World-Wide Access to Geospatial Data by Pointing Through The Earth

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Abstract
Traditional augmented reality UI views are restricted to the visible surroundings around the user. In this paper we present a concept that enables viewing and accessing geospatial data from all around the Earth, by pointing with the device towards a physical location. We describe a prototype of the concept and share the results of the first user experience study conducted with the prototype. We also discuss our future research directions.

Keywords
Reality-based interaction, geospatial data, location based data, embodied interaction, first-person view

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces

General Terms
Design, Experimentation, Human Factors

Introduction
It has become common to tag data such as photos to physical locations. Photos can be visualized on maps on the corresponding locations, based on location metadata or visual cues (for example www.flickr.com).

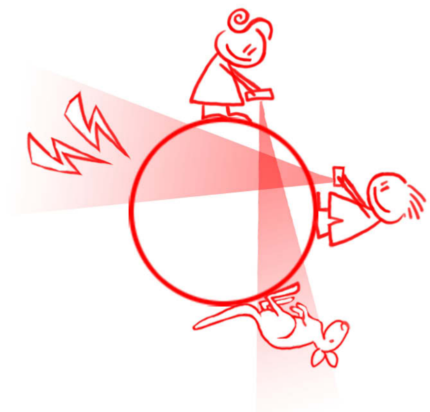

Figure 1. Illustration of the MAA concept. Users are able to see content and geographical information through the Earth, on which they stand.

Also locations of people, points of interest, or details of any pointed object may have location metadata and thus be shown on the map. Another way to utilize location metadata is in augmented reality (AR) views: the content is shown in the view so that it matches the visible physical location.

Traditional AR views are restricted to the visible surroundings around the user: an AR view augments e.g. a camera viewfinder with additional virtual information about the things seen through the camera. The challenge is that if the user is interested in locations that are too far away to be seen through the camera, there is no intuitive way to present that in the AR view — such far-off information would be confusingly overlaid on top of the objects seen in the viewfinder.

We have developed an interaction concept that enables seeing information about a pointed location in a first-person view even if the location is not in the viewing distance of the device's camera. We mean not only showing what is behind any nearby obstacles but most importantly by turning the pointing direction downwards reaching locations on the other side of the world, as seen through the Earth (Figure 1).

Jacob et al [3] have proposed the notion of reality-based interaction (RBI) as a unifying concept that ties together a large subset of emerging interaction styles. We consider our research to be part of RBI, positioned between AR and map based interaction.

Related research

Although there is a lot of existing work that is closely related to ours, we have not encountered this concept of seeing content through the Earth before. In addition to the earlier mentioned RBI research, for example, following research has been done in the area of our work.

There is a lot of research on AR, Rekimoto et al. being one of the firsts to talk about an augmented interaction style which focuses on human-real world interaction and not just human-computer interaction [7]. Also philosophers and media artists have been presenting various ideas related to mixing physical and virtual reality [1, 5]. One specific related example concept is Nokia Point and Find [2] which is a system that enables getting information about pointed objects through an AR view. Jorge et al. use a peephole metaphor in their research about Whole Body-Orientation in virtual reality interaction [4].

Spatial memory and cognitive maps have been researched a lot in cognitive psychology and neuroscience. People have an innate ability to build cognitive maps of three-dimensional spaces and objects [6]. People can use the cognitive map of the environment (spatial memory) by thinking about the landmarks and their spatial relationships to reach a target location. Also non-physical things can be remembered with help of spatial memory. Method of loci is a technique which was originally used by ancient Greek and Roman orators to remember long narratives. They associated story fragments to different rooms in architectural space and used the architecture as a mental model to tell the story [8].

Figure 2. Prototype of the concept in use. A user in Tampere, Finland sees the Mediterranean and northern Africa through the Earth, below the southwest horizon.

Figure 3. The hardware used for the MAA prototype: Nokia N900 with an external sensor module attached.

Concept

The concept we present here is a novel, embodied interaction method for playfully browsing any geospatial content, seen through the Earth. We call our concept "MAA", which is a Finnish word meaning the Earth and as a longer term, in English, we use "Mobile Augmented Awareness".

The concept is based on a 3D model of the planet, which is drawn on the display so that it matches with physical reality. The main idea in the concept is that by pointing with the device to any direction around him or her, the user is able to see which physical locations are in those directions, anywhere on the Earth, seen in first person view (Figure 2). In addition to the geographical information, any geospatial content located in the visible places can be shown. The content can be for example photos, live videos, weather information, routes, Wikipedia articles, or people.

