3D MAPS FOR INTERNET APPLICATION

Temenoujka Bandrova, Stefan Bonchev

Temenoujka Bandrova, Assoc. Prof. Dr.
e-mail: bandrova_fgs@uacg.bg

Stefan Bonchev, Dipl. Student
e-mail: bonchev_st@abv.bg

Department of Photogrammetry and Cartography
University of Architecture, Civil Engineering and Geodesy,
1, Chr. Smirnenski Blvd. 1046 Sofia, Bulgaria

Abstract:

The report considers an innovative technology for creating an interactive 3D map for WEB applications based on VRML format – open standard for 3D multimedia and distribution of virtual world in Internet. This technology is based on well known technology ***"From Paper to Virtual Map",*** *proposed in 1999 as cheap and fast way for creation of 3D city map. The proposed project develops the mentioned technology, named* ***"Internet Interactive 3D Map Technology"*** *for creation of any kind of 3D map as well as its Internet application.*

All steps of the proposed technology are shown here. Its application is the creation of a 3D map of the famous mountain resort Pamporovo in Bulgaria. The object description is done, sources and data collection is considered. All steps for 3D map modeling and creating are shown and the processes of screen and paper applications are considered. As last step the Internet Interactive application is shown and this could be considered as a step of developing the Technology ***"From Paper to Virtual Map"*** *to new innovative one* ***"From Paper to Virtual Map".***

Key words: 3D map, Internet, Photorealistic visualization, Interactive application, cartography, innovative technology, Google maps

INTRODUCTION

During the last decades the 3D maps have become one of the most powerful tools of cartography. The visualization and manipulation with such maps give the professionals-cartographers more possibilities to represent special information. On the other hand non professionals and all users not only receive more attractive cartographic products but have in their hands opportunities to manage, add and extract information.

Not a long time ago, the users had at their disposal only 2D maps and media to represent real phenomena, which have restricted some analysis of processes, relationships and behavior of real objects. The recent achievements in hardware and software technology, that have shown encouraging results toward storage and maintenance of large amounts of data, motivate us to expect a dominant role of the third dimension in this millennium [Zlatanova S., T. Bandrova, 1998].

3D maps start finding their users in different fields of science, practice and communications.

A way for Interactive application of 3D maps is achieved by the use of Internet. The entire process of gathering information and sources and their processing is shown. For this aim the satellite images are imported in AutoCAD environment. After that the sources are scaled and vectorized to be prepared for 3D platform.

The technology "From Paper to Virtual Map" described in [Bandrova, T., K. Ivanova, 1999] is upgraded in the steps of defining virtual camera and spotlights as well in the process of creation of maps for touristic usage. More over the Internet application with interactive possibilities for user manipulation is created and all steps are proposed.

The created 3D maps for WEB application are based on VRML format – open standard for 3D multimedia and distribution of virtual world in Internet. After First International Conference on WWW (World Wide Web) in Geneva 1994, Silicon Graphics Inc. developed a specification based on Open Inventor ASCII format. VRML 1.0 was started in 1995 and special group proposed facilities for animation, sound and greater interactivity. These applications are already included in VRML 2.0 in 1996. From this time a formally constituted consortium is responsible for development of VRML, or well known Web3D Consortium (see http://www.web3d.org) [Lovett A. at al., 2002,].

1. DIFFERENT KIND OF DATA FOR PROCESSING IN 3D MAP

1.1. Object description

Pamporovo resort is situated in the heart of the Rhodopi Mountain, 260 km away from Sofia, the capital of Bulgaria, 85 km south from the city of Plovdiv and only 15 km from the town of Smolian. Pamporovo is one of the sunniest mountain resorts in Bulgaria – the sunny days per year are more than 240. The climate is mild, with strong Mediterranean influence. The average annual temperature is 8,5° C, and the thickness of the snow cover is 140-150 cm. The altitude of the resort is 1650 m, the highest peak is Snejanka – 1926 m.

Neither sudden changes of temperatures, nor avalanches are typical for this mountain resort. The main touristic stream is during the winter mounths, because the resort is suitable mainly for ski sports. Almost all ski slopes in the resorts starts from Snejanka – the highest peak, and their average altitude is from 1926 m to 1400 m. The touristic season starts from December and continues almost till the end of April. The ski slopes in Pamporovo are with different level of difficulties.

