ARchitecture: Augmented Reality in Architecture and Urban Planning

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Abstract

The term "augmented reality" (AR) might sound like science fiction at first, reminding one of Hollywood movies such as "Terminator" or "Iron Man". Augmented reality means the overlay of a real existing situation with virtual content. Starting with simple text information, pictures, audio- and video-files to 3D-models, there is a whole range of realizable content to augment reality. For every AR-visualization there are four elements needed: a render-unit, a tracking-unit, a camera and a monitor. A few years ago, there were only stationary AR-visualizations or users had to carry heavy equipment to explore the virtual environment. Nevertheless, with the rapid development of new techniques and tools, augmented reality visualizations can now even be realized with smartphones and tablets. Concerning the fast development of these techniques, it is necessary to stay tuned to these development processes and think about new applications for planning communication.

The man-made environment affects every human who lives within it. When changes are made within this environment, citizens have to be able to form their own opinion about these changes. However, the key problem is that not every person involved has a planning or architectural background, so the spatial perception of each person is to be valued in a different way. Based on these requirements, communication of planning processes needs various and adaptable tools in order to offer an understandable information transfer. While the use of two-dimensional plans and renderings in planning communication is state-of-the-art, the paper's focus lies on interactive tools and gives a general overview on common augmented reality techniques and their specific characteristics. Depending on these characteristics, one must think about possible scenarios in the fields of architecture and urban planning.

1 Introduction

Based on the quick development of geoweb techniques during the last few years, planners and architects have to stay tuned to bring these techniques into their daily work. Therefore the DFG founded research project "Development of methods for spatial planning with GeoWeb and Mobile Computing (Städtebauliche Methodenentwicklung mit GeoWeb und Mobile Computing)" at University of Kaiserslautern focused on checking new techniques on their characteristics and developing methods for daily use in urban planning (ZEILE 2011). With the topic of augmented reality techniques, the following paper concentrates on the further development of visualization and communication methods and analysis of them.

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2 Basic AR Elements and Techniques

Basically, you always need four key-elements to realize an augmented reality visualization. A computer with special software delivers the render-unit, making all the back-round calculations to build up the picture the user can enjoy later on. For delivering the tracking-unit there are different types to do so: While using the built-in GPS-module, the smartphone detect the user's current position, showing him the content as soon as he arrives at the certain spot where the overlay-information was geo-located before. On the other hand, marker-based tracking uses reference images to check if the situation, the user is currently looking at, matches with the situation that is going to be overlayed. Used to record the existing situation, the smartphone's camera is the third element. The results of the whole process can be seen on the smartphone display, which is the fourth element to realize an augmented reality situation (ZEILE 2011).

Despite the described Monitor Augmented Reality (MAR) or its smartphone based mobile version (MMAR), you can also build up a Projective Augmented Reality (PAR), a Video-See-Through (VST) or an Optical-See-Through (OST) AR-visualization as far as the four core elements are present. In PAR projectors are used to visualize virtual content on real objects. While there is a difference if you can see through (OST) or if the surroundings are closed (VST), both, VST and OST, are using glasses to augment reality (HÖHL 2008).

Participation, and the citizens' possibility to be involved in participation processes easily, is one of the main aspects in "good planning", the focus is on applications that can bring the AR experience to the tiny computer in almost everybody's pocket (STREICH 2011).

3 Tool Analysis and Scenarios

3.1 Campus Navigation

Even simple text information can create a greater value if it is geo-located. In using navigation systems, there is the so-called "last 100 meter problem" scenario: If you have navigated yourself to the area you wanted to go to already but do not know which building your exact destination is, AR can fit in to show you. At the University of Kaiserslautern, students can navigate themselves around the campus using the AR-app "Layar". Building information such as building numbers, departments and distances in between are visualized in an AR surrounding. In early 2010, it was one of the first available Layar channels in Germany (LAYAR 2010).

At University of New South Wales in Sydney, there is a similar example of campus navigation. Instead of showing the surrounded building information, the UNSW Green Trail shows further information on the campus trees.

Fig. 1: Campus navigation at University of Kaiserslautern (left), UNSW Green Trail (right)

However, there is a problem with the accuracy of the GPS-signal, although the information in both scenarios is geo-referenced with a variation of five meters the content may start to "jump around". If the distances between the overlay contents are not that far, it might also get difficult for the user to assign the virtual information to the real objects correctly because the different overlay information starts to interfere with each other.

