Towards Better Requirement Definition for Multimedia Travel Guiding Applications

Evgeny Pyshkin
Software Engineering Lab
Unversity of Aizu
Tsuruga, Ikki-Machi, Aizu-Wakamatsu
Fukushima, 965-8580, Japan
Email: pyshe@u-aizu.ac.jp

Matvei Pyshkin
Natural Science Lyceum
Peter the Great
St. Petersburg Polytechnic University
29 Polytechnicheskaya st.
St. Petersburg, 195251, Russia

***Abstract*—There are many current efforts in investigating personalized traveler assisting applications through the perspective of human-centric computing and ambient intelligence. In this work we examine a number of existing approaches within a particular context of travel planning services. Specific attention is paid to the domain of designing tools supporting authored itineraries created by professional and amateur guides or interested travelers who want to share their visit and post-visit experience in the form of multimedia excursions to be accessed from mobile devices. Based on the analysis of existing implementations we propose a set of requirements for advancing human-computer interaction models used in multimedia traveler assisting applications.**

I. Introduction

While being in travel, people don't only spent time for pleasure but often like to share their experience with other travelers. There are different forms of sharing travelers' experience: posting notes on social networks, giving feedback via travel information aggregation web sites (like *TripAdvisor*[1] or *Expedia*[2]), posting photos linked to Google Maps points, creating or accessing thematic blogs and web sites. As we mentioned in [1], apart of such regular activities as journey transportation and accommodation planning there are many other aspects related to the careful forethought of a journey with paying attention to travelers' cultural, social and even scientific interests and expectations. Many existing traveler assistance services are designed with a particular attention to user personalization, so as to improve trip program suggestions and recommendations as well as to enhance using features available in the present day information retrieval, processing and presentation tools.

Somehow, many current efforts are about delivering personalized solutions following major scenarios we could learn on the base of study of traveler experience. Mobile technology provides a further advancement in travel centered development [2], [3] Indeed, creating personalized itineraries requires using rich facilities of multimedia assistance automation. This aspect is connected to such issues as creating multimedia travel books integrated with the electronic maps and accessible from mobile devices [4], creating audioguides for museums and cultural sites [5], [6], as well as designing personalized recommendation systems.

In this work we are focusing one specific area of travel planning services which is itinerary and excursion construction in a way that would allow leveraging existing traveler experience for the benefits of the followers. The major objective of our contribution is to rethink user interfaces and requirements for creating better multimedia based travel guiding applications.

II. Models and Implementations

There are many existing desktop, web and mobile applications focusing different aspects of travel centric computing agenda. Among them we could mention electronic travel guides implemented as a collection of stories and suggestions linked not only to tourist attractions but also to the information about the events and personal impressions. Good examples are *Timeout*[3], *I.Know*[4] and *Japan Guide*[5].

There are solutions which particularly address the aspects of user collaboration and post-travel experience such as *TripJournal*[6], *TripCast*[7], or *TravelDiaries*[8].

Though travelers are able to refer to numerous electronic offline and online resources (discussed here below), people still like to use paperback editions of travel guides available at book stores. Usually in such travel guides you can find the commented excursions presented using simplified map fragments. Figure 1 gives a hint how such a commented itinerary is presented by using Paris Michelin guide as an example.

Figure 2 illustrates a more flexible way when the route isn't proposed explicitly, but there are attractions mentioned on the map. A user may follow the order of numbers or invent his or her own path.

There are many software implementations using a similar approach in combination with multimedia display facilities

[1]http://tripadvisor.com
[2]http://expedia.com
[3]http://www.timeout.com/
[4]http://iknow.travel/
[5]http://www.japan-guide.com
[6]www.trip-journal.com/
[7]https://tripcast.co/
[8]www.traveldiariesapp.com/

