
End-User Place Annotation on Mobile Devices: A Comparative Study

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Abstract

Advances in Location-Based Services (LBS) are opening opportunities for using the location of people, places, and things to augment or streamline interaction. While computers work with physical locations like latitude and longitude directly, people usually think and speak in terms of places, which adds personal, environmental and social meaning to a location. To address this conceptual mismatch, location-aware applications must incorporate the notion of place to achieve their full potential. In this paper, we investigate four techniques for collecting end-user place annotations *interactively* using cell phones. The results from a usability study suggest that while all the four methods receive similar preference ratings in understandability, the “photo memo plus offline editing” method is the most favorite approach in ease of use. In addition, users indicated their desire to adopt more than one place annotation method in location-aware applications.

Keywords

Context Aware Computing, Location Based Services, Mobile Computing, End-User Programming

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation: User Interfaces evaluation/methodology, user-centered design.



figure 1. Cell phone Interfaces for *DText*. (number order is left to right, top to bottom) figure 1.1 represents the upper part of the primary menu. 1.2 represents the middle part. 1.3 is the place type collection sub-menu. 1.4 is the place range collection sub-menu. 1.5 is access control sub-menu. 1.6 is the bottom part of the primary menu

Introduction

Location based services (LBS), or location-aware computing [5], draws increasing attention in the ubiquitous computing research community. With the popularity of low-cost Global Positioning System (GPS) solutions, more and more LBS applications are becoming widely available to regular cell phone users in the recent years. One typical example is the TeleNav driving directions service [10], which provides on-demand map and driving services over the cell phones to subscribed users.

However, there exists one critical conceptual mismatch [4] that hinders the scalability of many LBS applications – i.e. while computers work with physical locations like latitude and longitude, people usually think and speak in terms of places, like “my home” or “Tom’s office”, which adds personal, environmental and social meaning to a location [3], [4]. Therefore, almost every location-aware application will encounter the problem of translating raw location data (longitude, latitude, cell tower information, access point information, etc.) to more symbolic, personally meaningful places.

Most of the existing LBS toolkits such as LocationStack [5] and PlaceLab [7] acknowledged such a conceptual mismatch between location and place and provided *abstractions* and *models* for mapping locations to places, however, none of them provided effective and scalable techniques for collecting the *data* to address this mapping problem. As such, most of the current LBS prototypes [6], [9] still require system developers to collect and load place names for users manually.

It’s possible to discover personal meaningful places from users’ history location traces automatically [1], [8]

by using spatial and/or temporal data clustering algorithms. It’s also possible to identify important place in everyday life semi-automatically by a set of heuristics such as GPS signal availability [9]. However, these methods still can not eliminate human intervention completely: First, automatic/semi-automatic methods will never become 100% accurate; Second, most of the automatic algorithms nowadays are focusing on discovering the positions of places; it is still a human’s responsibility to annotate the names of places.

Due to the above reasons, we feel it is compelling to identify intuitive and non-intrusive place annotation methods to collect place annotations from end-users. In the rest of this paper, we propose four prototypes that can be used to collect place annotations interactively from mobile devices, and describe the results of an experiment which aims to obtain *preliminary* understandings of the following two questions –

- How to effectively collect place labeling information from grassroots contributors?
- Whether and what users are willing to disclose regarding their personal place profiles?

End-User Place Annotation

In this paper, we focus on end-user manual annotation methods for two reasons: First, pure pre-loading approaches used in current prototypes do not scale well with more users. Second, even for semi-automatic or automatic methods, they still need end-users to enter feedback and corrections, input the label name and additional properties etc, so manual annotation is still required to complement automated methods.



figure 2. Cell phone interfaces for *Map*. After pressing the ok button, the *DText* interface will pop up for place annotation collection



figure 3. Cell phone interfaces for *Photo*. (number order - left to right, top to bottom) 3.1 is the initial interface after activation. 3.2 is the photo capture interface. 3.3 is the photo history. After pressing the ok button in 3.3, the *DText* interface will pop up.

We designed and implemented four techniques for end-users to make place annotations on mobile devices. We explored different modalities and input capabilities available on cell phones in these prototypes. The prototypes are written in Java 2 Micro Edition (J2ME).