The resort is relatively difficult for orientation and lots of tourists have problems to find their way for the first time, because of the distance between the ski slopes and the numerous hotels. That's why we chose Pamporovo for our pilot project to test the proposed technology.

1.2. Data Sources

The earth information is collected from different sources – remote sensing data, GPS data, photogrammetric or surveying measurements, which give us a possibility to make 3D presentations. The maps are one of the most used tools for presentation of such information. Nowadays, most companies create 3D models of city or country environment. These 3D models give a possibility to understand and gain knowledge of the real world and thus we achieve an easy, communicative access for all users [Bandrova, T., K. Ivanova, 1999]. The photo-realism of these models (see Figure 5) gives the possibility for a quick and easy access to large range of users: from the youngest pupils to the highly skilled specialist in different fields of science and practice.

The project for creation of 3D map for touristic needs in mountain resort is presented. For this aim satellite images from Google maps are used. They give readers information for enough large territory situation and relief information; have enough high resolution and accuracy for cartography needs. Other reason to use them is a free access to data sources. Especially for mountain resorts, as presented Pamporovo is, the images from Google maps give the necessary terrain information, ski-tracks and equipments, as well as information for afforested territory. Additionally to the images from Google maps, the existing maps of territory in scale 1:10 000 are used [Bonchev St., 2009].

1.3. Data processing

The gathered data and sources should be proceeded. The authors of 3D maps use different methods and data to approach the 3D applications. In Kuwait for example they use the topographic base data and the software technology for 3D mapping in private industry applications [Hermsmeyer D. at all, 2005]. In Malaysia the topographical contour lines are digitalized into GIS and they are assigned to be an attribute value. On this base authors generate DEM [Amirin K., M. Hasmadi, 2009]. In Helsinki a 3D Model is produced by using digital photogrammetry, digital aerial photos and orthophotos, which serve as a great source of geospatial information presented in various resolutions [Lee Kim Haw, 2007].

In the proposed project the processing of the images, before going to 3D modelling, is done in AutoCad. The pictures are imported as raster images and are scaled according to the linear scale of each picture. When a larger

range of territory is needed and respectively larger resolution of the pictures, the whole image should be pieced together from the different small pictures and each picture should be scaled according to the linear scale before that. After this, the small pictures can be put together with the help of some typical and highly distinctive points, which present in both pictures that must be connected. That's why in the pictures there must be a zone of overlapping (see Figure 1).

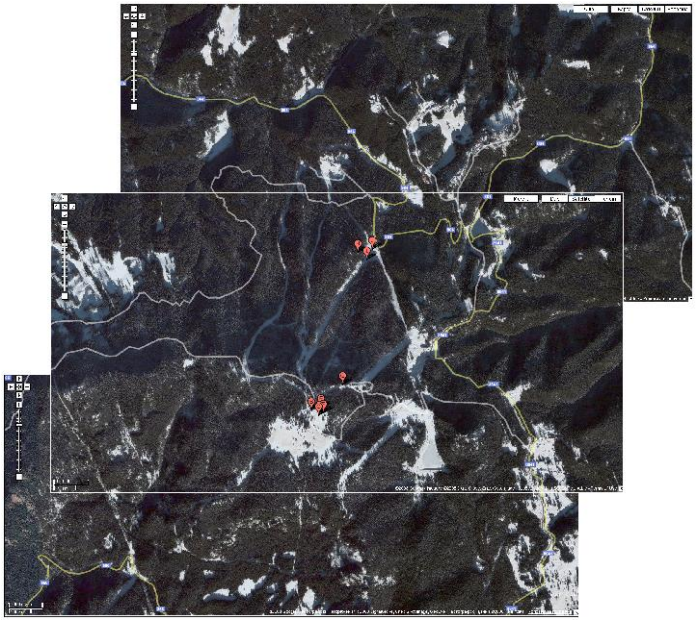

Figure 1. Satellite images from Google maps

When we get the whole image, then we proceed to vectorizing. For getting a relief and different objects, that are important for the subject of the map, we vectorize contour lines. The contour lines and the different types of objects are separated in different layers, and thus they can easily be imported later in the 3D modeling program and can be easily manipulated with.

