Interactive Panels

A tool for structured three-dimensional scene exploration and visualisation

Michael Starke | Jan Wojdziak | Martin Zavesky | Rainer Groh
Technische Universität Dresden
Professur für Mediengestaltung
michael.starke@hicknhack-software.com
http://mg.inf.tu-dresden.de/

Abstract

We present a tool to easily create, arrange and edit multiple views in a single window allowing the user to coordinate them with the help of modifiers thereby enhancing the interaction with objects and the navigation in a 3D-scene.

1 Introduction

In common interactive virtual environments there are plenty of useful tools to view and edit data. These try to aid the user at visualisation, interaction or interpretation tasks. A common pattern to enhance the interaction with and understanding of data structures is to use more than one view to display the data. By offering more than one view useful information can be displayed in a more efficient way (see figure 1 for a simple example). 3D-modelling tools for example support the user by presenting several different views into the scene or of objects of interest. With different projection methods to render different views of an object, the creation and manipulation gets easier.

The idea of using more than one view to help the user at interaction and analysation can be applied to a variety of scenarios. Coordinated Multiple Views (CMV) extend this benefit of multiple views by enabling controlled coordination between different views. They give the user a deeper understanding of their data, as shown by Roberts [Rob07]. Being implemented in a dynamic viewing system the controlled coordination of views yields a tool to better represent data and it's structure. Our approach is based on the concept of CMV but with the focus set on visualising real-world related 3D-data. Roberts already identified several problems that arise with such a coupled viewing system in [Rob07]. Because we let the user create and arrange the views on his own, more problems surfaced. Some of which where how the views should be arranged or what the size for the views should be and if they all should be uniform or different in size.

Incorporating the method of sequential pictures—or panels—in comics to make even complex scenarios understandable in a limit number of pictures we tried to combine this way of presenting views with the nature of a dynamic visualisation tool. Considering

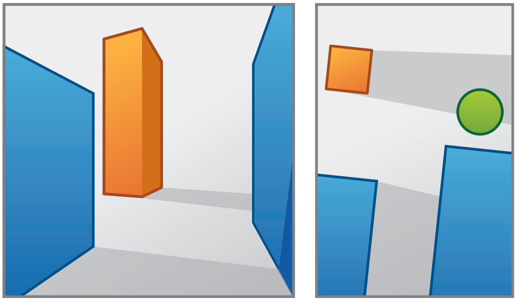

Figure 1: If the user just has the single left view it's impossible to see anything that is occluded by the geometry. With the additional right view the user gains more knowledge of the scene and knows that there's a green object behind the right wall.

different views as mere panels enables us to use the expressiveness of a comic with the dynamics of real time renderings. And thus by combining the flexibility of comic-visualisation and the structural and semantic coordination of views we introduce the method of interactive panels.

2 Related Work

Visual arts show to what extend the frame effects the meaning of a picture [Sch69; Pri08]. KIM showed how panels could be used to guide attention and help show connections in a single view [Kim08]. Giving the user the ability to choose the framing and position of a couple of panel views therefore yields a powerful tool. On top of having control over the layout of the panels, the user gains a sophisticated method to combine the contents of these views which have proven to be an enormous aid to visualise and explore data [Wea04; Wea10]. The panel views and their coordination is heavily dependant on the data and the intention of the user. Thus the interactive approach to the visualisation is beneficial for a tool [Kee+09]. The use of a multi-view system provides additional information for the user and can enhance their experience and ability to navigate in 3D-worlds [MMJ04] or reduce the time to search through vast amounts of sequential data sets [Bor+00].

3 Concept

To aid the exploration of a data set in a virtual 3D-system our goal was to create a flexible, but still easily understandable system to add, remove, edit and coordinate different panel views. An obstacle to overcome was to find an easy method for panel creation, sizing and arrangement. We decided against complete freedom for the user in favour of a more constrained but still flexible system. One argument against freely positionable and sizeable panels was the complexity of such a system. We went for the simpler solution with the possibility to later extend it to a more sophisticated interface.

The layout of the panels is constrained by an evenly divided grid. It's possible for the user to manipulate the number of columns and rows in the grid. Every view needs at least on free cell in the grid. If the grid is changed the existing cells are resized with the new grid layout. Newly created cells are always empty and the existing views are resized according to the size of their cells. These views—we call them panels to adhere the comic heritage—deliver the same freedom a normal single view system offers. Inside them, it's possible to navigate freely throughout the scene. With their flexible position, the user is able to use the size and position just like a comic can use it's panels to support the intended meaning, importance and content of different panel views. Compared to traditional 3D-authoring tools, the flexible layout is a distinctive advantage of the interactive panels method. There is no relation between the sizes of different views. Traditionally a new view would be added as a separate window or it would be integrated into the existing viewing grid. If such views are resized, the space freed up is used by other views. Vice versa the space is shrunken on extending the size of a single view. The placement of single windows is arbitrary but not applicable to our grid based layout.

