Creating Personalized City Tours Using the CHIP Prototype

Natalia Stash, Loes Veldpaus, Paul De Bra, and Ana Pereira Rodeirs

Eindhoven University of Technology,
Dpt. of Mathematics and Computer Science and Dpt. of the Built Environment,
Den Dolech 2, 5612 AZ Eindhoven, The Netherlands
{n.v.stash,l.veldpaus}@tue.nl
debra@win.tue.nl
a.r.pereira-roders@bwk.tue.nl
http://www.tue.nl

Abstract. This paper explores the applicability of the software prototype developed for personalized access to semantically enriched art collection of the Rijksmuseum in Amsterdam in a different environment – city rather than museum. As a case study we take Amsterdam, a World Heritage City, i.e. a city that includes urban areas designated as World Heritage (WH). This is the first step towards turning our prototype into a generic tool applicable for generating recommendations/personalized routes in indoor and outdoor environments based on semantically described data of the museum collection or points of interest in the city. Moreover we allow for user model information reuse between various domains/scenarios served by our Web-based application therefore addressing the cold start problem while starting to use a new application.

Keywords: Personalisation, cultural/world heritage, semantic enrichment, sightseeing, city guide, protected urban planet

1 Introduction

Personalized access to cultural heritage information attracts the attention of many researchers and practitioners. A variety of applications can be found for cultural places, such as museums ([1],[14]), cities ([3],[4]). The focus of this paper is more specifically, on World Heritage city guides to be used by locals and tourists to make them understand what makes the WH property outstanding. Some very interesting though non-adaptive mobile guides have been developed over the past years e.g. mTrip[1], Pocket Guide[2].

There exist databases for managing data about museum collections[3], and WH cities[4]. Moreover, there exist international standards for detailed descriptions of

[1] http://www.mtrip.com/
[2] http://pocketguideapp.com/en/city/map
[3] http://www.den.nl
[4] Protected Urban Planet (PUP), http://protectedurbanplanet.net

objects in a database such as Dublin Core[5], VRA[6], SKOS[7] and Spectrum[8]. Also for uniform content description terminology sources are being used. Terminology sources include thesauri, (controlled) keyword lists, taxonomies, classifications or ontologies such as the Getty Vocabularies[9] and the CIDOC Conceptual Reference Model[10]. The hierarchical and associative relationships, which are defined in such thesauri, help search engines in interpreting and grouping of heterogeneous sources. In this way the terminology sources can make a significant contribution to the effectiveness of semantic Web applications such as the MultimediaN ECulturedemonstratorTM[11]. Although standards exist in the fields of museums and cultural objects[12], and combining those probably covers part of the heritage field, as for example CIDOC states "The term cultural heritage collections is intended to cover all types of material collected and displayed by museums and related institutions" and this "includes collections, sites and monuments relating to natural history, ethnography, archaeology, historic monuments" however the main aim remains Supporting Museum Documentation. Ontology creation for historic buildings has been explored only a little, particularly in relation to their conservation [3]. Only one attempt to build up an ontology around built heritage and WH was found[13]. This is a very timely and relevant recent attempt. However, such ontology is not yet used to build up nomination files for WH Properties. As such the descriptions found on the UNESCO WH List are not structured along this or any other ontology.

In a number of papers ([5],[6]) we presented the results of the CHIP project[14] (stands for Cultural Heritage Information Personalization/Presentation). As the project name says it dealt with providing personalised access to cultural heritage artefacts. The project was done between 2005 and 2009 in collaboration with the Rijksmuseum[15], Amsterdam, and Telematica Institute[16] in the Netherlands.

Within the project we performed the semantic enrichment of the Rijksmuseum collection data by connecting it to standard vocabularies and adding extra semantic relationships from these vocabularies; and we used it for developing our software prototype. With the help of this tool a museum visitor can prepare his/her museum tours in advance and follow them on a mobile device (if wifi or other location technology would be present inside the museum). The produced software is taking into account the specifics of the museum collection such as the way artworks are described, physical museum constraints, etc.. Data from

[5] http://dublincore.org/
[6] http://www.vraweb.org/
[7] http://www.w3.org/TR/2005/WD-swbp-skos-core-guide-20051102/
[8] http://www.collectionslink.org.uk/spectrum-standard
[9] http://www.getty.edu/research/tools/vocabularies/
[10] http://www.cidoc-crm.org/index.html
[11] http://e-culture.multimedian.nl/
[12] http://www.dlib.indiana.edu/ jenlrile/metadatamap/seeingstandards.pdf
[13] http://www.cherplan.eu/cultureonto/
[14] http://www.chip-project.org
[15] http://www.rijksmuseum.nl
[16] http://www.telin.nl/index.cfm?language=en

other museums can be described in a way similar to the way the Rijksmuseum collection is described, as will be shown in the following section. Therefore the software could be reused for the other museum collections as well.

