WikEar – Automatically Generated Location-Based Audio Stories between Public City Maps

Johannes Schöning[1], Brent Hecht[2], Michael Rohs[3], Nicole Starosielski[4]

[1] Institute for Geoinformatics, University of Münster
48149 Münster, Germany
j.schoening@uni-muenster.de

[2,4] Department of Geography / Department of Film Studies, University of California Santa Barbara
Santa Barbara, CA 93106
{bhecht, n_star}@umail.ucsb.edu

[3] Deutsche Telekom Laboratories, TU Berlin
10587 Berlin, Germany
michael.rohs@telekom.de

Abstract. Many mobile applications that lead tourists to landmarks and businesses ignore the educational component of tourism. The systems that do satiate the tourist's desire for learning about visited places require so much costly custom content development that they can only be implemented at very local scales. Moreover, these systems quickly fall out-of-date and continually have to be manually updated. In our approach, called WikEar, data mined from Wikipedia is automatically organized according to principles derived from narrative theory to woven into an educational audio tours starting and ending at stationary city maps. The system generates custom, location-based "guided tours" that are never out-of-date and ubiquitous – even at an international scale. WikEar uses a magic lens-based interaction scheme for paper maps, which have been shown to be particularly important in the tourist experience. By leveraging on the wide availability of large public city maps, WikEar avoids the costs of GPS and the interaction problems of small screen map programs.

Keywords: Tour Guide, Wikipedia, Mobile Map Interaction, Mobile Device

1 Introduction

According to a Berlin tour guide with whom we talked about WikEar, many tourists would appreciate at least something of an educational experience out of their expensive efforts to see the world. These tourists need more than the place names and directions provided by Google Maps or a GPS-based device. Currently, they have two options – paper guidebooks and customized, highly localized mobile device applications – both of which have severe content limitations and are not available for many locations. Writing, editing and post-production of content in these types of tourism tools can be expensive and overwhelming. In addition, the content can quickly become out-of-date. WikEar is an attempt to wed the pervasive and easily-updated content of a mobile map application with the educational capabilities of a guidebook. The content is one of the key factors for such applications.

The premise of WikEar is quite simple: The user stands in front of a public city map and selects a spatial feature (such as a building or landmark) using her camera phone as a magic lens, as described in [1]. A guided audio, narrative-based tour between the location of the city map and the destination is then delivered to the user, with the intent that she will listen to the story as she travels to the destination. To track the mobile device relative to the map we use the magic lens tracking technology of Rohs [2], which combines the high-resolution visual context of paper maps with the dynamic information capabilities of mobile technology.

The guided tour comes in the form of a narrative that is automatically mined from Wikipedia by the Minotour system [3]. The output is rendered in audio form using text-to-speech (TTS) technology. As in [3], we follow the advice of Isbister and Doyle [4], Lanegran [5], and others, and assume that the best tours are those that weave a *story* as one travels through the landscape. This is our basis for implementing

narrative theory methods into our tour generation algorithms, a process that will be described in more detail later. The goal is that users of WikEar will know about historical and current themes present in the regions they have visited.
Finally, it is important to note that by combining city maps with guidebook-like content, we meet the call of Brown and Chalmers [6], who suggest that one of the greatest challenges in mobile tourism technology is greater integration of *paper* maps and *electronic* guidebooks.

2 Related Work

WikEar builds on the WikEye project [7], which makes accessible Wikipedia-derived content with a magic lens interface for a paper map. Like WikEar, the goal of WikEye is helping users to understand more about their surroundings via an easy to use mobile interface. For example, when a WikEye user views a small portion of a Berlin paper map through the camera phone – like the area containing the Reichstag building and the Brandenburg Gate – Wikipedia content is overlaid on the camera image of the map, highlighting these spatial objects and their relationships. Following a clock metaphor, rotating the device about the camera axis switches to a different time in history and delivers an overview of content related to that time period. Depending on the spatial extent of the map visible on the camera display unit, the system responds by offering Wikipedia data about spatial objects with larger area footprints. In other words, as the cartographic scale decreases, the threshold area of a spatial object to be featured with Wikipedia data increases. While WikEye concentrates on the interaction within a single map, WikEar is a bridge between two or more maps, a concept that will be elaborated upon in the next section. WikEar also differs in its approach to content. While WikEar utilizes whole narratives from the Minotour project, WikEye is limited to much simpler forms of educating the user with Wikipedia data.

