realistically. The object is reconstituted in several steps and each step has its own problems. The first step is the acquisition of images. Photogrammetric methods find their wide application in architecture, in particular the execution of architectural buildings and monuments of historical reports. Directions for applying photogrammetry in architecture are: surveys of existing monuments, facades restitution in order to restore, photogrammetric recording of historical monuments the degree of degradation and their initial image reconstruction based on restitution made, raising domes arranged interior details or ceilings in order to restore. A complete 3D reconstruction serves as a permanent record of heritage buildings in their original locations. Reconstruction can also be used to detect changes occurring on them. The main objective of this work is to obtain realistic models of objects in the real world. For models to reconstruct objects you want to use some equipment at affordable prices. Generally, getting the 3D object can be done using remote sensors or laser scanners using CCD camera. Since one of the objectives of this work is the creation of 3D models of objects with cost saving will follow modeling of historic buildings in the sequence of images taken with a CCD camera. This paper wants to achieve a realistic visualization reconstruction best photogrammetric methods.*

**Keywords:** *scanning system, 3D reconstruction, 3D section, digital model, photogrammetry at close range*

### INTRODUCTION

In photogrammetry "at close range" requirements on measurement accuracy are based on accuracy required for the proper presentation model or view model. The reconstructed object will be made of object points extracted from images can be performed using pre-orientation points. Points can be used and a number of constraints assuming certain relationships: collinearity, perpendicularity or coplanarity between object points. In the final stage creates a model, which may be attached images as textures of the surface. The realistic model obtained can be viewed from any perspective. There are various fields that require data on the geometry of real objects, both in plan and in space. Architecture, preservation and inventory of historic buildings, archeology, landscape architecture and others prefer 3D CAD data for presenting an object (building, land, monument).

Improved methods of measuring monuments and historic sites has an important contribution to recording and monitoring of cultural heritage for preservation and restoration. There exist various imaging programs designed for simple applications (such as image rectification and mosaic them for vectorization their subsequent) or complex (getting the digital model, the Orthoimagery derivative, animations). Architectural photogrammetry software package can use different types of files obtained directly from the CCD camera or by scanning slides or metric. CAD models is the ideal method for building forms, features and functions of an object representation real. Data that are ordered, form the basis for applications, which is not directly accessible, but by algorithmic models available.

### **Technical Method of 3D models**

We classify the techniques of optical 3D acquisition in two groups:

Active methods - image sensors determine the depth by measuring the time or the position of a pulse laser triangulation projectat.Rezultatul is an image that shows the differences in depth on a grid obisnuita.In active stereo models , the light is projected onto the object surface and recorded on two or more camera.Aceasta reconstruction method allows only a portion of the surface, for a reconstruction of the entire area requiring more pasi.O surface design method consists of a set of bands of light called " structured light " . Through passive use of structured light , the object surface is textured with a large number of points and is evaluated by correlation techniques [ MAAS , 1992 ] . scanning an object with light is a method for obtaining 3D information about its shape. Passive optical methods - including computer vision techniques , such as shadow shape reconstruction of movements of focus / defocus and stereo triangulation for pairs of passive imagini.Metodele not come into physical contact with the object being scanned.

### **STRATEGIES FOR IMAGE PROCESSING**

An image provides more information about the object investigated , however we do not have enough information to reconstruct a model 3D.Acest is caused by the projection of a 3D scene into a 2D scene , losing profunzimea.Daca have but two or more images , the 3D point can be obtained as an intersection of two lines required triangulatie.Conditiilevizare.Aceste process is called triangulation are :

- common points in the two frames ;
- knowledge of the relative position of the cameras ;
- the relationship between the point of the photogram and line of sight.

To make a restitution of a 3D point is necessary intersection of at least two rays (from point to point image object) in space or area of a radius and includes punctual.In if known camera parameters , position and orientation its object points in space can be computed by intersecting rays from the camera to the object surface .