Based on the knowledge and experience in developing tour guides for indoor environments gained within the CHIP project we aim at applying the same ideas in the outdoor environment. The same content-based recommendations based on semantically enriched data as discussed in [6] could be used for generating personalised routes along cultural heritage assets in indoor and outdoor environments. On the UNESCO website[17] one can find how those assets are described in official documents, per WH property. Analyzing those documents reveals a list of the attributes (WHAT is making them Outstanding) and values (WHY are they Outstanding). Those can be allocated in the city, so that a city guide can be prepared and the Outstanding Universal Value presented to the visitors by means of such a city guide. At the moment this analysis has to be done manually, and per case study as no official ontology has been agreed upon yet. If this would be the case, a more generic set of attributes could help on linking and matching sites to each other (e.g. show a WH Property with a *church building* as an attribute), which could then influence the recommendations within the application beyond the one city that is visited at the time.

The novelty of our approach is in the fact that the tool becomes more generic and applicable for entering either museum or city data (in a specific RDF format) e.g. by art experts or tour guides and that it allows for providing personalized access to this data for the museum or city visitors. Since our application is Web-based and the user models are being stored centrally on the server, they can be made available for all applications developed with our tool and placed on the same server. In this way the personalised museum and city guides can exchange and reuse/update information about the same user, e.g. if the user of our Rijksmuseum application indicates that (s)he likes *Baroque* style (the style of the major part of the artworks from the Rijksmuseum collection) then (s)he could be guided towards buildings in Baroque style in Amsterdam. In this way we can (a) connect applications for indoor and outdoor environments and (b) address the cold start problem. The CHIP software is open-source and platform-independent.

The rest of the paper is structured as follows. Section 2 discusses the specifics of WH Properties. Section 3 walks through an example scenario of generating a personalised tour through Amsterdam and describes the requirements of the CHIP software to include a museum or city data set. Section 4 provides conclusions for this paper and discusses some insights for future work.

2 World Heritage Cities, Specifics of Data Description

At the moment the WH List includes 962 heritage properties, 745 cultural, 188 natural and 29 mixed properties. This list is growing steadily, adding about 25

[17] http://www.unesco.org

properties annually. Nearly half of the current properties are located in urban contexts. Currently there are already over a thousand cities that have protected areas, inscribed on the UNESCO WH List, located in or at the outskirts of their urban areas, and a database of them is being built up on Protected Urban Planet site. A WH Property is listed for it being of Outstanding Universal Values (OUV). OUV is considered the highest level of significance, to be preserved as part of the WH of mankind as a whole [10] those outstanding values are conveyed by attributes, which can be tangible or intangible. The "qualities and characteristics seen in things - in particular the positive characteristics" [9] – embodying cultural values are defined as attributes, of which two types have been defined: tangible and intangible. The tangible attributes regard the legacy of physical artifacts such as "form and design; materials and substance and other internal factors". The intangible attributes regard non-physical aspects related to the cultural heritage properties, such as "use and function; traditions, techniques and management systems; location and setting; language, and other forms of intangible heritage; spirit and feeling; and other external factors" [11]. Every WH Property has such attributes and values, and those can be used as *characteristics* of the site to be described and mapped in the application.

Attributes, or their tangible results or representations can be mapped along the urban context to reveal the actual presence of the cultural significance as described in the official documents within its urban context. This way an overview of what is of value (attributes) and why they are outstanding (values) can be constructed per WH Property. Due to the lack of research in this field this paper takes a categorization based on what has been described, though with the remark that further ontology building would be very relevant . First of all the application considers the indicated difference between tangible and intangible attributes. Next, it uses a developed ontology of categorizing the attributes within eight cultural values[13]. Last, it categorizes on different levels of urban scale: building element, building, and urban. The building element scale could for example include signs and symbols on facades, or to the use of the same type of building material. The building scale could refer to specific building types or uses, or to urban objects e.g. bridges. On an urban scale the value could be found in attributes like the urban structure, a historic route, squares, or the roofscape. Such system would be improved or changed if research reveals a more adequate categorization.