3 Interaction Pattern

Imagine you are a tourist in a city or a region and want to learn about the place you are visiting. You find a public city map and hold your camera-enabled cell phone up to the map. You then select your destination, probably one of the city's or region's more famous locations. A story designed to match your start location, destination, and traveling time is then delivered to your phone over the Internet, ready for you to listen to the parts of the story as you head towards your destination, interspersed with directional guidance. The actual guidance is not part of WikEar yet, but could leverage existing tour guide technology [11]. Once you reach your destination you can find another city map and repeat the process or access another tour you have already pre-downloaded.
A key benefit of this interaction framework is the independence afforded to the tourist. The tourist is not limited to prescribed tour paths or restricted by a paucity of available content. In fact, the only check on the tourist's movement is that, due to the algorithms used in tour generation, the start (location of the map) and end destinations must have associated and geotagged Wikipedia articles – which might even have been written prior to the trip by the tourist herself. As such, WikEar, as an instance of mobile tourism technology, is in line with Weiser's vision of Ubicomp [8] in that technology should be much more supportive of spontaneous choices and desire for flexibility.

4 Narrative Theory Approach and Wikipedia "Story Mining"

As is noted in the introduction, Lanegran [5] and researchers in the field of intelligent narrative technologies state that a successful educational tour is one that weaves a story as one travels through the landscape. As such, the optimal approach to automatic educational tour generation is one that gives narrative a central role. However, before explicating the algorithm used to generate guided tour narratives from Wikipedia it is first necessary to highlight some characteristics of Wikipedia.

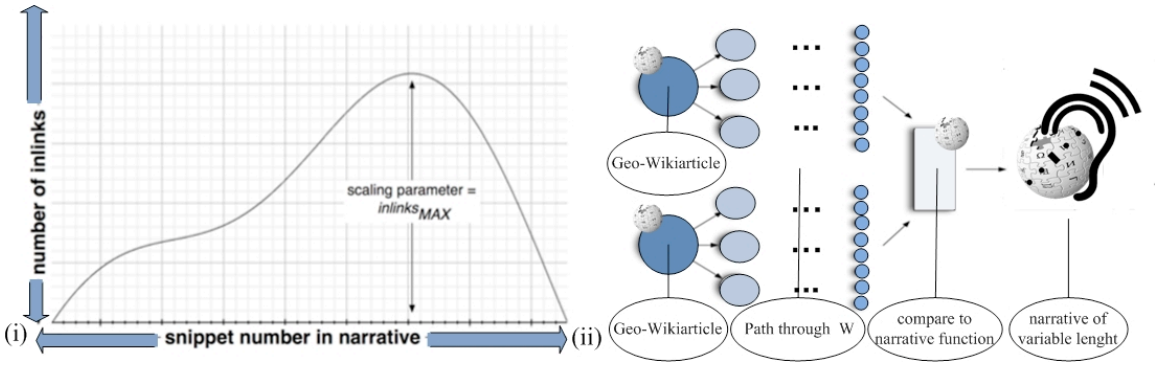

Fig. 1. (i) The ideal Narrative Function. The narrative algorithm chooses the path through the Wikipedia graph that most resembles this function. (ii) A diagram depicting the operation of the path finding portion of the narrative algorithm. Once found, the paths are evaluated by narrative-theory informed function. Finally, the narrative with the best output (the one most similar to the optimal narrative(i)) is selected.

Aside from being the largest-ever compilation of user-contributed human knowledge, Wikipedia has three other important features that we exploit in WikEar:

1) From a geospatial viewpoint, Wikipedia can be split up into two types of articles, two of which are vital to the understanding of our algorithmic approach to narrative generation: *georeferenced articles* and non-georeferenced articles.
2) Because Wikipedia is collaboratively edited, the average Wikipedia article is contributed to by at least seven different authors [9]. This fact, in combination with the encyclopedic tone of nearly all of Wikipedia, allows for self-contained paragraphs that are extremely disconnected from each other. This allows us to treat Wikipedia paragraphs as individual entities we have named *snippets*, and re-order them in any way our algorithm demands.
3) Wikipedia has an elaborate graph structure, a fact that is at the very center of our narrative generation approach. We define the "Wikipedia graph" *W* as the set of Wikipedia articles and the associated link structure.

The goal of our algorithm is to find the path through *W* between the articles about the start and destination spatial features that most resembles the optimal path we have defined according to our approach to narratology. We then take the snippets hosting the links in the nearest-to-optimal path and present them in order to the user as a guided tour. In other words, the algorithm optimally queries and restructures Wikipedia's content to (1) provide location-based information, and (2) to do so in a way that can be perceived as a narrative. In this re-structuring process, the snippet is treated as atomic. The algorithm determines the number of snippets to include in each tour using an estimate of the travel time between the start and end destinations, thus preventing us from using standard shortest-path solutions to this problem. The snippets are converted to audio using text-to-speech technology, admittedly a drawback in user experience given the current state of that technology. In our prototype, we have used actors to make listening to the tours more enjoyable.

