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Control of 3D scenes GIS applications

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Abstract

This paper is focused on the exploration of controlling of 3D scenes GIS applications. The first part of the project is exploring approaches to 3D scenes existing GIS or CAD applications. The outcome of this survey was used to design two concepts 3D control. The paper describes the method of usability testing which was used to evaluate those concepts and finally provides a set of knowledge, how to approach to the creation of 3D scenes GIS software.

Introduction

All the major GIS software today allow to view and analyze spatial data. The developers should try to create such as interactive control that allows a simple interaction on the scene with a virtual model. This approach requires an intuitive control in a way that ensures that this software will be used effectively and efficiently, and enjoyably [1] [3]. To create a successful user interface the designer must understand how people think and work. The designer must realize that users do not actually use algorithms, data structures, networks, functions or subroutines, even though as technical professionals this is typically the domain in which they work [2]. For developers these products can be therefore the problem to see through the technological requirements into real user behavior and thinking. This study uses a usability testing as method that can help identify the basic elements, principles of behavior of the user during controlling of GIS 3D scenes.

3D in GIS

The whole project can be divided into three parts. The first phase was exploring the existing approaches to the controlling of 3D scenes of GIS software. From point of commercial GIS software was explored these products: AutoCad Map 3D 2010, ArcGIS – ArcScene 9 and MapInfo Professional. Into this search was also ranked non-commercial system gvSIG 1.9. In the field of controlling 3D scene was study focused on switching between 2D and 3D scene, selecting elements of spatial data, rotation, pan, zoom and flying. There is an assumption that the users use the keyboard and mouse. For this reason, we mainly focus on software behavior and gestures as: pressing mouse buttons, mouse gestures and keys pressing. Finally, we studied the icons, their default position in the GUI, and the cursor icon for the various input methods. Table 1. shows default mouse gestures connected with control function. Table 1. also shows the mouse cursor for each function.

Table 1. Default mouse gestures 3D scenes of GIS software














Action/Cursor	AutoCad Map	ArcScene	MapInfo	gvSIG
pressed left mouse b.	Select data 	Rotation 	Rotation 	Pan 
pressed scroll wheel	Pan 	Pan 	Pan 	Rotation 
scroll wheel rotation 	zoom-in cursor disappears	zoom-out 	zoom-in 	no action
pressed right mouse b.	Options window -	Target zoom 	Options window -	Pan 

Table 1. shows that very often are used mouse scroll wheel for zoom function and pressed scroll wheel for pan. Table 2. presents mouse gestures when user used function Rotate/Orbit. Table 3. shows controlling 3D scene in situation when function pan was enabled.

Table 2. Mouse gestures of GIS software for function Rotate









Action/Cursor	AutoCad	ArcScene	MapInfo	gvSIG
pressed left mouse b.	Rotation 	Rotation 	Rotation 	Rotation 
pressed scroll wheel	Same as default	Same as default	Same as default	no action
scroll wheel rotation				
pressed right mouse b.				

Table 3. Mouse gestures of GIS software for function Pan

Action/Cursor	AutoCad	ArcScene	MapInfo	gvSIG
pressed left mouse b.	Pan 	Pan 	Pan 	Pan 
pressed scroll wheel	Same as default	Same as default	Same as default	no action
scroll wheel rotation				
pressed right mouse b.				

It is obvious that by activation of the particular methods is this function controlled by left mouse button and in the case of commercial software rest of mouse gestures doesn't change.

Control Concepts

On basis of the survey 3D scenes GIS programs were developed two drafts (concepts) of controlling 3D scenes for GIS programs. Both concepts contain methods for selecting data, rotation, pan, zoom/loupe and fly. In the following section parts are described the properties of both concepts.

Concept A

- *Default behavior:* When users switch to the 3D scene they have the following possibilities: By pressing left mouse button it is possible to select spatial data.