To capture all levels of scale, this application takes the perspective of the urban settlement which includes the WH Property in contrast to existing applications on WH, which are mostly focused on the protected site only. As such, the application can be used to discover what is of value within the WH Property (attributes and values) but also the WH Property context (e.g. indicated key views, buffer zones, related conservation areas) and at the same time the user has the overview on the spread or concentration of sites, and specific attributes and values across the city. In addition, this way the application could in the future also include attributes and values that are listed at the national or local level.

As a case study for our city guide we take Amsterdam with its WH Property *Seventeenth-century canal ring area of Amsterdam* inside the Singelgracht. First, we have to decide upon the data description. Fig. 1 shows an example description of an artwork from the Rijksmuseum collection. Every artwork is provided with an image, textual description, information about creator(s), creation site, year of creation, material medium, material support, dimensions, exposition place (room number in the Rijksmuseum), a list of associated art topics (or themes).

Fig. 1. Artwork description

Fig. 2 describes the semantically enriched museum collection data. Connections were made to three Getty thesauri: AAT - Art and Architecture Thesaurus; TGN - Thesaurus of Geographic Names; ULAN - Union List of Artist Names, and Iconclass[18]. There are three kinds of relationships in semantically-enriched data about the Rijksmuseum collection:

- *Artwork feature* is an explicit relation between an artwork and a concept. E.g. the artwork in Fig. 1 is related to the concept "Gabriel, Paul Joseph Constantin" via the artwork feature "creator", the concept "Scheveningen" via the artwork feature "creationSite" and the concept "Dutch landscapes" via the artwork feature "subject".
- *Semantic relation* is a relation that links two concepts e.g. "teacherOf", "style", "broader/narrower".

[18] http://www.iconclass.nl/home

– *Implicit relation* connects two concepts that do not have a direct link between each other but can be deduced if both (e.g. "Rembrandt van Rijn" and "Chiaroscuro") are used for annotating a large number of the same concepts, as discussed in [6].

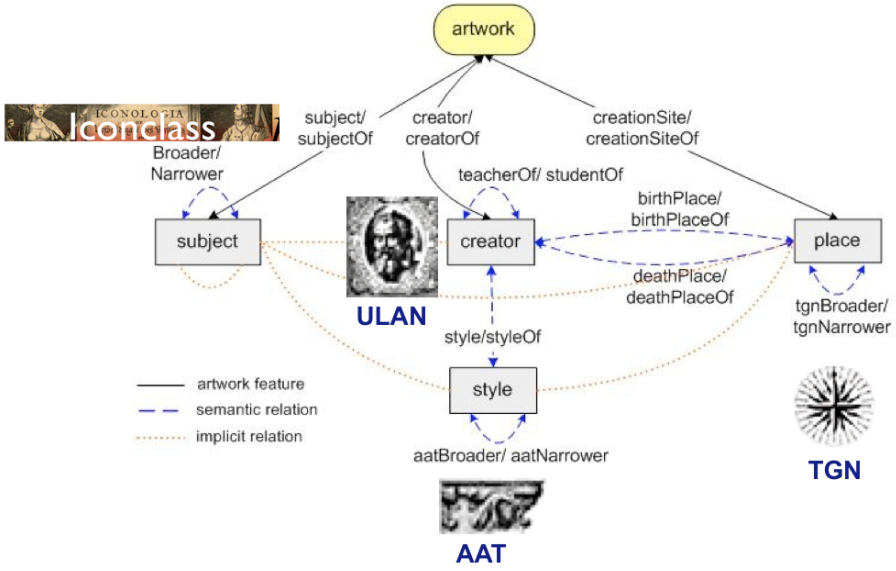

Fig. 2. Semantically enriched museum collection data

In a city guide we exclude the "Creation site" since it is obvious that this is the city that a person is visiting, "Dimensions" could refer to the number of floors or other descriptions indicating the size of the building, etc., "Exposition place" can be better renamed to "Location" and refer e.g. to the district of the city, etc.. For a point of interest (POI) in the city we need to add the following categories/attributes:

– *scale*, e.g. urban object element,
– *geographic location*: latitude, longitude,
– whether it is *tangible* or *intangible* attribute,
– *described value of attribute*, sentence context,
– *attribute value*: age, historic, scientific, aesthetic, social, political, economic.

