Spatial models of historical sites and their use in geotourism

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Abstract
The present brings intensive development of geographic information systems (GIS) and related hundredth ability of working a wide range of spatial problems, not excluding 3D visualization. Bearing frame system is based on spatial information, which supports a simple method of processing objects and phenomena-based spatial localization. The article contents to be present possibilities of spatial models of historic sites using the latest methods and techniques for collecting spatial data with GIS support.

Key words: 3D model, GIS, historical monuments, photogrammetry, laser scanning

INTRODUCTION

Nowadays the importance and use of solid modelling objects increases. This helped the development of computer technology, software equipment and in particular the creation of new data models enabling full 3D approach. The transition from two-dimensional to three-dimensional space in computer CAD and GIS systems was a matter of time and today it is possible to create three-dimensional map outputs based on information from two-dimensional nature, all within a single computer system. Currently is going digitization project of cultural heritage, which includes the creation of spatial models of objects and buildings. Three-dimensional object processing in the computer environment must be clearly described. Representation can be expressed as:

- Analytical representation - a mathematical representation of the object. It can be a functional regulation, parametric or implicit.
- Surface representation works only with the surface of the object, which can be given analytically or approximated by points, line segments or polygons.
- Bulk representation keeps the entire volume of the body, that is, information about all points of space that an object occupies.
- The logical representation requires information about how the object was created from some simpler units (folding, penetration, differences, rotation etc.) (Tuček, 1998).

NEW TRENDS IN THE CREATION OF SPATIAL MODELS

The beginnings of spatial models date back to the 50^{th} - 60^{th} - the last century. Passed a gradual evolution and refinement, which was closely linked with the use of quantitative (statistical) techniques and procedures. They focused mainly on the structural analysis of point, line, area presentations geographic objects, phenomena and their surfaces presented in 2D space model (Kusendová, 1998). At present, however, placed great emphasis on efficient and most accurate creation of spatial models that describe the reality of

the modelled phenomenon. Creating solid models expands in various areas of social life. Their application of spatial patterns found in medicine, automotive industry, in tourism, in the simulation of manufacturing processes and the like. Effective tool for capturing the real fact is a 3D representation. Excellent research and commercial workplaces come every day with the latest applications based not only software products that make it possible to create the perfect 3D display various models. This slowly but surely ends the era of views in 2D environments. A new trend design and final production models of phenomena observed in 3D is a collection of spatial information revolution, which is supported by modern approaches in this area.

This approach significantly solves the problem of the quality and quantity of collected input data for creating solid models. The basic assumption of success is based on inputs received in sufficient detail (ie, spatial information). One of the main inputs represent geodetic measurement baseline reference object. Progressive methods are based on terrestrial laser scanning or surveying using GPS and GNSS technologies. Finally, the final form is enhanced by the possibility of conceptual connections through GIS systems (Orfánus et al., 2011). Spatial object model can be displayed in three different details:

- block model, which shows some basic insights into the territory, eg. buildings are indeed correct height, but not sculpted roof,
- urban model as a block model of the basic shapes of roofs,
- a detailed model includes all the essential details with photo textures.

In the field of spatial models is needed to address a variety of tasks. Appropriate application software products are an integral part. The market is on offer multiple software products enable the making of spatial models (based commercial software or freeware).

The main advantages of using an application are mainly:

- time saving,
- increasing the accuracy and quality of the resulting model,
- reduce the cost of the actual implementation (Gergeľová et al., 2013).

THE COLLECTION METHODS AND DATA SOURCES USED FOR CREATING SOLID MODELS

Collecting of spatial information appropriate for the formation of spatial patterns is one of time and financially demanding tasks. There are many different sources of geospatial data and based many ways their collection. In practice, apply two main methods of data collection:

- Direct (direct data collection for the house or on the unprocessed image);
- Indirect (based on the data that are available in processed form (eg, maps, statistics, etc.).

Selecting data collection methods depends on the application (deployment) GIS and the types and nature of objects whose data is to be obtained. In any case, the collection of sufficiently accurate and complete depends on the specified application. Set of basic spatial data is a representative result of geodetic application of selected methods for determining the spatial position of the reference object. Geographic information obtained in this case is seen as a means of knowing the monitored phenomenon.

Geographic information involves spatially associated information presented by X, Y and Z coordinates. A full-featured score harvest spatial information represent data in digital form, which is the basic foundation for the deployment of 3D GIS. Collection of information, which must result data in digital form, is a key pillar for the use and success of 3D GIS deployed in the area of spatial patterns. Due to the high demands made on the completeness and perfection of

data collection is divided into two main classes namely:

- geometric data, including topological relationships with neighboring objects
- descriptive and thematic data (Pavelka, 2003).

