

AR Navigation for Improving Social Networking

Md. Raihanul Islam
Chair for Augmented Reality
Technische Universität
München
uniqueraihan007@mytum.de

Tayfur Coskun
Chair for Augmented Reality
Technische Universität
München
coskun@in.tum.de

Frieder Pankratz
Chair for Augmented Reality
Technische Universität
München
pankratz@in.tum.de

Andreas Dippon
Chair for Augmented Reality
Technische Universität
München
dippona@in.tum.de

Gudrun Johanna Klinker
Chair for Augmented Reality
Technische Universität
München
klinker@in.tum.de

ABSTRACT

Augmented Reality (AR) has an enormous potential of changing the way we interact with our surroundings. It enhances our perception and helps us to see, hear, and feel our environments in new and enriched ways. Modern mobile devices, such as smartphones, are far more than a communication device. Technologies such as GPS, inertial sensors, and cameras, allow to track the location of the user and the orientation of the device itself. This can be further used to develop mobile navigation systems coupled with an AR view. In the context of this study¹ and the CRUMBS project², we developed an AR based pedestrian navigation system. This system shows nearby social events and facilities created by users. This paper presents the results of our user-centered study of improving social networking using this system. It also presents the result of a comparison between AR and maps based navigation.

1. INTRODUCTION

AR has become a popular topic in academic research. A widely accepted definition of AR by Azuma is that, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world[7]. Therefore, AR supplements reality, rather than completely replacing it.

There are many applications of AR. The most well known application is present in major sports events, such as motorsport in which AR allows to show the current position, speed data and the name of a driver. Another application is sailing competition, in which the country flags are digitally overlaid on the respective boat. Apart from this, AR

¹This work was supported by the European CELTIC project CRUMBS CP7-003 and funded by BMWi.

²<http://crumbs.tid.es/>

opens up immense possibilities to revolutionize various fields of work by providing new ways of interaction with our surrounding environment, such as archaeology[3], architecture³ and education⁴.

This work explores the impact of AR technology in navigation and mobile social network applications. This paper describes the design, implementation and evaluation of an AR based pedestrian navigation application that improves social networking among users. It has been implemented in the context of the CRUMBS mobile social platform. CRUMBS enables users to consume multimedia social content stored in so called “crumbs”, which can be created by users and stick to GPS positions. The application shows these crumbs and provides navigation towards them.

2. RELATED WORK

Recent years have seen an increasing interest in social networks. Major players in this field such as Facebook alone has 1.11 billion active users at the moment⁵. Many researchers have been working to integrate AR based navigation in various fields in order to improve user experience. A classic example of such an application is the Feiner et al.[8] “Touring Machine” for exploring the urban area. It used a head-tracked, see-through, headworn, 3D display, and an untracked, opaque, handheld, 2D display with stylus and trackpad for tracking and displaying information. It overlaid POI on user headworn display and provide GPS based outdoor navigation. There were some limitations pointed out by the authors such as the weight of the system was 40 pounds, low brightness of the headworn display and quality of tracking due to satellite signals.

Tsai et al.[9] have developed an AR based training system for mobile devices which trains people to escape in nuclear accidents. This system is helpful for the design of various other training programs in accident and emergency management. The authors have carried out a comparative study between AR and electronic map based escape guidelines and found that users using electronic map required more time and had a lower success rate in the escape than AR based guidelines. They concluded that AR based navigation would

³<http://www.designmena.com/inspiration/augmented-reality-ar-part-architecture-design>

⁴<http://www.prweb.com/releases/2011/10/prweb8899908.htm>

⁵<http://investor.fb.com/releasedetail.cfm?ReleaseID=761090>

be an alternative method for enhancing the efficiency of various training programs. However they suggested that AR based navigation guidelines should supplement the paper based training materials, rather than replace them. This is because mobile phones may have limitations or are out of service in extreme situations, such as nuclear accidents.

Narzt et al.[4] developed INSTAR system, a indoor and outdoor navigation framework that focused on pervasive tracking data acquisition and the mobility aspect of navigation devices. The kernel of INSTAR was portable to different navigational devices and therefore, could be used as car as well as pedestrian navigation system.

Lautenschläger[2] developed an AR campus navigation system for the University of Calgary. The system helps students to find buildings and rooms on the campus and also provides pedestrian navigation assistance. It has support for both indoor and outdoor navigation with limitations as he suggested. One such limitation is that it cannot determine the orientation of the device during indoor location tracking. Also, it can only show Points Of Interest (POI) within the campus and thus can not be used outside of the campus. He considers this as the major drawback of the system. The system is only limited to display some hard coded POIs due to lack of information of POIs in the university database. As the main focus of the work was to create a navigation system, it does not address social networking aspects that may occur within a university campus environment, such as students communicate with each other to organize a group study or to go to lunch together at the university cafeteria.