The next section walks through an example scenario of generating a personalised tour through Amsterdam and explains what type of data has to be prepared from the side of the author of the application.

3 CHIP Prototype: From Personalized Museum Guide to Personalized City Guide

3.1 The Appearance of the City Tour

You can view the city guide at http://www.chip-project.org/cityguide and compare it to the walkthrough the CHIP demonstrator for the Rijksmuseum collection at http://www.chip-project.org/demo/chip_walkthrough/index.html.

Fig. 3 shows the *Sightseeing Recommender* page (after a number of interactions). It shows POIs in Amsterdam that you can rate (in the *Rate these points of interest* part), and once you do that it also shows a list of recommended POIs and topics that you can rate as well.

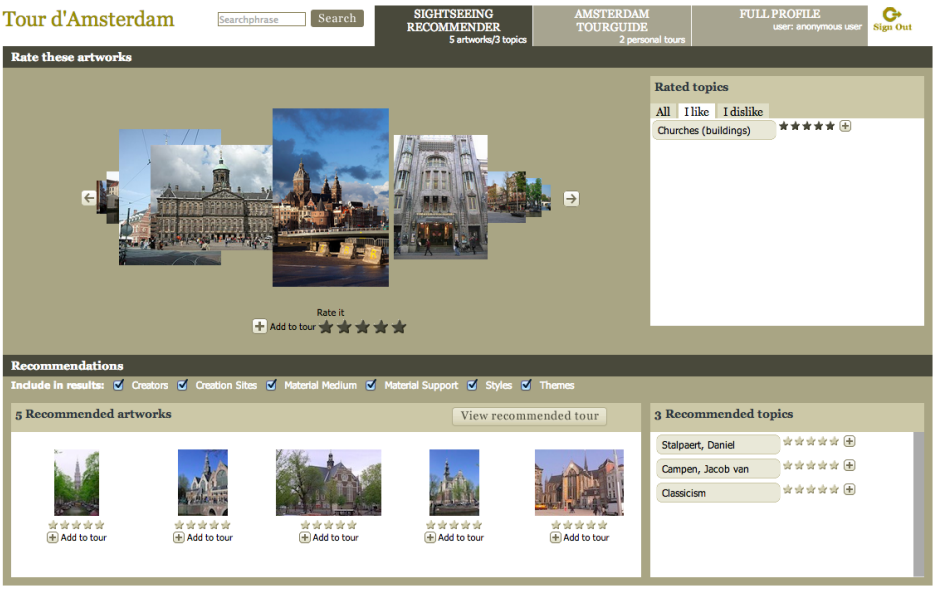

Fig. 3. Sightseeing Recommender - recommender for points of interest in the city

If the user wants to know more about some POI before rating it (s)he can click on its image and a full description will appear in the popup window (see Fig. 4). In this popup window the user can also see topics associated with the selected POI e.g. *Jacob van Campen* and *Stalpaert Daniel* – the architects of the *Royal palace*, the architectural style of the building – *Classicism* (currently shown in a list of themes and not separately), etc.. The user can toggle between options "Hide/Show namespace prefix" to see from which vocabularies/thesauri/specifications topics come from – *aat* prefix means that it comes from AAT thesauri, *ams* – base namespace for Amsterdam tour guide. The idea

is that the initial set of POIs in the carrousel (Fig. 3) has a rich variety in topics. Rating some of these POIs thus gives a lot of information about person's preferences while visiting the city.