If the geometry of a 3D object is completely unknown, it is impossible realizat.In restitution case requires at least two images .

### **CALIBRATION ROOM**

#### **CALIBRATION PROGRAM ROOM WITH PHOTOMODELER**

Photomodeler is a photogrammetry software that was used to process the data in this paper . This tool was designed and used for terrestrial photogrammetry to measure a variety of items , including buildings and large excavation by smaller objects .

The program allows calibration of cameras , 3D modeling of objects from their images and export the processed data in several common formats .

#### **TAKING calibration data**

Photographing the calibration network in the same environment in which images were taken of the object are compensated for the effects of temperature and humidity room . 6:12 For calibration images Photomodeler network can automatically identify its points and calculate the parameters camerei.Pentru photogrammetric data acquisition , in this paper we used a room nemetrică Digital DSLR Nikon D50 with two different objects , one with variable focal length. All images taken at focal length of 18 mm and a fixed focal length of 24 mm .to determining their calibration , using network camera calibration points . It consists of 100 points in the plan. Images were taken from four different positions , two for each position.

### Case study

In this chapter the experimental research carried out on an historic building , St. Ladislaus Church in Oradea. 3D model of the building was obtained by a method photogrammetry and laser scanning method. Reconstruction of historic building photogrammetric method was done in a sequence of images taken with a camera converging with CCD nemetrică respectively Nikon D50 . Data processing was done with the program and presentation Photomodeler 3D model using AutoCAD .Are presented stages of the 3D model results and accuracies obtained. Statistical evaluation of the accuracy of the obtained model was made with MathCad program .

3D model of historic building has been obtained by means of laser scanning . The two object models were compared in terms of the degree of realism of measurements that can be made on this and the representation of object details . I also did a cost benefit analysis of the two methods presented .

### RECONSTRUCTION OF A BUILDING USING A SLIDESHOW CONVERGENCE - St . LADISLAU FROM ORADEA

Presentation of historic building Roman Catholic Church , Oradea monument , dedicated to St. Ladislaus , is one of the oldest ecclesiastical buildings of the city. The church of St. Ladislaus in Oradea is the oldest church in Oradea altar dating from the eighteenth century.

### NETWORK GEOMETRY

In photogrammetry at close range an important issue is the optimal spatial distribution positions of the camera when taking pictures [ OLAGUE , 2001] . Generating 3D positions of points is achieved by designing model straight lines of camera positions , image points and points in the object space . The intersection of these beams generate object positions of the points .For this application using the same Nikon D50 SLR camera with lens different.

