GeoLens: Multi-User Interaction with Rich Geographic Information

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ABSTRACT

Zoomable 3D map viewers have been used many times as excellent demos of the potential of multi-touch systems. While they showcase the possibilities of multi-touch very well, they are inherently not capable of supporting multi-user interaction. We present enhanced magic lenses - Geo-Lenses - as user interface concept that expands on prior magic lens work. GeoLenses are fully multi-user capable while still being intuitive to use. We built a complete end-user application based on this concept and deployed it in an exhibition. Our observations of application usage by about 150 visitors suggest that the concept is viable and easy to understand for the general public.

Author Keywords

Geographical information systems, GIS, multi-touch, multi-user, tabletop computing, in situ, magic lens

ACM Classification Keywords

H.5.2 Information Interfaces and Presentation: User Interfaces

INTRODUCTION

Demos of 3D multi-touch map viewers abound[1]. The interaction paradigms of these demos are immediately understandable and showcase the possibilities of multi-touch very well. However, they are inherently not multi-user capable, since the interaction of one user will always disrupt the interaction of all other users. A good example for this can be seen in a video[2] of two children trying to simultaneously interact with a map application (see Figure 2): After a short while one child blocks interaction by simply touching the screen.

Magic Lenses support multi-user interaction. In the context of GIS (Geographical Information Systems), they consist of screen areas that modify what is displayed inside - for instance, by magnifying the map view or by displaying different layers of data. Since several lenses can be active at one time, interaction by multiple users does not present a problem. There is a significant amount of research on this

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[1]For examples, see http://www.youtube.com/watch?v=3gxVjzmTnS4 and http://vimeo.com/4973440.
[2]http://www.evl.uic.edu/cavern/tactile/kid.mov

Figure 1. Users simultaneously interacting with the GlobalData application on our multi-touch table.

topic. However, no data on use outside of research laboratories exists and usage in a real application context has not been demonstrated.

We are interested in the use of multi-touch, multi-user GIS systems for the general public. To this end, we have expanded existing Magic Lens concepts to support additional geolocated information and additional methods for configuring the data that is displayed inside the lens. We constructed a full end-user application, deployed it in an exhibition and report on observations of visitors using the system.

RELATED WORK

Tabletops and wall-sized interactive displays are well suited for collaborative work. Co-located collaborative work at tabletops has been an active research field for many years. In the early 90s Tang [16] did observational studies and derived requirements for collaborative work at tabletops and walls. Scott et al. [15] proposed system guidelines for collaborative work at tabletop displays. The DiamondTouch [6], with its capability to distinguish between different users, was often used to explore collaborative work at tabletops (e.g. [7, 8, 17, 19]).

Installations in museums and other public spaces present unique challenges. Hinrichs et al. [10] sum these up very well. Hornecker and Stifter [12] report that time pressure and the number of exhibits in an average exhibition result in many exhibits being abandoned quickly: 'the first ten seconds need to provide an incentive to continue.' In addition, several studies of interactive surfaces in the wild (e.g. [5, 11,
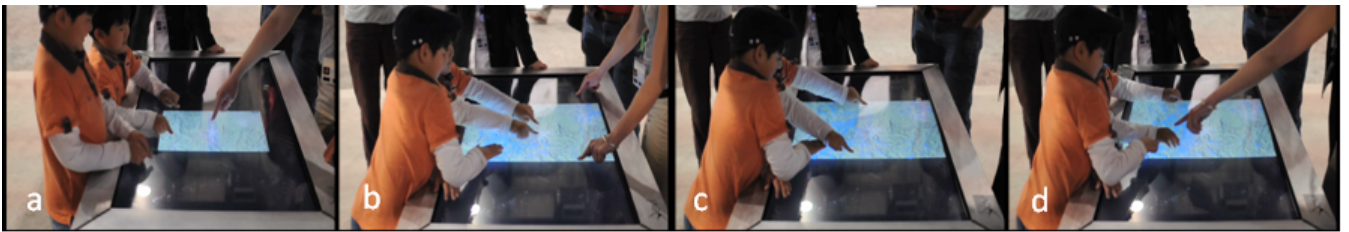
Figure 2. Children blocking each others input (screenshots from video[2]): (a) Children interacting with the table (panning and zooming the map); (b) - (c) The child in the foreground is accidentally blocking the interaction with the table and then consciously blocking the other's input by pushing permantly on the screen; (d) Intervention of instructor to correct the childrens' interaction.