2. STEPS IN THE MODELLING OF A 3D MAP

2.1. A 3D map for a screen presentation and print

A 3D map could be defined as computer, mathematical defined, tree-dimensional high realistic virtual representation of the world surface or other heavenly body, the objects and phenomena in the nature and society. The represented objects and phenomena are classified, designed and visualized according the specific purpose.

The concrete content of the 3D map is designed after the definition of objects and phenomena that will be included. It could be subdivided into three themes:

- **Main content -** large topographic or landscape objects such as relief bodies, roads, buildings etc. Most designed 3D maps, presented by different companies in the world represent it.
- **Secondary content**, carrying the basic information. For example in 3D urban maps – objects, represented by symbols – traffic signs, facilities, transport elements, information signs, trees, etc.
- **Additional content**, providing the quality and quantity information about objects, often created as a textual database, regarding each of designed objects or the map as a whole.

All these 3 themes are included in a 3D map which is created by the next steps:

- Import of the vector data in 3DS Max;
- Creation of TIN;
- Modelling of the different objects in the situation and input them on the terrain;

- Fixing of the virtual camera and lights;
- Photorealistic visualization – choosing a point of view and image resolution;
- Processing the raster image in PhotoShop, creation of 2D symbolic system;

The schema of the technology for 3D map creation is attached in Application 2. We can name it **"Internet Interactive 3D Map Technology".**

2.2. 3D map for interactive Internet application.

The creation of a 3D map for interactive Internet application follows the same typical technology for the creation of a 3D map for print, to a sertain step. Till we reach the step where we obtain VRML file, again we have to proces the 3D model in 3DS Max.

The gathering of data and its processing for interactive Internet application, is identical with this one for creation of typical 3D map. The reason is proceeding the map in vector format.

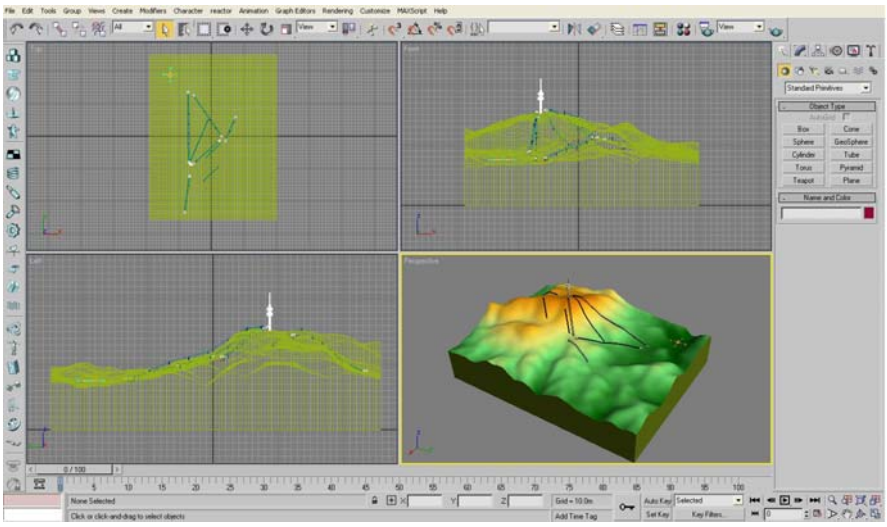

Figure 2. Construction of the digital model of the terrain in 3DS Max

- **Construction of the digital model of the terrain**

The surface of the terrain is constructed on the base of vector contour lines, which are input on their corresponding elevations. So, the character of the relief is correctly described. The contour lines should be modeled in AutoCad as polylines, so the software can constuct the triangular irregular net. They represent the object called „spline" in 3DS Max. The function „terrain"of the program takes care for the creation of triangles, by using the points of the polylines from the contour lines. Before that we need to adjust the number of the points, that will take part in the creation of the map to avoid the creation of unnecessary sides of triangles, because this makes the relief look rough and create heavy graphic information. Most often for the creation of TIN we use ¼ of the number of all points, that take part in the creation of the contour lines. The use of TIN is needed only for the typical 3D map (screen and print presentation). But if we want to work with WireFusion program, the model has to be created as regular one. After that we can input a texture on the model (see Figure 2).

