

Exploring faceted geo-spatial data with tangible interaction

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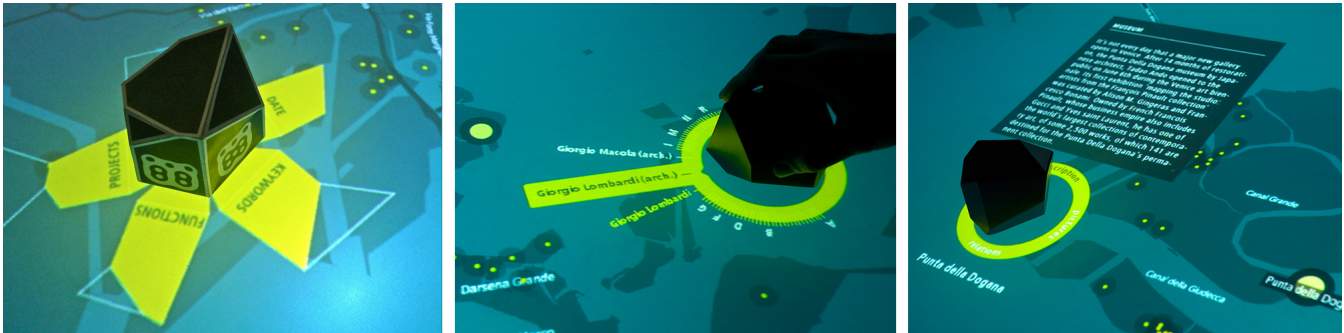


Fig. 1. Interaction sequence with the tangible object, starting with a) selecting one of the facets, b) choosing a specific entry from the radial menu, and c) browsing through further metadata and media of a selected project

Abstract—In this paper we introduce a case study on tangible geo-visualization on an interactive tabletop to enable the exploration of architectural projects in Venice. The tangible user interface consists of a large display showing projects on a map, and a polyhedral object to browse these data interactively by selecting and filtering various metadata facets. With the object we aim to reduce the barrier between the physical world and virtual data, and ease the understanding of faceted geo-spatial data.

Index Terms—Tangible interaction, geo visualization, tabletop interface, urban planning, multi-touch, faceted data, visual browsing.

INTRODUCTION

Work with geospatial data is routinely carried out in groups with users exploring the data in ways according to their different needs. Public participation geographic information systems (PPGIS) “usually call for an open-ended exploration in which users [...] examine various issues that relate to their community and locality” [1]. In her literature review, Sieber [2] summarizes that PPGIS “allow participants to dynamically interact with input [...], and empower individuals and groups.” Instead of creating a PPGIS with all the possibilities complex GIS offer, we intended to develop a reduced but simple-to-use interactive tabletop visualization with a narrow focus on a specific data set to trigger discussions at town-hall meetings or urban centers, and to support active citizens and local stakeholders to impact the directions of their cities. We strived to create an explorative visualization to invite residents to participate in the analysis of information referring to their physical environment, and in the understanding of territorial transformation processes.

1 FACETED DATA

The “Venice Unfolding” prototype [3] visualizes the spatial and conceptual relations of 116 architectural projects of the City of Venice. The metadata of each project includes the title, description, media files, the geo-location, and multiple terms from an architectural taxonomy.

Metadata is faceted when it is composed of orthogonal sets of categories, allowing the assignment of multiple classifications to an object. Faceted metadata has been proven to support exploration and discovery [4]. For this prototype we employed facets relevant to architecture and urban planning, i.e. designer, date of construction,

and functional typology (such as “Infrastructure” or “Residential”). We picked these classification categories, as they can describe the visualized projects appropriately. For the latter two facets we utilized a subset (selected by architectural experts) of flattened classification terms from the hierarchical MACE taxonomy [5], to reduce the conceptual complexity while still enabling semantic interoperability among contents. All facets are used to determine relations between projects based on shared metadata.

1.1 Polyhedral object

For browsing and selecting these facets we used a physical object, allowing the user to explore the data in a tangible manner. It provides a sensory experience, and aims to reduce the barrier between the haptic world and the intangible virtual data.

The object is a polyhedron, with each side representing a facet. When users want to choose a facet, they tilt the object towards the respective area. The asymmetrical polyhedron consists of one base area and five responsive facets in different shapes, which act as filters to various facets of the data.

In the design of the object we opted for a shape signifying the interaction possibility, hinting to the literal meaning of a “facet”. Furthermore, we intentionally designed the object to create curiosity by being an interesting physical artefact to invite users to touch and utilize it.