3.2 IGA 2017 Berlin

Architects and planners use drawings and renderings to show how a future building will look. Nevertheless, even with using these pictures, sometimes it might be hard for nonprofessionals to imagine how and if the building will fit in the given surrounding. Instead of showing just a rendering from one point of view, with the use of augmented reality techniques, user can walk around, look at every angle of the future building and can build his own opinion about its design.

With the project "IGA 2017 Berlin", augmented reality techniques were used to put geolocated information Hellersdorf, Kienbergterassen, where the IGA will take place. Using Layar, a digital walk throughout the area was built. While for using Layar an own server is requested the barriers to build your AR-channel are a higher than in Layar's version based on image recognition. To lower these barriers, Research Center for Artificial Intelligence (DFKI) Kaiserslautern developed the RADAR-system (Resource Annotation and Delivery for Mobile Augmented Reality Services). RADAR is a platform where the users can put their own geoinformation on a map connecting the relevant information and content to this position. Then, geo- referenced content can be streamed to AR browsers like Layar, Junaio or Wikitude at the same time (MEMMEL & GROß 2011). With the RADAR-system, the users had an easy to use-application with which they could realize their own ideas after a short period.

Fig. 2: Showing future buildings of the IGA 2017 in Berlin using AR-apps

The accuracy of the GPS-signal and the mobile internet connection still caused some problems from time to time. Streaming large files to the user's smartphone may take a while so the students also thought about using applications that allows saving the file on the local storage of the device. The application "Sightspace 3D" is a mobile 3D viewer which also offers the opportunities of an augmented reality mode. The file can be referenced either by a geo-position or by using a defined marker. If neither of these tracking-systems is used the user can also define a position by fingertip on the screen. The realizable level-of-detail depends on the hardware configuration of the device, so there are no limits by the mobile internet connection.

3.3 Building Culture Saarbrücken

Where GPS-tracking has its problems with the accuracy of the GPS-signal, image recognition tracking-methods start to deal with this situation. In 2011, Layar published their "Layar Vision"-called version and within this step also brought out their own Layar Creator. Using the Layar Creator the user has no longer to set up his own server. The platform offers a drag and drop user interface where you can start to upload your first marker immediately after you have registered. Afterwards the uploaded image can be augmented with individualized and interactive buttons from the Creator's menu.

The opportunities of Layar Vision were tested in a research project in Saarbrücken during summer 2013. During communicational work on building cultures of the 1950s, the city of Saarbrücken wanted to use new ways to inform owners and sensitize them on the specialties of this architecture. Especially with some "bad" modernizations by the owners going on, or putting lots of outdoor advertisement on street level, the city's work is very important to keep the heritage present.

To compare what the city looked like in the 1950s, original color photographs from this time were displayed in the actual situation on the smartphone screen. Details of the 1950s architecture were highlighted as augmented information on the facades. To show what kind of treasure the buildings hide on their inside, pictures of their stairways were also displayed as overlay information on the outside. With several stations throughout the street where the

project took place, the user could do a virtual walk-through, get an impression of the past and inform themselves how the city of Saarbrücken plans to bring the feeling back into the modern day's street life (BROSCHART et al. 2013).

Fig. 3: Augmented structure elements of 1950s architecture in Saarbrücken

Besides the guided tour through the streets of Saarbrücken, there was also a central information point at the market place where everyone could inform themselves before, during and afterwards by using augmented posters and flyers. Citizens who could not come to the actual tour had also the chance to experience the Eisenbahnstraße as virtual 3D model. To build this scenario with "AR Media" another augmented reality-application was used. AR Media is a plug in for common CAD-applications, extending them with an additional export function. The virtual model can be placed on a marker that slightly can be individualized. However, the logo in the middle of the marker is edited, the marker's four black edges are important to scale the model on the device's screen later on. While the file of the virtual model is synchronized onto the device's local storage, you can realize much bigger files than using the streaming versions Layar offers. Using Layar Vision on the outside sometimes caused problems with the image recognition system because of different light and shadow situations during the day. To solve this problem every station was referenced with four different markers hiding the same content. So while sun and light changed during the day, users could enjoy the AR experience anyhow (BROSCHART 2013).