- **Modelling of different objects from the situation.**

The modelling of the objects from the situation is the same as their modelling in a typical 3D map. It is good to assess in advance the level of details of the different object. More detailed objects contain more points and polylines or more graphic information, which the VRML file is going to transfer in the software for creation of an interactive Internet application. There the high level of detailness means that the level of compression would not be reduced because we could lose certain information and parts of the objects. That means the initial file will have higher memory and its manipulation and loading it in WEB will take hardware resources and consume a lot of time.

- **Fixing of texture and lights**

The choice of textures and lights needs to be done while working in 3DS Max. The information they carry is also recorded in the VRML file and is transfered in the WireFusion program, where they are further fixed. An object, without fixed texture in 3DS Max, can not be textured in WireFusion. It can change only its color and properties of the material. But if this object is textured before imputting in the software, after that we can change or add the texture.

The number of the sources of lights and their intensity also can be put in 3DS Max. After that they can only be removed or we can change their intensity.

After completing the work on the model in 3DS Max, the scene is exported VRL (VRML) file format.

The example of VRML file, created by 3D Studio MAX is shown in Application 1.

3. WORK WITH WIREFUSION

We need Demicron WireFusion software for importing, processing and web visualization of the 3D model.

Demicron WireFusion is a software for creating interactive Web3D presentations. A typical work flow consists of loading a 3D model, configuring/optimizing the 3D model and at last adding widgets and logic to the presentation. The 3D model is created in a 3D modeling software, like 3DS Max, Maya or any other 3D modeling software that can export as X3D or VRML. The result is presentations that can run in browsers supporting Java 1.1+.

3.1. 3D-scene

The work on the 3D scene requires some adjustments on how it would appear, move and react to commands from the user. There is a possibility each object to be edited separetely and inserted with its own name. Each object could be turned off and on or assigned as "Touchsensor" (responding to movement or a mouse click). There are settings for degree determination of objects smoothing, adding texture, color and adjustment in the the material properties (Figure 3).

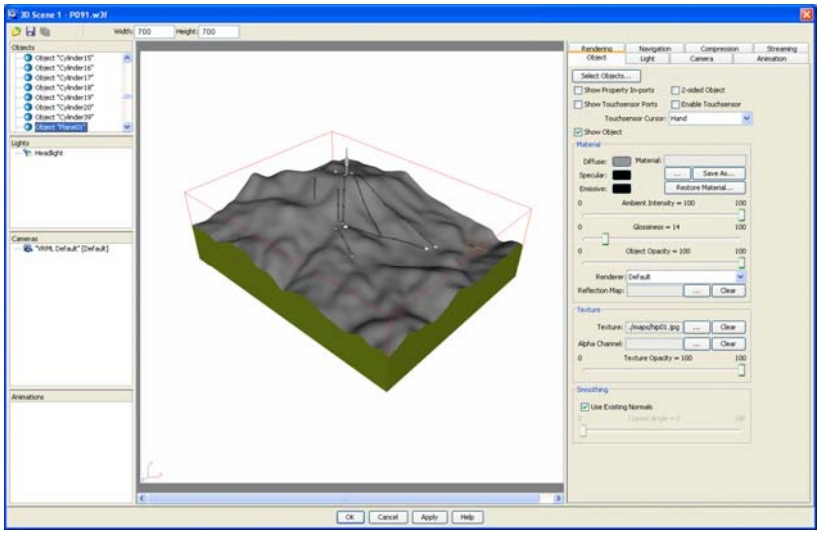

Figure 3. 3D model on the 3D scene in WireFusion

- **Rendering general settings**

It is assigned what kind of rendering can be used. It can be a shade, for example. In case that the checkbox "Anti-Aliasing" is turned on - there's a possibility of smoothing the edges when rendering is performed. If this checkbox is

on permanently, the object movement is going slowly during the presentation. It can be configured to be on, when the movement stops, so it wouldn't slow the operation.

- **Camera settings**

There are some universal properties in comparison with those of 3DS MAX. There can be added an unlimited number of cameras, setting their focal length, which determines the view angle. It is assigned which camera to be working by default when the interactive presentation starts. There are settings for the minimum and maximum distance between the camera and the objects and setting of the rotation limit in the along axes X and Y.