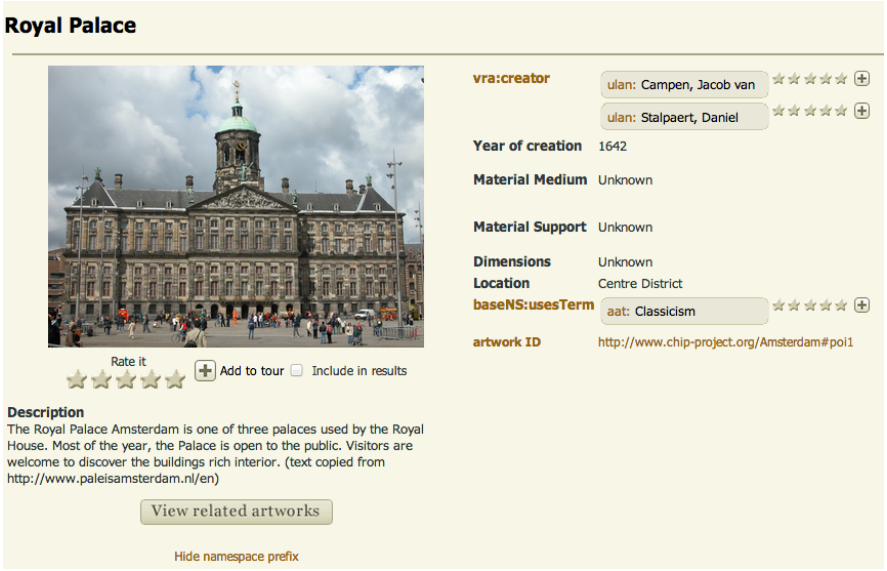

Fig. 4. Description of the point of interest

In the *Amsterdam Tourguide* tab the user can see the personalised tours' list:

- automatically generated *Tour of favourites* containing POIs rated with 5 and 4 stars, and *Tour of (20 top) recommended points of interest*,
- manually created tours.

In contrast to the museum guide there is no museum map view – only a visualisation of the tour on Google maps (Fig. 5) and a historical timeline (Fig. 6). In the current version of Google maps view only a set of POIs is displayed but the route between these points is not calculated yet.

After selecting the *Mobile Guide* tab the user can see what his/her tour will look like on a mobile device (see Fig. 7). In the first screen of the *PUP Sight Guide* on Fig. 7 the user logs in using his/her existing account or chooses the "Guest account" option, if (s)he hasn't worked with the demonstrator yet. (The second scenario is discussed in [14]). PUP stands for *Protected Urban Planet*. In the second screen the user can choose a tour to follow and adjust settings like number of POIs and the duration of the tour. In the third screen the user is presented with the carrousel of POIs in the selected tour. While following the tour the user can give ratings to POIs and related topics. Based on the ratings the rest of the tour can be adapted if the "Adapt tour?" option was selected

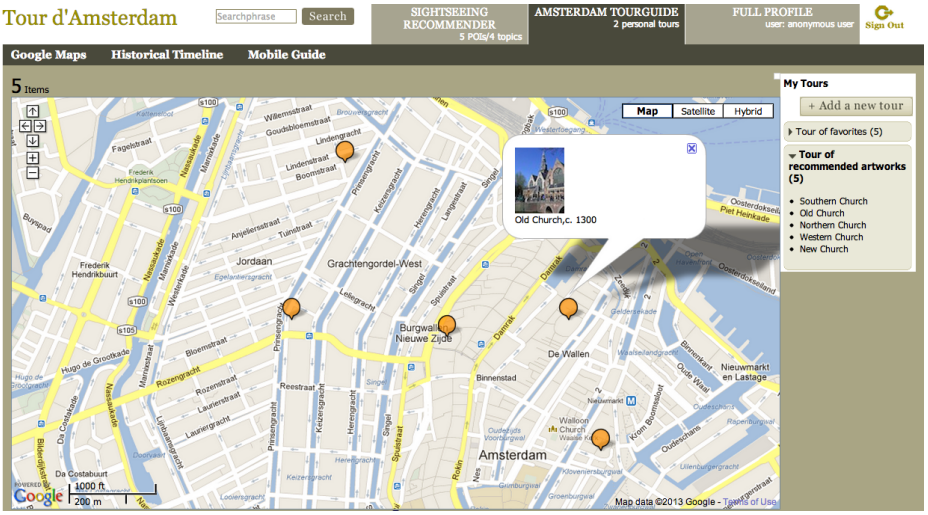

Fig. 5. Tour view on Google maps

Fig. 6. Tour view on historical timeline

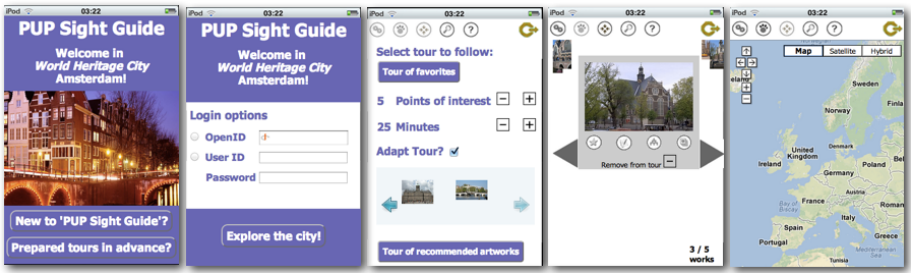

Fig. 7. Mobile App *PUP Sight Guide*

in the second screen of the PUP Sight Guide. The last screen shows the tour on Google maps. An essential part of the GUI in the last three screens is the menu bar which aids the user in navigation. Icons in the menu bar link to tour configuration, tour overview, tour map, search function, help and logging out.