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Pressing left mouse button and dragging is displayed rectangle which defines all data for selecting. Key ESC unselect data. Zoom-in or zoom-out is bound to rotation with scroll wheel. While rotation with scroll wheel away from user causes zoom-in and conversely and rotation towards the user causes zoom-out (thus the same principle as for example Google Maps). From previous experiments we found that this approach is quite feasible for users [4]. Pan is implemented by pressing the middle button or scroll wheel mouse. When users press CTRL + left mouse button, it switches from default mode (selection of data) to the mode rotation.

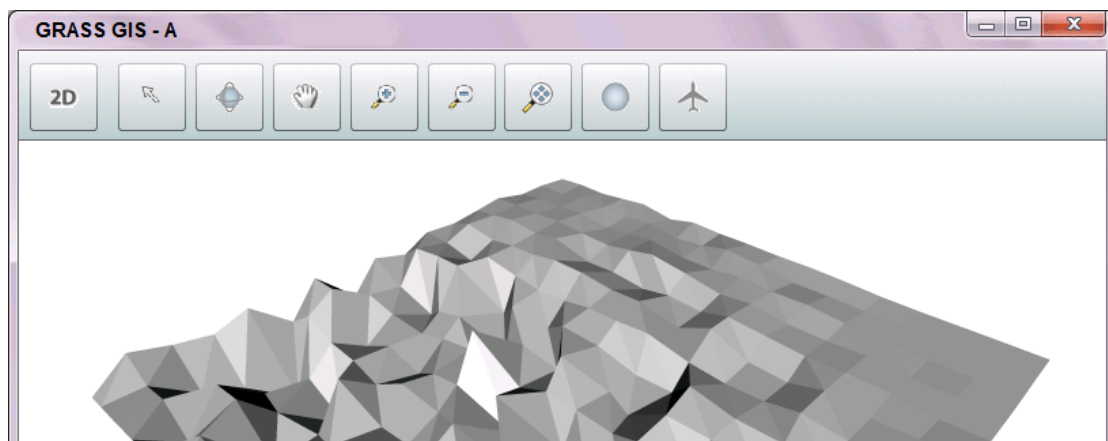


Figure 1. Concept A, GUI

- *Function rotation*: Center of rotation at any given moment is the center of gravity of the currently displayed data. The activated function rotation is to control by pushing the left mouse button and dragging the mouse.
- *Function pan*: This feature is bound to push the left button and dragging the mouse. Pan of the object is realized in the plane of the monitor.
- *Function loupe, show all*: Loupe plus - clicking the left mouse button, the user zooms into the area under the mouse cursor (levels are identical with default zoom). When users press the left mouse button and drag with mouse, a rectangle is drawn, defining the cut, which will be zoom-in. Loupe minus has the analogous behavior of the loupe function plus. The last loupe tool is a *loupe show all* which enables show data fit into the application window.

- *Function reset*: this function redraw the entire scene into the cut displayed in default state.

Concept B

- *Universal Manipulator*: When users switch to a 3D scene is set as the default mode universal manipulator, which offers users all the control options (rotation, pan, zoom). Particular functions are bound to mouse buttons. Pan is controlled when users press left mouse button and dragging mouse. Pan of the object is realized in the plane of the 3D scene. The rotation is controlled with the right mouse button and dragging mouse. The direction of rotation corresponds to the direction of movement of the mouse. Zoom is controlled with the mouse and the direction is same as in the case of concept A.

