Mobile Augmented City – New Methods for Urban Analysis and Urban Design Processes by using Mobile Augmented Reality Services

Benjamin Allbach, Martin Memmel, Peter Zeile, Bernd Streich

(Dipl.-Ing. Benjamin Allbach, Weinstraße 118, 67169 Kallstadt, benjamin.allbach@googlemail.com)
(Dipl.-Math. Martin Memmel, Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI GmbH), FB Knowledge Management, Trippstadter Straße 122, 67663 Kaiserslautern, http://www.dfki.de, memmel@dfki.de)
(Dr.-Ing. Peter Zeile, TU Kaiserslautern, Fachgebiet CPE, Pfaffenbergstraße 95, 67663 Kaiserslautern, zeile@rhrk.uni-kl.de)
(Prof. Dr.-Ing. Bernd Streich, Fachgebiet CPE, TU Kaiserslautern, Pfaffenbergstraße 95, 67663 Kaiserslautern, http://cpe.arubi.uni-kl.de, streich@rhrk.uni-kl.de)

1 ABSTRACT

New technologies like smartphones provide a variety of opprtunities for the traditional fields of work and methods in urban and spatial planning. It is important to analyse the changes in geobased information and communication platforms to understand their potential impact on scientific methods in spatial planning. One of these new technologies is the so called mobile augmented reality. This papers focuses on the methods and technologies which are available for merging the real world with virtual objects/information. Which benefits are possible for urban planning by using mobile geoweb applications and augmented reality? Is it possible to lower the participation hurdle for citizen contributions regarding planning processes? Besides, the question is whether built-in sensors in mobile devices can deliver meaningful data for planning and for the so called “urban sensing." The combination of data from different sources, mainly aquired through the World Wide Web, results in new opportunities to display and analyse information in a mixed reality enviroment, as well as to interact with this information. The paper presents an evaluation of existing mobile augmented reality applications and gives various examples of potential use cases for these applications in urban planning. Through the newly developed RADAR system, it is possible to contribute information to different mobile augemented reality services and thereby it serves as an example to present scenarios and to illustrate the presented findings.

2 THEORETICAL BASICS

New Planning and life have in many cases won additional value through the “World Wide Web.” The social and the cultural life are being more and more influenced by the World Wide Web in general and by various social communication networks in particular. The Internet revolutionised communication and the exchange of knowledge.

Another revolution was the development of mobile communication devices. Mobile devices make it possible to communicate with the whole world at nearly any time and place. The development of these devices is progressing so fast that they can nowadays nearly replace stationary personal computers (Schneider, 2008:112FF).

Through the growing urge for information and communication in context of the development of a knowledge-based-society both of these revolutions are more and more merging with each other. Knowledge and the individual are becoming more or less ubiquitous (Streich, 2005:11FF). The above described merging is being pushed forward by the use of cable-based and wireless broadband-connections, by the Global Positioning System (GPS), by an increasing mobile processing power, and by mobile sensor techniques (optical, mechanical, acoustical).

Another development is the creation of virtual worlds through computers or the blending of virtual objects into the real world. New “mobile techniques” (e.g. Smartphones / “mobile devices”) make the merging of the real world with the virtual world into a new “extended real world” or “augmented reality” (AR) possible.

At this juncture, new virtual worlds, subcultures, and networks are being created which are not anymore rooted at a fixed place. Simultaneously, these techniques are recreating and reshaping the physical space.

Additionally, these “mobile devices” or “embedded computers” can be used to gather and generate knowledge. Through the availability of an uncountable mass of single measurement stations it would be possible to gain exceptionally accurate and special data (“urban sensing”).

The technological side shows that the applications do not aim at establishing a closed range of sense. The focus is mostly the real, physical space which is being extended or enriched. New media technologies and software formats are supporting the individual and his or her creation and experience of life through the hybridization of our World (Unger, 2010:111).

The accumulation and extension of the real world space with a transformation between material and virtual parts leads to a hybridisation of the everyday world. The virtual places are connected with education and development processes and develop a new way of training individual environments and designs with more and more hybrid characteristics (Unger, 2010:114FF). The World, the physical space, is becoming an information space in which various data can be stored and provided by the users (Schroll, 2010).