3.2 Initialization of the Demonstrator

If an art expert or city tour guide wants to use the CHIP software for providing visitors with the possibility of creating personalised tours through the city (s)he has to prepare the following information:

- RDF model describing the POIs in the city e.g. *Amsterdam.rdf*. See an *Example description of a point of interest* below:

```
<rdf:Description xmlns:vp="http://www.getty.edu/vocabularies/vp#"
   rdf:about="http://www.chip-project.org/Amsterdam#poi1">
   <rdf:type rdf:resource="http://www.vraweb.org/vracore/vracore3#Work"/>
   <vra:title>Royal Palace</vra:title>
   <vra:date>1642</vra:date>
   <vra:description>The Royal Palace Amsterdam is one of ...</vra:description>
   <vra:creator rdf:resource="http://www.getty.edu/vocabularies/ulan#500115589"/>
   <vra:creator rdf:resource="http://www.getty.edu/vocabularies/ulan#500065031"/>
   <ams:usesTerm rdf:resource="http://www.getty.edu/vocabularies/aat#300056513"/>
   <tgn:latlng>52.373, 4.891</tgn:latlng>
</rdf:Description>
<rdf:Description rdf:about="http://www.chip-project.org/cityguide/royal_palace_m.jpg">
   <rdf:type rdf:resource="http://www.vraweb.org/vracore/vracore3#Image"/>
   <vra:relation.depicts rdf:resource="http://www.chip-project.org/Amsterdam#poi1"/>
   ...
</rdf:Description>
```

- list of POIs' URLs that appear in the carrousel in the Recommender e.g.:

```
http://www.chip-project.org/Amsterdam#poi1
http://www.chip-project.org/Amsterdam#poi2
...
```

- (optional) weights for implicit relationships as explained in [6] e.g.:

```
0.229983829830428 http://www.chip-project.org/Rijksmuseum#encyclopedia47499
http://www.getty.edu/vocabularies/ulan#500011051
...
```

After starting up the server the author should go to the initialisation page to specify settings such as the names of the tabs in the demonstrator (e.g. *Tour de Rijks* or *Tour d'Amsterdam*), the location of the user profiles on the server, whether the demo is used for indoor or outdoor environment for making a decision upon showing/hiding tabs such as museum map, etc..

4 Conclusions and Future Work

Based on the knowledge and experience in developing tour guides for indoor environments gained within the CHIP project we aimed at applying the same ideas in the outdoor environment. Moreover we decided to investigate the usability of the existing software in a different domain – city rather than museum. By

moving from museum to city we performed some testing of the existing CHIP software and improvement to make it a more generic tool. The presented *improved* version of the prototype only requires a proper description of the city data in RDF format, specifying the list of POIs to appear in the carrousel in the Recommender page and optionally the weights for implicit relationships, and an extra configuration step to choose the right data set (particular museum or city) to be used by the demonstrator. In fact, from the authoring perspective it is even easier to use the tool for preparing a city guide rather than a museum guide since a museum application would require the additional use of museum maps and specifying the coordinates (on the museum map image) for rooms, doors, hallways, artworks locations for constructing and visualising the route on the museum map.

All presented tools for generating/following personalised tour(s) – Recommender, Tour Guide, PUP Sight Guide – are Web-based, written using Java Servlets, HTML5/JSP, CSS, JavaScript, etc.. The idea is that Recommender and Tour Guide can be used e.g. for preparing a visit to the city in advance and next, the mobile PUP Sight Guide can be used for guiding the visitor through the city. The first next step is to turn the PUP Sight Guide into a GPS-enabled Web application. At the current state PUP Sight Guide has all the advantages of Web-based mobile apps such as platform-independence, easier and cheaper updates of a Web site than of a native app, independence from App stores, etc.. We should nevertheless take into account the advantages of the native apps such as targeting the specific limitations and abilities of the device in a much better than a Web app can while running inside a browser. We are planning to look into the existing frameworks such as PhoneGap[19] to see what kind of quality native app they can produce from our Web-based mobile app and whether this quality is sufficient.

