AN APPROACH FOR GRAPHICAL USER INTERFACE DEVELOPMENT FOR STEREOSCOPIC VISUALIZATION SYSTEM

Rositsa R. Radoeva

St. Cyril and St. Methodius University of
Veliko Tarnovo,

ABSTRACT— *Human-computer interaction currently faces the challenge of taking advantage of new technologies, which efficiently use the capabilities of the computing systems of today and more effectively match human capabilities and perception. The rapid development of computer hard- and software has caused significant changes in the way users interact with computers. People have seen a development from the early stages with character based interfaces to modern Graphical User Interfaces (GUI) of today.*

This paper presents a brief overview of the development of user interface and overview of the user interface design; examines some of the basic elements for interaction in 3D interactive systems: manipulation, navigation and application control. On the base of the survey an approach for graphical user interface development for stereoscopic visualization system have been presented.

Keywords: *3D, Graphical User Interfaces, interaction, stereoscopy, system, visualization*

1. INTRODUCTUON

3D applications create visualizations that are closer to real-world metaphors or to improve space usage by adding an extra dimension. In order the user to be able to rotate and move 3D objects and navigate inside a 3D world, a Graphical User Interfaces (GUI) is required.

Problem definition: A system for stereoscopic visualization requires an appropriate interface through which the user to perform different actions on the 3D model. Interactive system for 3D visualization usually represents more space than can be viewed from a single point. Users have to be able to get around within the environment in order to obtain different views of the scene. The ability to control an object in the 3D scene is essential when visualizing dynamic changes in 3D model. It should be set a specific requirements in the process of designing GUI for the system but also the general interface requirements should be satisfied (e.g. is easy to use, prevents user disorientation).

The system for stereoscopic visualization of 3D models has been developed by the author - it is object-oriented; different libraries with a specific purpose have been used. The relations between classes in the hierarchy and the relations between different methods and functions of the used libraries have been determined. The functions and the set of variables to which the user will have access have been defined. The ranges of permissible values of the variables are defined. These variables must be associated with appropriate controls in the GUI. There should be no duplicate functionality part of the GUI. Parts of the interface should be designed as dynamic elements that are usable only if certain options are selected.

* Corresponding author at: *University of Veliko Tarnovo, Faculty Mathematics and Informatics, Department "Computer Systems and Technologies" Bulgaria, e-mail:* **rositsa_r@yahoo.com**

A system for stereoscopic visualization of 3D models which is cross-platform will support the process of model observation and will provide the observer with more information about the presented model independently of the file format.

To achieve the goal the following tasks have been set:

- Survey and problem definition;

- Development of a model of an interactive stereoscopic camera system;

- Visualization of three-dimensional models by the stereoscopic camera system;

- A system graphical user interface development;

The problem of stereoscopic visualization has been investigated and an appropriate model for a stereoscopic virtual camera has been established. The module of the system which provides stereoscopic visualization has been developed by the author [9], [10]. Methods for moving and rotating the cameras have been developed also by the author. A software module that provides importation and presentation of 3D models in the information system for stereoscopic visualization also has been developed [11].

On Figure 1 the conceptual model of the stereoscopic information system for visualization of three-dimensional geometric models developed by the author, is shown. 3D models that are drawn using any kind of 3D design and modelling software such as 3dsMax, Blender and Maya serve as the input for the presented software module. The modelling software used for drawing the models can exports the data into different graphic files format. The software module for 3D model importing imports the datasets and processes them for visualization. The main feature of this visualization software is to parsing the different files formats generated by 3D modelling software and to render stereoscopically the corresponding image on screen.

