

Challenges of User Experience Design for Human-Centered Location Based Services

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ABSTRACT

This paper raises a number of open research challenges with respect to the theme “User Experience Design for Location Based Services (LBS)”, namely “context-aware user interfaces”, “collaborative user interfaces”, “cross-device interaction”, “cognitive implications of mobile user interfaces”, and “social and ethical issues”. We formulate important research questions within each challenge.

Keywords

Context-Awareness, Human-Centered Location Based Services, Mobile Cartography, Social and Ethical Issues

INTRODUCTION

Mobile devices account for more Internet usage than personal computer worldwide since October 2016[5]. In other words, we are now living in a mobile information era, which potentially allows us to access information anytime and anywhere. Location Based Services (LBS), which deliver information tailored to the current location and context of the user, have attracted significant research interests from different disciplines, especially Cartography/GIScience and Computer Science. In recent years, LBS are becoming more and more ubiquitous in our daily life.

LBS are often designed to facilitate people’s daily activities and decision-making in different environments. To provide good user experience, LBS or mobile map-based applications should be human-centered, i.e., adapted to their users’ preferences, needs, constraints, and context. In other words, there is a need for a paradigm shift from technology-centered to human-centered.

Huang et al. (2018)[2] provide a state-of-the-art review of the research trend of the scientific field of LBS in the past years, and present a research agenda for LBS. Particularly, it highlights a series of research challenges, organized into six groups: ubiquitous positioning, context modeling and context-awareness, mobile user interfaces and interaction, user studies and evaluation, analysis of LBS-generated data, and social/behavioral implication of LBS.

In contrast to the general research agenda presented by[2], this position paper aims to focus on issues related to mobile user interfaces, especially map-based user interfaces in

LBS. Specifically, we provide a personal view on the research challenges relevant to the user experience design for human-centered LBS.

SELECTED RESEARCH CHALLENGES

In general, the two key overall questions that need to answer when it comes to user experience design for human-centered LBS are “*what information is relevant to the user and his/her context and should be communicated to him/her?*” and “*in which way (i.e., communication forms)?*”

We don’t intend to cover all the research challenges within this theme, but particularly highlight the following six essential challenges. The first three cover aspects relevant to the design of mobile user interfaces for LBS, and the others focus on the cognitive and social issues related to the use of LBS.

Context-Aware User Interfaces

Compared to other geospatial and web mapping applications, LBS are often used in dynamic and mobile environments, by diverse users, in various contexts, for different tasks. Therefore, context-aware user interfaces should be provided in LBS. Please note that, “context” is an umbrella term, which denotes any information that might be relevant to the interaction between a user and an LBS application[1]. In this sense, location and users are part of context, however, there is more to context than location and users. In other words, context-awareness implies location-awareness and personalization.

To provide context-aware user interfaces in LBS, several essential issues should be addressed.

- 1) A systematic framework to study LBS users/context, and the users’ information needs should be developed. Some key questions are: What kinds of context information should be considered and modeled, as well as how they can be acquired and inferred from different data sources? How can LBS users and their characteristics be classified? How far can users’ information needs be categorized and formalized?
- 2) Techniques to provide context-aware user interfaces are needed. The overall question is “How can we transform users’ information needs and contextual constraints to the design decisions regarding mobile user interfaces in LBS?”. Take

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mobile maps as an example. It is important to understand “which map contents and presentation styles are relevant for which contexts and communication goals”[4], as well as “which cartographic design patterns, techniques, and rules are needed to implement these map design”.

- 3) Guidelines on choosing a right level of automation in the context-aware adaptation process should be developed. While a high level of automation (e.g., self-adaptation) requires no interaction of the user with the system, the user might get a feeling of losing control over the system. This challenges researchers to find a balance between level of automation and level of user interaction.

Collaborative User Interfaces

Currently, LBS have been mostly built and assessed only for use by individuals. In the real world, many of our activities and decision-making in space actually involve other individuals, such as wayfinding in an unfamiliar environment with friends, exploring a city or museum together, or planning a meeting place when each individual is on the move. It is still rather unclear how LBS should be designed to support this kind of collective actions, tasks and activities. Various types of group-based interactions might be differentiated, regarding whether the users are together or distributed at different places (same place vs. different places), whether the interaction happens synchronously or asynchronously (same time/real-time vs. different time), and how many mobile devices are used (one shared device vs. one device per user). It is important to investigate these different types of group-based interactions, and how the user interfaces of LBS should be developed to facilitate the collaboration.

User Interfaces for Cross-Device Interaction

In recent years, more and more people are carrying different mobile devices (e.g., smartphones, smartwatches, digital glasses, and other wearable devices) at the same time. Potentially, these different devices can be concurrently used to communicate relevant information to users in LBS. For example, for navigation applications, smartphones can be used to provide overview information at the beginning of the navigation process and whenever needed, while turn-by-turn instructions can be communicated on smartwatches at each decision point. Therefore, it is important to explore how the user interfaces of these devices can be designed to allow cross-device interaction to achieve good user experiences in LBS.

Cognitive Implication of Mobile User Interfaces

While LBS (e.g., navigation systems) can facilitate users' daily activities and decision-making, they potentially bring some “side effects”. This seems logical, as “technologies change how we think, often by reducing our ability to reason efficiently without the technology” [6]. As shown by several initial studies (see [3]), over-reliance on navigation systems might actually harm our spatial abilities and spatial knowledge acquisition. However, until now, a systematic

understanding of these issues and their relationship to other individual differences is still missing, and very challenging. Addressing this issue requires longitudinal empirical research. Meanwhile, as these potential side effects seem to exist, it is important to investigate how LBS can be designed to facilitate people's activities and decision-making without harming their spatial abilities.

Social and Ethical Issues

As mentioned before, LBS or mobile maps provide information to users by making use of their current location and preferences, as well as the context they are in. This information is often private and thus very sensitive, and therefore raises privacy concerns and even other ethical and legal issues. Addressing these issues during the design of LBS seems to be critical to ensure a good user experience. Questions like “what are the privacy and ethical issues in LBS” and “how can we best address users' privacy and ethical concerns while ensuring the services quality of LBS” should be answered.

SUMMARY

Due to the diversity of users, user tasks, and use contexts, there is no more “one-for-all” solution when it comes to the interface design of LBS and mobile maps. This paper introduces some essential challenges existing within the theme. We argue that many of these challenges continue to be essential even in our future world with all kinds of autonomous systems (self-driving vehicles, social robots) being integrated into our daily life.

As can be seen above, these challenges mostly cover multi-disciplinary aspects, therefore it is important for Cartography community to work with other disciplines to address these challenges.

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