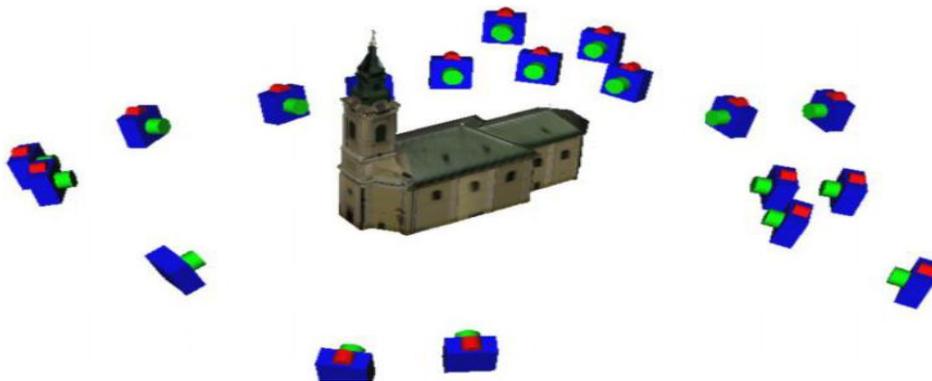


Fig.1. Data collection and modeling

Shooting the object was made of 20 stations with angles between  $20^\circ$  and  $90^\circ$  convergence placed round the object. Due to the shape of the object and the presence of obstacles in the south of the building we used for taking pictures two objects with different focal lengths . Around the building were taken 14 pictures with your Nikon D50 with 18mm lens . In the east and southeast were taken 6 files with the same camera but with the objective of 24mm.Toate images were taken with regard to compliance with the convergence angle coverage of the image and the distance to the object. Object distances were determined by the final resolution model object was set to 5cm .They have been used in the modeling of the object image 20 . Images were photographed only of the accessible sites on the ground and up to about 2m high. Therefore, many parts of the building could not be photographed in these positions depending the need to use the intersection principle for determining the position of " hidden" building .

These points were not included in the processing, their coordinates are obtained by the intersection of the visible edges of the building. All images have been configured to use the set of parameters corresponding inner orientation room that were taken . These parameters were determined by camera calibration for obiectivii Nikon D50 with 18mm and 24mm focal lengths as they were presented in the previous chapter.

