Telling Geo-Stories on Spherical Display

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Digital globes as spherical displays are one of the major subjects of research at the Department of Geography and Regional Research (IfGR) at the University of Vienna. The display format of tactile hyperglobes is suitable especially for schools, museums, science centers as well as in the realm of public relations. We think that it is worthwhile to present global issues in a more "personal" way, rather than going on in producing them in the currently common manner. Therefore we consider Interactive Digital Storytelling as an eminent metaphor to display themes that concern "Mother Earth". Thus, this contribution focuses less on technical preconditions rather than on types of currently established geoanimations on spherical displays. Furthermore, a classification of Digital Global Stories according to conventional Digital Stories will be presented.

Keywords: geovisualization, digital globe, spherical display, global stories

1. Introduction

Globes have a long tradition in "narrating" worldwide themes. In particular the information era with its manifold technical possibilities enables an enormous innovation potential for globes. A spherical display fascinates its viewers through its novelty and gives them a better understanding of Earth's phenomena.

In 2005 the Hyperglobe Research Group (HRG) was established at the Department of Geography and Regional Research at the University of Vienna to explore the potential of spherical displays and its suitability to visualize global issues both theoretically and practically. Therefore, in early 2006 a spherical display with a diameter of 1.5 m (in case of the Earth this is a scale of 1:8.5 mio.) was acquired for the first time at an European research facility. In the following some of the issues and results related to "story creation" on a digital globe will be discussed.

2. Digital Globes and Spherical Displays

The renaissance of globes appears as well in the variety of digital globes as in its daily use. Whereas differences of digital globes are constituted in the character of the globe body and its kind of representation space, the linking part is the digital image.

In general terms a globe may be defined as: "a scale-bound and structured model of a celestial body (or of the imaginary, spherical celestial dome) in its undistorted three-dimensional completeness" (Riedl, 2000).

In accordance with Riedl (2006), globes can be distinguished by means of the following three parameters:

- The nature of the cartographic *image* (analogue, digital),
- The character of the *globe body* (material, immaterial) and
- The kind of representation *space* (real, virtual)