2 PROTOTYPE

The application is built for a tabletop display, and shows a map as basis layer, which can be navigated by finger interactions. On the map, projects are displayed at their locations, with further metadata visible on demand. The polyhedral object can be placed on the interactive surface, and can be used to select various faceted data and filter the projects.

The surface of the tabletop is 1.87 square meters, and allows multiple persons to use the visualization prototype, at the same time. For more details on the tabletop and the technical setup see [6].

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2.1 Maps

Cartographic information depicted through the map comes from OpenStreetMap [7], while Cloudmade [8] provides the image tiles. This allowed us to embed interactive maps fast and effortlessly without the technical setup of a complete map server stack. While the main reason was to customize the map according to interface design necessities, one further advantage is users may contribute and update underlying spatial data. This crowd-source approach may encourage stakeholder communities to participate in discussing territorial problems.

We created a reduced map style, which displays only few geographical features. As the prototype is aimed at residents knowing their environment, the map supports recognition, while being discreet enough to not hinder the display of the data and interface layers.

2.2 Interaction & Visualization

In the beginning, the map of the whole territory is displayed with all projects represented as markers at their locations. Users can zoom and pan the map to select an area they are interested in (by pinching, respectively dragging it with their fingers). Tapping a marker (i.e. touching it with a single finger) selects the respective project and shows its background information and media files, as well as connections to related projects.

The main exploration activity is performed with the physical object, which allows haptic direct manipulation. To select a facet the polyhedral object can be tilted to one of its sides. The edges of the polyhedron are flattened, aiming for an effortless and easy-to-use tilting maneuver.

For the visualization of the data facets we used the metaphor of unfolding a 3-dimensional object, to support users grasping the concept of opening the data set from different perspectives, and “to present a broad overview of the entire collection and to allow many starting paths for exploration” [9].

The polyhedral object can be placed anywhere onto the table's interactive surface to begin with one of two interactions: (1) Select criteria to filter and display specific projects, and (2) Browse background information of a single project. When a user puts the object onto the tabletop, the facets are displayed, each represented as an unfolded face of the polyhedron (Figure 1 a). After the user tilts the object onto one of its sides, the entries of the chosen facet are displayed as a radial fisheye menu surrounding the object (Figure 1 b). The text items are alphabetically ordered and displayed as small ticks, thus visualizing the overall amount of items. By rotating the object the user can now browse through the terms. The currently viewed one is set in large type. Its direct neighbor entries are legible as well, while farther apart ones are blanked out due to space constraints. The user can choose a specific item by moving the object towards its text representation. After a user's selection, the application filters the data set, and highlights matching projects on the map. If necessary, the map section automatically adapts appropriately, so highlighted projects always fit the whole table surface.

After the user selects a single project, the radial menu around the polyhedron changes to offer background information. The three categories “description”, “pictures”, and “relations” are shown at North, East, and South position so as to not interfere with the facet item selection (which is at West). Keeping the same interaction mechanism, users select a category by moving the object towards its respective orientation. By rotating the object inside the ring users can explore project information in detail: scrolling through the descriptive text, and browsing through explanatory pictures (Figure 1 c). Selection of the third category (“relations”) activates the project's conceptual network with other projects (Figure 2).

When the user selects this modality, all corresponding projects are highlighted with their titles on the map. The possibility of showing related projects in a direct visual way is a key feature of the interface.



Fig. 2. Exploring relations between projects.

The relations are based on common metadata, e.g. same designer, or sharing some conceptual classifications according to the taxonomy.

3 EVALUATION

We conducted a formative user study to gather first feedback from users working with the prototype. We asked the six participants to think-aloud while executing specific simple tasks, and to fill out a post-test questionnaire on their satisfaction with the tool.

While the map and the display of the projects were interpreted correctly, the polyhedral object was not immediately understood by all participants. After they learnt the implemented interactions, the participants described the prototype as “playful”, “inspiring”, and “liked” the explorative approach. We are currently investigating if an embedded accelerometer would allow us to communicate the tilting mechanism more direct, by giving an immediate visual feedback.

4 CONCLUSION

We presented a case study visualizing architectural projects in Venice. First results suggest the tangible interaction with the polyhedron reduces the barrier between the physical world and virtual data, and eases the understanding of faceted geographical data. The presented mechanisms look promising to be used in other domains with tabletop applications enabling non-expert users to explore various facets of a dataset in a unified visualization.

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