Our system tries to imitate the appearance of a comic page by offering the freedom to arrange and size an arbitrary number of panel views on the screen. The modification of the underlying grid still has an impact on all of the panel sizes but if a view is present it's size does no more interfere with any of the other views. It's thus in contrast to traditional tools possible to create free space where no view is rendered. Positioning the views is just the first step.

To enable coupled views, connections have to be made. In order to create connections between views and/or objects in the scene, we introduced a concept called 'modifier'. A modifier can be attached to only one panel view but each panel can hold a (theoretically) unlimited number of modifiers. These modifiers encapsulate small modifications—hence the name—of a set of attributes of the panel view they are attached to. They offer the user the ability to change certain parameters by presenting them inside the user interface. The modifications are grouped by the parameters they affect.

The system is designed to prevent the use of more than one modifier with overlapping modifications on a single panel. This prevents the use of more than one modifier, that tries to change the same attribute in a different manner which would result in a collision. The set of attributes is currently restricted to the modification of the transformation (by manipulating the transformation matrix $\boldsymbol{T}$) and projection matrix ($\boldsymbol{P}$) of the panel view's camera. A modifier hereby can change the orientation and position of a view in space and has the ability to manipulate the projection behaviour of that view. We call the direct manipulation of a panel without any input from another scene object or panel *static modification*. Modifiers offer the coupling with other elements by a reference. This reference makes so called *dynamic modifications*—modifications that dynamically change according to changes in the reference—possible. Each modifier is able to use this reference to gain access to the attributes of other elements in the scene. A reference can either be any scene geometry[1] or another panel view.

The panel view parameters are exposed through it's camera in the scene. Table 1

[1]We chose to limit the referencing to geometry, preventing the user to attach a panel view to arbitrary nodes in the scene (e.g. transformation nodes, group nodes) otherwise unpredictable effects would occur.

lists all the currently supported parameters of a panel and it's content. With this basic

Parameter	**Variable(s)**
static	
panel shape*	rectangle
panel size*	$\{w, h\}$
panel position*	$\{s, r\}$
camera location	$\boldsymbol{T}$
camera orientation	$\boldsymbol{R}$
projection	$\boldsymbol{P}$
dynamic	
camera location	$\boldsymbol{T} = f_t(reference)$
camera orientation	$\boldsymbol{R} = f_r(reference)$
camera projection	$\boldsymbol{P} = f_p(reference)$

Table 1: Overview of panel parameters. The parameters marked with * are currently not accessible by a modifier.

concept it is easily possible to create sophisticated coordinated views by combining simple modifiers to form complex coordinations.

4 Results

To create a useful prototype the interactive panels concept was implemented as a plug-in for our existing evaluation and viewer system [Woj+11]. This system provides basic functinality to load and navigate 3D-scenes. The plugin enables the user to add and remove panel views to a viewer window. This window is divided—as explained in section 3—in an editable grid. A panel view occupies at least a single cell in this grid. If a number of panel views is created, these views can be moved and resized as needed with the keyboard, the mouse or a context menu. Although movement and size is always restricted to the grid. To introduce smaller steps in the resizing and movement, the grid can be altered—made finer for example—to accommodate a more appropriate configuration. After a panel view is added to the viewer, the user can navigate inside this view and use it just like a single window (see figure 2). Overlapping of panel views is not introduced in this stage of development but possible.

An example for an application of our system is the comparison of the symmetry of an object. Using two or more views and mirroring their orientation and location over different axis, the movement inside a single (main) view is followed precisely but mirrored in certain degrees of freedom in the other coupled views (see figure 3). Another example is to compare inside and outside aspects of architectural or mechanical structures. By coupling two views to aim at each other and moving the same way inside and outside of a structure one can deduct the connections of features on different sides of an object. Also a scale-factor based comparison is possible. A modifier can multiply the movement of a reference with a scale factor. Thereby the movement of a (main) view is followed