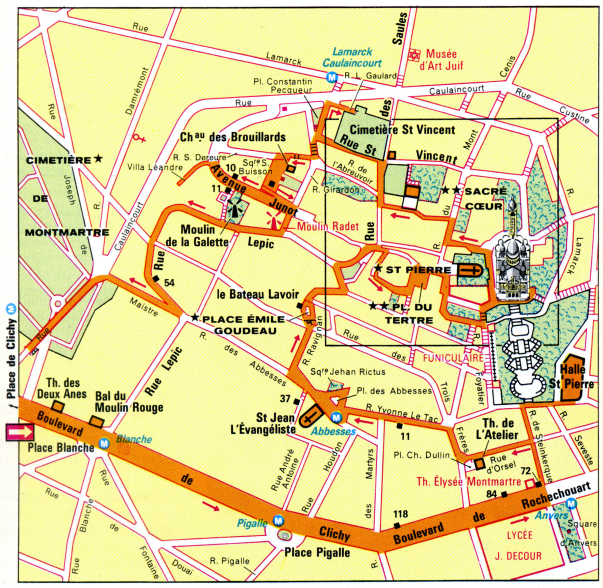

Fig. 1. A travel itinerary from Paris Michelin guide [7] (Montmartre)

Fig. 2. A visit proposal from Paris Orange guide [8] (Montmartre)

allowing accessing to the audio tracks, video clips, photos, texts, web links and so on. Good examples of such mobile applications are *Musement*[9], *Izi.travel*[10], *PocketGuide*[11], and *Azbo*[12]. There are solutions integrated with social networks and traveler forums.

But what if a person makes an effort to prepare an interesting excursion for his or her friends or customers?

Surprisingly, despite touch interfaces are provided by many mobile devices, there is a lack of tools allowing creating a commented excursion which would fit the needs of a professional or an amateur guide. A flexible (but rather an old-fashioned way) still exist: one puts the scattered notes directly on the printed map. So, pens and pencils are still very good friends of every historian (one example of such preparation sheet from the authors' personal experience) is shown in Figure 3).

Fig. 3. How the excursion appears

At attempt to find a bit more fashionable way to deal with excursion construction is one of reasons to start a project of creating a tool for automated construction of annotated travel itineraries [9], [10], [11]. A screenshot presented in Figure 4 illustrates the idea.

Fig. 4. A tool for annotated itinerary construction (a fragment of the excursion in Nevsky prospect in St. Petersburg)

In *TAIS* and *Aurigo* projects [12], [13] the authors also propose the implementations of itinerary construction tools. A particularly interesting feature available in *TAIS* is an access to a collection of user impressions for a certain point and to the recommendations based on the travelers' experience and evaluations. In *Aurigo* the authors combined a recommendation algorithm with an interactive visualization for creating and managing personalized itineraries by balancing an automated and purely manual approaches. In *TripBuilder* described in [14] the authors use a collection of geo-tagged photos from *Flickr*[13] as an information source for planning personalized

[9]www.musement.com/
[10]https://izi.travel/en
[11]http://pocketguideapp.com
[12]https://azboguide.com/en
[13]http://www.flickr.com

sightseeing tours in cities. The photos are considered as traces revealing tourists' behavior and as a source of spatio-temporal information about their sightseeing experience.

Table I lists a selection of existing applications providing features for travel itinerary construction, using or guiding. With respect to the scope of this paper we limited our selection by the solutions which explicitly work with travel itinerary interactive construction and which use multimedia resources in supported excursions.

III. Travel Guide Applications Supporting Multimedia Based Travel Itineraries

In this section we examine a selection of guiding web services. The objective of this study is to discover the requirements for developing tools which would follow better the concepts of personalized guide construction focused on geo-spatial and temporal contexts in ambient interface design. We selected three popular applications available both for iOS and Android platforms: *Izi.Travel*, *PocketGuide* and *Azbo* (see Table I).

Izi.Travel application (Figure 5) is being marketed as a storyteller platform for indoor and outdoor audioguiding. Besides audio tracks, the application supports an access to additional multimedia information (texts, links or pictures) displayed on the screen. Audio track playback starts automatically as soon as a user approaches a visibility trigger zone defined for each attraction point included to the tour (as Figure 6 (left) shows). Upon creating an account, users are able to upload there own excursions using a provided interface and the content management system. So, trigger zone definition is a tour contents creator's responsibility. Tour creators are not always able to pay attention to all overlapping objects located in the area. In turn, the system doesn't check whether the defined zones are uncontroversial. Figure 6 (right) provides an example of such inconsistency. That's why sometimes the playing begins before a moment when an object really becomes visible for a walker.

