No vertical limit - Conceptual LBS design for climbers

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CHI 2007, April 28 – May 3, 2007, San Jose, USA

Abstract
In this paper we present a novel conceptual design for a location-based service (LBS) for climbers. We focus on ideas for LBS in the vertical domain, combing concepts from augmented reality, mobile social applications and multimodal integration. We address problems such as merging paper maps and reality, hands-free interaction, communication in environments without infrastructures, and geosensor networks that provide information on weather and other relevant subjects.

Keywords
LBS, conceptual design, climbing

ACM Classification Keywords
H.1.2 User/Machine Systems, H.5.1 Multimedia Information Systems, H.5.2 User Interfaces

Motivation and related work
Today's mobile devices easily outperform the desktop computers of even a few years ago. The ongoing miniaturization trend allows us to carry devices with us in situations formerly hostile to technology. For example, there are some existing location-based applications, like the "Alps Ranger" [1] and the "Paramount system" [2, 3], that make wilderness experiences safer. These GPS-based LBS run on a PDA, lead hikers through the mountains and can also help

rescue teams to locate a stranded hiker. In addition, an increasing number of sensors are integrated into such devices. Camera, GPS, compass and similar sensors are already somewhat standard [4]. Other sensors, e.g. for surveillance of human vital functions, enable the development of new applications.

In an informal focus group established around faculty members and students from the Institute for Geoinformatics, University of Münster, we have developed a concept for a novel LBS for climbers. Both mountain guides and members of the target group — the climbers themselves — were involved in the design process to make sure that all aspects of a climbing experience were considered. In this paper, we address the four main issues raised by the group:

Navigation (i): For climbing, so called "climbing topo maps" are often used (see figure 1). Focus group members said these maps are often difficult to understand. A "topo" is a guide for a crag or climbing area. It contains details on the grade of each of the climbs. It includes the lengths of the climbs and most importantly it usually specifies which gear has to be used. *Communication (ii):* Climbers normally work in small groups of not more than three persons on one single rope. As such, *communication* plays a big role in the belaying process. Such communication may be very difficult if it is windy or if the route is very narrow or obscured. *Weather forecasts (iii)*: In many climbing situations the *weather* plays a big role — for example, a thunderstorm is very dangerous in the mountains. So the climbers need to be informed of the current and upcoming weather. *Climbing community (iv):* A detailed estimation of the degree of difficulty of a route and knowledge about special challenges contribute to a better-planned and safer climbing experience. Such detailed knowledge is best exchanged among climbers, an idea that can easily be realized through specialized online portals. However, important characteristics of a climbing trip are not supported by these services, e.g. the sporty challenge, adventure and the thrill.

Smart Navigation — Augmented climbing routes

From the perspective of supporting services, a climbing day can be separated into three distinct segments: planning the trip at home and going to the starting point, the actual climbing experience, and finally going back home and documenting the tour.

Figure 1: A photo augmented with a topo

The choice of the climbing trip is facilitated by an online climbing portal, which provides information on length, degree of difficulty and other characteristics of the available routes. The climber, going by car, is first routed to a parking lot near the starting point, and then

guided to the rock face via pedestrian navigation [1, 4]. However, the most difficult part is often finding the exact starting point of the climbing route at the foot of the wall. As such, the mobile assistant is equipped with augmented reality functionality to help the user to solve this task. The image of the integrated camera is overlaid with the topo to visualize the route on the wall, as shown in figure 1. This functionality is available throughout the tour and allows the alpinist to project the topo upon the real-time image of the wall whenever he needs support.

Smart communication between the climbers

Once the climbers have begun ascending the wall, they are supported by enhanced functionalities of their gear. Harnesses, ropes and sports watches are equipped with sensors that allow the climber to retrieve information on the next grip or stand. Moreover, the smart equipment allows climbers to communicate and monitor each other's vital functions through non-obstructive displays on the harnesses (see figure 2). This can be critical during ascents where two climbers cannot see each other because of a ledge. Belayers can watch for increases in their climbers' heart rates — a change that usually indicates that a fall is imminent — and can use the communication channel to clear up the situation. All communication is transferred through the rope, which acts as a data cable (see figure 3), since wireless connections tend to be error-prone in the mountains. For individual support, the climber's watch is equipped with easy-to-read symbols that point in the direction of the next crevice. Beyond that, the distance and the type of nut previous climbers have used at this crevice are shown. This information is stored on the digital assistant and was downloaded from the climbing portal when the route was planned. The system also automatically stores the kind of nut the current climber is using, so that the collected information can be uploaded to the portal after the tour. This functionality is enabled by geosensors integrated in the nuts and carabineers, as shown in figure 3.

Figure 2: The smart harness - the harness provides information on the climbing partner

Geosensor network provides weather information

The fast changing weather conditions in the mountains are a notorious problem for climbers. The conditions can often change from sunshine into rain in a few minutes. Moreover, it is very difficult for climbers to perceive weather moving in from directions that are out of sight, making it nearly impossible for them to react appropriately. On the north wall of a mountain, for instance, the climber cannot perceive the arriving storm from the south. Information about incoming dangerous weather enables the climber to leave the wall at an

appropriate exit. As such, short-term weather forecasts are essential to the safety-aware climber. The mobile device delivers the necessary weather information. The climber sees all appropriate information visualized on the harness display (see figure 2). Since she is not able to permanently observe the information on the display of the mobile device during climbing, the system must alert the climber via a voice signal when the weather conditions are changing in a way that would force her to stay in the wall, e.g. a hard storm. The sources for the weather information are the hooks themselves. Equipped with sensors and Internet connections, they comprise a geosensor network [5] that collects and distributes the necessary information (see figure 3).

Figure 3: The smart hooks built up a geosensor network to collect and dispread information.

Support the community

Today´s online portals (e.g. DAV Felskataster [6]) support climbers in their decision making process by delivering information such as the degree of difficulty of a route. This information comes from independent critics or other climbers from the community, who present their personal experiences and impressions on the web. However the personal preferences of a visiting climber will be emphasized. Users will be able to create, save and change their own profile. Fundamentals of the profile are for instance personal abilities, desired location and degree of difficulty. Additionally, the portal will be able to compute a tour that matches the profiles of all individuals in a group of climbers. Climbers can also contribute to the community by transferring their personal impressions and experiences of a past climbing tour from the mobile device into the online portal [7].

The challenge is to combine these different services in a manner such that climbers can use their mobile device to complete all of the aforementioned tasks. The goal of our conceptual design is to provide an integrated user experience through a consistently designed interface.

Conclusion und future work

In this paper we present some basic ideas for a climbers' LBS. We are starting to implement the Augmented Climbing Route Viewer based on our work on mobile interaction with maps [8]. Beyond that, we are developing a positioning system based on rope length and air pressure to determine the vertical position of the climbers, a task that GPS still performs poorly [9]. All ideas mentioned are from a research retreat in the Alps. We would like to thank the participants for discussions on this topic, especially Sebastian Südbeck, Oliver Paczkowski, Brent Hecht, Krzysztof Janowicz, Hans Jörg Müller, Martin Raubal and Antonio Krüger.

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