According to Pavelka (2003) are methods to obtain the spatial coordinates:

- Digital Photogrammetry (aerial, terrestrial, satellite) - Measuring method enabling modeling in 3D space using a 2D image.
- Laser scanning (air, land) - is currently the most effective method of spatial measurement and three-dimensional (3D) models. It is a non-contact determination of spatial coordinates, with extreme speed, accuracy, complexity and security, work on the principle of spatial polar method
- Triangulations of 3D scanners to obtain the shape of small objects are devices that typically use a combination of several CCD cameras, laser pointer or other assistive devices.
- Radar Interferometry (air, satellite) - a method that treats two or more radar satellite images used to create a digital terrain model or monitoring deformations of the earth's crust.
- Surveying methods (land measurement)
- GNSS (Global Navigation Satellite Systems)
- Special (physical) - Physical Geodesy

CREATING OF SPACE MODEL UISNG OF LASER SCANNING

As a spatial object to model creation was chosen tunnel in the village Smolník. Smolník ic historic mining town located 18 km north of Rožňava in the southern part of Volov hills. The beginnings of mining activities date back to the 11th century, but the first written mention of Smolník is up from 1243. Mining in the early days focused on precious metals, especially gold and silver. Later he moved to the mining of iron and copper, whose production base gave glory Smolník mining for many centuries (Szabó, 2011). At the foothills of the hill, just opposite the municipal office to see grated entrance to an underground passage. This goes under the historic inn, where there are vast cellars. It is likely that in Smolník as in miners gave this corridor dig to get over it supplied the restaurant. It was easier to bring goods before the inn and then bear down into the cellar, where the need for cold storage of food. However, it is also possible that the old shafts was situated there earlier and only use because Smolník basement is pierced through and through and lead mines of the Medieval is not any records. In the past, because in the town lapsed into the ground multiple objects, even in the centre (Szabó, 2011).

The basic principle of operation is the scanner spatial polar method. To determine the coordinates of a point P is necessary to know the length of *d* (measured by length) and angles ζ, ω. Angles are obtained as the position mirrors that scatter the laser volume and length as pulse rangefinder scanner synchronized with the position of mirrors. The result of the calculation of the 3D coordinates of the measured point of the object in the coordinate system of the scanner, which is generally oriented and positioned. Objects to scan points used scattering laser beam, whereby the surface of the measured object points in the selected density profiles. Thus aiming points are called Points cloud (Štroner & Pospíšil, 2008).

To measure was used the universal measuring station Trimble VX Spatial Station (Fig. 1 and Tab. 1).

Measurement was preceded by terrain reconnaissance and was stabilized three opinions. Scanning starts setting the device parameters such as temperature, pressure and others. The next step is determining the extent of scanning, in our case, the limitation on the big screen used a closed polygon. When scanning is necessary to specify the scanning parameters, horizontal and vertical interval and the quality of

Fig. 1 VX Trimble Spatial Station

Tab. 1 arameters Trimble VX Spatial Station (Trimble)

Angular accuracy	1″
The accuracy of lenght (prism)	3 mm + 2 ppm.d
Rangefinder (without prism)	More than 800 m
Max. scanning speed	< 15 points/s
Min. interval points	10 mm
Range scanning	> 150 m
The accuracy of 3D points	10 mm ≤ 150 mm
Scan range (Hz)	360°
Scan range (in)	3°36´to 150°
Max. image resolution	2048×1536

images. The actual scanning is done automatically measuring stations. The result is a set of scan points of each opinion, which shall be connected to the resulting clouds of points and panoramic images. Spatial data processing is done in the program Trimble, RealWorks 6.5.

Figure 2 shows the spatial pattern created by a network of triangles, which is called the Mesh representation. Mesh model allows assigning images to each surface for the purpose of visualization. Figure 3-D model with an associated fotorexture. As visualized object is inside the small dimensions, was used to show only images of the entrance.

CREATING OF SPACE MODEL USING DIGITAL PHOTOGRAMMETRY

In this development model is used prieseková photogrammetry. The principle of this method is based on intersecting ahead with known ground baselines, use images that are convergent. It is a contactless measurement method. Processing should be carried out using special software. Before shooting the object was carried out terrain reconnaissances, which allowed exclusion and reduces the negative impact of buildings on the shooting schedule and allow camera positions.