Recently the developers introduced a free walking mode where a user may select stories from the story base according to his or her own preferences. There is also a support for online audio streaming. At the same time, a user may download the excursions in advance in order to listen to them offline. There is also a useful feature for nearby objects recommendations. Unfortunately it doesn't differentiate users according their movement speed. For example, walkers might be not enthusiastic enough so as to reach a displayed nearby object which is as far as about 10 km from the current position. In contrast to walkers, such a distance is not a big deal for bikers or for travellers using cars.

In the current implementation, if a user quits a trigger zone for a while and enters it again, the playback begins from scratch. We believe that an option to continue playing from the point which is close to the moment of previous interruption might kindle some users' interests.

PocketGuide app (Figure 7) targets mostly travelling in big cities. Apart from being a tool to access an audioguide

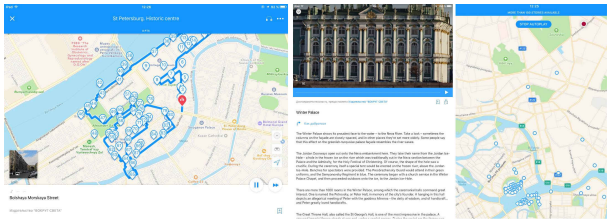

Fig. 5. *Izi.Travel* features

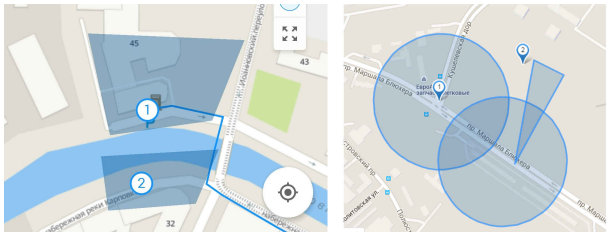

Fig. 6. Visibility area usage (left) and definition (right) in *Izi.Travel*

collections (which mostly contains numerous must-visit style tours), it also provides information about such objects like cafes, restaurants and shops displayed on the map. Tours are classified by cities. Currently this is the only classification schema available for the end users. Streaming previews are free for a selection of objects displayed on the map. Most tours are available for download on a "pay per tour" or "pay per pack" basis. The application follows a model "see the best in the shortest time", so for each tour there is information about its distance and required time; for some tours the best and the worst visiting time periods are mentioned. However, a user is unable to search a tour lasting a given period of time [14] or within the limit of a desired distance. There is a travel diary feature (with a possibility to synchronize with user's Facebook account), which is an important part of recording personal post-visit experience.

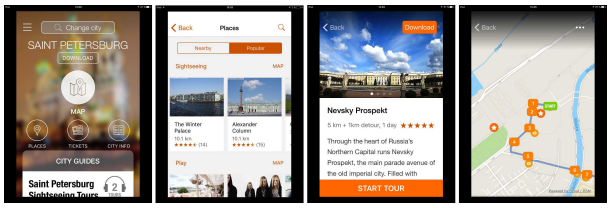

Fig. 7. *PocketGuide* features

Field of vision is not taken into the consideration in *PocketGuide*: sometimes playback begins even if an object is overlapped by another objects. Similar to *Izi.Travel*, the recommended nearby objects might be very distant in reality. *PocketGuide* provides also a ticketing platform for the partner companies selling regular (non-electronic) tours. A user can sync audio with others (a certain fee required) but we didn't

[14] It corresponds to the different model: see the most particularly and personally interesting things within a given time limits. Nice illustration of an approach following this model can be found in [15].