Technique 1: Direct Text Annotation

The first end-user place annotation interface we created is "Direct Text Annotation" (a.k.a. *DText*, figure 1). *DText* is a relatively straightforward method – after pressing a hot key, the primary interface of *DText* will pop up, the user can give a name to her current location, specify a type of the location (There are 7 pre-defined location types in the current version, i.e. unlabeled, home, work, shopping, dining, leisure and others), define the valid range of the current annotation (current configuration includes: 20 feet, 50 feet, 100 feet and custom), and choose the access control property for the current annotation (existing options are self, family members, friends and anybody).

The *DText* method is not just a standalone annotation technique. It was also used by the other three techniques to prompt the user for the name and other properties of the current place at appropriate moments.

Technique 2: Map Selection and Text Annotation

The second place annotation technique is "Map selection and Text annotation" (a.k.a. *Map*, figure 2). Unlike *DText*, this interface is designed to allow users to define places other than their current location. After pressing the hot key, a map corresponding to the user's current location will be downloaded to the cell phone. The users can pan, zoom-in and zoom-out the current map. He can also move the hot-spot cursor on the map by using the built-in cursor keys and context menu

keys of the cell phone. After pressing the ok button, the *DText* interface described in technique 1 will pop up to collect the place information for the location under the hot-spot cursor.

We propose this technique to give users the flexibility to annotate places other than their current location through selecting places from a graphical map display.

Technique 3: Photo Memo plus Offline Text Annotation

The third technique is "Photo Memo plus Offline Text Annotation" (a.k.a. *Photo*, figure 3). After pressing a hot key, the user can take a picture using her camera phone to create a reminder of such a place that she is visiting, after which, when it is convenient for the user, such as when she is waiting for a bus at the bus stop or waiting for food in a restaurant, she could activate the label picture function and annotate places she visited based on the photo memos she had taken. After annotation, only the properties appeared in the *DText* interface will be transmitted to the server, the pictures taken will only stay in the user's local cell phone as a reminder and will not be shared by other users.

This design is motivated by our observation that when people are in personally significant places, it may not be the ideal time for them to spend significant amount of time to annotate the place immediately even though the place is meaningful to them.

Technique 4: Voice Memo plus Offline Text Annotation

The fourth and the last technique we created is "Voice Memo plus Offline Text Annotation" (a.k.a. *Voice*, figure 4). The basic idea is similar to the photo memo method, except that instead of taking a picture as the reference to the interested place, the user records a short voice

memo to describe the place she is interested in. When it is convenient for her subsequently, she can then retrieve her previous voice memos and label them the associated places after hearing the content of the voice memos.

Similar to the photo memo method, voices recorded are only used as reminders. They are not shared with other people as part of the place annotations.

Usability Study

We conducted a trial usability study to investigate the performance of the four place annotation techniques described above.

Experimental Design

Six subjects participated in this preliminary usability study - three males and three females with an average age of 26.7. Five of them are undergraduate and graduate students at a local university. The user study consists of three parts. First, subjects complete an opening questionnaire, which include a background survey, a task asking the user to identify the important places he/she had visited in the past one week and assign a name to each of the place identified; and a form asking the user whether they are willing to share the location to place information that they provide during the study with their family members, their friends, their classmates/colleagues or just anybody.

Second, the subject is asked to use each of the four prototype interfaces to annotate a place that she visited in the past two hours and the restaurant where she had lunch (or planned to) on the day of the study. The order of interfaces tested in this part was counter-balanced by the Latin-Square pattern.

Third, the subject is required to complete a closing questionnaire. Each subject gives each prototype interfaces tested a score on the whether the user interface is easy to understood and a score on the ease of use of the interface (scale = 1 - 5, 5 means easiest, 1 means most difficult). The subject is also given blank spaces to leave her own usability feedbacks and suggestions in this section.

Opening Questionnaire Results

In the place identification task, all the six subjects identified 74 personally meaningful places totally (12.3 places on average. min = 6, max = 21). The average length of place names used by subjects is 1.8 words (min=1, max=3) or 7.1 English characters (min=3, max=15).

Top referred places from the opening questionnaire include - home, office, restaurant, shopping mall, bus stop, ATM etc. One interesting finding is that about 78% (58 out of 74) of the places are indoor places. This finding not only provide supports to the lost signal heuristic used in the ComMotion [9] project, but also suggested us that effective place annotation techniques shouldn't use the assumption that "live" GPS fix signals are available at the time of activation. Instead, the application should try to use either historical data or switch to different positioning techniques (e.g. AGPS, cell tower ID) when direct GPS signals are not available.

