StrapMaps: Bringing Map-based Navigation to the Straps of Bags

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Abstract
Most outdoor activities and outdoor sports include a navigation component. For example, hiking, biking, mountaineering and climbing activities require orientation and wayfinding at certain points to certain degrees. With the rise of personal GPS devices, numerous navigation apps now exist that are tailored to the specific needs of outdoor enthusiasts. Nevertheless, they all have the common problem, that they require the users to "store" the mobile device in their pockets to have the "hands free" for interaction. While wearable devices such as smartwatches overcome this problem, they have the disadvantage that they often offer very small screen space. In this paper we present StrapMaps, a concept to bring interactive e-ink displays to straps of backpacks or harnesses to present map information while on-the-go in nature.

Author Keywords
wearable devices; cartography; mobile maps; strapmaps; stripemaps; hiking; climbing

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: *User Interfaces — input devices and strategies, interaction styles*

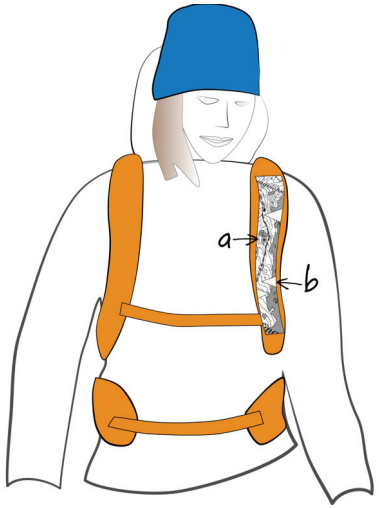

Figure 1: The StrapMaps concept; an interactive e-ink display is attached to a backpack. A location indicator a) shows the current location on the linearized map. The cuts, e.g. b), along the route indicate the direction of the turn the user needs to make to navigate along the path.

Introduction & Motivation

UbiComp technologies have great potentials to support alpine sports. In a range of activities, from climbing, mountaineering or mountain biking to hiking, navigation and orientation often is a great portion within these activities. Even though people are used to rely on navigating with their mobile devices in urban environments, most outdoor enthusiasts still rely on fairly low-tech solutions in the mountains [4].

Papers maps, handheld GPS devices or fully ruggedized smartphones are used for good reasons. First, as outdoor activities typically last for a full day, low power consumption is a critical aspect. Second, standard screens are hard to read in bright sunlight conditions and therefore people often get back using "low-tech solutions" (e.g., paper maps or handheld GPS devices) instead of modern smartphones or smartwatches. Nevertheless, also the low-tech variants do have their own disadvantages.

Handling those devices in nature can be cumbersome: Typically, a paper map or a handheld GPS device needs to be stored in a pocket or in a bag while climbing or mountaineering. As a result, the users do not always have their hands free. In addition, the user experience of e.g. handheld GPS devices is not meeting the standards of today's smartphones and the interaction with them is typically quite slow.

Wearable devices have the potential to overcome these problems, for example by including e-ink (or e-paper) displays that are better to read outdoors (e.g. the smartwatches by Pebble[1]), as they can be red in direct sunlight. However, they have the main disadvantage, that they just offer a very limited screen space of typically 4 to 9 cm^2.

In this paper, we present the concept of StrapMaps to combine the best of both worlds. StrapMaps bring maps and position information (by linking StrapMaps with a mobile device stored in the bag) to the straps of a backpack or climbing hardness (as can be seen in Figure 1). By linearizing the map content, StrapMaps are offering a fairly large screen. Therefore, they are able to provide an overview on a full route at one glance. Full route knowledge is particularly important outdoors, as a decision at a waypoint may influence further decision throughout the day. Therefore, map based techniques are preferred compared to alternative approaches, such as tactile navigation techniques [6], which better address the navigation needs in urban environments.

Related Work

The StrapMaps concept is highly inspired by the StripeMaps applications presented at ACM MobileHCI 2015 [7]. StripeMaps is a novel cartographic approach for smartwatch maps targeted at pedestrian navigation. StripeMaps adapts the mobile web design technique of linearization to display maps on small screens. Just as web designers simplify multiple column desktop websites into a single column for easier navigation, StripeMaps transforms any two-dimensional route maps into a one-dimensional "stripe". These "stripes" can be easily browsed on a smartwatch by scrolling in only one direction, as one does with a well-designed mobile website.