TABLE I
MAJOR FEATURES IN TRAVEL ITINERARY MANAGING APPLICATIONS

Features	*Major implementations*						
	Tourist Eye	*Aurigo*	*TAIS*	*TrackMyTour*	*Izi.Travel*	*PocketGuide*	*Azbo*
Mobile app	Yes	No	Yes	Yes	Yes	Yes	Yes
Suggested itineraries	No	No	No	No	Yes	Yes	Yes
Search and classification	No	No	No	No	Few	Partially	Partially
Professional articles	No	No	No	No	Yes	Yes	Yes
User feedback	Travel tips	No	5 stars	Blog	5 stars	5 starts	Likes
Positioning sensor usage	Yes	No	Yes	Yes	Yes	Yes	Yes
User locally accessible routes/guides	No	Yes	No data	Yes	Yes	Yes	Yes
User publicly accessible routes/guides	No	No data	No data	Yes	Yes	Partially	Partially
Event or activity based suggestions	Yes	No	No	No	No	Partially	Partially
Sharing routes and notes	No	No	No	Yes	Yes	Yes	Yes
Public transport routes	No	No	Yes	No	No	Yes	No
User collaboration on-the-fly	via social networks	No	Yes	via social networks	No	No	No
Travel diary/blogging	No	No	No	Yes	No	Yes	No
Time planning	Yes	No	No	No	No	Partially	Partially
Offline mode	Yes	Yes	Yes	Yes	Yes	Partially	Yes
Integration with social networks	Facebook, Twitter	No	No	Facebook, Twitter	No	Facebook	Facebook
Audio-guides	No	No	No	No	Yes	Yes	Yes
Online guide streaming	No	No	No	No	Yes	Yes	No
Downloadable guides	No	No	No	No	Yes	Yes	Yes
Automatic excursion playback	No	No	No	No	Yes	Yes	No
Nearby recommendations	Yes	No	No	No	Yes	Yes	Yes
Field of vision efforts	No	No	No	No	Yes	Partially	Yes
Time tracking	No	No data	No data	Yes	No	Partially	Partially
Distance tracking	No	No data	No data	Yes	Yes	Partially	No
Available platforms	Android, iOS	No data	Android	Android, iOS	Android, iOS	Android, iOS	Android, iOS
Major focus	Find destinations and ideas, planning the trip, tips	Interactive tourist itinerary automation	Route recommendation	Travel blogging, route tracking and sharing	Multimedia travel guides	Multimedia travel guides	Multimedia travel guides

find any possibility for creating and sharing user's own routes. Thus, *PocketGuide* is rather a consumer-centric (not creator-centric) platform.

In *Azbo* guiding application (Figure 8) the available audio-guides are classified by cities and city districts. The collection of tours is reasonably big. However, the tours aren't equally distributed in different cities. In contrast to *PocketGuide* and *Izi.Travel* the audio tracks are launched manually. In addition to the available points of interest there is some advertisement about shops, food facilities and amusement places. A user may create a personal tour, but this feature is limited by using only those points which already exist on the *Azbo* map and only in the cities included to the *Azbo* list (this feature requires user authorization). Among other advantages we could mention a possibility to select a tour within a given city district. Such parameters as a desired time and duration are supported. There is a nearby excursions searcher (which propose tours in 1 km area close to the actual user position). Local user itinerary construction is possible with using points defined in the system. Registration is required only for new public itinerary creation.

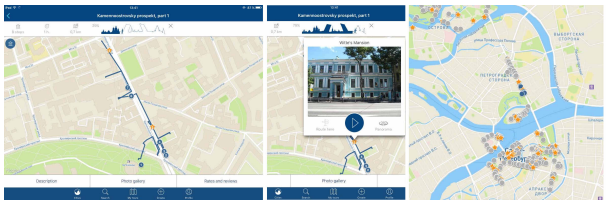

Fig. 8. *Azbo* features

There are several drawbacks which could be a rationale for further improvements of this application:

- Currently *Azbo* doesn't support automated audio display. Apparently, a user has to permanently hold a device in his or her hands.

- We didn't find an option to create a tour in a city which is currently not included to the *Azbo* list. We think that it could stand in the way of gaining more popularity among those users who would like to share their own experience in new places.
- The route between the existing points is created automatically which could be far from being optimal, especially from the perspective of tour interestigness from its creator's point of view.
- Excursion online streaming is not supported. Every excursion has to be downloaded to a user device.

As we see, though many interesting features are designed and implemented in the existing applications, there is much space for further improvements. Hereafter we examine some significant aspects of collecting better requirements for interactive multimedia travel guide applications.