One application that is related very closely is called Wikitude Navigation⁶. It is an AR based GPS navigation system with precise turn-by-turn directions overlaid onto a real world image. It has support for both pedestrian and car navigation. In addition to display navigation, Wikitude Navigation also informs users of their surrounding POIs. However it does not focus on the social networking aspects such as creating social events, viewing participants list of an event, etc.

3. SYSTEM DESIGN CONCEPTS

The purpose of our developed prototype application is to provide an AR view of CRUMBS events around a user and provide AR and Google Maps navigation to enable users to reach to these CRUMBS events. The application is built around metaio SDK API and junaio API/plugin⁷ and uses built-in GPS and inertial sensors based tracking of metaio SDK. Two location based channels have been created for the application. Both the channels provide an AR view of available crumbs. Additionally one channel provides the AR navigation and the other channel provides the Google Maps navigation to reach to these crumbs. The channel content is provided by a hosting server.

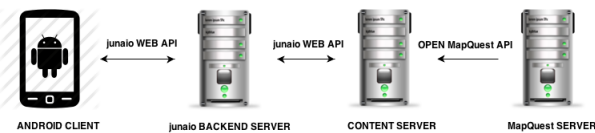


Figure 1: System architecture

⁶<http://www.wikitude.com/showcase/wikitude-navigation/>

⁷metaio Developer Portal: <http://dev.metaio.com/>

A junaio plugin application with specific channel id is installed on an Android device. The Android client loads the specific channel from the junaio backend server. The server verifies the channel and loads the corresponding data from the content server. The data include POI generation files, logic files and multimedia contents. There are two location based channels hosted on the junaio backend server. The client, backend and content server communicate with each other using junaio web API.

4. PROTOTYPE IMPLEMENTATION

The application implementation follows the client-server model. The client implementation is a junaio plugin application for the Android platform and has been registered at the metaio developer portal. The server implementation consists of two junaio channels registered on the junaio backend server: “Maps Navigation Channel” and “AR Navigation Channel”. The former provides Google Maps navigation and the latter provides AR navigation.

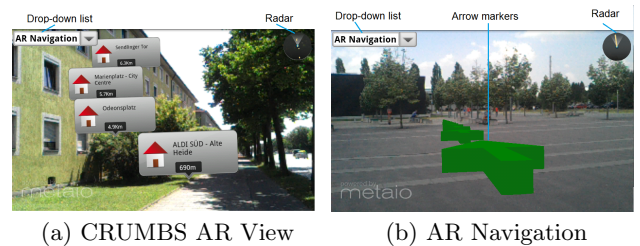


Figure 2: Application screenshots

CRUMBS AR View

The AR view of crumbs is the entry point to the application. It shows all available crumbs on the browser as shown in Figure 2(a). The radar on the top right corner on the screen shows all available crumbs as individual dots on it. Both AR and Maps Navigation Channel start with this GUI. The drop-down list on the top left corner of the screen is used to switch between channels. Tapping on a crumb shows its details.

AR Navigation

The navigation is visualized using a radar and arrow markers as shown in Figure 2(b). A 3D arrow is rendered on each GPS point and also added to the radar. Each arrow is represented as a yellow dot on the radar. Both of these metaphors provide visual guidance to reach a destination.

5. USER-CENTERED EVALUATION

An experiment was carried out to evaluate the developed application. The experiment was set up as a within-subjects design in which all participants are exposed to every testing condition. This experiment design has been chosen to draw a fair conclusion with a limited number of participants and resources. The experiment started with a short briefing to the participants about what AR is and how the application uses AR to provide visual navigation aids to find people or places. After this introduction, all participants had to perform a sequence of actions to test AR and maps navigation to reach an assigned location.

In total, 15 people (1 female) took part in the evaluation. They were all university graduate students from different faculties and their ages ranged from 20 to 30. All participants had experience with the use of smartphones. Each participant took part in one of three groups. A specific scenario was assigned to each group. An example scenario was to navigate to a crumbs event from a location using AR based pedestrian navigation and come back to the starting location using maps based pedestrian navigation. Two groups carried out the assigned task during the day and one group at night. Experiment data have been gathered during the evaluation process for further processing.

5.1 Questionnaire

Evaluation questionnaires are adopted to do both quantitative and qualitative assessment of the application and the concept. Two set of questionnaires were used. One set is based on the standard System Usability Scale (SUS) questionnaire[5] for measuring the usability and learnability of the application. The other set focuses on the social networking aspects and the comparison between two types of navigations. Both the questionnaires used a five-level likert scale, ranging from “strongly disagree” to “strongly agree” and are represented as 1 to 5 on the scale respectively. The likert scale is based on forced choice questions, where a statement is made and the participant then indicates the degree of agreement or disagreement with the statement.