[1] https://www.pebble.com

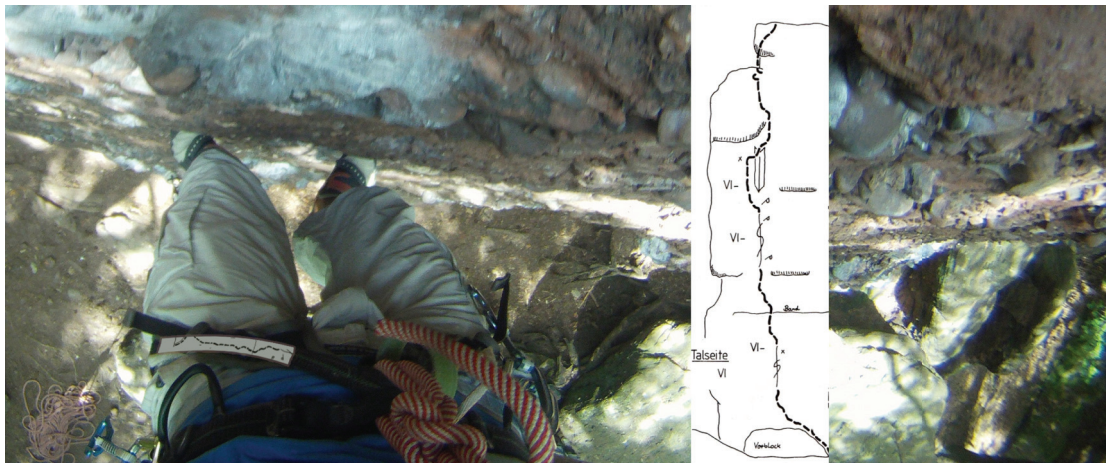

Figure 2: A climbing topo displayed on a StrapMaps attached to a climbing harness (left bottom corner). Compared to Figure 1 no location indicator nor cuts are shown, as no positioning information is available and climbing topos are already linearized (see cutout).

Besides a large corpus of related work on improving the input and output capabilities [e.g. 3] and map-based navigation techniques in general [e.g. 5], researchers have also started to explore the advantages of e-ink displays [2] for wearable device. For example, the DisplaySkin device [1] uses a flexible e-ink display circling around the user's wrist. In contrast to related work, StrapMaps is the first approach to attach e-ink displays to sports accessories and to show linear maps at once, compared to the StripeMaps approach [7].

The StrapMaps Concept

The main concept of StrapMaps is linearizing the map content to make it fit the long, but small straps of a mountain backpack or climbing harness. Interestingly, climbing topos, as shown in Figure 2 (a topo shows the approximate shape of the route, the important rock formations and the details of the grade and protection of each section of the climb[2]), typically already have a linear shape and nicely fit on our StrapMaps screens.

For hiking maps, we use the StripeMaps algorithm [7] to create linear maps. The users first select a route they would like to hike, bike or climb. The algorithm then divides the route into segments that can be displayed in a linear way, as can be seen in Figure 1. The cuts along the route indicate the direction of the turn the users need to make to navigate along the path. Wenig et al. [7] have already shown that this simplification allows StripeMaps to outperform both traditional mobile map interfaces and turn-by-turn directions for pedestrian navigation using smartwatches.

By using e-ink technology, the StrapMaps display is both flexible and does only consume very little power. This makes it suitable for long day and multiple day trips. Even though StrapMaps can be used without positioning technology, we aim at integrating position information from mobile devices via Bluetooth LE. In this case, beside the route information, also position information is displayed, as shown in Figure 1 a).

Conclusion & Future Work

In this paper, we have discussed and described the StrapMaps concept. With StrapMaps we believe to combine the best of two worlds and bring a novel and useable map-based navigation technique to many outdoor enthusiasts. Even though we are still at an early stage, we are convinced that the benefits of StrapMaps are manifold including the following three important aspects:

[2] https://en.wikipedia.org/wiki/Topo_(climbing)

- First, no additional device is required. StrapMaps works as a self-contained add-on to most backpacks. Multiple maps can be stored on the strap and, when needed, changed throughout the day. All route information can be inspected at any time with a simple glance at the strap of the backpack or climbing harness.

- Second, StrapMaps can be operated hands-free. This is particular important for alpine sports such as rock climbing. In addition, e.g. compared to a wearing a smartwatch while climbing, it has no safety risks.

- Third, the StrapMaps e-ink display form factor supports the presentation of linear route visualizations which have been proven, in practice as well as in research, to be well-suited for pedestrian navigation.

We are currently developing a first prototype and plan to conduct user studies to compare the performance of StrapMaps against paper maps and GPS handheld device in outdoor environments.

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