SwissPeaks - Mobile augmented reality to identify mountains

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Abstract

The paper describes the implementation of SwissPeaks, a mobile augmented reality application for identifying mountains on Apple's iPhone 3GS. The presented prototype includes a novel approach for correcting inaccurate sensor data with manual user input and uses a web service to display only mountains which are actually visible from the user's point of view.

1 Introduction

It does feel great to get a panoramic 360-degree view of the horizon encompassing snow-topped mountains splattered with the myriad hues of a setting sun. Experiencing such a great moment in nature it does not take long until one asks "what's the name of this peak over there?" or "In which direction from here is Matterhorn?".

Today this question can be answered with mobile augmented reality using a mobile phone with camera, location, compass and accelerometer data. The combination of these features allows to superimpose information over objects displayed on the screen captured by the phone's the camera.

Several systems for mobile augmented reality exist on various platforms [1, 5, 2, 6, 7]. Just recently, first applications for identifying mountains have appeared on Apple's iPhone [3, 4]. However, existing mobile augmented reality applications still face two major challenges: First, how to find out which objects are actually visible from the user's point of view? And second the imprecision of the used sensor data. Especially digital compasses in mobile phones are prone to interference.

This paper describes our implementation of a light-weight augmented reality application for the iPhone 3GS, which provides users with information about mountains in sight, and our approach to the above mentioned challenges. The application tries to solve the visibility problem by accessing a geo-information service with pre-calculated view-sheds to display only the peaks actually visible from the observer's viewpoint. Our approach to correcting sensor errors is to use additional, manual user input. In the following we describe our implementation and first experiences with it.

2 Design Challenges

Accuracy of digital compass. First tests showed that accuracy of the phone's built-in digital compass is limited and prone to interference, e.g. when using it near metal surfaces or electric currents.

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Accuracy of location information. Location information varies based on the line-of-sight to available GPS satellites. Additionally, the height information is even less accurate, typically by a factor of two to three compared to the horizontal location.

Field of view. Based on location and heading the actual view captured from the phones camera has to be calculated. Then the visible horizontal and vertical viewing angle can be mapped to the actual screen pixels of the mobile phone in order to superimpose the information over the image accordingly.

Selection of mountains to display. Only those visible mountains not occluded by higher mountains in the foreground should be selected for display. Furthermore, in order not to overload the screen and the CPU, the selection of labeled mountains has to be limited in a meaningful way. Tests showed that 60 peaks are reasonable.

3 Description of the Prototype

Our implementation uses the iPhone SDK 3.1 which provides an API for overlaying camera's video live-streams and access to the digital compass. The compass provides horizontal orientation of the phone, vertical orientation is derived from the accelerometer.

Sometimes an icon's location on the screen and the mountain's location in the camera image may not be correctly overlaid due to inaccurate GPS/compass data. The demo makes this error information visible with a semi-transparent rectangle around the information icons. Depending on the error range the color of the area goes from red to orange to green (see Figure 1).

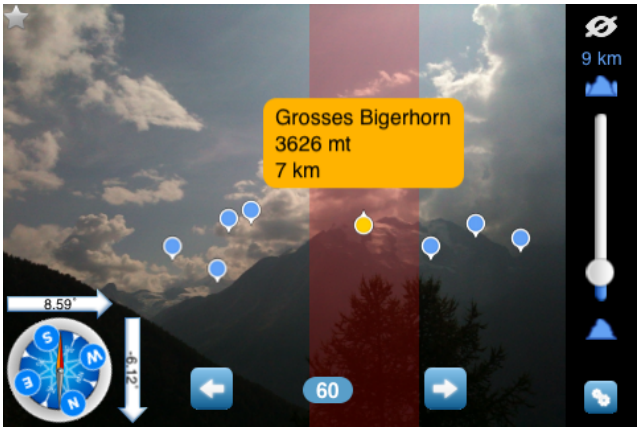

Figure 1: Superimposition of peaks.