IV. Toward Better Requirement Definition

In this section we make an effort to rethink possible use cases and requirements which (as we expect) would improve current traveler experience and would provide new features allowing experts to create their new commented itineraries with the help of available multimedia and information technology.

A. "Time Machine": Guides Using Old Maps and Resources

A process of developing a geo information system for annotated traveler route construction includes development of models, views and algorithms which would pay attention to supporting geographical, cultural and historical perspectives. In turn, these perspectives would be incomplete without an examination of ways to include older artifacts like maps, texts and visual resources to an excursion discourse.

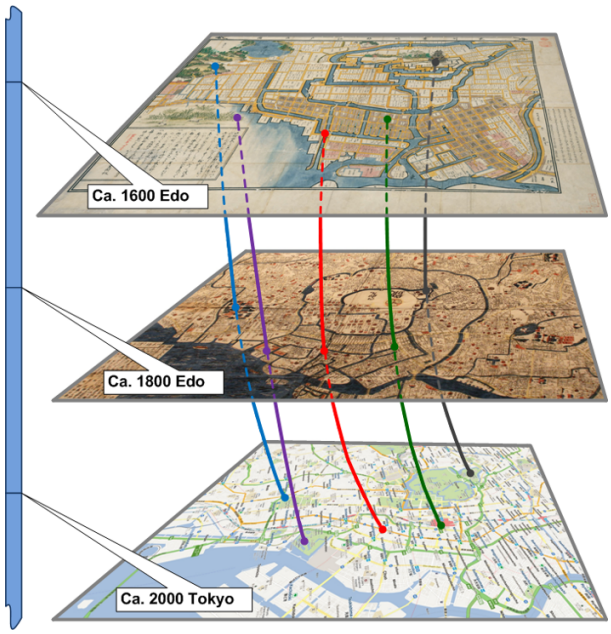

Fig. 9. Using old maps: you can see the difference in map completeness, scaling, and orientation

That's why a perspective to the ancient maps and views accessible electronically (available normally as images) would extends significantly the process of discovering new travel destinations and attractions. It would develop a way to learn history while visiting tourist attractions all around the world. In order to provide a way to "travel in time", we have to develop tools which would allow marking up the maps in order to establish the sets of corresponding points as Figure 9 illustrates. There is a certain number of problems to resolve, including eventual map incompleteness, difference in map orientation (conditioned often by national and cultural particularities), different scaling and area shapes, different object names, differences in landscapes, existing natural of artificial objects, disappeared names and territories, etc.

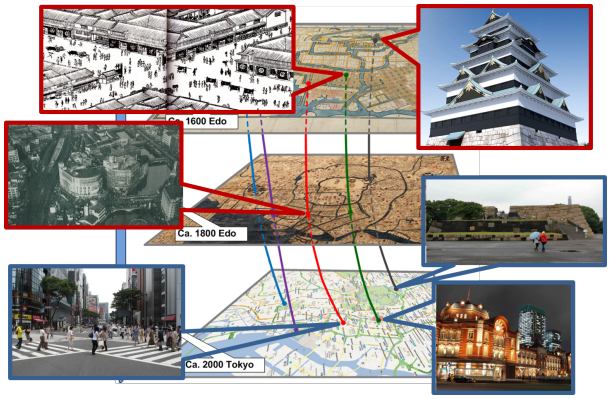

Fig. 10. Views to the former and current objects around the central Tokyo

Implementing tools supporting such a historical perspective may open totally new way to discover a place. In Figure 10 we use an example of Tokyo area. The map layers corresponds to the different epochs. At the map layer there are attached pictures showing the objects existing presently and in the past on the same or closest sites. Thus, on the place of former bridge over a former channel there is a famous Sukiyabashi crossing nowadays [15]; there are only some foundation remnants on the site where there was a main tower of Edo castle long ago; finally, a spectacular Tokyo Station hotel was built on the site of the road crossing in the Edo period business district [16].

We also believe that a possibility to use the maps containing some objects to be created in the future would be a very interesting idea too.

There could be a challenging task to deal with the maps being at a distance of ages. Compare, for example, the fragments of two Scandinavia maps exposed in Carelicum museum[17] in Joensuu, Finland (see Figure 11). As a rule, in contrast to the "big scale" case shown in Figure 11, the local maps (even very distant in time) might be much closer to each other.