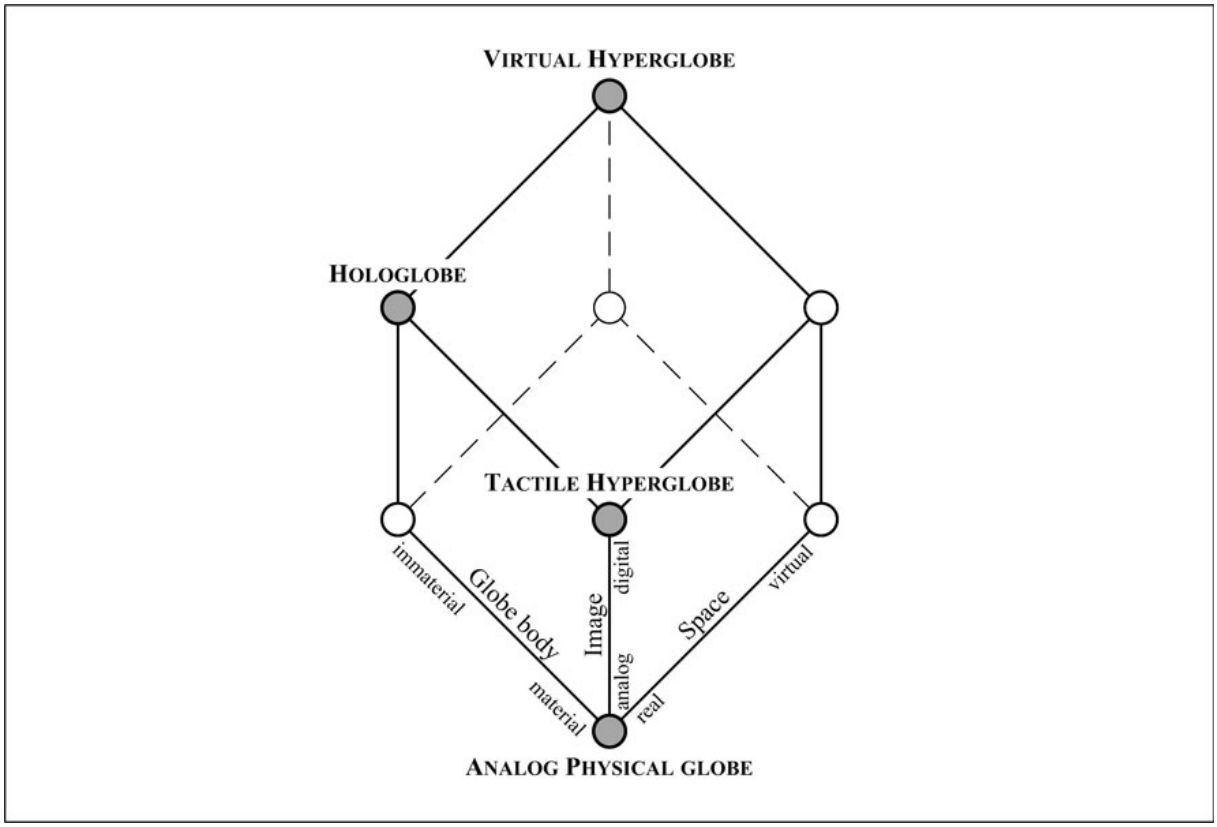


Figure 1. Typology of globes (slightly modified after Riedl 2006)

Out of the named parameters, four realizable representational categories of globes can be distinguished. Beside the well-known analogue physical globe, the following categories of digital globes can be identified (Riedl, 2000):

- Virtual hyperglobes (VHG): visualization of the digital image on a virtual globe body in virtual space
- Tactile (material/physical) hyperglobes (THG): visualization of the digital image on a material (touch-sensitive) globe body in real space
- Hologlobes (HoG): visualization of the digital image on a virtual globe body in real space

Within this classification, because of its character, the THG can be seen as the designated successor of analogue globe.[1] The close relation results from the material, three-dimensional globe body, which serves as a projection screen for digital geoanimations (so called "Global Stories"). The term 'tactile' is used because of the ability of 'touching' the globe body (rather than in a haptic sense that would include the possibility to gain through the sense of touch).

In order to ease the users' access to global issues, the HRG developed an extensive system of topics. Every single theme (story) may be shown directly on the spherical display via a constantly expanding theme catalog (story library). The themes range from static to animated globe images to the point of real-time or forecasting stories, although not all of them are based on a storyboard as described in this paper (see fig. 2).

[1] For more detailed information about technical build-up and functionality see Riedl (2012) and Riedl & Kristen (2010)

3. Telling Stories with Global Animations

The adoption of spherical displays as digital globes for knowledge transfer e.g. in education or within scientific public relations (e.g. in research facilities or in science centers and museums), uses diverse levels of complexity and (didactic) methods to visualize global issues. Besides imparting knowledge about topography, thematic contents play an important role. Their creation has to be based on a didactic concept and their presentation must be as user-friendly as possible. To reach these conditions, an appropriate editorial preparation of geodata in terms of age group and target audience (to meet the users' level of education and standard of knowledge) is necessary. Furthermore hyperglobes, in contrast to analogue globes, allow not only to depict different static globe images but to show temporal changes in the form of animations as well. Thus, the evolution of spatial phenomena can be visualized dynamically and leads to new insight. Professional implementation assumed, an animated development process facilitates the cognitive processing and interpretation. At the same time, this allows higher information density (data finishing) compared to static time series.

Figure 2. Preview of a Global Story in the Global Story Library, covering more than 230 stories (see complete list at www.globoccess.com)

Below, different levels of complexity of globe images (resp. geoanimations) as the basis for "Global Stories" are analyzed, which further leads to a corresponding classification (cf. Riedl & Schratt, 2011).