The user can also correct this error manually: tapping on the compass in the bottom left corner of the screen enters the calibration mode (see Figure 2), dragging the overlay over the video stream adjusts the horizontal and vertical offset with simple finger movements. Thus, for a given location and environment the sensor error can be manually corrected. The correction values are shown in arrows around the compass.

Figure 2: Calibration mode.

To find out, whether a peak is visible from a certain viewpoint, so-called view-sheds of 89 selected peaks are calculated: based on the terrain surface those locations from which a peak is visible are labeled (see Figure 3). Currently, a web-service provides access to view-sheds of 89 selected dominant peaks in Switzerland. Queries are returned in less than half a second. The number of peaks with visibility information will be increased in the future.

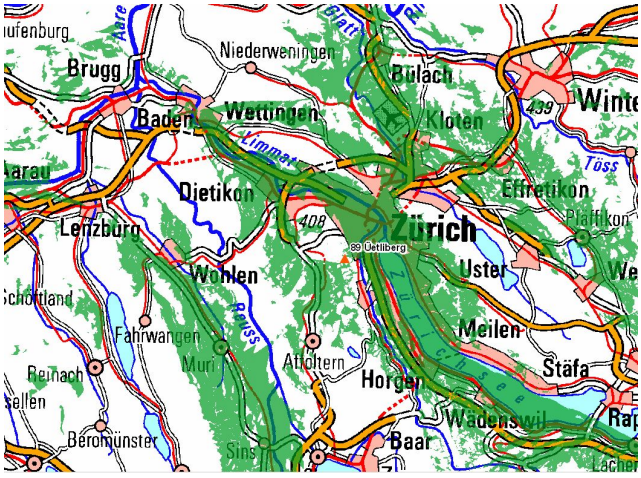

Figure 3: One out of 89 view-sheds. From the green areas Uetliberg is visible.

For all other peaks without calculated view-sheds the mode can be switched by the eye-icon in the upper right corner - a reverse geocoding service derives the current country the user is in in. Then mountains of the country can be downloaded from geonames.org and stored on the phone locally. Based on the phone's current view, the mountains to display are selected for the calculated overlay. The displayed peaks are limited to a number of 60 in order to preserve a satisfying refresh rate and user experience. A slider selects the maximum distance from the current location to the mountain to display (see Figure 1, right edge). If the returned result exceeds the threshold of 60 mountains, the user is asked if the set should be limited by either the closest or highest peaks. The user's decision is saved and can later be changed in the application preferences. Furthermore, favorite peaks can be bookmarked preserving the users preferences.

Each mountain within the field of view is displayed by a blue peak icon. The peak nearest to the center is pre-selected highlighted in yellow. A label displays name, height and distance of the selected peak (see Figure 1). The user can navigate through the selected mountain using the left/right arrows at the bottom of the screen. When the user taps on the label of mountain a browser window opens wikipedia for additional information using the mountain name as a query string. For Switzerland the prototype queries a user-generated tour description repository.

More details about the implementation can be found on our development website[1].

4 Discussion and Conclusion

We showed how information available today in geo-information systems can be made available to non-professional users providing value in a meaningful and intuitive way. The presented prototype works with mobile phone sensor data only without requiring more advanced AR techniques such as image processing and object recognition. It also allows users to correct inaccurate sensor data with manual input.

First informal evaluations with mountaineers testing the applications were positive. We see this as an indication to continue this work, conduct additional tests and user studies, and extend the application with more features in the future.

References

[1] Layar reality browser. http://layar.eu.
[2] Sekai cam. http://www.tonchidot.com/product-info.html.
[3] Peak.AR. http://peakar.salzburgresearch.at, September 2009.
[4] Peaks. http://peaks.augmented-outdoors.com, September 2009.
[5] Wikitude world browser. http://www.wikitude.org, March 2009.
[6] M. Kähäri and D. J. Murphy. MARA - sensor based augmented reality system for mobile imaging. Demo at ISMAR 2006.
[7] D. Wagner and D. Schmalstieg. Making augmented reality practical on mobile phones, part 1. *IEEE Computer Graphics and Applications*, 29(3):12–15, 2009.

[1] http://dev.im.ethz.ch/wiki/Peaks