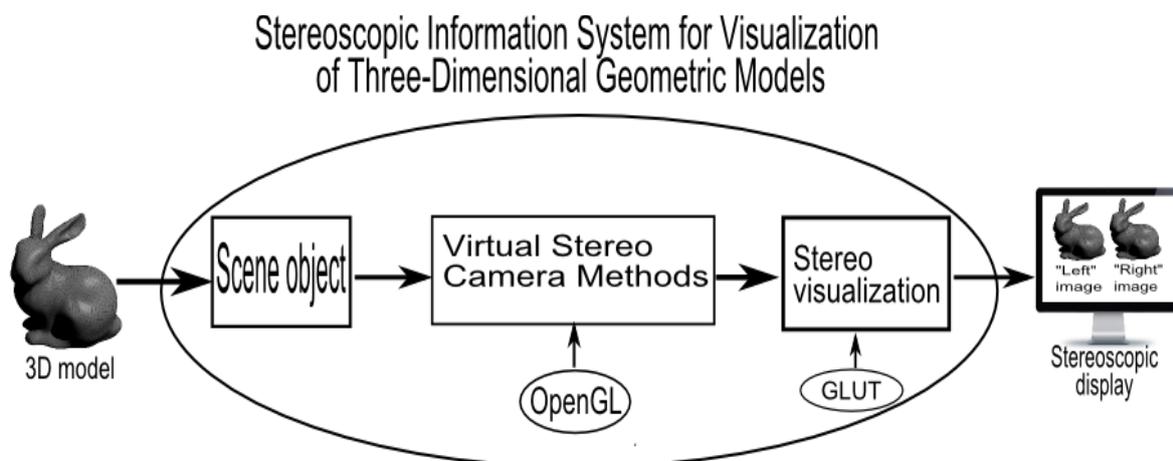The aim of this research is the development of a graphical user interface for the system.

Fig. 1: Conceptual model of stereoscopic information system for visualization of three-dimensional geometric models [11]

To achieve the goal of the research the following tasks have been defined:

- Survey of user interface design and study of basic techniques for UI design;

- A choice of the suitable concepts for UI;

- Implementation of the GUI with the stereoscopic system for importation and presentation of 3D models that has been developed.

2. BACKGROUND

A good application control technique should be easy to learn for novice users and efficient to use for experts; it has to also provide the means for the novice users to gradually learn new ways of using the interface [1, 6]. Window, Icon, Menu, Pointing device (WIMP) interfaces have proven to support all these characteristic. People using computer applications have become familiar with a particular set of WIMP UI components: windows, icons, menus and a mouse. Since the introduction of WIMP interfaces in early 1980s, they are still the leading type of interaction style.

Menus and icon bars are easier to learn as they are self-revealing. The set of available commands is readily visible during the use of the software. These interface components were designed specifically to help users learn and remember how to use the interface without any external help. Theoretical models, experimental tools and real applications have resulted in a generally very good understanding of traditional WIMP interfaces for 2D applications such as word processing and spreadsheets.

WIMP GUIs, with their 2D interface components, were designed for 2D applications controlled by a 2D pointing device. Nevertheless, when the information is represented in 3D space, the mapping between 3D tasks and 2D control widgets can be much less natural and introduce significant indirection and *"cognitive distance"* [6].

Various approaches have been made to develop new metaphors and interaction techniques to take advantage of the greater possibilities of 3D. One approach is the concept of 3D widgets, which involves making the interface components first class objects in the same 3D environment as the rest of the objects in an application. There are no generally accepted metaphors for 3D interfaces analogous to the well-established metaphors for 2D interfaces. The lack of metaphors denotes that essentially no toolkits for 3D interfaces exists [5]. Selective Dynamic Manipulation is a paradigm for interacting with objects in visualizations [8]. Users control the visualizations using 3D handles that may be attached to objects. To manipulate the objects the handles are pushed or pulled. The objects move and react continuously to the manipulation of the handles. Use of interactive animation in this way can help users understand and track the changes that occur to an object set [8].

Other examples of 3D widgets include the Arcball which is a mouse-driven 2D interface to simulate a physical trackball. The virtual object is shown on the screen, and when the user clicks and drags on the virtual object, the computer interprets these drags as tugging on the simulated trackball. The virtual object rotates correspondingly. To provide the third rotational degree of freedom, a circle is drawn around the object, and when the user clicks and drags in the area outside of the circle, rotation is constrained to be about the axis perpendicular to the computer screen [7].