3.1. Geoanimations Using Analytical Globe Images (Univariate, Monothematic)

a) Singlelayer: geoanimation is limited to modifications of only one geographical variable (the subject of matter) over a period (e.g. visualization of changes population density by the use of different colors on reference areas at different instants of time).

b) Multilayer: the change of a geographical variable over a period is simultaneously shown in (at least) two layers. An example is the combined visualization of the change of relative and absolute population (relative: population density with a set of graduated colors; absolute: population change using circular signatures).

3.2. Geoanimations Using Complex Globe Images (Multivariate, Polythematic)

a) Simultaneous: if the simultaneous change of two or more geographical variables (thematic elements) with direct or indirect context is visualized over a certain period of time. An example for physical-topographical changes are paleo-animations showing the continental drift and orogeny (i.e. change of the global geometry as the first geographical variable) – processes that are implicating climatic and, for instance, vegetational changes on a global scale level (change of land cover as the second geographical variable using the element "color").

b) Sequential: the change of two or more geographical variables with or without direct or indirect thematic relation, but with a common context of mediation, through sequentially visualized partial animations. For spherical displays, this kind of presentation is currently the most commonly used form of „Digital Storytelling".

3.3. Geoanimation Using Synthetical Globe Images

For this kind of visualization, correlations of different geographical variables are reviewed based on subject-specific knowledge and are (via synthesis) combined to new types. In the geovisualization (map), the input variables are not identifiable any longer. The illustration of quality of life gives an example.

3.4. Real-Time Capability of Geoanimation

Not only the degree of complexity of the cartographic visualization needs a closer examination but also the extensive potential for interaction with the globe, i.e. the users' influence on the globe image and the course of the „global story". The interactive possibilities of a global story are tight-knit with the real-time capability of the geoanimation that underlies the story. As a matter of principle, there must be differentiated between the real-time capability of the compositing and those of the projection.

Variations of the real-time capability of the compositing:

a) Pre-Processed: Available images/animations are composed in a special authoring-program and provided as a movie. In this case, raw data from different points in time respectively for a time period has to be prepared by the animation's author or by an editorial team in order to be able to visualize the change in the spatial types. This has the advantage that the complete geoanimation can be calculated in advance even without available real-time capability. It needs to be considered, that every change in the storyboard needs a re-rendering of the movie.

In the playback environment this method has the highest performance, but with the least potential for interaction (play, pause). The user can playback the geoanimation (more or less a passive way of knowledge transfer), but he cannot create new spatial types. Interactions are limited to software-player-functionalities as are common with receptive-passive animations (see 3.5 a).

b) Live-Compositing: Available images/animations are accessed and adequately presented in real-time by scripts/parameters. There is much more potential for creating interaction compared to pre-processed global-stories, e.g. the free rotation of the globe animation, the arbitrarily on/off switching of picture layers, or the user-driven exertion of influence on the storyboard.

c) Live-Creation: The visual content is produced in real time (e.g. with geographic information systems – GIS) or respond directly to input from the user. The geoanimations' content can be created and altered by the user during run-time. Live-creation enables the user to manipulate geodata via data analysis or GIS functions to synthetically create new spatial types and render them as geoanimation (see 3.5 c).

Variations of the real-time-capability of the projection (respectively warping):

The three above named options present variations of the content preparation. Further differences between pre-warping and live-warping are not related to the content but to the projection method that brings the content onto the globe.

a) Pre-Projection: For an accurate visualization the globe image will be geometrically warped in advance (special azimuthal projection). The output can be an image or a video. An interactive exertion of influence on parameters like rotation would not be possible during run-time. This variant would only allow creating pre-processed geoanimation.

b) Live-Projection: The projection of the globe image is carried out in real-time, e.g. on basis of an equirectangular projection (plate carrée). Only through this option, interactive global stories can be realized. Live-projection is the precondition for geoanimation based on live-compositing and live-creation.

Based on the named variations of real-time capability of geoanimations the following degrees of interactivity can be derived. A more detailed exemplification can be found in Riedl & Schratt (2011).