We plan on improving PUP Sight Guide in a way that it could be used on the spot without preparing tour(s) in advance e.g. when the user selects the "Guest account" option (as shown in Fig. 7):

- calculating the optimal route on the fly given the POIs to visit, including starting point and end point of the tour,
- importing/using information about the visitor from social sites[20],
- information about what other visitors liked,
- taking into account opening hours of churches/museums to adjust the tour,
- making suggestions based on weather information, e.g. "It is going to rain in the coming hour, maybe it is best to visit a museum first", or time left "You should hurry, otherwise you'll miss your train".
- adapting the story content based on visitor's language, age, context e.g. time:
  - *evening/night* – "Look how beautifully and romantically the bridges over Amstel are lightened at night",
  - *day time* – "Come back here at night to see how beautifully and romantically the bridges are lightened".

[19] http://phonegap.com/

[20] e.g. Facebook, http://www.facebook.com; Twitter, http://www.twitter.com

Acknowledgments. This work is supported by EIT ICT Labs[21] and is based on the experience gained within the CHIP project. The CHIP project was funded by the Dutch Science Foundation program CATCH[22].

References

1. Stock, O., et al : Adaptive, intelligent presentation of information for the museum visitor in PEACH. User Modeling and User-Adapted Interaction, 17, 257–304 (2007)
2. Aoki, P. M., Grinter, R. E., Hurst, A., Szymanski, M. H., Thornton, J. D., Woodruff, A.: Sotto voce: exploring the interplay of conversation and mobile audio spaces. In: Proc. of the SIGCHI Conference on Human Factors in Computing Systems: Changing Our World, Changing Ourselves (2002)
3. Cheverst, K., Mitchell, K., and Davies, N: Gullivers Genie: The role of adaptive hypermedia in a context-aware tourist GUIDE. Community. ACM 45, 5 (2002)
4. G.M.P. O'Hare, M.J. O'Grady: Gullivers Genie: A Multi-Agent System for Ubiquitous Intelligent Content Delivery. Computer Communications, Vol.26, Issue 11, pp.1177–1187, 2003 Elsevier (2003)
5. Stash, N., Aroyo, L., Wang, Y., Rutledge, L., Gorgels, P.: Semantics-driven Recommendations in Cross-Media Museum Applications. In: Proc. the PATCH Workshop on Hypermedia and Adaptive Web-Based Systems, Germany (2008)
6. Wang, Y., Wang, S., Stash, N., Aroyo, L., Schreiber, G.: Enhancing content-based recommendation with the task model of classification. In: Proc. International Conference on Knowledge Engineering and Management by the Masses (EKAW), pp. 431–440 (2010)
7. Malcolm, T., While, A.: Ontology and the Conservation of Built Heritage. Environment and Planning D: Society and Space 27, no. 4, pp. 721-737 (2009)
8. Pereira Roders, A.R. and Hudson, J.: Change Management and Cultural Heritage. In E. Finch (Ed.), Facilities Change Management. Chichester: John Wiley & Sons, submitted / in press (2011)
9. Mason, R.: Values in Conservation Planning: Methodological Issues and Choices, in M. de la Torre (ed.) Assessing the Values of Cultural Heritage. Research Report, pp. 530. Los Angeles, CA: The Getty Conservation Institute (2002)
10. Convention concerning the Protection of World Cultural and Natural Heritage, Paris, available at: http://whc.unesco.org/en/conventiontext/, UNESCO (1972)
11. UNESCO, The Operational Guidelines for the Implementation of the World Heritage Convention, Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO), (2011)
12. Veldpaus, L., Pereira Roders, A., Colenbrander, B.J.F. : Urban Heritage : putting the past into the future. The Historic Environment: Policy & Practice, 4(1), pp.18–33 (2013)
13. Pereira Roders, A.R.: Re-architecture: lifespan rehabilitation of built heritage – Book I, II, III. Eindhoven: Technische Universiteit Eindhoven (2007)
14. Stash, N., Veldpaus, L., De Bra, P., Pereira Roders, A.: The Protected Urban Planet App "PUP Sight Guide": Amsterdam as Case Study, To be published in the proceedings of KUI 2013, Conference Culture and Computer Science, Berlin, Germany (2013)

[21] http://www.eitictlabs.eu/, TIMS 12113 T1204 10015214, Emergent Social Mobility
[22] Continuous Access to Cultural Heritage, http://www.nwo.nl/catch