TOGO: a Contextual Tourist Mobile Guide

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TOGO: a Contextual Tourist Mobile Guide

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Abstract. *In this paper, we present TOGO, a general model and a limited prototype of a contextual tourist mobile guide dedicated TO the city of GOrizia. Our goal is twofold: first, we offer contextual views to the users, and, second, we provide them with a personal workspace in which they can also create new, personalized paths. In order to capture semantic interconnections among data, we use advanced data structures called zz-structures, a graph-centric system of conventions for data and computing, able to simply offer semantic modalities of navigation.*

Keywords. semantic interconnection, mobile applications, advanced data structures, personalized workspaces, authoring.

1 Introduction

In parallel with the wide diffusion of mobile systems (as tablet or smartphone), the number of tourist mobile guides is rapidly increasing: they offer detailed information, and interesting tours related to cities, museums, cultural heritage but also to shopping, attractions, services, and so on. But, in the major part of the cases, they share same drawbacks: do not offer personalization; do not manage dedicated user workspaces; do not provide semantic navigation; do not enable users to insert their preferred tours or to create new itineraries.

The work we present in this paper has the aim to provide a proposal for overcoming these limitations: TOGO is also a prototype, but mainly a general contextual model for a virtual tourist guide dedicated TO the city of GOrizia, Italy.

Our contribution: TOGO offers contextual and semantic navigation on the data; it introduces user personal workspaces and manages user profiles; it enables the users to create and share news paths. In order to achieve these objectives special attention has been given to identify an advanced model for structuring the data but also to maintain the users' navigation history, their contributions, and the evolution of their profiles.

Application domain: In this paper, we focus our discussion on a case study dedicated to *Palazzo Coronini Crönberg*, the residence of the last count of Gorizia, Guglielmo Coronini, and the historical and artistic patrimony put together in the centuries from his family (furnishing, pictures, sculptures, archives, library and collections), now property of the city of Gorizia according to his testament.

The prototype: The TOGO prototype is based on Flash technology, Action Script language programming, and XML semi-structured database; it is conceived for current generation smart-phones and tablets: its implementation has been important for testing the abstract model and for studying innovative approaches to dynamic paths and authoring in the field of mobile guides.

The rest of the paper is structured as follows: in Section 2, we discuss the related work; in Section 3 we present our framework, describing the structure of the contextual knowledge base and the user model specification; in Section 4 we propose two use cases dedicated to the user navigation and the authoring processes. Final discussion and future work end the paper.

2 Related Work

Current mobile guides of (also international) museums suffer from some limitations: the *Musée du Louvre* application [1] is rich of information and multimedia contents, and proposes an advanced graphical interface. But, it presents navigation issues (bad orientation of a picture when selected and displayed a part of the collection), emphasizes disorientation, and limits the user tasks. Furthermore, the stimulating presence of a '+' button provides the user with commercial information and not with insights instead. Similarly, the *MOMA* mobile guide [2] helps the visitor with an audio support but provides the user with rigid and predefined paths of visit.

A number of research projects are looking for innovative models: some of them are described in [3] where the authors survey mobile applications and research prototypes, highlighting the research methodologies, objectives and services. We identified five challenging aspects for an innovative mobile guide and concrete issues in the current systems:

- *Provide personalized content and views*: profiling the user means also to filter the content and customize the views, based on her behavior, preferences (e.g. in terms of most rated and visualized item, number of shares

- *Enable user to author new tours*: rarely mobile applications provide people with authoring and creation features, and when they do, these are often limited. An interesting example in this direction is the *Italian Touring Club Mobile Guide* [4]: a user can add personal contents, such as notes, photos or bookmark specific localities, but when the user uses these functionalities the application many times crashes. If the operation ends with success, there is no way to modify or delete the inserted content.