We use a telescope analogy: the device acts as a telescope allowing looking through the surface of the Earth all the way to the other side, as if the planet was a hollow sphere. Another way of thinking about the concept is having x-ray vision through the Earth.

The "Mobile Augmented Awareness" name is derived from the hypothesis that the concept makes the user more aware that the Earth is physically below his or her feet, and it is not just a 2D map nor a 3D globe one can rotate with a flick of a finger.

Prototype

To conduct a user study in this early state of research, we developed a prototype including the highest priority aspects of the concept we wanted to test at this point.

The user interface has three overlaid parts: *the Earth 3D model, geospatial content,* and *UI controls*. The current implementation of the prototype has only a preliminary user interface, mostly concentrating on the model of the Earth. Zooming in and out was allowed with on-screen buttons.

All the content used in the prototype was stored locally in device memory; no real online services were used. The content comprised a set of city coordinates and some manually placed photo thumbnails popping up in specific locations around the Earth.

The 3D model of the Earth used a single texture of 2048 x 1024 texels. Consequently, very deep zooming was disallowed to avoid too blurry views. The default zoom level had a horizontal field of view (FOV) angle of 75 degrees. The FOV angles of the maximum and minimum zoom levels were 20 and 100 degrees, respectively. The day and night sides of the planet were visualized using different color schemes. The approximate direction of sunlight was calculated at the time of day according to the clock of the device, and according to this information a set of colors was applied. For regions on the day side, the colors were light green and turquoise, and on the night side they were dark violet.

The prototype was implemented as a C++ application for the Nokia N900. The user interface was rendered with OpenGL ES 2.0 to achieve a high frame rate for the view of the 3D Earth. An external sensor module (SHAKE SK7 by SAMH Engineering Services) was attached to the back cover of the N900 to provide accurate compass heading values and device tilt angles (Figure 3).

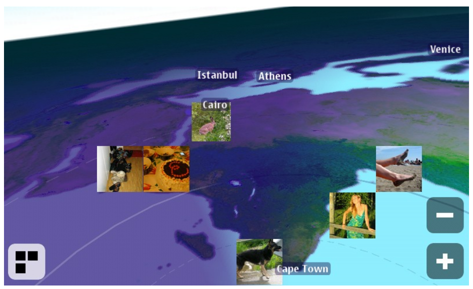

Figure 4. User interface of the prototype used in the evaluation. Photograph thumbnails are shown overlaid on the Earth model. The day and night sides of the planet use different colors (here night is on the left).

User Study

Our research hypothesis is that MAA makes the user more aware of being part of the planet. We conducted a user study to test this hypothesis and to collect feedback and first impressions of the user experience.

There were two rounds in the study, and the same 12 persons participated in both. The gender of the participants was balanced and the persons were equally distributed to four age groups (26-30, 31-35, 36-40, and 41-45 years old). A two-round study was selected to give the users time to familiarize themselves with the concept between the rounds, as we were aware that the concept might be difficult for the users to understand immediately due to its novelty and the conflict with prior mental models. We were interested in hearing how the participants felt about the concept on the second time. The study was conducted with the prototype in a usability laboratory (Figure 4).

During the first session the participants tried out the concept for approximately 30 minutes. We gave them very little information about the concept beforehand in order to collect their initial reactions to the concept (we only said it's about using sensors in the navigation of a mobile application). As the session progressed we gave them more information and described the concept after they had first described their experiences. The session was organized as a semi-structured interview while the participants were interacting with the device. At the end of the session the participants filled in a questionnaire with free text answers in addition to an AttrakDiff survey by Hassenzahl (www.attrakdiff.de). AttrakDiff measures practical quality, hedonic quality identity, attractiveness, and hedonic quality stimulation, and was translated into Finnish for this study (the native language of the participants).

The second session took place two weeks after the first session. For this time the participants explored the concept for 15 minutes. In this session we wanted to collect feedback how the participants experienced the concept when seeing it for the second time and what has changed comparing to the first session. No new features or modifications were done to prototype. At the end of the session the participants answered the same questionnaires as in the first session. For the second session we brought a globe to help in mental model building.

During the data analysis, session observations and questionnaire results were combined to construct an affinity wall to find out the common themes between all participants. The responses to the AttrakDiff survey were analyzed separately and used to determine how the perception of the concept had changed between these two sessions.

Results

On the whole, the experiences of the participants were positive and the results did not contradict the hypothesis. The overall AttrakDiff score was clearly positive and together with attractiveness scale the concept was seen as positive. MAA was considered an inspiring, completely new way of presenting and thinking about the Earth. In this paper we will concentrate on the findings which we find most interesting and important.