All of the subjects indicate that they won't mind to share all of their place profiles with friends and family members. Four of them even indicated that they won't mind to share their location profiles (the customized mappings from locations to places) with anybody. These numbers are interesting because they appeared to differ from people's opinion on disclosing their



figure 4. Cell phone interfaces for Voice. 4.1 Initial interface after activation. 4.2 voice capture interface, 4.3 voice history. After pressing the ok button in 4.3, the DText interface will pop up.

current location [2]. There are two possible explanations to this phenomenon: First, people may think information related with their personal places, such as their home address are no longer a secret already. Indeed, considering that most people won't pay the telephone company to hide their contact methods from phone books and there are so many companies that collect and sell personal contact information, such reaction looks reasonable. Second, people may simply not define places which they don't want to disclose via the annotation application.

Performance of Four Prototypes

All the six subjects completed the assigned tasks successfully. Their rating of the four method are summarized in figure 5.

From figure 5, we can see that users believe all the four designs are very easy to understand. (Average score =3.9, min=3.7, max = 4.0).

The users also have mixed feeling on the four techniques according to the criteria of "ease of use". The *Map* selection method received a relative low score (2.9) according to this standard. We assume that the low score on the *Map* method is caused by the relative clumsy interaction methods to navigate on a map without proper pointing devices. It may also be caused by the fact that defining a place other than the user's current location might not be a very frequent task. Last, 78% of the significant places are indoors, which can not be located effectively from standard maps.

The *Voice* annotation method received the lowest score (2.7) score on ease of use, among the four techniques. Most subjects dislike this method for two reasons –

recording a voice memo for a place might *look* silly in many scenarios. What is more, selecting a desired voice memo later is often difficult since the users must listen to the voice memos one by one.

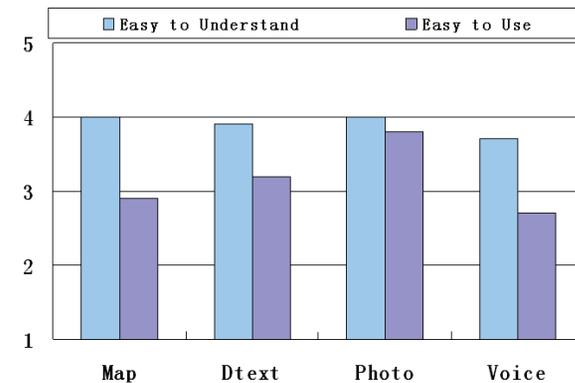


figure 5. End user ratings on the four annotation techniques. Ratings are in a 1 to 5 scale, 1 means worst, 5 means best and 3 means neutral

The *Photo* method received a significantly higher ease of user score among the four. Subjects thinks the idea of using photos as reminders and annotate the place name later is a neat idea, considering the relative slow text entry speed on cell phones.

Closing Questionnaire Results

Many usability issues have been identified from the usability study and the closing questionnaire. For example, some users feel that a confirmation screen is necessary when a place has been annotated successfully. More mode switching supports in the place label editing box are desired according to the users'

feedback. E.g. one subject got stuck for more than 5 minutes in the usability test when he switched to the T9 input method by mistake and couldn't figure out how to switch back to the default Multi-Tap input method.

Although users gave the photo memo plus offline text annotation method the highest score in ease of use, they also indicated their desire to have more than one annotation method in the final application. Thus they can choose the one that best fits their need according to the given context.

Conclusions and Future Work

In this paper, we designed four techniques for collecting end-user place annotations interactively by cell phones. A trial within-subject experimental study is conducted to evaluate the performance of these techniques. The results suggest that while all the four methods got similar preference ratings in understandability, the photo memo plus offline editing method is the most favorite approach in ease of use. In addition, users indicate their desire of adopting more than one place annotation methods in location aware applications.

In the current experiment design, creating place annotations are completely voluntary, users will not get any reward after creating and sharing their place profiles with others. This scenario might be problematic in a real deployment if most of the users are not willing to create or share their own place profiles. How to establish some incentive mechanisms to foster place sharing might be an interesting topic to investigate in the near future.

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