- *Apply semantic relations* among items, providing virtual tour services primarily based on recommendations. An opportune use of semantic Web technologies could provide the user with recommendations during virtual tours, as discussed in [11, 12], overcoming for instance the issue of the first-time user. Also, it can be interesting (as proposed in [5]) provides the user with augmented reality views thanks to *semantic annotations*. In this setting, semantic relationships become essential in order to allow the user to discover interconnections between different typologies of objects, explore new itineraries of visit and obtain rich and contextual information.

- *Provide support to social aspects*: a mobile guide should enable the users to share their favorite objects, their paths and generally their feedbacks. Some guides, as the *Musée d'Orsay* mobile guide [6], allow users to share each view on several social networks, but offer a rigid and quite confusing navigation schema, and no other support to the social aspects. Others, as *MOMA* [2], do not consider at all the sharing on social networks.

- *Provide contextual information and navigation*: the hierarchical structure, typical of the file systems, dominates the way in which the information is proposed. Our idea is that we should overcome this restriction and provide for each view/object also the other information semantically connected with it. This provides a contextual and semantic vision of the contents. To the best of our knowledge this aspect has not been considered yet and our prototype should investigate it improving the user experience applying specific contextual structures, the zz-structures.

In this paper, we focus our discussion on two of these issues: the limited, or even not considered, contextual visualizations, and the lack of a customizable user workspace. Our research wants to analyze and design an innovative model, where the users can pick from each view/item the semantic relationships and links with other ones, create their personal workspace and share information and knowledge with their social communities.

3 The TOGO architecture

Our framework relies on a client-server architecture; it has been developed following a Model-View-Controller design pattern [16] as shown in Figure 1. The main components

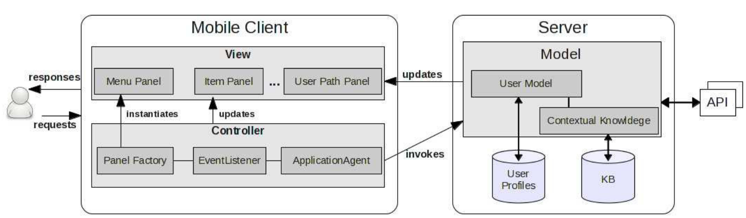

Figure 1: The TOGO architecture.

of our architecture, distributed among server and mobile client, are:

- **Model**: it contains not only data and knowledge, but mainly a set of methods. The data is organized in two separated datasets, *Knowledge Base* and *User Profiles*, that collect respectively the items concerning the museum domain collection, and the user profiles (her chronology, her preferences, her features, etc.). This data is opportunely aggregated and structured by: (a) the *Contextual Knowledge* that, using specialized methods and the zz-structures data model, transforms information in semantic knowledge; (b) the *User Model* that simplifies the user navigation, enabling her to create personal paths and manage her workspace. Specific methods allow the Controller to query and retrieve data both from the User Profiles, due to a package devoted to the user management, and from the Knowledge Base thanks to a set of classes concerning the museum domain collection.

- **Controller**: this component mediates between the Model and the View. It has been organized in terms of a multi-agent system, able to receive the user (and system) requests and manage them in order to carry out the appropriate actions. Whenever the *EventListener* receives a request, a dedicated class of *Coordinator Agent* detects the *Application Agent* able to elaborate it. The result of this process is managed by the *PanelFactory* that, with the necessary parameters, sends the response to the View.

- **View**: this component gives a graphical interface to the Controller and Model activities. View implements different screen panels, one for each type of content (such as main menu, personal user workspace, specific items of the museum - rooms, plans, collections). Particular attention has been given to the panels aimed to create, edit and display the customized paths of users.

Below we deepen the discussion on the content of the knowledge base (Subsection 3.1), the semantic organization of the contextual knowledge (Subsection 3.2) and on the user model specification (Subsection 3.3). Then we describe (in next Section 4) two scenarios related to a multi-dimensional navigation and to the authoring of new paths.