- **Light settings**

There is an ability for each light resource to be adjusted the degree of intensity and ambient intensity. It can be turned on and off, but his spatial properties can not be edited - it is the same in the 3DS MAX, so as any other object.

- **Compression level**

The compression level determines how detailed should be the displayed objects. If it is set on a high value, then all details of the objects are visible, but it increases the file memory. When we specify a low value, the objects are shown generalized - the smallest polygons, involved in their construction are dropped out. It may lose graphic information, but the file size is extremely reduced. There must be a balance between detailed displaying of the objects and the file size. Therefore during the modelling process it would be good the object to be generalised to some extent.

- **Navigation settings of the scene**

From this setting the user can assign the rotation speed during the mouse dragging process, the speed of zooming in and out the objects as well as the camera motion.

3.2. Adding other components to the project

After the work on the 3D scene is completed, a wide range of components and controllers can be added to the presentation, so the user can do all actions and movements he/she wants.

The subjects were divided into several groups: 3D, Data, Enviroment, Filters, Logic, Misc, Multimedia, Widgets.

Visible scene objects such as buttons, sliders, and media as well as functions and commands to establish connections and set up links between the different components also can be added.

3.3. Creating logical links between the different components

These links give the abbility all these components to work and the user can make any action he/she would like. Each object has a wide range of possible "out-ports" and "in-ports", so it may be assigned logical consecutions of the actions and making some procedure (see Figure 4). All that is said so far, is like the programming languages, for example Visual Basic. The difference is that here the user mustn't write a code. He can just visually create the algorithms. For better results, it may be added Java script code.

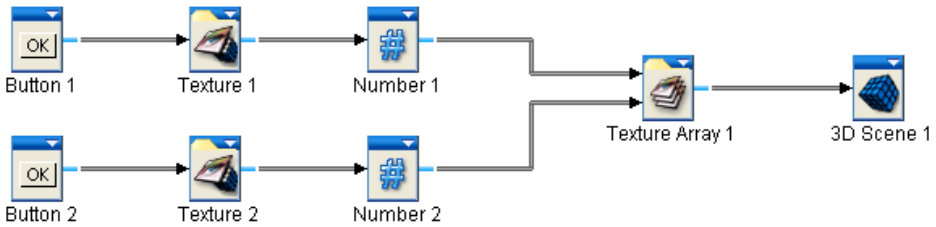

Figure 4. Creating logical links between the different components

3.4. Exporting from the software of Java applet and Java application for web publishing

In the case of Java applet the software exports *.HTML file along with adjacent folders, that are needed for web publishing of the presentation. When there's Java application, a *.jar file is exported for independently visualization of the presentation (see Figure 6). The derived from the software *.HTML file is edited by adding an HTML code for the complete design of the WEB-page. The complete project is uploaded to a site, offering a free server or domain.

4. CONCLUSIONS AND DIRECTIONS FOR FUTURE WORKS

3D maps give very good notion for city or country environment, objects, phenomena and representation of territories (Figure 5). A variety of input data can be used for this purpose in addition to materials used in the technology, e.g., photogrammetric or remote sensing data. Such information is automatically imported in most of the modelling systems, which will facilitate repeatedly the process of usage of the data in the 3D map.

Internet and VRML offer big new possibilities for the cartography. They make cartography and mapping more accessible for the general public. The interactivness and the dynamic of the 3D maps minimize the difficulties of all users-nonprofessionals in reading the information. Through interactive presentations for one territory the users can obtain all kinds of information (texts, media, etc.), that do not overload visually the map, but are at hand when they are needed and wanted. The presented models are visual and realistic, they can change the point of view any time, different objects can be brought nearer. The technology gives a possibility to distribute the interactive presentations via Internet, which is one of the biggest advantages, or can be used on portable devices such as laptops, mobile telephones and other, that support Java.

The fast development of the technologies offers a possibility for elaboration of the 3D interactive cartography – the models become more and more detailed, without slowing the work process, they represent even more information and links to other sources. Thus these models become a part ot one big database and a step to the construction of virtual worlds.

