Linear Location-Based Services

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1. Classifying LBS by their degrees of freedom

Location-based services (LBS) support users during their mobile decision-making. They are information services which are sensitive to their user's location and relate it to the surrounding environment, which in turn provides location-based information to facilitate the successful completion of spatio-temporal tasks. Traditionally, LBS have been classified into different application areas [5].

We propose to describe LBS by the degrees of freedom they offer to their users in choosing the space-time path [6] while using the service. Two dimensions are considered: whether or not an LBS offers the freedom of choosing 1) the spatial trajectory, and 2) the speed of locomotion. These lead to the following four categories (see also Table 1):

A) *Explorer LBS*: the user can freely choose both, spatial trajectory and speed. Most LBS fall into this category, such as pedestrian tourist guides where points of interest (POI) can be visited in arbitrary order.

B) *Flow LBS*: the user can freely choose her trajectory, but not her speed. A car driver's speed, for example, is typically constrained by the traffic flow, while there is usually more than one route option. Location-based in-car entertainment systems for drivers fall into this category [1].

C) *Path-following LBS*: the user is bound to a linear path, but can choose her speed freely. Examples include tour guides for bikers or hikers traveling along a linear feature, such as a hiking trail or a river [2].

D) *Passenger LBS*: the user passively follows a given space-time path, being able to neither influence the route nor the speed. This applies to passengers of different means of transportation, such as buses, planes, trains, or boats [4].

Table 1: Categories of LBS, based on the degrees of freedom they offer in choosing the spatial trajectory (T) and the speed of locomotion (S)

T	S	Name	Example application areas
yes	yes	Explorer LBS	Pedestrian tourist guide
yes	no	Flow LBS	In-car entertainment for drivers
no	yes	Path-following LBS	Biking/hiking tour guide
no	no	Passenger LBS	Boat/train trip guide

Thinking of LBS in these categories helps us to identify the issues particularly important for the spatio-temporal LBS design: LBS with speed constraints (B and D) require the system designer to adjust the presented content according to temporal parameters. The user cannot stop in order to consume the content, therefore it should be delivered in chunks of appropriate length. LBS with trajectory constraints (C and D), on the other hand, require a spatial adjustment of the content. This can be achieved by selecting only those POI appearing along the track, and/or by dissociating the interesting place from the trigger region where the information service for that place is presented.

2. StoryLiner: a Passenger LBS

As a first step of this ongoing research, we have considered the design of a *Passenger LBS* for touristic boat trips on the Lake Lucerne, Switzerland. The goal of this LBS is to reveal the hidden imaginary literary worlds connected with the Lake Lucerne region, as a complement to the nature experience of the Swiss mountain region. The content was developed by Barbara Piatti [3] for the project "A Literary Atlas of Europe" (http://www.literaturatlas.eu/en/).

In a Master's thesis [4], an Android app (*StoryLiner*) was developed which notifies the tourist when places of literary importance come into sight (see Fig. 1). Text passages of books related to this place, its author, photos of the place, and general touristic information ar e offered o n a smartphone. A panorama view adaptive to the device compass helps the user identify the place in the surroundings.

A specific focus during the development of *StoryLiner* was put on dealing with the *Passenger LBS*-specific design issues. Since the places of interest are located so mewhere i n the m ountains s urrounding t he l ake while t he boat is f ollowing a f ixed t rack on t he l ake (trajectory c onstraint), trigger regions w ere d efined b ased o n a v isibility anal ysis o n a d igital e levation model. As further constraints, the trigger regions had to be placed in a way that e ach i nformation i s t riggered e xactly o nce, and that the r espective place is in sight for at least a given duration threshold, based on the known speed of the boat (speed constraint). This ensures that the tourist can per- ceive all information before the place gets out of sight and before the next trigger region is entered.

The analysis w as d one by co mbining A rcGIS t ools wi th a c ustom P ython script. Figure 2 displays the result of the analysis for the 14 places selected by a literary scholar.