The four most important findings of the first user experience study are:

1. *Real-time and reliable information is expected.* Due to direct, embodied interaction as well as seeing the day and the night areas differently in the UI, the participants expected all the presented content to be real-time. Participants expected the device to present content coming from the pointed location. Seeing the difference between day and night regions and seeing in real-time what time it is in any place was found fun and interesting. Some participants for example would have liked to see if the time is right to call a friend or see what kind of weather there is currently in a place of interest.

2. *Examining the Earth is interesting with this application.* Participants commented that they could learn new things about the world by using the application; examples about nature, people, culture, and geology were mentioned. Being able to discover information serendipitously without actively searching was liked, but in addition to this, participants also would have liked to search for specific things.

3. *Seeing through the Earth is novel and requires getting used to.* Seeing through the Earth was unfamiliar to the participants, both in idea and on practical level. The participants had not thought this way about the Earth earlier and they found the application novel and unprecedented. Some felt it was even a brain exercise, in a positive way. Many users commented that the map is mirrored. Even though in the beginning the application was unfamiliar, the world felt closer and more controllable when using the application. It was considered interesting to see through the Earth and to become aware of what there is and what is happening in the pointed places. One user said this could be used to see if people are happy. It was not intuitive to look downwards to examine the Earth.

4. *AttrakDiff indicates that the concept is interesting, as the Attractiveness and Stimulation values were the highest ones.* The presented view was confusing in the beginning, but it also stimulates a new way of thinking, what the Earth looks like in a first-person view, and in which 3D direction places lie in reality. The real-timeness of the concept adds the attractiveness and exploring the Earth itself is interesting. There was no statistical difference between the two rounds in the AttrakDiff survey results.

Discussion

This application presents a completely new way of thinking about the world around us. It can be argued that as the world gets more and more globalized, it is more important to be aware of what the Earth is like in reality, and to be aware of what is happening on it. MAA is not only helping in awareness of where far-away places, people, and events physically exist in relation to the user, but also it has potential to make people aware of the state of the world. As it encourages the user to think about himself or herself as part of the Earth, it has the potential to increase awareness of the user's own responsibility of the future of our planet.

People seem to have a preconceived notion that there is nothing interesting below our feet, that the Earth is essentially flat, but this application made people realize the actual state of affairs and forced them to stand up and turn around physically to see the whole world.

It is possible to form associations with the physical space and directions around you and the content, persons, or places you are interested in. For example, when you are sitting in your office in Finland, you might learn to remember that the content in Italy can always be seen by pointing out through your office window.

A two-round study method worked well in the user experience evaluation of a novel concept. Although participants are not using the system during the two-week break, they have the time to get familiar with the concept.

In the future we will develop the prototype further by refining the user interface and by adding actual content from real online services. More user studies are also planned for the future versions of the prototype.

Conclusion

We have presented a concept which provides world-wide access to geospatial data by pointing through the Earth. A prototype of the concept was created for evaluation purposes. The most important findings from the user study were that real-time and reliable information is expected, examining the Earth is interesting with this application, seeing through the Earth is novel and requires getting used to, and that the AttrakDiff survey indicates that the concept is interesting. In the future we will continue developing a more full-featured prototype and conduct further evaluations.

Citations

[1] Baudrillard, J. *Simulacra and Simulation*, University of Michigan Press (1995).

[2] Gao, J., Spasojevic, M., Jacob, M., Setlur, V., Reponen, E., Pulkkinen, M., Schloter, P., and Pulli, K. Intelligent Visual Matching for Providing Context-Aware Information to Mobile Users. In *Supplemental Proc. Ubicomp* 2007 (2007).

[3] Jacob, R.J.K., Girouard, A., Hirshfield, L.M., Horn, M.S., Shaer, O., Solovey, E.T., and Zigelbaum, J. Reality-Based Interaction: A Framework for Post-WIMP Interfaces. In *Proc. CHI 2008*, ACM Press (2008), 201-210.

[4] Jorge, V.A.M, Ibiapina, J.M.T, Silva, L.F.M.S., Maciel, A., and Nedel, L.P. Using Whole-Body Orientation for Virtual Reality Interaction. In *Proc. SVR'09*, Brazilian Computer Society (2009), 268-272.

[5] Krueger, M.V. *Video space*. Museum of Natural History, Vernon (1988).

[6] O'Keefe, J., and Nadel, L. *The hippocampus as a cognitive map*. Clarendon Press, Oxford (1978).

[7] Rekimoto, J., and Nagao, K. The World through the Computer: Computer Augmented Interaction with Real World Environments In *Proc. UIST'95*, ACM Press. (1995).

[8] Yates, F.A. *The Art of Memory.* Routledge and Kegan Paul (1966).