3 HUMAN PERCEPTION – WHY TO USE 3D AND AUGMENTED REALITY

AR method give users the opportunity to add a new level of content through the overly of additional digital information and situations in real-world situations. So, real elements could be connected with objects from a virtual system and these elements stay in relation to each other (Streich 2005:201). Generally, Augmented Reality is referred to as a realtime overlay of human senses with virtual computer models (Milgram, Colquhoun 1999). Therefore, an AR system can overlay visual, acoustic and tactile information with the reality in real time (Höhl 2008:10). Characteristic of Augmented Reality techniques are the combination of virtual and real objects in a real environment, the direct interaction and presentation in real time and display all content in three dimensions (Azuma 1997).

In the past, due to the immense hardware requirements for an AR system, different visualization methods are developed (Höhl 2008:12):

- Video See-through (VST) is characterized by the wearing of a closed projection goggles
- Optical See-through (OST), in contrast to VST, this method is using an optical combiner, a semi-transparent mirror, and the environment can be perceived too
- Projective AR (PAR) projects digital content to an object by using a projector
- Monitor AR (MAR) uses a software mixer, the digital information is displayed on a monitor display of a desktop PC.

A new visualisation method is now available, the so called Mobile Augmented Reality, in principle a kind of Monitor AR, but with the advantage, that the user isn’t fixed to one location. He can use these systems everywhere he want, the only requirement is the access to mobile internet for streaming content and the availability of a GPS-sensor and a compass in his Smartphone.

For the depiction of contents it is crucial to have a display format which is matched for its intended use. A coherent and secure communication between sender and recipient has to be assured. The used repertoire of signals has to be coherent to all participants of a process (Zeile, 2010:226). The human being experiences his or her environment as three-dimensional space. The dimensions help the human being to orientate in space and to process spatial information (Gibson, 1973:243FF).

The process of perception consists of receiving, selection, interpretation, and processing of information (Gibson, 1973:32FF). The use of a three-dimensional presentation of information could be considered as reasonable. The already difficult communication between human being and machine is also of importance. The link between human being and machine is in most cases complicated and not intuitive. One possibility for information presentation and communication is the augmented reality technique.

4 TECHNOLOGICAL BASIS

4.1 Mobile information systems

Mobile information systems allow us to access information resources and information services via “End-User Terminals” which are mobile and can operate at nearly all locations (Pernici, 2006:4). Examples therefore are cell phones, netbooks, notebooks, or PDAs. The gadgets differ in size, weight, power, energy consumption, built in sensor techniques, and usability. The wireless information and data transfer as well as the possibility of tracking via GPS are important basic features of mobile devices. Furthermore, there are built in cameras and absolute position transducers which can define the angle and the tilt of the device in almost every smartphone available. Most new smartphones already have these basic configurations for mobile augmented reality services.

Through the choice of the mobile device or rather the hardware producer one also chooses the operating system of the device which as a result defines the development possibilities for applications. Android is not the only mobile platform; others are Symbian, Apples IPhone platform, Microsoft's Windows Mobile, or RIM's BlackBerry platform.

4.2 Android OS

Android is an all-embracing software platform for mobile devices. It is a Linux based operating system with libraries and a runtime environment as well as mobile key applications. Huge parts of the Android platform are open source. The use of Android is free and applications developed by third-party-developers have the same rights as already preinstalled applications. Through this, innovative applications should spread faster and easier. On the technological side Android is based on established standards such as the program language "Java" and the development environment "Eclipse" which are widely spread. The integrated libraries contain open source products like "SQLite," "WebKit," SSL, and "Media Framework" (Mosemann; Kose, 2009:1FF). Android offers a good software platform because of its unlimited development possibilities.

4.3 AR-Software

If one analyses augmented reality services one should keep in mind that the applications are developing very fast and dynamic. On a long-term scale the applications will perhaps adapt their functions or niche products will emerge. At the moment, most applications are bound to different platforms; however, the developers claim that the porting for other mobile devices is in planning. Many products are still under development. An important difference between the different services is the ability of the user to participate, e.g., are users allowed to contribute contents or can contents only be accessed? Examples for the two models are "LAYAR" [1] where contents can only be contributed by the developers and "Sekai (World) Camera"[2] where contents can be contributed by the users.