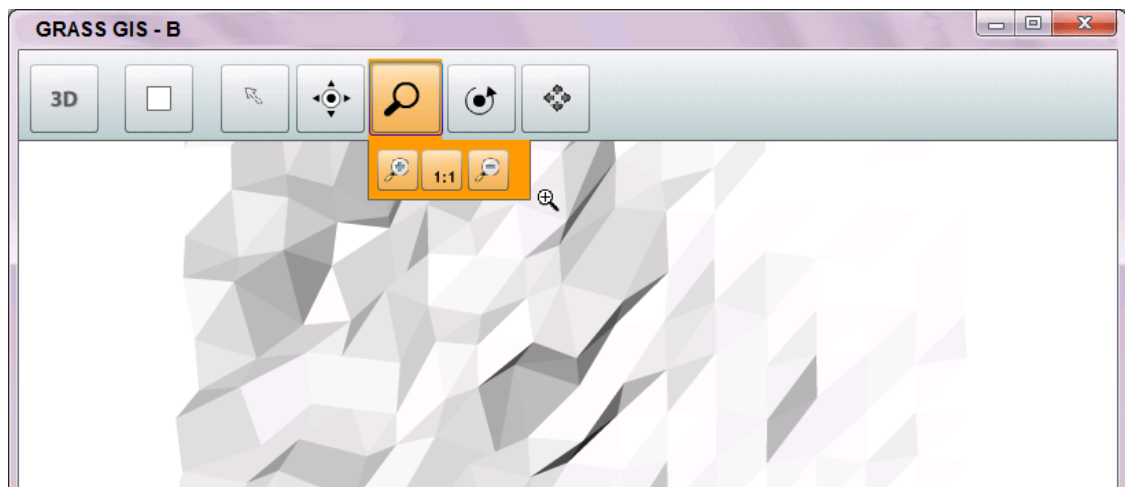


Figure 2. Concept B, GUI

- *Function rotation*: The activated function rotation is to control by pushed left button and dragging the mouse.
- *Function Loupe*: In contrast to the concept A has concept B combined control method for zooming. As is shown on Figure 2. users must first to click on the loupe icon and then choose appropriate function from submenu (zoom plus, minus or show all). Furthermore, the control is the same as in the case of the concept A

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- *Function pan*: control is the same as in the case of universal manipulator, with the difference that the control button is the left mouse button.
- *Function Reset*: this function redraw the entire scene into the cut displayed in default state.

Usability testing of 3D GUI concepts

The suitability of the created concepts was tested using usability testing. Six users participated on usability testing (3 men, 3 women). All participants were students (master or PhD program Geodesy and cartography) with experiences with GIS software. Participants performed three main tasks with both types of concept:

- Moderator showed to participant initial state of concepts and asked them to describe (try guess) function of icons
- In the second task users had to switch into 3D mode use function rotate and set up new position of the 3D model in spatial scene. Moderator gave to user the screenshot of concept, on which was displayed the required position of the model.
- Last task was similar as second task, but there was different required position of the model (users had to use pan and zoom function)

Results of usability testing

Results from tests are divided into three parts. The first describes the general problems that correspond to the both concepts. Two next parts show the issues related with particular concepts.

General results

Users worked with function rotation fine, but rotation reacts very sensitive to mouse gestures. One half of users used for zoom-in/out mouse scroll wheel, second half of users used loupe icons. Both concepts have function for reset view. In a situation when the users got lost, they were looking for this function, but the icons are unsatisfactory.

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Problems of Concept A

Rotation, pan - Nobody used pressed scroll wheel to gain pan (in default select mode). Combination keys ctrl and left mouse button wasn't used to gain rotation (in default select mode)

Results of Concept B

There is as default method used "Universal manipulator" - left mouse button for pan, right mouse button for rotation. Users didn't press the right mouse button to gain rotation. Users prefer method "Universal manipulator" instead function pan. Besides the problems described above, there was problem with icon interpretation. Some users thought, that function rotation allows rotate with model only around one axis. There was also problem with loupe function, because users had to click two times. The action zoom-in/out has two parts. First when user select loupe icon and second when user have to select loupe plus or loupe minus icon. The second step most of users didn't perform.

Conclusion

This paper is focused on research in controlling 3D scenes GIS program. Based on the survey off controlling were developed two concepts and these concepts were evaluated using usability testing. By comparing the number of critical situations, we can say that suitability of the concept A better than concept B. But concept A had a critical point - for example, the reset function. The test showed that the users wanted this function, but in terms of an icon. Partly suitable method seems to be universal manipulator (concept B). There is therefore a possibility for future research that would lead to joining usable parts of B and A concepts.

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