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3D Cartographic Applications

Thesis of PhD dissertation

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Introduction

The 3D technology started to spread in cartography in the last few years, we have more opportunity to create 3D maps than before. The newest generation uses the mobile environments daily, they get more visual stimulus than years before, and the devices are interactive. This change has an effect on cartography too, there are great potentials in the new technologies and in further development. The users' needs generates progress in cartography too. Therefore chose my research topic the 3D technologies in cartography and developing 3D visualization methods and applications. In the last few years are progress in 3D cartography, the development of the theoretical basics has been started, but many of them still missing. More researches are required, so I wanted to bring solutions, develop the missing theoretical methods.

At the beginning my main objectives were:

1. Develop new theoretical visualization methods in cartography. Examine of these methods, which are recommended or not.

2. How can 3D maps be created? Examine the possibilities of 3D map creation and the software. Compare of software and examine the international examples. How can interactive maps be created?

3. Create the methodology of 3D maps and examples. Represent the theoretical methods with maps.

4. How can the 3D maps be applied? When can the 2D and the 3D be used?

Methods

I examined the international 3D theoretical methods, and the implemented 3D cartographic projects/examples. I examined its methodology, technical background and in which software was created. Where were they use for?

I developed new 3D visualization methods in thematic mapping, generalization and representation of graphic elements.

Compared and rated the tested software, which one is the best to create 3D maps and capable to create my methods. I used my visualization methods in practice. I learned how to use the software I have been chosen.

I created many 3D animated and interactive maps, I represented my 3D visualization methods and their use.

Compared and analyzed my visualization methods, which are recommended to use, what are they field of use.

Results

My theses are:

I. Work out the 3D theoretical methods

I made a wide research in 3D visualization methods in cartography. I developed new 3D thematic methods with completeness which bases are the traditional rules. I used the animation the part of the representation,

so I worked out the animation methods too. I examined the goodness of the visualization methods, and how can be combine in one map, which has disadvantage. This theoretical basics were not developed so widely before in cartography.

I worked out the 3D versions of the traditional generalization rules. The generalization in three dimensions is especially important if we use architecture blueprint as reference. I examined the other way of generalization, the LOD levels, it is a known term in GIS and game development.

I developed the 3D representation methods of graphic elements, like: rivers, roads, borders, cities, surface, texts, special thematics, etc. I worked out in which cases is the 2D and the 3D visualization recommended. The writing of names are different in 2D and 3D techniques, I developed new methods in favor of easy reading.

II. Research the prepare of 3D visualization methods

Examined the software which supports the 3D visualization. I described their operations, functions. Do they create animation or interactivity? What kind of application are they used for? I was looking for a software which covers my requirements in 3D visualization, I could create all my developed representation methods. I presented the program I have been chosen and shortly its operation. I worked out the creation of 3D thematic maps, and an underground map of a city. I developed how interactive maps can be created, how can be published on the internet. I examined the real 3D display, I created also many maps on different devices in 3D, tested them.

III. Develop the methodology of 3D map creation

I created many 3D maps in practice. They belong in two mayor topics, the 3D thematic maps and the underground map of Budapest. The working process of maps are: collecting the data, systematization and

selection, modelling, and visualization. I presented the workflow and what the differences are between the thematic and the underground map. I presented in detail my 3D maps, which method should be used in a specific case. I made a serious research in underground map, I presented my results and the historical research.

IV. Utilization of the 3D cartographic visualization methods

I analyzed the 3D visualization methods, where can 3D maps be used. I examined when to use the 2D and the 3D techniques. I presented the fields of use the 3D maps. The one of the most important application areas are the education and 3D city models. Examined the newest generation, they behavior. The modern maps have to satisfy their needs. I examined the applications areas of underground city maps.

Conclusions

In my research I developed new theoretical 3D visualization methods, which wasn't investigated before. I applied my 3D representation methods successfully in cartography in a new creative way.

The 3D underground map of Budapest is a significant achievement also internationally. The collection of data took many years, it was so wide range as never before, with a unique 3D display.

The 3D maps will be more widely use in the future, particularly in education, dissemination of knowledge, natural sciences, and city models. The virtual and augmented realities, the game engine based applications, the interactive maps will be more popular. There is a high demand in underground city models, more maps and researches will expect in the future.

Publications

Articles:

Zsoldi, Katalin (2014) *3D-s és animációs technológiák a tematikus kartográfiában*. Geodézia és Kartográfia 2014/7-8, 66. Volume. Pp 20-25.

Zsoldi, Katalin (2015) *Budapest földalatti világa 3D-ben*. Geodézia és Kartográfia 2015/11-12, 67. Volume. Pp 14-19.

Conference posters:

Zsoldi, Katalin (2011) *3D methods in cartography*. IAMG2011 conference, Austria, Salzburg.

Conference papers and presentations:

Zsoldi, Katalin (2013) *Economic and social data in 3D thematic maps*. Geospatial World Forum conference, The Nederland, Rotterdam.

Zsoldi, Katalin (2013) *Budapest 3D underground map*. ICC 2013 conference, Germany, Dresden.

Informative and other presentations:

Zsoldi, Katalin (2012) *3D-s térképek*. Digitális képelemzési módszerek a térinformatikában conference. Budapest, Eötvös Loránd University

Zsoldi, Katalin (2012) *3D-s térképészeti alkalmazások*. Presentation, Magyar Földmérési, Térképészeti és Távérzékelési Társaság, Budapest.

Zsoldi, Katalin (2012) *3D-s térképek*. Presentation, Magyar Térképbarátok Társulata, Budapest