5.2 Results

The application has the mean SUS score of 71.67. The result of the SUS evaluation is shown in Figure 3. The x-axis represents SUS questionnaire and the y-axis represents the SUS scale. The graph shows that odd numbered questions (i.e. Q1, Q3, Q5, Q7, and Q9) have high scale values and the median of these dataset is around 4 in the SUS scale. Whereas even numbered questions (i.e. Q2, Q4, Q6, Q8 and Q10) have low scale values and the median of these dataset is around 1 in the SUS scale except Q6. This indicates a positive result, since the odd numbered questions scale values positively affect the SUS score, i.e the higher the scale values of odd items the better the SUS score. Whereas even numbered questions scale values negatively affect the SUS score, i.e. the higher the scale values of even items the less the SUS score.

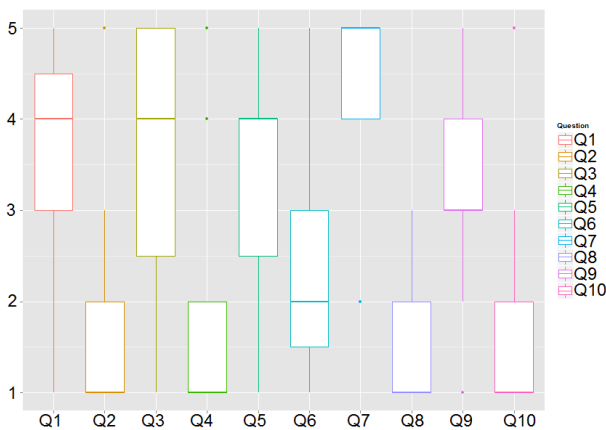
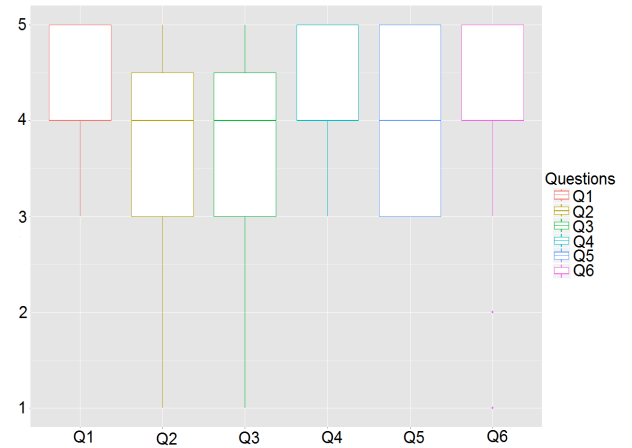


Figure 3: Results of SUS evaluation[5]



- Q1. AR navigation makes it easy to find people/events around me.
 Q2. The application has a user friendly visualization of AR navigation.
 Q3. Radar is better than Arrow for AR navigation visualization.
 Q4. AR navigation is better than Maps navigation.
 Q5. I will prefer to join social events if AR navigation is provided to me.
 Q6. AR navigation improves Social networking.

Figure 4: Results of subjective assessment

The result of the subjective assessment is shown in Figure 4. The x-axis represents the questionnaire and the y-axis represents the scale. The figure shows that the median of the data set for the questionnaire is 4.

Q1 in Figure 4 shows that AR navigation makes it easy to find people/events. While Q2 shows that most participants found the navigation visualization user friendly. Two navigation metaphors exist in the application, radar and arrow. Participants were asked to choose between these two based on their user experience. Q3 shows that most participants preferred radar over arrow.

The application provides both AR navigation and maps navigation. The maps navigation implementation uses the Google Maps navigation. The participants were asked to choose between AR navigation and maps navigation after using both of them. Result of Q4 in Figure 4 shows that most participants preferred AR navigation over maps navigation. Similarly 80% of the participants said that they prefer to join social events when AR navigation is available to them as represented by Q5. The results of Q6 show that more than 50% of the participants found that AR navigation improves social networking.

6. DISCUSSION

The analysis of results of the quantitative data is presented in the following subsections.

6.1 Usability

The SUS measure perceives ease-of-use of an application. Recent research shows that it also provides a global measure of system satisfaction and sub-scales of usability and learnability[6].

Bangor et al.[1] have done 2324 surveys and came up with an average SUS score of 71.14. They also claim that a system is *good* if its score is above 70 and *better* if its score is in the high 70s to upper 80s. *Exceptional* systems get score above 90. The average SUS score of the implemented AR

navigation application is 71.67. This is slightly higher than the average SUS score of 71.14. Therefore, the application has a tendency towards a good and easy to use system.

6.2 Improve social networking

One of the goals of this paper is to find out whether AR navigation makes it easy for people to find other people or events. The participants had been asked about it and the results represented by Q1 in Figure 4 show that nearly all participants said that AR navigation makes it easy to find people or events around them.