3.1 The Knowledge Base

The knowledge base contains entries related to historical and artistic patrimony (furnishing, pictures, sculptures, archives, library and collections) of the Coronini Crönberg Palace. These have been carefully modeled working with cultural heritage experts and by extending previous classification at a high level of specification. Even though this has been a time-consuming process, it also had a twofold advantage: it has allowed us to define a highly customized, proper and effective data structure suitable for manipulation and querying, and to create a scalable, structured knowledge base reusable in future extensions and applications.

The knowledge base is stored in a XML semi-structured database, conform to a specific DTD definition: it contains14 rooms on two floors, 11 representative cultural heritage categories, for a total of more than 3000 classified objects. The categories are paintings, sculptures, prints, ceramics, coins, miniatures, jewelry, silverware, clocks, fans, laces and weapons. All the items share a common data structure layer which has been depicted by the following attributes: a unique nomenclature, a list of pictures, the room in which they are situated, the position within the room (related to the image plan representative of the floor), a textual description, a historical perspective description, the category to which the item belongs and a curiousness description. For each element we have also identify three different kind of *tags* which are used both for descriptive purposes and for creating connections among the items; in particular each element is described with a list of (i) *primary tags* which represent qualifying features of the element (e.g. the element name, its category); (ii) *secondary tags* that refer to information that is contained in the element description which may be considered of secondary interest (e.g. its position, historical info); (iii) *referential tags* namely the terms that represent links to other elements. This annotation schema allows us to have a rich description of the elements useful for implementing *the search algorithm* which exploits these tags, but also for inferring semantic interconnections between different objects annotated by neighbor tags.

3.2 Contextual Knowledge

The cultural heritage virtual tours, mainly based on mobile guide, suffer from a rigid navigation. In order to overcoming this issue and provide new, advanced, and contextual navigation modalities, the TOGO navigation model is based on zz-structures [14]: they are a graph-centric system of conventions for data and computing, able to simply connect different element through semantic connections.

Readers interested in a formal description of a zz-structure will found it in [10]; intuitively, a zz-structure is an edge-colored[1] multigraph[2], subject to the following constraint: the degree[3] of each node for a given color can assume only three possible values: 0, 1, or 2. In other words, for each color/label the multigraph presents or singletons, or linear paths, or cycles.

Each vertex of a zz-structure is called *zz-cell* and each edge is a *zz-link*.

In this way, for each color/label, we can extract by a zz-structure a sub-graph, composed by connected components (linear paths or cycles). Each connected component is called *rank*, while the subgraph *dimension*. Each color/label is associated to a specific semantic context; for this reason, ranks and dimensions provide a semantic interpretation of the zz-structure.

An example of zz-structure is the edge-colored multigraph proposed in Figure 2.

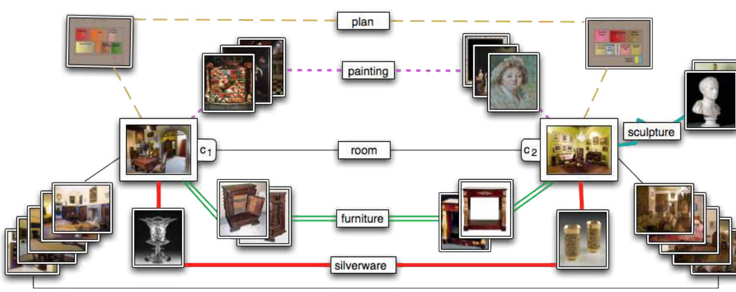

Figure 2: Multiple starview.

The nodes (zz-cells) represent rooms and objects of the Coronini Museum, and the colored (labeled) edges define semantic relations among rooms and objects.

Looking Figure 2 from top to bottom, we can see that the links connect the plans of different floors (two, in our example), the paintings, elements visited by a specific user (a personal path), the different rooms of the museum, the furnitures, and the silverware present in it. These (one-color) sub-graphs are the dimensions. We graphically visualize the ranks as particular sub-sequences in a dimension: so, for example, all the paintings present in the cell c_1 (the room 'Atrio/Hall') constitute the rank `painting_of_Atrio` of the dimension `painting`.