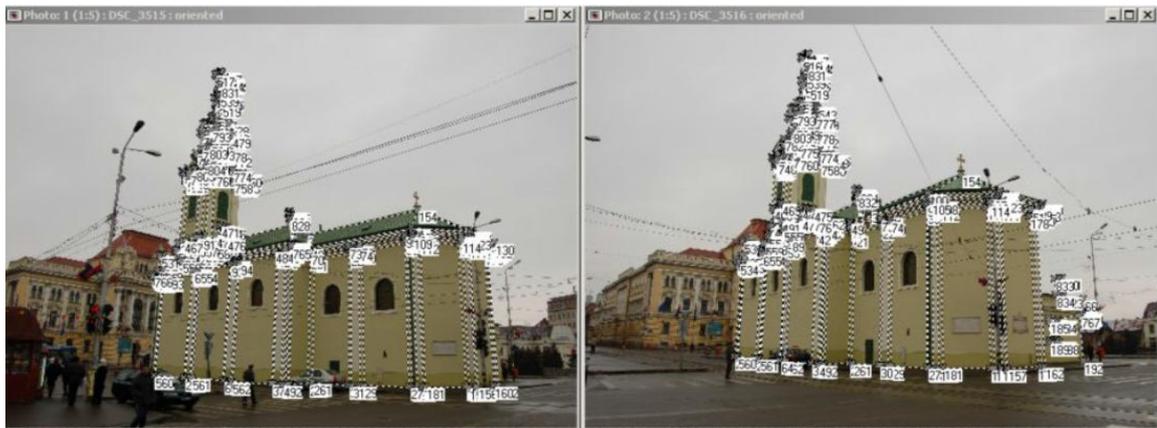


Fig.2. Marching every spot exactly for both images

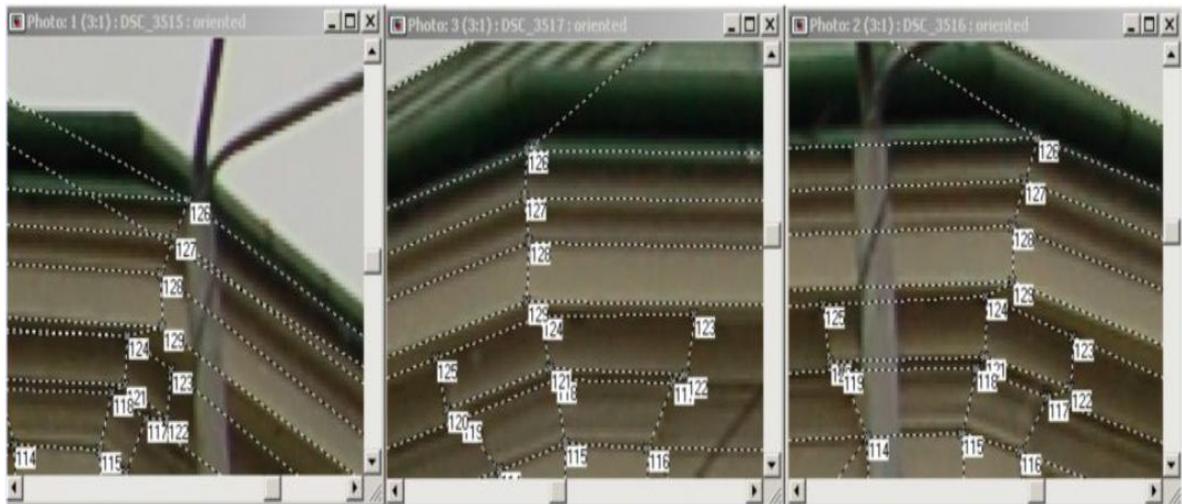


Fig.3. Referencing points in three images (detail)

The object modeling results can be presented either in graphical form or in numerical form. The program allows viewing both types of data, export them in various formats and their interference with the purpose of subsequent changes. The model can be represented as points, lines, network model ("wireframe") or textured model by associating the image for each surface model.

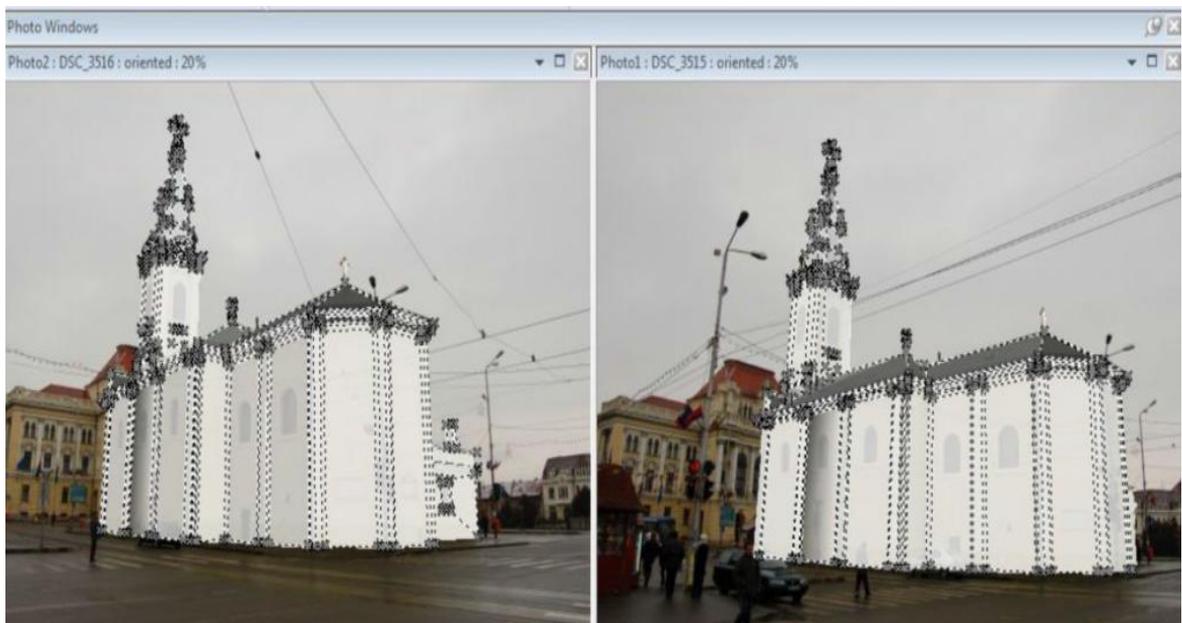


Fig.4. Model building in areas

### **Cost-benefit**

In architecture, historic buildings inventory and the conservation and restoration growing emphasis on achieving three-dimensional models by photogrammetric methods , partly due to lower costs of purchasing equipment for collecting and processing information . Another reason would be when the precision requirements , which in this area are very strict .