The main goal of this paper is to find out if the AR navigation feature can help in improving social networking among people. Consequently, the participants were asked during the evaluation about their preference to join social events when AR navigation is provided to them. They were also asked if they found that AR navigation improves social networking. The results of these two questions are represented by Q5 and Q6 in Figure 4 respectively. The results show that more than 75% of the participants would prefer to join social events when AR navigation is provided to them and the rest were not sure about it.

Figure 4 also shows that more than half of the participants said that AR navigation improves social networking as represented by Q6. The rest of the participants neither agree nor disagree to it. One reason for this could be the absence of the social event creation functionality in the prototype application. It may prevent some participants to get the idea of the social networking aspect of the application. The application does not implement this functionality since it is beyond the scope of this work.

6.3 Improve navigation

This paper also compares AR navigation and maps navigation. Participants were asked to compare the AR and maps navigation functionalities of the application. Q4 of Figure 4 shows that most participants preferred AR navigation over maps navigation as the median of this dataset resides at 4. In fact, 8 out of 15 participants preferred AR navigation over maps navigation and only 2 participants preferred the later over the former. 5 participants were undecided between these two. Also during the evaluation, 2 participants could not reach their destination while using maps navigation. Therefore, in our experiment, AR navigation performed better than maps navigation.

The participants were also asked to evaluate the developed AR navigation itself to find out its strengths and weaknesses. Most participants said that they like the user friendly visualization of AR navigation and prefer the radar metaphor over arrows as a navigation visualization as represented by Q2 and Q3 in Figure 4 respectively.

7. CONCLUSIONS AND FUTURE WORK

This research work has investigated the potential use of the AR technique to enhance users social networking experience. For this, a prototype application has been developed. Also a user-centered evaluation of the application has been conducted. The outcome of this evaluation shows that AR navigation provides an easy way to find locations around users and improves social networking among them.

There are some technical issues that will need to be addressed for commercial versions of such system. For example, the system should generate alerts when there are obsta-

cles, such as buildings or vehicles in front of the user. Also the mobile camera is only capable of showing limited surrounding area. Therefore, maps navigation can be added as a navigation metaphor on certain part of the AR navigation interface in order to give user a broader view of surrounding area.

However, this research focuses only on outdoor pedestrian navigation. Therefore it can be extended to include driving and bicycle navigation scenarios as well. Also an addition of indoor navigation capability to the developed navigation application will make it more interesting and useful. Indoor navigation can be particularly helpful for large indoor places such as an airport or a university campus, where outdoor navigation does not work. It will enable users to interact within these places as well. Furthermore, integration to other social networking platforms such as Facebook and Google+ will enable users to share their activities with their existing social networks. Once these features are integrated, another user study with more participants will be carried out.

8. REFERENCES

- [1] Bangor, Aaron, Philip T. Kortum, and James T. Miller. An Empirical Evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction*, 24(6):574–594, 2008.
- [2] Benjamin Lautenschläger. Design and Implementation of a Campus Navigation Application with Augmented Reality for Smartphones. <http://ase.cpsc.ucalgary.ca/uploads/Publications/ThesisV1.0.pdf>, 2012. [Online; accessed 14-June-2013].
- [3] Dahne, P. and Karigiannis, J.N. Archeoguide: System Architecture of a Mobile Outdoor Augmented Reality System. In *Mixed and Augmented Reality, 2002. ISMAR 2002. Proceedings. International Symposium on*, pages 263–264, 2002.
- [4] N. W. et al. Pervasive information acquisition for mobile ar-navigation systems. *Proceedings of the Fifth IEEE Workshop on Mobile Computing Systems & Applications (WMCSA 2003)*, pages 13–20, 2003.
- [5] John Brooke. SUS: a “Quick and Dirty” Usability Scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland. *Usability Evaluation in Industry*. London: Taylor and Francis, 1996.
- [6] Lewis, James R., and Jeff Sauro. The Factor Structure of the System Usability Scale. *Human Centered Design. Springer Berlin Heidelberg*, pages 94–103, 2009.
- [7] Ronald T. Azuma. A Survey of Augmented Reality. *Teleoperators and Virtual Environments*, 6(4):355–385, 1997.
- [8] Steven Feiner, Blair MacIntyre, Tobias Höllerer, and Anthony Webster. A touring machine: Prototyping 3D mobile augmented reality systems for exploring the urban environment. *Personal Technologies*, 1(4):208–217, 1997.
- [9] Tsai, Ming-Kuan, Pei-Hsun Emma Liu, and Nie-Jia Yau. Using Electronic Maps and Augmented Reality-Based Training Materials as Escape Guidelines for Nuclear Accidents: An Explorative Case Study in Taiwan. *British Journal of Educational Technology*, 44(1):E18–E21, 2013.