Alternatively, we can interpret the same Figure 2, focusing our attention on the left part of it; we note that the cell c_1 represents the central node of the so-called *star-view* [10], which connects this room with all the contextual information related to it. In this way, from c_1 we can simply reach all the semantically connected information; they are identified by different colors and labels. The dimensions shown in Figure 2, starting from the cells on the top left containing a plan, are: the plan of the first floor in which is situated the room c_1; the paintings present in it; the other rooms on the same floor;

[1]The color can be substituted by a label.
[2]A multigraph is a graph where are permitted multiple edges, that is, edges that have the same end nodes.
[3]The degree of a node is the number of edges incident to it.

the furnitures, and the silverware. But also users can follow path eventually created by themselves or by other users. Analogous discussion may be repeated for the cell c_2.

So, each dimension has a specific meaning related to the museum domain: basically we define a zz-dimension for each of all the category identified (painting, sculpture, print, etc.), for each of the two floors of the museum and also for the park. It is noteworthy that each user can create her own dimension, as, for example, a *customized path of visit*.

We note that in our application zz-structures can be created in a flexible way: each dimension can contain one or more ranks and the logic mapping of ranks and dimensions can be interchangeably arranged.

The semantic of each dimension can be opportunely defined and associated to specific methods of software agents: for example, we defined a meta-dimension, called $view$ that link each cell with its content (description, position on the plan, history, curiosity, semantic connections, etc.).

In our prototype the instantiation of the zz-structure containing our case of study is made following the flow described in Figure 3. The agent `zzXMLOperator` pre-loads

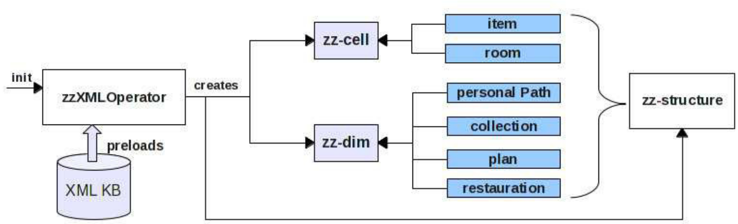

Figure 3: The zz-structure instantiation.

the XML Knowledge Base, organized in terms of XML file containing the 'items' and 'rooms' details (`data.xml`), on the mobile client. Then, the same agent dynamically defines the interconnections (`zz-dim` between items and rooms `zz-cell`, inquiring the XML documents containing the collections (`collection.xml`), the plans (`plan.xml`), the personalized paths (`paths.xml`), the predefined tours (`tour.xml`), the restauration (`restauration.xml`).

3.3 User Model Specification

The definition of the user workspace offers an interactive use of the mobile guide. In order to develop these dynamical and adaptive aspects of the application, we need to model the users' profile, their behavior, preferences and needs, but also their chronology and personal contributions. The aim is that the user can create and manipulate a customized personal space, save the visit paths, create new ones, annotate information, express votes on items and rooms, and so on. We conceived the user model specification in terms of four different perspectives: *personal information*, *history*, *workspace*, and *social features*.

4 Use Cases: Navigation and Authoring

The prototype TOGO is based on Flash technology, Action Script language programming, and XML semi-structured database. Only few third-party APIs have been used such as the *IphoneScroller*[4], a library which deals with the scrolling issue within mobile display, and the *TweenLite*[5] library, a specific set of features devoted to manage screen changes with swipe effect.

Up to the time of the design and deploy of this project, the choice of the Flash technology has gained several advantages such as rapid development time and high portability and adaptability to different devices. Although recently Adobe has decided to abandon the Flash technology for Mobile software in favor of developing for HTML 5 support instead, we retain that this experience is significant for testing the mobile interface and the scalability and effectiveness of the model.