14], to some extent [10]) determine that many users were interested more in the technology or visual effects than the content.

The notion of the "magic lens" was first introduced by Bier et al. in 1993 [1]. Bier et al's original lenses are transparent or semi-transparent user interface elements which can be placed over objects to change their appearance and/or facilitate interaction. Since then, the concept has been applied frequently to geographic visualization. Carpendale et al. made significant contributions, introducing virtual magnifying lenses in GIS applications [3, 4]. Here, they are used as a focus+context technique showing detailed information without loosing the context. The goal of the technique is to allow zooming in while retaining a sense of the global position of the zoom region. In the context of multi-user environments, these lenses allow multiple users to simultaneously inspect details in different foci in a global context. Forlines et al. added user interface tools to the lenses [7]. Furuichi et al. [8] used a magic lens concept to provide several layers of geographic information. However, beyond layers and zoom, configuration of the data set or its visualization is not possible in prior work. Beyond geographical information layers, no additional data is visualized in these approaches. All work on magic lenses described above was done in lab or demo settings; real-world data sets were seldom used, and no study with end users has been performed.

With GlobalData we present a ready-to-use end-user application with a significant quantity of real-world data that can be explored interactively.

THE GLOBALDATA MULTI-TOUCH APPLICATION

The GlobalData application was commissioned as part of the Science Express Germany Exhibition[3]. The Science Express Germany was a mobile exhibition train focusing on research in Germany. It was open for six months in 2009 and was visited by more than 250.000 people. GlobalData was also presented as a demo at ITS 2010 [18].

We used an Archimedes SESSION DESK[4] – a 125×80 cm multi-touch device based on DI – for the exhibit. A horizontal tabletop was a natural choice given that this shows the maps in the correct perspective and is open to collaboration. This was aided in part by the the narrowness of the

train wagons: the table was only accessible from three sides.

GlobalData was developed using the open-source media development platform libavg[5].

Content

As content we used the National Geographic Special Edition on the Planet Earth 2008 [13], including many maps, statistical data, images, additional videos and documents. From this, the GeoLens concept was derived: Multi-user interaction is facilitated using personal "magic lenses" on a 2D map of the earth. To integrate the content into the application concept, we made an early decision to have several different map views, per-map geolocated images and videos, per-map geolocated text snippets and a legend for each map. In the end, we had 4 maps and a total of 63 geolocated info points, with most of the points containing textual as well as image or video data.

In accordance with the topic of this railcar, the map views selected were: Population (per-country population density data), Habitat (density of farm and pasture land), Overfishing (density of ocean fishing) and Water (density of irrigated areas). The population view deserves special mention: It shows population data for the years 1950-2008 and projected data for 2030. This data was not part of the National Geographic Magazine, but compiled from GapMinder[6] and mapped to a world map using standard GIS software.

Interaction

In idle mode, the device shows a stylized map of the earth. No usage instructions are provided. However, users can open circular GeoLenses by simply touching the surface (see also Figure 3). These circles show the same map segment as the underlying base map and superimpose different data layers on it. GeoLenses can be dragged and resized using the standard pinching motions. GeoLenses are novel enough to attract attention to the exhibit. Still, they are immediately understandable as a user interface concept and thus easy to use. All interaction takes place in the context of a lens.

While the device has no concept of lens ownership, personal space issues that come into play in such a collaborative environment [9] are dealt with smoothly. The initial size of a magic lens roughly corresponds to the intimate space of the

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Figure 3. Screenshot of GeoLens showing the user interface components: (1) Geolocated point of interest; (2) Map view menu; (3) Geolocated text; (4) Open/close button for geolocated images and videos; (5) Geolocated image; (6) Open/close button for map legend; (7) Time slider for population data; (8) Language toggle.

Figure 4. Future work: The GeoLens concept transferred to a different domain.

person interacting with it. Dragging and resizing operations allow collective ownership and ownership transfer. All additional content and user interface elements specific to a lens are grouped around it. The area inside the lens is intentionally kept clear of user interface elements and contains map data and location markers for georeferenced items. The goal was to keep the lens itself visually clean and avoid user interface conflicts between the elements and dragging or sizing operations.