3.5. Degrees of Interactivity in Geoanimations

Two types of geovisualizations can be distinguished: visualizations without intervention in the data that forms the basis of the globe-image (receptive-passive and constructivistic-interactive geoanimations) and visualizations where manipulation or modification of the cartographic design parameters (choice of color/legend, class limits, etc.) is allowed (explorative-interactive geoanimations).

a) Receptive-passive geoanimation: At present in most instances receptive-passive (i.e. linear proceeding) animations are used for the illustration of global changes on spherical displays. With a graphical user interface such linear geoanimations can be replayed, stopped and ended like a movie using (play-/pause-/stop-) keys. In receptive-passive geoanimations the user may have more intervention possibilities, when there is an interactive timeline with a slider that can be moved forward or backward with the mouse (or in case of a touchscreen with the finger) to scroll the animation forward or backward as wanted (comparable with a jog-shuttle in a video processing software). The digital globe image - respectively the data the image is based on - cannot be manipulated by the user. The user is solely passive receptor of visualized content.

b) Constructivistic-interactive geoanimation: With this kind of interaction the user has the possibility to draw freehand with a digital pen either on a touch-sensitive spherical display or on a separate touchscreen that is synchronized with the projection on the hyperglobe by means of "dynamic linking". Optionally, the user can switch on or off globe images that are either static or contain receptive-passive geoanimations with simple player functions mentioned above. However manipulation of the geodata is not possible.

c) Explorative-interactive geoanimation: Animations are always based on a geodatabase. The therein contained geodata can be manipulated interactively and the result can be visualized ("interactive digital storytelling"). Two interactive approaches or forms of the explorative-interactive geoanimation are to distinguish:

First, the analytical approach, where data in the geodataset are analyzed, but no new spatial types created. In contrast to the up to now described forms of geoanimations diverse "direct manipulation" interaction-techniques can be applied (cf. Shneiderman 1998), which allow access to the geodata. On a spherical display the outcome of those interventions in the data can be cartographically visualized. Suchlike interaction-techniques, which are deployed in various application areas of interactive information-visualization, could be, for example, "filtering" (e.g. "brushing"), "details-on-demand" ("semantic zooming" respectively "drill-down") or dynamic queries.

Second, in the synthetic approach, new spatial types are created ("data upgrading") via combination or spatial overlay of different thematic contingent datasets with the use of appropriate (inter- or multidisciplinary) expert knowledge and with the use of GIS-functions (buffering, intersections, modeling, etc.). With geoanimations this will be applied to time series where the creation of the spatial types can be monitored. Regarding global data it is imaginable that in the future a spherical display will play an important role in collaborative reasoning.

4. From Geoanimation to Digital Global Stories

The aforementioned specifications of geoanimations are not only the basis for the currently used categorization of digital globe images, but also for global stories. Sequential geoanimations with complex globe images (cf. 3.3b) for example are already a variant of digital global stories. The theme (or the "story") has a structuring with regard to contents into multiple chapters and follows a certain dramaturgy. Because of the sequential structure sub-animations could differ in duration. Exemplifying (audio-)comments can be embedded in between those animation parts to give additional information and a better understanding or to serve as an introduction of subsequent animation.

The main point for the categorization of digital global stories is the relation to conventional digital stories. Lambert (2009, 2010) distinguishes the following classes of digital stories:

- The Story About Someone Important
- The Story About an Event In My Life
- The Story About a Place In My Life
- The Story About What I Do
- Other Personal Stories

Especially with the class "The Story About a Place In My Life" with its obvious spatial component it is easy to show the connection with geography on a tactile hyperglobe. Out of this reason, it represents the first class in the following categorization. However, it is possible to distinguish different points of view in digital global stories:

4.1 The Story About a Place In My Life

The tactile hyperglobe without is not just a platform for geographical themes. For digital stories like "Almost Paradise" (digitalstorytelling.coe.uh.edu) which feature personal narrations about global presentable changes of places, a visualization on spherical displays is not only thinkable but also a new spectacular opportunity. As for common representations on flat screens the story is told in a first-person-narrative mode by a narrator who is also character in the story and shares his or her personal experiences or opinions.