Using this method was developed spatial model of the Slanec castle (Fig. 4)

USE IN GEOTOURISM

Spatial models in addition to their basic function object visualize play nowadays a very important role in modeling phenomena in the country. The application of models is very diverse and extensive. First of all, it's visualization of objects, whether alone or in connection with the environment (country, city) with application to the simulation of the appearance of the city, the reconstruction of objects eventually new construction. They are used in assessing the impact of new construction on the surrounding buildings and landscape.

With the development of information technology, spatial models become part of 3D navigation. Very popular are virtual tours towns, castles, nature trails eventually inaccessible underground spaces, caves. At use presentation created spatial model via the Internet so tourists have the opportunity to target your interest and look to prepare. Similarly, hotels and restaurants can offer as added value to visualize their complex, attractions, views from the windows of the towers and the etc. Attractive is a tour of museums and exhibits. For historical research to create models taking into account the time factor and creates the model object or landscape allows to study the historical development and change. One example of the application of GIS in Geotourism is a project created in Bulgaria. A special public geoportal (Asenovgrad, 2013) provides access to rich information

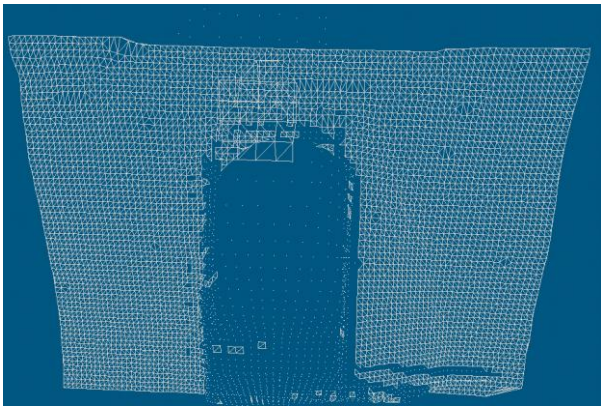

Fig. 2 point cloud and mesh model (Kuzevičová at al., 2012)

Fig 3 Photo-textured Model (Kuzevičová at al., 2012)

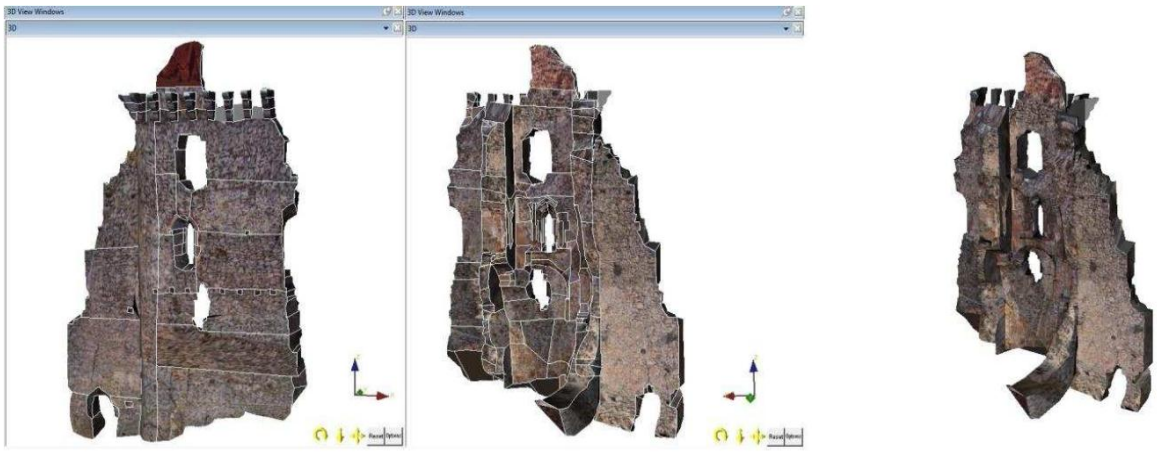

Fig. 4 The 3D vector model with displayed textures and an axonometric view of the wall (Bartoš at al., 2011)

about the cultural, historical, and natural attractions in the municipality. The geoportal allows visitors to learn their locations and how to reach them and to discover related projects. In addition to the gallery of video and photography, there are also 3D models of all the tourist attractions. In project was developed and integrated into the geoportal a 360-degree virtual tour of the Assen's fortress in Asenovgrad (ArcNews Fall, 2013).

CONCLUSION

The issue of spatial models is quite extensive and time consuming. In the initial phase, it is necessary to obtain data about the object, where the use of the most appropriate methods of surveying both digital photogrammetry and laser scanning. Applicable methods is much more choice and is largely subjective. Subsequent processing of the measured data and the creation of a model is usually very time consuming. Creating detail requires precision work and quality software. However, the use of the generated models is widespread in various fields of human activity, even of science and research.

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