A menu near the lens switches between different map views. Buttons on the lens perimeter open and close the map legend and geolocated images and videos. An additional button is used to switch between different languages. The geolocated text snippets are also displayed close to the lens. These change automatically without user interaction as the lens is moved around the tabletop. When the population view is active, an additional slider allows the user to choose the year that is visible in the GeoLens. Note that this represents an additional degree of freedom not present in prior work.

OBSERVATIONS

We observed about 150 exhibition visitors in early June 2009. Group size ranged from 1–5 people, with a few larger groups (school classes) and a wide age distribution, including a significant number of senior citizens. As is typical for museum exhibits, mean interaction time was about 3 minutes. Most of the groups recognized the collaborative potential of the application and interacted together on the table. As with many public displays, getting people to interact with this exhibit proved to be a critical point (see [2]). Some visitors passed by the GlobalData exhibit without noticing its potential at all (see Figure 5c: visitor watching world population clock instead). As soon as one person started interacting, others invariably followed.

As hoped and anticipated, collaboration and communication between visitors was widespread. In many cases, people would open lenses by themselves but communicate with each other at the same time, teaching each other how to do things or showing each other interesting info on the map. In
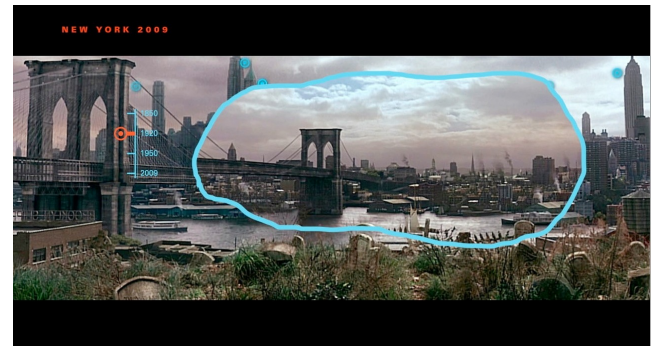
contrast to prior studies [10], it was common for more than one group to interact at one time.

We observed that about one third of the people interacting used only a single finger. One simple reason was that a lot of people were carrying things (backpacks, jackets), but others simply did not expect multi-touch functionality. A significant number of visitors belonging to the second group did not attempt to drag the lenses either, but simply opened new ones as necessary. Luckily, the application supported this type of interaction as well. Age-wise, we found that older users were just as capable of interacting with the application as younger ones. As was to be expected, younger ones experimented more and were mostly interested in the visual effects, while older people were more thoughtful in their actions and spent more time browsing the actual content.

One of the most important observations we made was that most people were actually able to access the content after a short period of exploration. Many visitors were genuinely interested in the content and spent some time moving lenses around, reading the text and generally learning about the actual subject matter. At first, this may not seem like a significant achievement. However, it is in contrast to several prior studies (e.g. [5, 11, 14]) of interactive surfaces in the wild, where the focus of the interaction was the technology and not the content.

CONCLUSIONS AND OUTLOOK

Our observations suggest the principal viability of the GeoLens approach for data exploration by untrained users - the principles of interaction seem to be immediately apparent to the majority, and access to a large amount of content is possible in this way. However, a full in-situ user study would be necessary to verify these findings and prompt further improvements.

The concept of GeoLenses would appear to generalize very well. Sliders, menus and buttons can be used to configure the content inside magic lenses in arbitrary ways. Geolocated data can be viewed, GIS layers selected and configured using controls arranged at the perimeter of the lens. The time slider in particular could be used in very different application settings as well - see Figure 4.

Figure 5. Observations in the train: (a) - (b) Visitors interacting with the table. (c) One person ignores the interactive table, watching the world population clock instead.

Further expansion of the GeoLens concept seems possible. While we enable more fine-grained control of the visualization in this particular application, further use cases as well as usability studies in a controlled environment would allow statements regarding the general feasibility of the approach. The combination of GeoLenses with zooming lenses is another promising research direction. Also, the current solution simply prevents lenses from overlapping; the ability to merge lenses could aid cooperation.

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