In this section we show two scenarios of the TOGO prototype, the first related to the navigation on the structure shown in Figure 2, and the second related to the creation of a new personal path.

4.1 Navigating though ranks and dimensions

In Figure 4 is shown a sequence of screens generated during the user navigation.

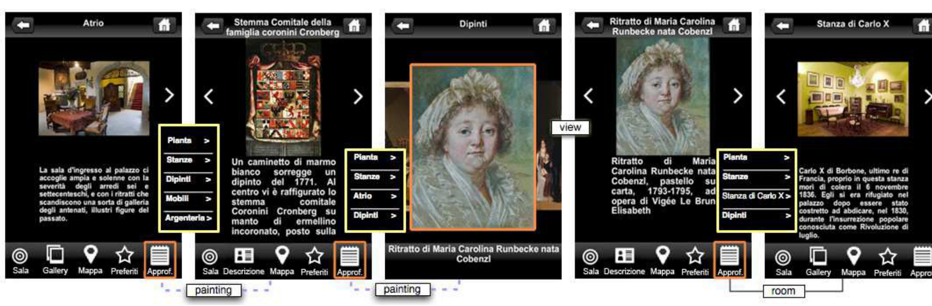

Figure 4: Navigation from c_1 to c_2 (see Figure 2) on different dimensions.

The first screen is the view of the cell c_1 (the room 'Atrio/Hall'), already introduced in Figure 2. The interface shows five possible choices in the footer menu: 'Sala/Room' is the current choice, containing some pictures of the room and its description; 'Gallery' presents a photo-gallery of all the collection items exhibited in the room, 'Mappa/Map' the position of the room on the floor plan; 'Preferiti/Favorite' contains the users' favorite items, while 'Approfondimenti/Semantic interconnections' provides a contextual list of all the other items semantically connected with the room 'Atrio' (in other words, the elements contained in a same rank or in a same dimensions). In our example, this last button shows 'Pianta/plan', 'Stanze/room', 'Dipinti/painting', 'Mobili/furniture', and 'Argenteria/silverware' dimensions. Among the paintings, the selection of the 'Stemma Commitale/Coat of arms' shows the second screen; here, a similar action (the selection of 'Approfondimenti/Semantic interconnections' and then of the dimension 'Dipinti/painting') shows the photo gallery (third screen) of all the paintings present in the museum; the selection of one of this (the 'Ritratto di Maria Carolina/Maria Carolina's portrait') opens the forth screen. Now following the 'Stanze/room' dimension, the user opens the screen (last screen) related to the 'Stanza di Carlo X/Carlo X's room' in which that painting is exhibited.

[4]http://www.FlepStudio.org
[5]http://www.greensock.com

4.2 Creating a personal path

Starting from her personal space, each user can create a personal path (‘Crea percorso/Create a path’), using the interface shown in Figure 5. She chooses the ‘nome/name’, and adds

Figure 5: Creating a new path.

all the items/rooms that she prefers (using the ‘+’ button). In the example in Figure 5, the user has created the dimension ‘Miei dipinti/My paintings’, inserting in it four paintings; for this path, she can decide the order of visit, view the details of each chosen items, or remove it. It is interesting to note that for executing this operation, the agent `zzXMLOperator`, applying the script `addPath`, updates the XML data (on the knowledge base) but also adds the instance of the new path in the mobile client.

5 Conclusion and Future Work

The TOGO prototype has been presented during the *Researchers’s Night 2011*, an event that occurs annually on the fourth Friday of September all over Europe. Currently we are working on a new version of the prototype that uses HTML 5 and native codes for the mobile systems. The new prototype will be a complete tourism guide that will consider all interesting sites of a city (our case of study remains Gorizia). In next future, we would like to extend the tier-layer of our framework in order to support user recommendation, harvest complex relationships among items, and enhance social aspects.

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