Most AR Browsers use proprietary data formats, thus, contents provided for a specific AR-Browser (e.g., LAYAR) cannot easily be used for another Browser (e.g., Junaio[3])

5 SAMPLE USE CASES

The use cases and their potential benefits for urban planning are examinded by the study "Augmented City Kaiserslautern" (Allbach 2010).

5.1 Timeline – „Talking places"

The "Talking Places" idea is developed by Florian Groß from m.e.s.s. (mobile task force city and style Kaiserslautern), and seizes the id to visualize invisible historic or future content on its place in a city.

In many archives one can find a lot of different information about localities. In the course of time, these localities changed their appearance, structure, and type of use. Through the linking of various archives it would be possible to show these changes. By including other private archives it is possible to offer even more information.

In the scenario "Timeline" this will be shown through old city maps and photos with the help of LAYAR.

[1] http://www.layar.com/
[2] http://sekaicamera.com/
[3] http://www.junaio.com/

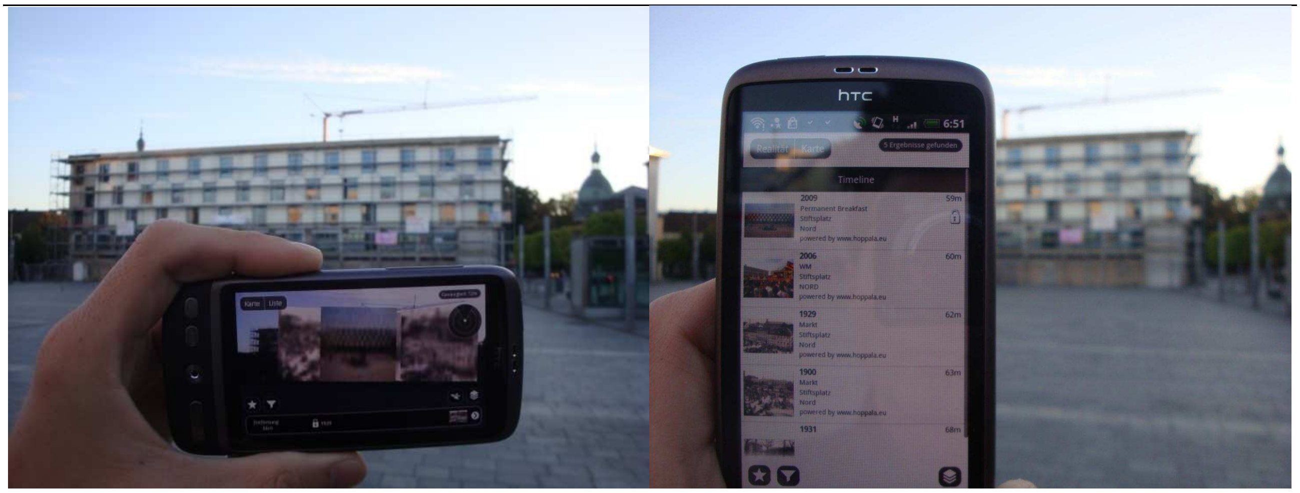

Fig. 1: Visualisation of the talking places scenario

During the "Realview-Presentation" first shortcomings of the software become visible. The preview feature clearly shows that the image quality is insufficient because of the restriction of the resolution. Furthermore, all pictures are displayed at the same time. If the pictures don't have identical coordinates they will obscure the whole field of vision. If they are congruent it can lead to errors in the presentation and it is difficult to find the right contents. Also a correct covering of the building structures is not possible at the moment. Nevertheless, it is already possible to perceive many advantages of this scenario. Tourists can experience history and locals can learn more about their cultural heritage and their identity. Old information and events can be preserved. If these information are uploaded by the citizens "Timeline-Scenarios" can be used by planners as a source of information and ideas. A critical examination with building culture is possible. Through the linking with forums or other platforms specific discussion platforms could develop.