3. DEVELOPMENT OF GRAPHICAL USER INTERFACE FOR STEREOSCOPIC VISUALIZATION SYSTEM

The interaction in an interactive system for 3D visualization can be characterized in terms of three universal interaction tasks [4, 3, 2]: Navigation—refers to the process of getting around a 3D scene: includes a motor component called travel, and a cognitive one, known as way finding; Selection and Manipulation— refers to techniques of choosing an object and specifying its position, orientation and scale; System Control—refers to communication between user and system which is not part of the environment. The problem of providing a user with an interface for exploring 3D environments is strongly related to all the above listed problems.

The GUI for system for stereoscopic visualization of 3D models should meet certain requirements:

- possibility to open a file;

- appropriate controls for performing rotation and translation along different axe in order to explore the 3D model;

- controls for changing the properties of the 3D environment;

- GUI should be a part of the graphic window.

3.1 Graphical User Interface library

There are a lot of software libraries for designing a graphical user interface. To achieve the task that has been defined and to fulfill the requirements that have been set we need a library which:

- provides an appropriate controls;

- is cross-platform;

- is OpenGL based.

After a search by the given criteria, the GLUI library has been selected. GLUI [12] is a GLUT-based C++ user interface library which provides controls such as buttons, checkboxes, radio buttons, spinners, and list boxes to OpenGL applications. It is window-system independent, relying on GLUT to handle all system- dependent issues, such as window and mouse management.

Many applications can be built using only the standard GLUT input methods - the keyboard, mouse, and pop-up menus. However, as the number of features and options increases, these methods tend to be greatly overworked. It is not uncommon to find glut applications where almost every key on the keyboard is assigned to some function, and where the pop-up menus are large and cumbersome.

The GLUI User Interface Library addresses this problem by providing standard user interface elements such as buttons and checkboxes. The GLUI library is written entirely over GLUT, and contains no system-dependent code. A GLUI program will therefore behave the same on SGIs, Windows machines, Macs, or any other system to which GLUT has been ported. Furthermore, GLUI has been designed for programming simplicity, allowing user interface elements to be

added with one line of code each.

3.2 Graphical User Interface development

An approach for GUI development for stereoscopic visualization system is presented in this section.

After the 3D model is loaded in the stereoscopic visualization system the user can explore it via the GUI. Each transformation applied to the imported model is presented in real time. Depending on the selected widgets, the interface is associated with the function from the corresponding module of the system (Fig. 2).GUI is used for loading the 3D models by connecting them with the 3D model importing module. Then the loaded model is forwarded to the stereoscopic visualization module.
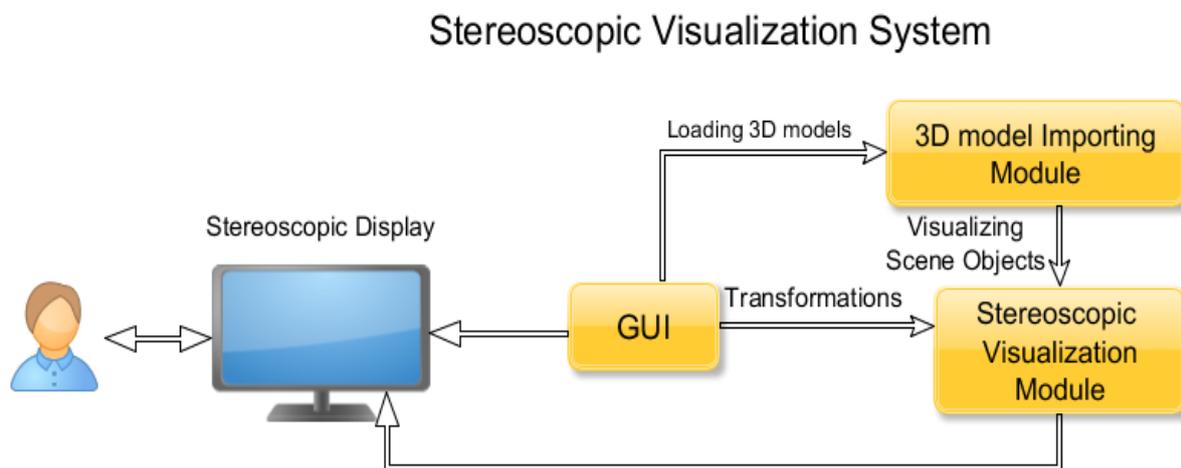