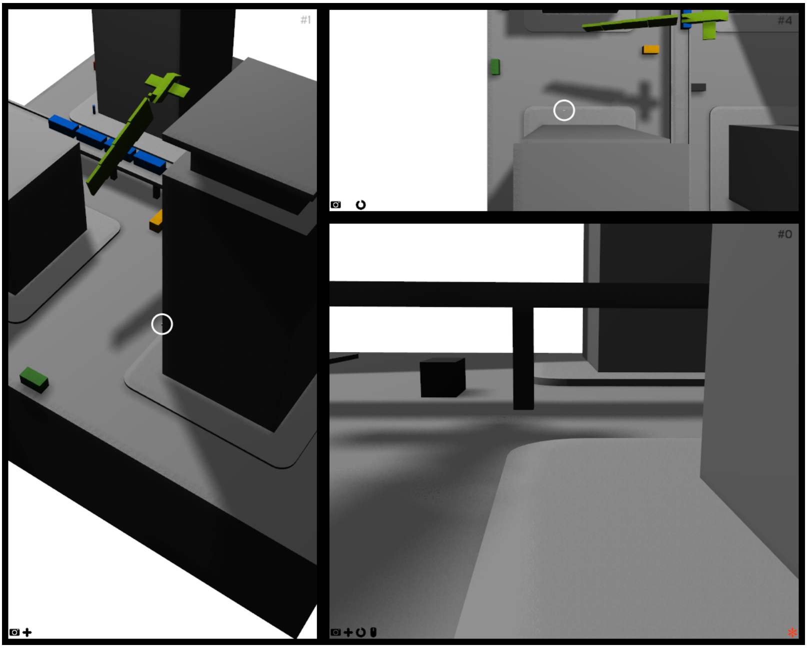

Figure 2: An example of a multi-view scene. The user navigates the scene in the main view (bottom right) and gains additional knowledge with a coupled map like view (top right) that follows him with a certain height offset and looks down. Another view (left) watches the user from a stationary location showing him his movement from a fixed position in relation to the environment. The position of the user is marked with a white circle.

by the coupled views with this factor. This offers a way to compare different scales of objects side by side (see figure 4). Other examples are the coupling of views that use different rendering methods (e.g. shaded and wireframe) to simultaneously show different aspects of an object, the reconstruction of viewable areas from eye witness reports, or fast construction of motion picture scenes by attaching views to different protagonists and using a simple 3D-model of the scene. Another possible scenario is the creation of panorama-like viewing system. By adding, sizing and positioning the desired number of views and using position and orientation modifiers to follow the main view with different angle offsets this can be achieved rather quickly.

These examples highlight another benefit of the panel view structure and the dynamic system—it's flexibility to quickly prototype viewer systems. With this it offers a highly efficient way to experiment with different viewing scenarios and connections between the views. Our experiments showed, that it's not easily decidable whether a scenario of connections is useful in a set of conditions. General rules for visualisation exist (e.g. for

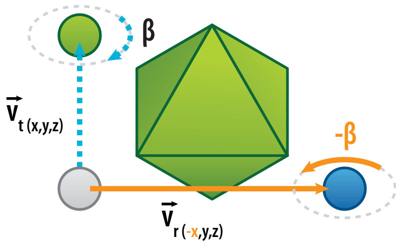

Figure 3: To compare the symmetry of an object a panel (green) is freely positionable and a second (blue) panel is coupled with it's rotation and position. In this case the rotation around the y-axis and the translation on the x-axis are inverted.

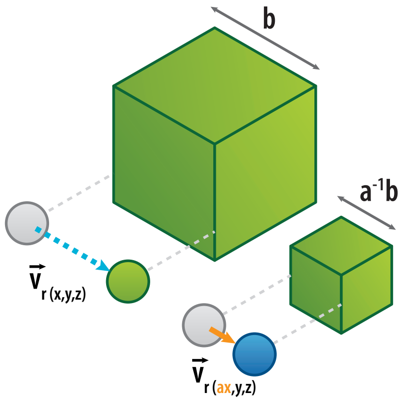

Figure 4: In this example two objects are compared with a scale factor, in this case $\frac{1}{a}$. To achieve this the position of the secondary panel (blue) is coupled with that of the main panel (green) that is freely movable by the user. The position is coupled by the factor a. If a is unknown empirical testing with different values can lead to an approximation.

detail and context, master and slave or depiction of differences [Rob07]) but the user experience and enhancements aren't directly predictable. By delivering a flexible system such scenarios can quickly be tested and the identification of meaningful coordination is vastly improved. We have implemented a number of modifiers for the system. A list of them is shown in table 2.

Modifier	Affects	Description
aim modifier	rotation	aims at the reference
projection modifier	projection	sets the centre of projection to the reference
follow location modifier	position	follows the position of a reference
location modifier	position	sets the position
orbit modifier	position and orientation	orbits around a reference
follow orientation modifier	orientation	follows the orientation of the reference
orientation modifier	orientation	sets the orientation
path walker modifier	position and orientation	travels along an editable path
3rd person follow modifier	position and orientation	follows and aims at a reference with maximum distance d

Table 2: Overview of the currently implemented modifiers and their effects

5 Future Work

Based on our current system, there are certain aspects that are feasible for further research. The placement and sizing of panels is limited right now. The introduction of free placement and sizing of panel views would enable us to use more complex view arrangements. Because of the grid in the current system it is jet unable to offer overlapping panel views. If one would like to introduce nested panel views—for example for detail pop-ups—or useful overlapping effects, this feature would be required.