5.2 „Sensing" – Measurements

This scenario shows the presentation of various measuring points of environmental data which were placed at the campus of the University of Kaiserslautern. This scenario is realised using the AR platform "WIKITUDE."[4]

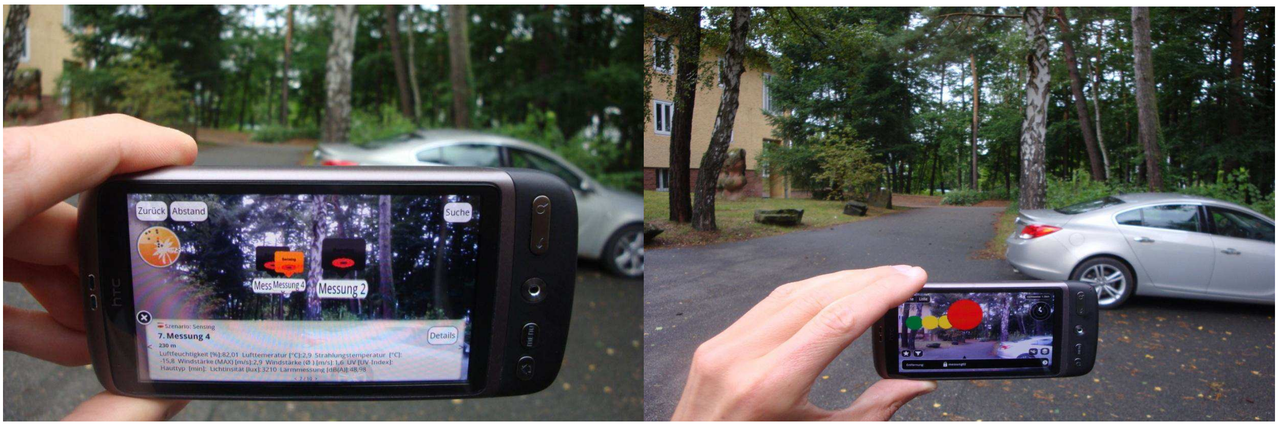

Fig. 2: Implementing sensor based results in WIKITUDE

The clear and simple semantic of the numbers could be modified by a graphical presentation. This might increase the pragmatics of the common user (Streich 2005, 58).

A difference in terms of colour seems to be reasonable in the "Sensing" use-case, e.g., red equals negative and green equals positive. Additionally, it would be possible to update the presentation by using 3D-globes. However, it is not possible to upload 3D models into WIKITUDE. Therefore LAYAR was used.

The augmentation of pollutants, emissions, immersions, or even a combination of emissions and the wind direction in order to simulate the spread of pollutants would be an interesting example for the usage of the

[4] http://www.wikitude.org

technology in the environmental sector. Displaying ozone magnitude, UV-magnitude, and temperature is possible.

5.3 2D-Information

One of the daily business in planner's life is, how to deal with 2d information and how the 2d maps can be carried in field services. One possibility is to use a so called "moving map" software, where georeferenced maps are available on a handheld or a Tablet PC. The other opportunity could be, to integrate the data set of special maps in a mobile Augmented Reality service. The advantage is, that invisible or hidden attributes can be presented directly in a screen overlay by an Augmented reality browser.

Fig. 3: Overlay of a 2d cadaster information in LAYAR

5.4 3d-information of new building structures

Fig. 4: Geolocating 3D-Models of a new building structure, on the left of proofing the representation of the new object on Campus University of Kaiserslautern in general, on the right the view of the new building in its building lot in Saarbrücken

5.5 Participation & Discussion

This scenario is an example for how citizens can lead discussions, exchange sentiments and proposes through the usage of AR technology. These information shout be uploaded and displayed at the location which is in the focus of the discussion. Therefore, this scenario was realized with Sekai (World) Camera.