4.2 The Story About a Place In Someone's Life

This category includes themes, which deal with a single person who can tell a story combined with global content. In contrast to the first class "The Story About a Place In My Life" it is not about personal stories but more like a way of biography. The point of view still is first-person-narrative mode but the stories are not personal.

Example: The Expeditions of Christopher Columbus

4.3 The Story About What I Do

The next category within Digital Global Stories contains themes dealing with the human impact on our planet Earth. Contents like the ecological footprint, the decrease of biodiversity, mostly in the field of ecology respectively environment, address entire mankind. They can be presented in the first-person-plural-narrative mode. A point of view that illustrates that changes and problems affect all of us respectively occur because of our actions.

Example: The Ecological Footprint

Figure 3. The Global Story "Planet Earth – Cosmic Oasis" in action at the Orbitarium (source: Technorama, Winterthur, Switzerland)

4.4 Other Digital Global Stories

"Other Digital Global Stories" include all issues dealing with the Earth's or other celestial bodies' phenomena. There are two options concerning the point of view: Either to tell the story using the third-person-narrative mode or to increase the dramaturgy and personality by using the first-person-narrative mode. In this case "Mother Earth" (or another planet) is in the position of the narrator to provide the viewers insight into what is or has been happening on our planet.

Example: Earth's Genesis

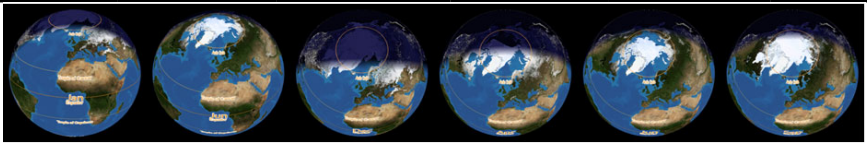
5. Storyboarding in Geoanimations

As in film industry the storyboard as a fundament of planning provides the final ideas and concepts of the director (in case of Digital Global Stories the story developer) on paper or computer. Simon (2007) mentions two important reasons proving the importance of storyboards: time and money. Whether there are blockbuster movies or low-budget films: the more elaborated the concept respectively the storyboard is, the faster and less expensive will be project's realization. This conclusion can be easily and fully assigned to this way of storytelling.

With the help of storyboards two important questions about the flow of a story can be answered (see Lambert (2009, 2010) for detailed information): What happens at what time? How do different media interact with each other? To answer these questions storyboards of digital global stories are composed along a time line, listing all necessary types media and effects. Again, they are differentiated according to the category of media: As for globe images, rotation and flow of the animation is in the spotlight, whereas with other images the options are as manifold as with conventional digital storytelling. Lambert (2009) mentions primarily panning, zooming, various transitions and blendings.

For global stories, which are rather simple (i.e. using only globe images with a legend and information provided on an extra flat screen) the storyboard only features five lines concerning time, globe image, globe effects, text and extern interface information (tab. 1). With this storyboard it is a lot easier to get an idea about the story and its effects. More complex digital global stories including other images, film sequences, music and sound need a more detailed storyboard, which features a line for every media to describe effects and transitions.

Table 1. Extract of the Storyboard – A Course of a Year

time (sec.)	30	36	42	45	48	51
globe image						
globe effects	slow rotation to north pole, course of one year			course of one year		
text	months, circles					
external interface information	Information about the course of a year on earth, the change of seasons, the differences between northern and southern hemisphere					

6. Conclusions

The Hyperglobe Research Globe does constant research on how geoanimations on spherical displays can be improved and further developed. As shown above, global stories exist in a manifold of varieties according to their grades of complexity and interaction. This diversity provides a range of possibilities to visualize global issues, but more and more they are also related to digital storytelling. This is the reason why storyboards as fundamentals of planning become more important. The main focus lies on the connection between interactive digital storytelling and geoanimations in terms of combining different media together with a more emotional way of telling a story. This supports the aforementioned advantages of digital globes and finally leads to better receptivity and understanding of our "Mother Earth" amongst the viewers.

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Article history:
Received July 9, 2013
Revision received August 5, 2013
Accepted August 9, 2013