Fig. 2 An approach for Graphical User Interface Development for stereoscopic visualization system

The graphical user interface for stereoscopic visualization system is a combination of interaction techniques listed above and a WIMP paradigm. The user can select from the 3D widgets, placed in the bottom of the window, how to navigate in the 3D scene. From a menu, which can be found on the right side of the main window, the user can change different characteristics of the scene: the colour of the light, the intensity of the light, to enable or disable the light source, to enable or disable the movement. The interface components were designed specifically to help users learn and remember how to use the interface without any external help. On Figure 3 can be seen the structure of the graphical user interface for stereoscopic visualization system.
The key characteristic of the GUI for the stereoscopic visualization system is simplicity.
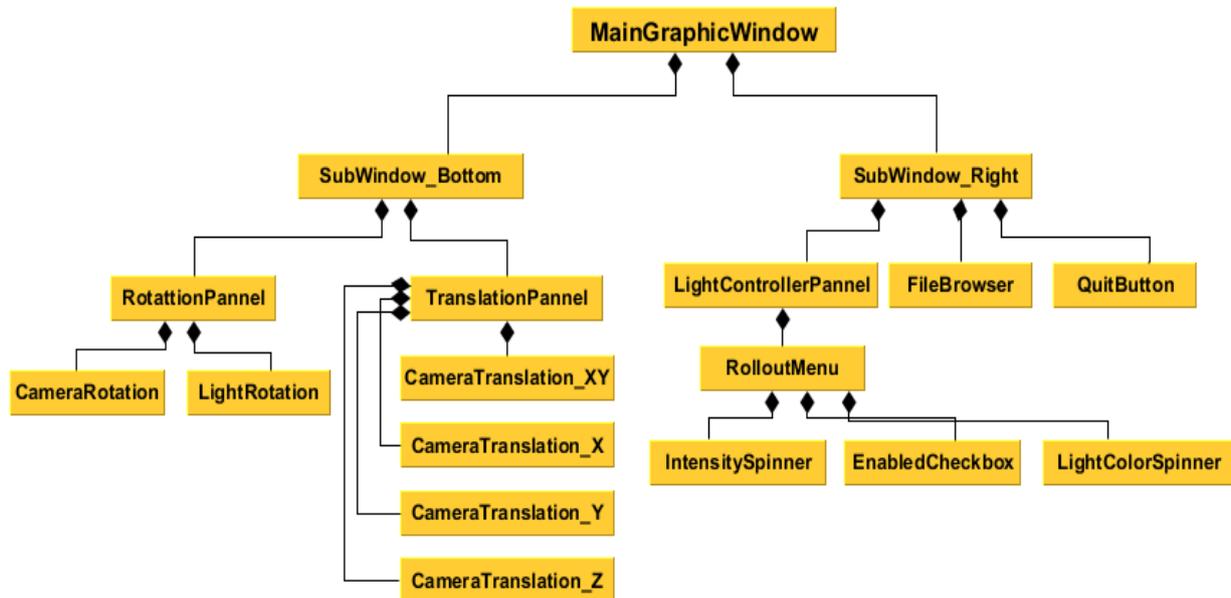
Fig. 3 Structure of the graphical user interface for stereoscopic visualization system

The task that has been set is not common. The presented solution is an approach for creating a GUI for stereoscopic visualization system. This approach is applied in the stereoscopic information system for visualization developed by the author.

4. CONCLUSIONS

User interface design is an essential part of the design of interactive applications. In this paper basic techniques in the development of user interface have been presented. An approach for GUI development for stereoscopic visualization system has been proposed. The presented approach covers the general interface requirements and the set of specific requirements for the GUI for stereoscopic visualization system. The structure of the graphical user interface for stereoscopic visualization system also has been presented. As a conclusion can be said that the principles of traditional user interface design can often be applied directly in interactive system for 3D visualization but 3D interaction have its own unique characteristics that require new approaches.

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