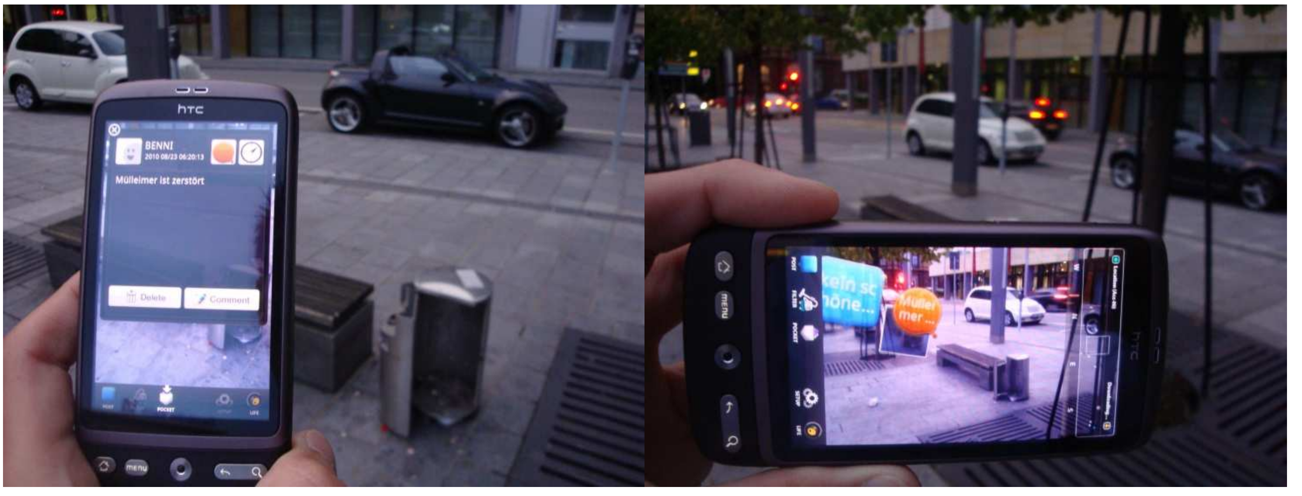

Fig. 5: Tagging 3D damage information by using SEKAI

Users can mark real objects through the usage of "Air Tag." This happens in the "Realview-Presentation." It is also possible to add photos and audio files. In the "Realview-Presentation" it is also possible to add comments and to lead discussions.

In this special case with this application, the communication can be lead bidirectional, in difference to other presented applications, who act only as browsers.Basically, the application offers a lot of possibilities for the communication between citizens and the government. Especially in this case, Castell's cite can that "the Internet offers an affordable horizontal and vertical communication channel for the state and the citizens" (Castells 2005:166FF) could be used. There is no other free application in the AR context, which is able to integrate own tagged information. Precisely in this context, the main problem is the well known inaccuracy of the GPS-signal and the involved tracking of information. The "Air Tags" are sometimes moving and don't stay at fixed locations. It is not possible to perfectly link information to a specific location. For the planner, the discourse with citizens is an interesting basis if one wants to know how a project or an idea is being valued. Grievances as, e.g., noise, dirt, problems with the floor cover, and lack of accessibility for handicapped people could be identified, and might be documented through the uploading of photos and audio files in a new way. In this way the Internet would not be used merely as an electronic bill-board, but in an interactive way.

The reaction of the citizens could be direct and even impulsive and intuitive. It is also possible that some groups would rather want to express their sentiments in this way. It is imaginable that this way of response could lead to more acceptance and participation as a traditional open council. Because of the user account one has to have for Sekai it is possible to secure that there are no violations or false statements made by users of the system a little bit more than in open and anonymous distribution channels.

6 RADAR

The aim of the project RADAR[5] (Resource Annotation and Delivery for Mobile Augmented Reality Services) is to establish an open ecosystem that allows making the abundance of location-dependent digital resources available in mobile augmented reality services.

Within this one-year project that started in 2010 an open infrastructure was developed following Web2.0 design paradigms. It realises a "social hub for geocontents" and allows end users without any specific technological expertise

- managing, organising, and sharing geocontents[6],

[5] see http://www.dfki.de/radar

- publishing geocontents to various mobile augmented reality services such as ALOQA, LAYAR, and WIKITUDE,
- accessing and aggregating geocontents from multiple sources like Flickr, Foursquare, Last.fm, LinkedGeoData, Twitter or YouTube, and
- visualising geocontents.

With RADAR, users can create augmented reality experiences to easily create augmented reality experiences that can be accessed with different AR browsers. Figure 6 provides an example for the visualisation of geocontents created within RADAR in different browsers

Fig. 6: Sample RADAR geocontents as shown in the list view of ALOQA, the map view of WIKITUDE, and the reality view of LAYAR

For different scenarios, specific RADAR instances can be set up, thus allowing the realisation of controlled and closed as well as open and collaborative scenarios.7 As a first use case, the scenario “Augmented City Kaiserslautern” is currently being realised.

7 CONCLUSION

Augmented reality browsers like WIKITUDE and LAYAR are offering a new form of information presentation.