Currently the referencing model for the modifiers is solely based on the 3D-attributes of a panel view. Future versions should enable reactions to panel movements and resizing Enabling a coupling on the panel attribute level makes dynamic changes the contents of a panel based on it's position possible. Another benefit of this enhancement would be the manipulation of the panel position and size based on the viewed content. An example would be to follow an object with the panel by moving it along the grid. View changes or projection manipulation based on the panel size and position would be possible.

Some tests with the manipulation of the projection centre were conducted but did not result in any useful modifiers.

An easy way for enhancements is the creation of additional modifiers. By delivering a broader set of possible coordinations for the user to evaluate, the system get's more usable and mature. A small list of possible new modifiers is shown in table 3.

Besides the extension and enhancement of the modifier system another aspect is interesting. Currently the user has to make all the decision on what views to create and how to connect them. With further formalisation of rules for coordination to solve specific problems the possibility for an assistant based system arises. Rules building upon the formalisation by ROBERTS could be used to offer suggestions to solve specific problems and create a base system that the user then can modify to his or her need.

Modifier	Modifies	Description
panel size	size of the panel	changes the panel size according to a ruleset
panel position	position of panel	changes the panel position according to a ruleset
geosynchronous orbit	position and rotation	orbits around a reference in geosynchronous orbit
difference image	rendered image	calculates a difference image of two arbitrary panels

Table 3: Examples for possible new modifiers and their effects.

References

[Bor+00] John Boreczky et al. 'An interactive comic book presentation for exploring video'. In: *Proceedings of the SIGCHI conference on Human factors in computing systems*. CHI '00. The Hague, The Netherlands: ACM, 2000, pp. 185–192. ISBN: 1-58113-216-6. DOI: http://doi.acm.org/10.1145/332040.332428.

[Bou+03] Nadia Boukhelifa et al. 'A Model and Software System for Coordinated and Multiple Views in Exploratory Visualization'. In: *Information Visualization* 2 (2003), pp. 258–269.

[Kee+09] Daniel Keefe et al. 'Interactive Coordinated Multiple-View Visualization of Biomechanical Motion Data'. In: *Visualization and Computer Graphics, IEEE Transactions on* 15.6 (2009), pp. 1383–1390. ISSN: 1077-2626. DOI: 10.1109/TVCG.2009.152.

[Kim08] Steffen Kim. 'Erweiterung der narrativen Panelsetzung zur Strukturierung von dreidimensionalen Szenen'. Studienarbeit. Technische Universität Dresden, Apr. 2008.

[MMJ04] Carsten Maple, Rob Manton, and Helen Jacobs. 'The use of multiple coordinated views in three-dimensional virtual environments'. In: *Information Visualisation, 2004. IV 2004. Proceedings. Eighth International Conference on*. 2004, pp. 778–784. DOI: 10.1109/IV.2004.1320229.

[Pri08] Markus Priebs. 'Der Rahmen als gestaltetes und gestaltendes künstlerisches Element - Untersuchung relevanter Parameter und deren Betrachtung in Aggregat- und Systemraum'. Studienarbeit. Technische Universität Dresden, May 2008.

[Rob07] Jonathan C. Roberts. 'State of the Art: Coordinated Multiple Views in Exploratory Visualization'. In: *Coordinated and Multiple Views in Exploratory Visualization, 2007. CMV '07. Fifth International Conference on*. 2007, pp. 61–71. DOI: 10.1109/CMV.2007.20.

[Sch69] Meyer Schapiro. 'On Some Problems in the Semiotics of Visual Art: Field and Vehicle in Image-Signs'. In: *Semiotica* 3.1 (1969), pp. 223–242. ISSN: 1613-3692. DOI: 10.1515/semi.1969.1.3.223.

[Wea04] Chris Weaver. 'Building Highly-Coordinated Visualizations in Improvise'. In: *Proceedings of the IEEE Symposium on Information Visualization*. Washington, DC, USA: IEEE Computer Society, 2004, pp. 159–166. ISBN: 0-7803-8779-3. DOI: 10.1109/INFOVIS.2004.12.

[Wea10] Chris Weaver. 'Cross-Filtered Views for Multidimensional Visual Analysis'. In: *Visualization and Computer Graphics, IEEE Transactions on* 16.2 (2010), pp. 192–204. ISSN: 1077-2626. DOI: 10.1109/TVCG.2009.94.

[Woj+11] Jan Wojdziak et al. 'Figure out perspectives: perceptually realistic avatar visualization'. In: *Proceedings of Computer Graphics and Imaging (CGIM2011)*. Innsbruck, Austria, 2011. URL: http://www.iasted.org/.