3. Conclusion and Outlook

A first pilot study with 6 users indicated that, while the app was generally perceived a s h elpful, s ome u sability i ssues n eed to be re solved in future work: the current implementation of the panorama view with static images shown a t pr edefined p ositions was confusing and will b e replaced b y dy- namically created panoramas or an augmented r eality view. Participants also noted that places on the map should be labeled. The main challenges of *Passenger LBS*, h owever, seem t o be s olved q uite w ell: p articipants w ere able t o i dentify the literary p lace i n t he surroundings, and no negative re- marks were made w.r.t. the spatial and temporal presentation of content. A larger user study will help to confirm these findings.

Spatio-temporally restricted LBS have certainly been developed before. We aim at classifying a l arger number of those previous LBS w.r.t. our classifi- cation s cheme (section 1). A specific f ocus on how th ey so lved th e sp atial and t emporal c onstraint p roblems will h elp to d evelop general guidelines for linear location-based services.
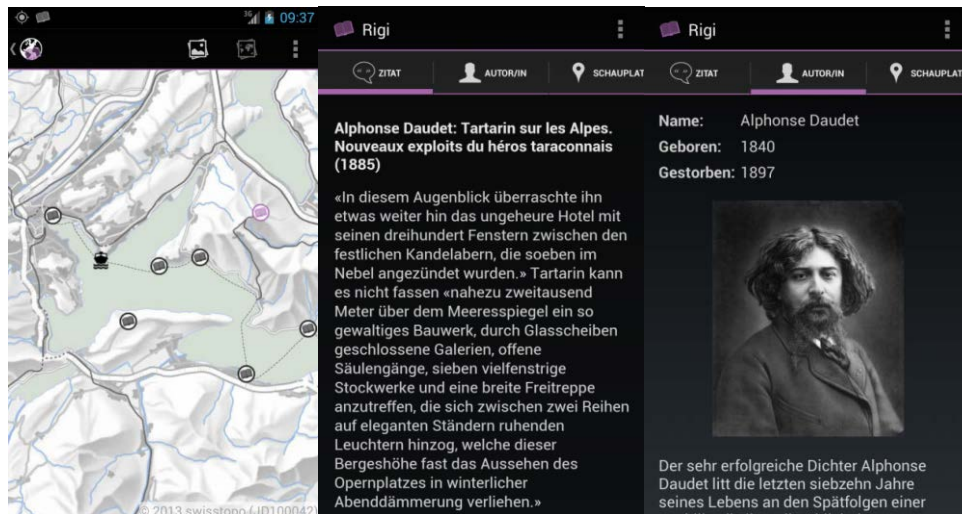
Figure 1: The *StoryLiner* app. Map view (left), book citation (center), and author information (right)
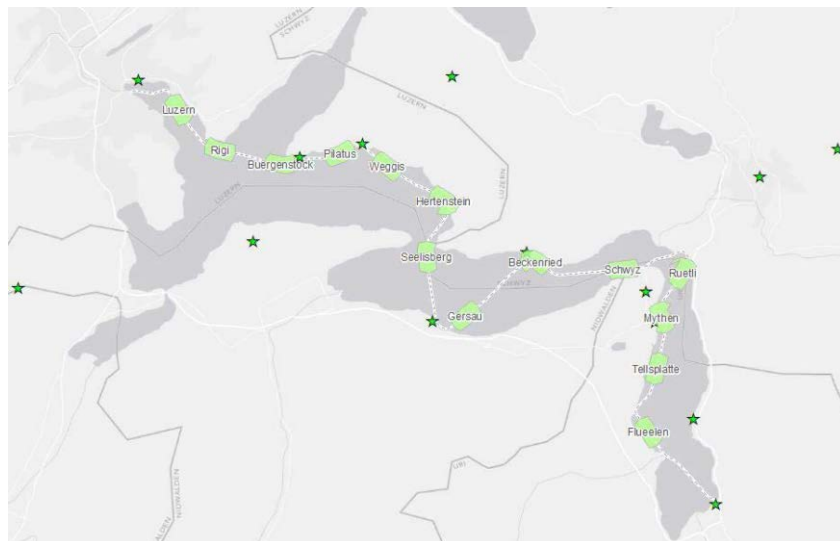

Figure 2: Trigger regions (polygons) and places of literary interest (stars) for the *StoryLiner* app

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