Due to the various providers and because of the fast development of augmented reality services it is not possible to recommend only one service. It is also possible that a sort of “AR-Browser-War” could begin – like it happened in the past between the different internet browsers.

The following negative conclusions can be stated after the work with the Mobile Augmented Reality Use Cases:

- Through the inaccuracy of GPS, the new systems cannot work precisely at the moment. Because of lacking tracking technologies a perfect or acceptable blending of content is not possible at the moment. The overall accuracy of tracking the information would have to be increased. In addition, all the app’s have some “teething troubles”, but a huge potential of benefit in the working field of participation.
- Perhaps with the help of AR markers, like presented in the ARTag project, could be a mid-term solution until satellite tracking works in screened surroundings and 100% precise.The usability of the mobile devices has to be improved. Lighter displays with higher solutions could help. Filter options, which exceed the display of information in a fixed radius, have to be implemented.

[6] a geocontent in RADAR consists at least of a geocoordinate and a title, and can be enriched with arbitrary multimedia contents such as text documents, videos, audio files, or even 3D-models

[7] an open and freely available instance can be accessed under http://radar-open.kl.dfki.de

- Providing different layers of presentation could increase the usability, however, the search, selection, and reloading of new layers is not user-friendly. An intelligent layer control, which uses one's personal profile and interests together with one's current location, might be a possible approach.
- The spread of mobile devices and mobile internet is too small at the moment. However, forecasts expect a wide spread in the future.
- Ignoring or banning of a new technology arguing that not everybody is able to use it seems to be more a banning of freedom and technological evolution than the protection of a disadvantaged group of people. More intelligent and user-friendly software and hardware could help these people. However, the exclusion of certain groups is a major problem and has to be prevented.

But, despite of these facts, mobile Augmented Reality offers a lot of possibilities and fields of application for urban design processes and the involvement of citizens in a new form of communication between planners, stakeholders and citizens. The AR technology will be established in the future and will be an additional option augmenting classical presentations.

Its strength is the combination of the single presentation types for each individual case. Persons who don't understand a map at first glance can use the augmented presentation to acquire a better understanding of the information. Also a simultaneous presentation with a map view seems to be reasonable. The AR technology will extend the common planning standards through 3D-models and classical views in the long term.

A good examples nowadays is, that a lot of tourist information or information about the urban nightlife can be presented.

In principle, the AR technology has nearly no limits. The developers of AR browsers are allowing an openness which can be compared to the openness of the Internet itself. Everyone will be able to define his or her own augmented reality. There will be corporate overlays or government layers. There might also be new professions and study paths as, e.g., "reality designer" and "corporate worlds developer" (Schroll, 2010).

The link between an overall database and a collective and individual intelligence, with personal profiles of human beings and AR technology, could revolutionize the experience and interaction with the world.

The next step in development of new concepts and applications could be a combination of social media platforms and AR services. The RADAR infrastructure could be an new method in creating augmented reality content in a very easy and comfortable way, even for non-programming experts, but for people and planners "like you, like me and like all of us" (for more information about the new developed RADAR, please compare with the paper of Memmel and Groß 2011). This will lead to the possibility to access the sensors of the mobile devices in order to create hybrid environments and offer an approach to "urban sensing."

It is imaginable that through the grouping of millions of mobile devices something like a "SETI@Home[8]" project will emerge which uses the combined processing power of all these devices. It is also possible that there will maybe be millions of private cartographers and information gatherer which will measure the whole world in real time like in the "Open Street Map" project[9].

Especially, the planner, who on a daily basis has to deal with structural and social interrelations, should study the abstract structures of information and knowledge, because:

Augmented reality is more than just a new form of visualization.

8 ACKNOWLEDGEMENTS

The authors are grateful to the support of the University of Kaiserslautern, which enabled these research studies by support the department of "CPE" and the faculty of spatial and environmental planning with financing the "Laboratory for Monitoring and Spatial Sensing". Furthermore, thank goes to the German Research Center for Artificial Intelligence (DFKI) for extensive knowledge transfer and for cooperating in informal projects. The authors would like to express their gratitude to German Research Foundation (DFG – Deutsche Forschungsgemeinschaft) for supporting the project "Development of methods for spatial planning

[8] http://setiathome.berkeley.edu/
[9] http://www.openstreetmap.de/

with GeoWeb and Mobile Computing (Städtebauliche Methodenentwicklung mit GeoWeb und Mobile Computing)". The project RADAR was funded by the Stiftung Rheinland-Pfalz für Innovation.

