Interaction with Combinations of Maps and Images for Pedestrian Navigation and Virtual Exploration

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ABSTRACT
While studies have shown the advantages of map-image-combinations for pedestrian navigation, none of them concentrated on interaction. We suggest to combine an intuitive pitch gesture with the natural peephole metaphor not only for pedestrian navigation but also for virtual exploration with mobile devices and present a first prototype implementing our ideas.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces—input devices and strategies, interaction styles

General Terms
Design, Human Factors

Keywords
image-based navigation, pedestrian navigation, virtual exploration, maps, mobile devices

1. INTRODUCTION
Several studies in the field of pedestrian navigation have shown that image-based navigation is a serious alternative and useful augmentation to navigation only dependent on maps. While Walther-Franks and Malaka [5] integrated visual navigation instructions into simple photographs, Chittaro and Burigat [2] augmented audio messages with a combination of maps and images. Beeharee and Steed [1] combined textual instructions, maps, and geotagged photos.

While in [2] the map view was automatically replaced with the image view in special situations, e.g. when approaching junctions, the system in [1] requires the user to switch between both views by touch screen interaction.

We introduce an intuitive and natural interaction technique for combinations of map and images for both pedestrian navigation and virtual exploration with mobile devices. Additionally, we present a first prototype for widespread smartphones implementing our ideas.

2. COMBINING MAPS AND IMAGES
Advantages of combinations of maps and images have been shown in both quantitative and qualitative evaluations.

Chittaro and Burigat [2] found out that audio messages augmented with combinations of directional arrows and photographs and also map-photograph-combinations perform significantly better than audio messages only augmented with maps, “(...) probably due to the fact that it is simpler for the user to match a photograph with a view of the physical world rather than switching between the geocentric perspective of the map and the egocentric perspective of the world (and viceversa) to obtain directional information.” Furthermore, users highly preferred the map-photograph-combination. Beeharee and Steed [1] noted: “Most participants found it useful to have the entire route overlaid on the map as it gave them a sense of how long they were expected to walk and the general layout of the route.”

In summary, both studies clearly indicate an additional value of map-image-combinations for pedestrian navigation. Maps give a brief and generalised overview of the surroundings; they present the context of the whole route, at the cost of mental effort. An advantage of images is the focus on the next navigation step which allows very detailed visual instructions. However, because a photograph images the reality at a definite time, aging is a serious problem.

Intuitive and natural interaction is important to enable the user to utilize the additional value. Therefore, we suggest pitching the device to switch between both views in combination with a peephole interface to browse through the image content.

2.1 Pitching for view switching

Spatially-aware displays, introduced by Fitzmaurice [3], implement an eye-in-hand metaphor and act as windows onto the virtual information space. They are aware of both their physical position and orientation and “[...] serve as a bridge or porthole between computer-synthesized information spaces and physical objects” [3] responding to the user’s movements.
While maps usually represent space from a bird’s-eye view, images in pedestrian navigation use some kind of human’s-eye view [1, 2, 5]. Therefore, by following the idea of spatially-aware displays, showing the map if the device lies in the user’s hand while displaying the image content if the user holds the device on edge should be an intuitive way of interaction. Furthermore, it allows easy and fast switching between both views. Fig. 1 shows the idea of a pitch gesture detached from a specific device.

2.2 Peephole interaction

Because of the limited screen size, mobile devices can always show only a small part of the virtual information space at once. Panning and zooming are typical interfaces dealing with these limitations.

Yee [6] introduced peephole displays, which augment the space around the user with information. They “[..] fall into the category of spatially aware displays, which differ [..] in that they create a positional mapping between the virtual space and the real world, enabling the use of spatial memory for navigation” [6]. Mehra et al. [4] distinguish between dynamic peepholes and static peepholes. While panning and zooming interfaces are static peepholes whereas the user moves the information space behind it, more natural dynamic peepholes browse a static information space by the user’s movements. Google implements a dynamic peephole interface for spatially-aware mobile devices, which supports the user to look around in panoramic photographs of the Street View service.

Situating geotagged image content on top of a map in the virtual information space allows a combination of the peephole metaphor with the pitch gesture. Pitching the device allows a continuous transition between the map view and the image view so that the user is always aware of the image’s pose. Rotating his body lets the user both align the map and browse easily through the image content. Thereby, the direct relationship between the virtual space and the user’s body minimizes the mental effort. Furthermore, the possibility to look at the images from different viewpoints allows the use of panoramic photographs. Both pedestrian navigation and the virtual exploration of panoramic environments should benefit.

3. Prototype

We developed a software prototype (see Fig. 2) for the widespread HTC2 Hero smartphone running Android OS3. The Hero uses a digital compass and 3-axis accelerometer to determine its orientation. By the use of OpenGL ES, the prototype supports the presentation of a map based on an online mapping service called maps.bremen.de and geotagged cylindrical panoramic photographs. It implements our interaction ideas as follows: on the one hand the user can pitch the device to switch continuously between the map and the images; on the other hand the prototype allows the user to rotate the view according to the dynamic peephole metaphor. Furthermore, we use the static peephole metaphor: touching the screen allows the user to pan the position.

Figure 2: Map view (left) and image view (right)

First informal user tests indicate a high usability and acceptance. Users learned very fast to use the prototype’s functionality and seemed to have a lot of fun.

4. Conclusion and Future Work

Our interaction ideas support using the advantages of maps and images at the same time in an intuitive and natural way not only for pedestrian navigation but also for virtual exploration with mobile devices. Further research has to investigate in detail whether pitching the device is usable and whether dynamic peephole interaction and automatic map rotation fulfill the user’s needs.

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5. References