[15]"Bashi" (Japan. romaji) means "bridge".
[16]A business district (Marunouchi) still exists, but in new shapes.
[17]www.joensuu.fi/carelicum

Fig. 11. Two maps of Scandinavia (exposed in Carelicum museum): Sebastian Münster/Claudius Ptolemaios, Scholandia, Basel 1540 (left); Peirre van der Aa, La Suède suivant les nouvelles observations Leiden 1714 (right)

B. Itinerary Tracking and Interactive Creation

One possible way to automate creating the annotated itineraries to be used during excursions is to use tracking applications together with an interface supporting adding multimedia annotations by an expert (e.g. a professional guide) walking in the area. In this case, instead of constructing an itinerary manually or automatically on the base of a set of predefined attraction points, the application would create a route automatically on the base of positional information achieved while tracking. The tourist spot descriptions (according for example to the domain specific ontology introduced in [1], see Figure 12) are to be created by an expert as a result of an interaction with an information system by using some smart device.

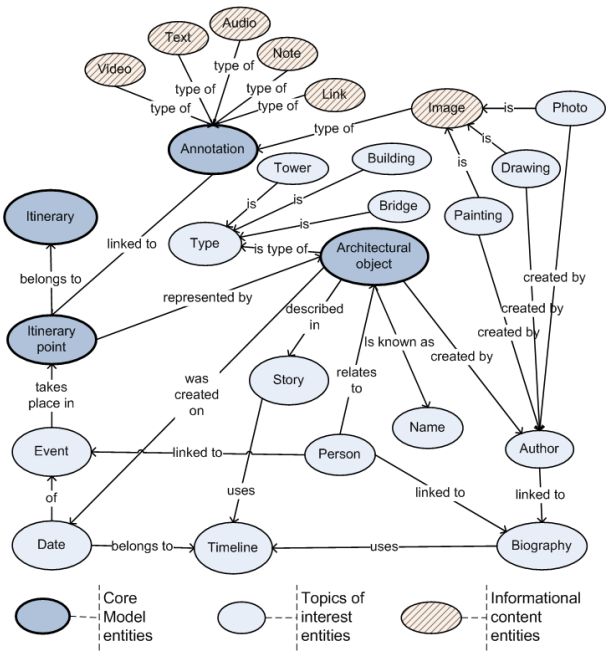

Fig. 12. An example of domain specific ontology fragment

C. Just Walk: Issues and Possible Solutions

A just walk concept means that a traveler might not be inclined to strongly follow a proposed excursion. In such a case it would be useful to implement a kind of positional intelligence when a smart guiding assistant starts playing the track related to an attraction as soon as a traveler enters an area where this object becomes visible. If a user re-enters the area after canceling playback earlier, an option to continue playback (instead of replaying the track again) seems to be very helpful. A problem of automatic computation of a visibility area is not trivial (especially if we consider three dimensional landscape model when an object can be overlapped by other objects [18]) A problem of geometrical definition of a field of vision may be partially resolved by using the above mentioned procedure of creating an itinerary attached to a tracking application (where not only distance but also other constraints like walk duration, day or night time, season, etc. can be taken into account). Visibility areas may also be manually defined by an expert by using some drawing features integrated with the geographical map. Figure 13 illustrates an interesting approach used in *Travoza* [19] audioguiding application.

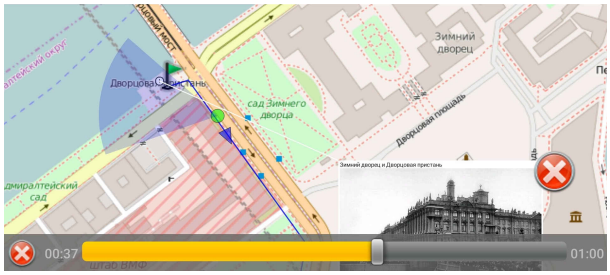

Fig. 13. Fields of vision in *Travoza* application

Many existing tools support automatic story playback according to the current user location. However, many tourists might also be interested in playing the tracks in advance in order to be better prepared for their journey. An option to simulate a walk in virtual tour mode might also be a very interesting option for some users.