9 REFERENCES

Allbach, B.: Augmented City Kaiserslautern - Web-basiertes Wissensmanagement in Mixed Reality Umgebungen, Diplomarbeit TU Kaiserslautern. Lehrgebiet cpe. 2010. http://cpe.arubi.uni-kl.de/2010/11/23/augmented-city-kaiserslautern-benjamin-allbach/

AZUMA, R. T.: A Survey of Augmented Reality. Presence: Teleoperators and Virtual Environments 6, 4 (August 1997), 355 – 385. (Online) http://www.cs.unc.edu/~azuma/ARpresence.pdf (2009-3-16)

Castells, M.: Die Internet-Galaxie, VS Verlag für Sozialwissenschaften, Wiesbaden.2005.

Gibson, J. J.: Die Wahrnehmung der visuellen Welt, Belz Verlag,Weinheim und Basel.1973.

Goldman, J.; Shilton, K.; Burke, J.; Estrin, D.; Hansen, M.; Ramanathan, N.; Reddy, S.; Samanta, V.; Srivastava, M.; West, R.: Participatory Sensing - A citizen-powered approach to illuminating the patterns that shape our world, Woodrow Wilson International Center for Scholar, Washington D.C. .2009. (Internet: http://wilsoncenter.org/topics/docs/participatory_sensing.pdf. Accessed 26.08.2010).

HÖHL, W.: Interaktive Ambiente mit Open-Source-Software: 3D-Walk-Throughs und Augmented Reality für Architekten mit Blender 2.43, DART 3.0 und ARToolKit 2.72 1. Aufl., Springer, Wien, 2008.

Memmel, M. RADAR White Paper, Technical Report, DFKI GmbH, Kaiserslautern, Germany.2010

Memmel, M.; Groß, F. RADAR – potentials for supporting urban development with a social geocontent hub,Proposed Paper for REAL CORP 2011 Proceedings, Zeche Zollverein, Essen, 18-20, May 2011 (in publication)

MILGRAM, P., COLQUHOUN, H.: A Taxonomy of Real and Virtual World Display Integration, in Ohta, Y. & Tamura, H.: International Symposium on Mixed Reality, 1999. Mixed reality : merging real and virtual worlds, Tokyo ;Secaucus NJ: Ohmsha ; Springer-Verlag, Berlin. 1999. (Online) http://etclab.mie.utoronto.ca/publication/1999/Milgram_Colquhoun_ISMR1999.pdf (2009-3-16)

Mosemann, H.; Kose, M.:Android, Hanser Verlag, München Wien.2009.

Pernici, B.: Mobile Information Systems, Springer-Verlag, Berlin, Heidelberg.2006.

Schneider, R.: Web 3.0 ante portas? Integration von Social Web und Semantic Web, 2008. (Internet: www.idsmannheim. de/gra/texte/schneider_web30.pdf. Accessed 06.05.2010).

Schroll, W.: Experten-Interview zu Augmented Reality - Ein Urknall steht bevor, (Internet: http://www.gamingxp.com/report-594-kategorieinterview-experten_interview_zu_augmented_reality.htm. Accessed 26.08.2010).

Streich, B.: Stadtplanung in der Wissensgesellschaft. VS Verlag, Wiesbaden.2005.

Unger, A.: Virtuelle Räume und die Hybridisierung der Alltagswelt, in: Grell, Petra; Marotzki Winfried; Schelhowe Heidi (2010):Neue digitale Kultur- und Bildungsräume, VS Verlag für Sozialwissenschaften, Wiesbaden. 2010.

ZEILE, P.: Echtzeitplanung - Die Fortentwicklung der Simulations- und Visualisierungsmethoden für die städtebauliche Gestaltungsplanung, Dissertation Fachbereich Architektur,Bauingenieurwesen, Raum- und Umweltplanung, Technische Universität Kaiserslautern, Kaiserslautern. 2010. http://kluedo.ub.uni-kl.de/volltexte/2010/2497/