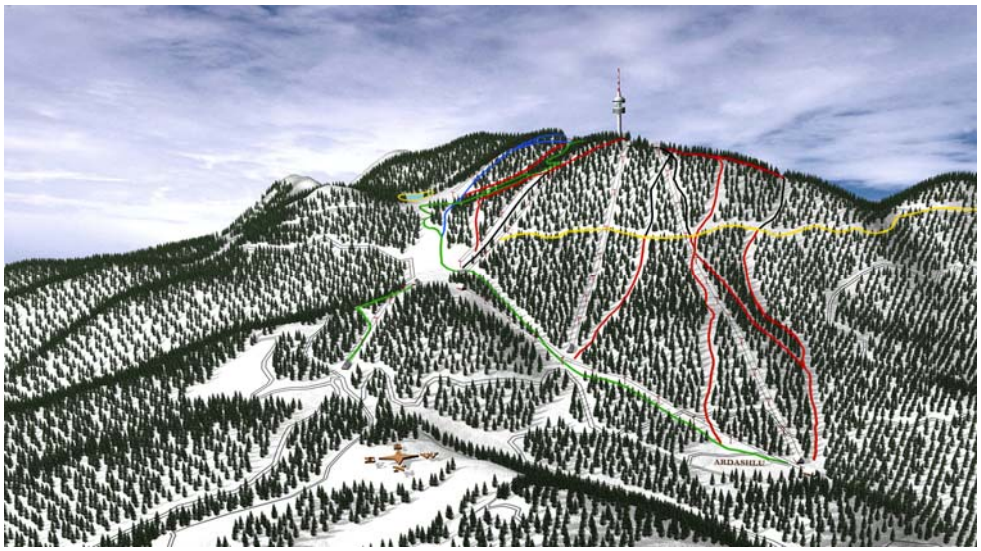

Figure 5. 3D map for a screen presentation and print

Figure 6. 3D map for interactive Internet application (Java application)

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http://davgeo.com

http://www.metroblocks.com

http://www.vexcel.com

Application 1

An example for VRML file from 3D Studio Max

```
#VRML V2.0 utf8

# Produced by 3D Studio MAX VRML97 exporter, Version 7, Revision 0,65
# MAX File: PAMPOROVO.max, Date: Sat Mar 20 19:05:48 2010

DEF Terrain01 Transform {
  translation -61.49 -251.7 69.32
  scale 1 1.502 1
  children [
  DEF Terrain01-TIMER TimeSensor { loop TRUE cycleInterval 3.333 },
    Shape {
      appearance Appearance {
        material Material {
          diffuseColor 0.5882 0.5882 0.5882
          ambientIntensity 1.0
          specularColor 0 0 0
          shininess 0.145
          transparency 0
        }
        texture ImageTexture {
          url "../maps/OPOCEAN2.JPG"
        }
      }
      geometry DEF Terrain01-FACES IndexedFaceSet {
        ccw TRUE
        solid TRUE
        coord DEF Terrain01-COORD Coordinate { point [
          1.37 192 14.92, 6.602 192 13.86, 10.48 192 10.16, 12.55 192
5.195,
          12.42 192 -0.1821, 10.56 192 -3.754, 5.157 192 -7.785,
          1.157 192 -11.38, -1.938 192 -14.03, -4.447 192 -14.91,
          -8.507 192 -14.34, -10.82 192 -12.98, -12.26 192 -10.7,
          -12.79 192 -8.01, -11.18 192 -0.05518, -9.068 192 7.773,
          -6.092 192 12.24, -1.313 192 14.67, -5.727 190 -25.62,
          -0.6688 190 -23.73, 8.398 190 -17.8, 12.24 190 -14.08,

                                    ...
coordIndex [
     4687, 4920, 4686, -1, 4919, 4920, 2282, -1, 2281, 4920, 4687, -1,
     4686, 4919, 4685, -1, 2283, 4919, 2282, -1, 2283, 4918, 4919, -1,
     4685, 4918, 4684, -1, 2284, 4918, 2283, -1, 4916, 4917, 2285, -1,
                                    ...
```

Application 2

A technology for creation 3D map for Internet Application "Internet Interactive 3D Map Technology"