D. Environmental and Infrastructural Conditions

In addition to regular excursions containing the series of linked points of interest, an option to deal with an open list of points with a possibility to find the next attraction to visit iteratively would be useful. It would allow us to take into consideration the possible changes in traveler's plans, as well as the changes in environmental conditions (e.g. bad weather might force tourists to pay a visit to an indoor object), the transportation changes, the changes in opening hours, the changes conditioned by some reconstruction periods, etc. Similar features exist in many navigation systems where the proposed route depends on current traffic conditions.

[18] In a case of natural objects or in a case of different light conditions (for example, in night time) there could be even temporal dependency – objects might be invisible due to bad light conditions or due to some natural phenomena (for example, water flux in river or sea areas). In [16] this aspect is nicely described with a respect to old Japanese architecture: "Effects of a building on the surrounding environment, its orientation, and the integration of nature creates a space of ambiguity, a space in constant harmony, as well as a space that can fully adapt to changing environments". A travel guide should not spoil this harmony.

[19] http://www.travoza.com/

E. Using Computer Models of Historical Sites

During an excursion a visitor's impression can be significantly enhanced by using computer models of historical sites [17]. It is particularly important in case when the buildings, their exterior or interior elements and structures are lost, changed significantly or damaged. A complementary display of such artifacts on a smart device screen may extend boundaries of an excursion in geo-spatial, historical, cultural and even temporal perspectives. Digital technology used within the field of preserving and (in a sense) popularizing cultural heritage through the prism of significantly transformed architectural and urban structures is one of the ways to help the society to conserve and to represent a cultural history [18]. Here there is also much space for augmented reality applications [19] for the benefits of creating a new style of multimedia travel guides.

V. Conclusion

Our study shows that despite there are many travel guide digital services and applications, further efforts are required for better journey personalization with special focus on implementing the features which would promote tour developers' creativity, originality and collaboration.

In [20] the authors examined an important aspect of enriching a tour contents by using information delivered by other tour providers. As we see from our brief review, different platforms use their own ways of representing a tour (based on proprietary or closed data formats), so it is often difficult or even impossible to use data from third party providers. It means that further efforts in defining commonly available standards and vocabularies are required.

To sum up, we think that advancing the interfaces of travel-centric systems within the framework of a platform for creating personalized tours and itinerary guides is still an open problem for new contributors. We expect that such features like a support for old maps and map timelines, using touch interfaces integrated with tracking features, tour simulation and virtualization, field of vision definition and management automation, using computer models of historical sites available on the way, up to using augmented reality technology would surely promote progress in personalized travel product design and delivery.

Acknowledgment

The authors would like to thank Alexander Baratynskiy, Boris Skripal and Pavel Korobenin, students from Peter the Great St. Petersburg Polytechnic University for very valuable notes and proposals. We also thank Prof. Vitaly Klyuev, Prof. Alexander Vazhenin and Prof. Hiroshi Saito from the University of Aizu for their helpful suggestions during a preliminary discussion of this work.

References

[1] E. Pyshkin, A. Baratynskiy, A. Chisler, and B. Skripal, "Information management for travelers: Towards better route and leisure suggestion," in *Computer Science and Information Systems (FedCSIS), 2016 Federated Conference on*, vol. 8. ACSIS, Sept 2016, pp. 429–438.

[2] T.-D. Cao and N.-D. Tuan, "Improving travel information access with semantic search application on mobile environment," in *Proceedings of the 9th International Conference on Advances in Mobile Computing and Multimedia*, ser. MoMM '11. New York, NY, USA: ACM, 2011, pp. 95–102. [Online]. Available: http://doi.acm.org/10.1145/2095697.2095716

[3] T. Y. Lim, "Designing the next generation of mobile tourism application based on situation awareness," in *Network of Ergonomics Societies Conference (SEANES), 2012 Southeast Asian*. IEEE, 2012, pp. 1–7.

[4] V. Mladenovic, M. M. Lutovac, and M. D. Lutovac, "Electronic tour guide for android mobile platform with multimedia travel book," in *Telecommunications Forum (TELFOR), 2012 20th*, Nov 2012, pp. 1460–1463.