Photogrammetric method

- Room NikonD50 - purchase cost 1000 euro
- Program processing Photomodeler - purchase cost 1000 euro
- Number of images required to obtain the 3D model - 20
- Number of points used to obtain model - 814
- Number of lines drawn : 1234
- Camera calibration for the two objects using - 2:00
- Data collection time - 20 minutes
- Obtaining a model time - 10 days

In conclusion , modeling objects by photogrammetric method is faster and cost much less . Reconstruction geometry object from images taken from the image and assigning textures to surfaces derived model , lead to a realistic representation of the object modeled with sufficient accuracy for various fields including architecture and inventory of monuments . Laser scanning method gives much higher accuracy than photogrammetric method but necessary costs are too high for the current market.

### **CONCLUSIONS**

Currently, to create a 3D model , good quality , it takes hard work and time. The development of commercial software, specifically designed for architectural photogrammetry greatly reduce this effort. Also , these programs are less expensive and allow Unbiased ordinary rooms , nemetrice , thus reducing considerably cost method . Because of the interest developed by international bodies for recording historical buildings , and their inventory of heritage conservation and restoration methods photogrammetric reconstruction and 3D modeling applications and find this area . Photogrammetric technologies using images taken from different angles to get the 3D model of the object. The object is identified in the image and its geometrical shape is obtained by a sequence of operations involving the marking points , minutia unification and building object surface . This paper provides a new approach to object reconstruction using photogrammetry at close range , using photographic cameras nemetrice using a sequence of images of the object. Photogrammetric method proposed allows extracting object shape and geometry modeling and concept modeling method applied to St. Ladislaus Church in Oradea can be used for modeling other buildings or objects. The practical results obtained by photogrammetric method ensures accuracy required for reconstruction of objects with application in architecture and conservation of historic buildings .

Of course, such results have a high degree of accuracy lower than that obtained by laser. Cu scanning technology however , no architectural applications where high accuracy is essential as during

their measurements to obtain a model . Photogrammetric methods ensures the 3D model of the object in a much shorter time . Photogrammetric model obtained allows a good view , realistic , different perspective angles . Through its export to other editing software can be used successfully in various applications and can be imported into a GIS urban.Precizia obtain photogrammetric models depends on the camera used and its characteristics ( resolution , lens characteristics , their deformations ) network geometry point of taking pictures and the accuracy of determining the points in object space . Using methods from close range photogrammetry allows modeling and realistic visualization of modeled objects . The initial data for modeling objects are determined by the coordinates that define these objects. Obtaining shape and geometry model involves determining the coordinates of those points whose number increases with the size and complexity of the subject . Minutiae can be extracted from images taken on object. To obtain the 3D model of St. Ladislaus Church in Oradea were extracted from a total of 814 points images .

### **BIBLIOGRAPHY**

1. ABDELHAVIZ A., 2009 , Integrating digital and terrestrial laser scanning photogrammetry Deutsche Kommission bei der Akademie der Geodatische Wissenschaften
2. ACKERMANN , F., 2001 , Digital Image Correlation : Performance and potential Application in photogrammetry , Thompson Symposium , Birmingham
3. BALTSAVIAS , E., WAEGLI , B., 1996 , Quality analysis and calibration of DTP scanners , International Archives of photogrammetry and Remote Sensing
4. BAUMGART B. , 1975 , Winged -Edge Polyhedron Representation for Computer Vision , National Computer Conference, Stanford University, California
5. CANTZLERHELMUT , 2003 , Improving architectural 3D reconstruction by constrained modeling , Institute of Perception , Action and Behaviour School of Informatics University of Edinburgh
6. COȘARCĂ C. , 2009 measurement systems in industry , Ed Conspress Bucharest
7. M. CRAMER , 2003 Eurosd network on digital camera calibration , Institute for photogrammetry , University of Stuttgart