How do we define the "optimal path" through W? According to our adaption of narrative theory, the optimal narrative is the one that best integrates the structural cues of unity and development into the generated text. In our current prototype version of the algorithm, we have found that such an optimal narrative can be approximated as in figure 1(i), using number of inlinks (indegree in *W*) as the primary variable.

5 Implementation

Wikear is fully implemented for Nokia mobile camera phones (S60 3rd edition). While mining for the optimal narrative takes place online, the procedure is supported by an extensively parsed database of Wikipedia information, the result of a large offline pre-processing step. The input to this step is one of the frequent Wikipedia dumps, which contain a "snapshot" of Wikipedia, i.e. all the text of every article in Wikipedia at a given cut-off point in time. With minor modifications, our parser will work with Wikipedia

dumps of any Wikipedia-supported language, although at the moment we have built in support for only English and German, Wikipedia's two largest encyclopedias. Our device tracking implementation is almost identical to that described in [2]: we use a printed grid of small black dots over the map to track a mobile device with low latency and high precision.

6 Conclusion

We have presented a prototype system that leverages Wikipedia's extensive content and structure in an effort to fill a gap in the mobile tourism technology field. While it will require better text-to-speech for wide-scale adoption, WikEar successfully demonstrates our data and methodology approaches. It is important to note that we have also implemented an application that requires a great deal of spatial context without any GPS technology at all, greatly reducing the cost on the user side. In addition, tourism boards simply need to outfit their existing network of city maps with marker-enhanced maps in order to support WikEar. The total cost is thus much less than that of every user having to buy spatial data and a GPS system, and accessibility is much greater.

WikEar incorporates many new concepts that give rise to a plethora of ideas for refinements and further work. First and foremost, we believe that while navigation is a solved problem [10] and thus not a high research priority, it would be a necessary part of a user-ready version of WikEar. One possibility is to implement landmark-based navigation technology, giving directions such as "head toward the big building", which is more conducive to how tourists prefer to navigate than using a street-based system [6]. Also, we have already begun investigating ways to improve our narrative generation process, as well as looking into ways to evaluate generated narratives. Finally, we are also continually working on ways to improve our tracking technology to the point where no obvious modifications are needed on the printed map.

References

1. Schöning, J., Krüger, A., and Müller, H. J.: Interaction of Mobile Devices with Maps. In Adjunct Proceedings of the 4th International Conference on Pervasive Computing, Dublin, Ireland (2006).
2. Rohs, M., Schöning, J., Krüger, A., Hecht, B.: Towards Real-Time Markerless Tracking of Magic Lenses on Paper Maps Pervasive 2007 Adjunct Proceedings, Late Breaking Results, Toronto, Ontario, Canada, May 13-16, (2007).
3. Hecht, B., Dara-Abrams, D., Starosielski, N., Goldsberry, K., Dillemuth, J. and Roberts, J.: Minotour: A Location-aware Mobile Tour Application that Weaves a Spatial Tale from Wikipedia. Proceedings of the 2007 Meeting of The AAG, (2007).
4. Isbister, K. and Doyle, P.: Web Guide Agents: Narrative Context with Character. Narrative Intelligence. M. Mateas and P. Sengers. Philadelphia, PA, John Benjamins Publishing Company: 229 – 243 (2003).
5. Lanegran, D.: Discussion on question, "What makes a good field trip?" B. Hecht. St. Paul, MN (2005).
6. Brown, B. and Chalmers, M.: Tourism and mobile technology. Eighth European Conference on Computer Supported Cooperative Work, Helsinki, Finland (2003), Kluwer Academic Press.
7. Hecht, B., Rohs, M., Schöning, J., Krüger, A.: Wikeye – Using Magic Lenses to Explore Georeferenced Wikipedia Content. Proceedings of the 3rd International Workshop on Pervasive Mobile Interaction Devices (PERMID), Toronto, Ontario, Canada, May 13, (2007).
8. Weiser, M.: The Computer for the 21st Century. Scientific American 265(3), (1991) 66-75.
9. Buriol, L. S., Castillo, C.: Temporal Analysis of the Wikigraph. Web Intelligence, Hong Kong, China, IEEE CS Press (2006).
10. Baus, J., Kray, C.: A survey of mobile guides. Workshop on Mobile Guides at: Mobile Human Computer Interaction (2003).
11. Cheverst, K., Davies, N., Mitchell, K., Friday, A., and Efstratiou, C. 2000. Developing a context-aware electronic tourist guide: some issues and experiences. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (The Hague, The Netherlands, April 01 - 06, 2000). CHI '00. ACM Press, New York, NY, 17-24.