[5] R. Karimi, A. Nanopoulos, and L. Schmidt-Thieme, "Rfid-enhanced museum for interactive experience," in *Multimedia for cultural heritage*. Springer, 2012, pp. 192–205.

[6] J.-P. Gerval and Y. Le Ru, "Fusion of multimedia and mobile technology in audioguides for museums and exhibitions: from bluetooth push to web pull," 2011.

[7] *Guide de turisme, 18, Paris, 2e edition*. Michelin et Cie, 1994.

[8] O. Cherednichenko, *Paris: Guide + Map (Orange guide), 7th ed.* EKSMO, 2014, in Russian.

[9] A. Baratynskiy and E. Pyshkin, "Traveler guide assistant: Introducing an application for an openstreetmap based travel itinerary construction," in *Proceedings of the International Workshop on Applications in Information Technology (IWAIT-2015)*, The University of Aizu. The University of Aizu Press, Oct 2015, pp. 25–28.

[10] B. Skripal and E. Pyshkin, "Automated leisure walk route generation for an interactive travel planner," in *Proceedings of the International Workshop on Applications in Information Technology (IWAIT-2015)*, The University of Aizu. The University of Aizu Press, Oct 2015, pp. 29–32.

[11] ——, "Using ant colony optimization for tourist route construction automation," in *Proceedings of the 2nd International Conference on Applications in Information Technology (ICAIT-2016)*, The University of Aizu. The University of Aizu Press, Oct 2016, pp. 103–105.

[12] A. Smirnov, A. Kashevnik, N. Shilov, N. Teslya, and A. Shabaev, "Mobile application for guiding tourist activities: tourist assistant-tais," in *Open Innovations Association (FRUCT16), 2014 16th Conference of*. IEEE, 2014, pp. 95–100.

[13] A. Yahi, A. Chassang, L. Raynaud, H. Duthil, and D. H. P. Chau, "Aurigo: an interactive tour planner for personalized itineraries," in *Proceedings of the 20th International Conference on Intelligent User Interfaces*. ACM, 2015, pp. 275–285.

[14] I. Brilhante, J. A. Macedo, F. M. Nardini, R. Perego, and C. Renso, *Advances in Information Retrieval: 36th European Conference on IR Research, ECIR 2014, Amsterdam, The Netherlands, April 13-16, 2014. Proceedings*. Cham: Springer International Publishing, 2014, ch. TripBuilder: A Tool for Recommending Sightseeing Tours, pp. 771–774. [Online]. Available: http://dx.doi.org/10.1007/978-3-319-06028-6_93

[15] A. Kachkaev and J. Wood, "Automated planning of leisure walks based on crowd-sourced photographic content," *46th Annual Universities Transport Study Group Conference, Newcastle, UK*, 2014.

[16] E. Beitha, "Ambiguous boundaries: a japanese way of designing with nature," in *ECO-architecture III: harmonisation between architecture and nature*. With Press Southampton, 2010, pp. 15–26.

[17] C. Vilbrandt, G. Pasko, A. Pasko, P.-A. Fayolle, T. Vilbrandt, J. R. Goodwin, J. M. Goodwin, and T. L. Kunii, "Cultural heritage preservation using constructive shape modeling," in *Computer Graphics Forum*, vol. 23, no. 1. Wiley Online Library, 2004, pp. 25–41.

[18] C. Balletti, N. Brussa, C. Gottardi, and F. Guerra, "The documentation and reintegration of a lost past," *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. 2, no. 5, p. 49, 2014.

[19] Z. Noh, M. S. Sunar, and Z. Pan, "A review on augmented reality for virtual heritage system," in *International Conference on Technologies for E-Learning and Digital Entertainment*. Springer, 2009, pp. 50–61.

[20] E. Ikkala, E. Mäkelä, and E. Hyvönen, *TourRDF: Representing, Enriching, and Publishing Curated Tours Based on Linked Data*. Cham: Springer International Publishing, 2015, pp. 145–149. [Online]. Available: http://dx.doi.org/10.1007/978-3-319-17966-7_19