3.4 Augmented Development Plan

Even if some citizens might have problems reading them properly, in architecture and urban planning printed plans are always used as communication tools. What if with AR techniques planners could add a certain amount of interactivity to their plans making them easier to understand?

Originally developed for print media, with Layar Vision you can use your own pictures serving as markers. That means that the use of an actual plan as a marker and augment it with virtual content is possible as well. To make the image recognition work, a high contrast in the basic picture is important. The Layar Creator checks this situation immediately after hitting the upload-button before you can start adding your information onto it. So the question is what kind of information on a plan is important and how can you visualize it in an easier way. To think about this particular problem, a development plan was used during the above-mentioned DFG research project. There are many rules defined which are

interfering with each other in the plan what and how an affected person can build something on his own land. So we tried to put these information-layers apart that the user can slide through different information-levels and decide which information is relevant to him. Another idea was to bring three-dimensional counterparts to the classic two-dimensional planning rules on the plan, making it easier to understand for people who do not have an architectural or planning background and are not that trained in spatial imagination (BROSCHART 2011).

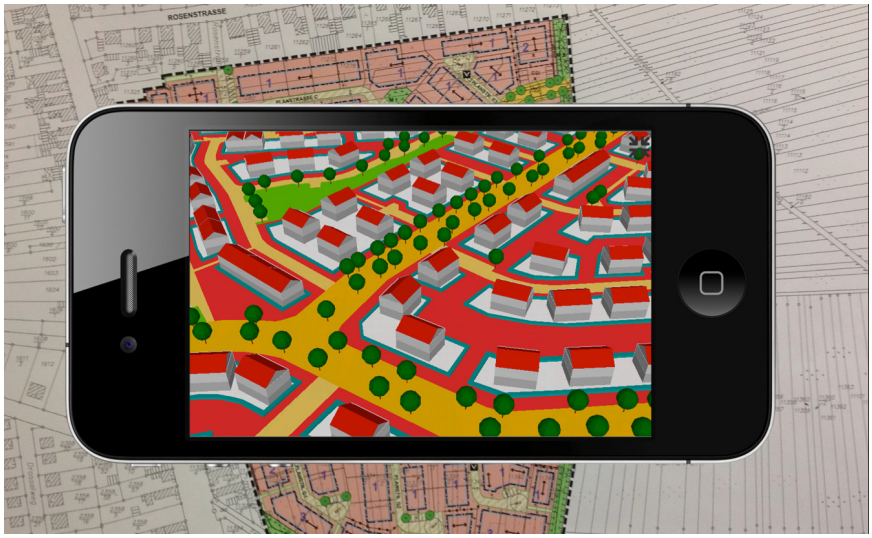

Fig. 4: Augmented development plan

The application "Wikitude" offers similar opportunities to build an augmented development plan. You can put text information, images, audio- and video-files and even three-dimensional models on your markers. Wikitude Studio is based on a drag and drop user interface as well and is as easy to use as the Creator from Layar.

4 Results

During the scenarios the characteristics, pros, and cons of a number of applications were checked on how they can be used in communication of planning information. Even if there are a number of applications with similar characteristics, the presented apps represent the main possibilities to differentiate the apps on the market. Starting with streaming versions, with a GPS and image recognition based tracking unit, and ending with those apps where a 3D model is saved on the local storage, there is a range of possible scenarios. Each of these apps has its advantages in a special use case scenario but is not suitable to realize every thinkable scenario properly. Therefore, the choice of the application depends on the specific use case scenario and the content that should be visualized. Table 1 summarizes the AR applications and their characteristics that were used during the research project.

Table 1: Overview on the AR-applications and their characteristics

AR App	Layar	Layar Vision	AR Media	Sightspace 3D
Tracking	GPS	marker-picture	defined marker	GPS | marker | self-defined
Storage	Streaming	Streaming	Local	Local
Supported files	Text, picture, audio, video, 3D-model (l3d)	Text, picture, audio, video, 3D-model (l3d)	3D-model (armedia)	3D-model (kmz)
Strength	Range of files, reachability	Range of files, reachability	Level-of-detail	Level-of-detail
Weakness	GPS-accuracy, level-of-detail (3D), mobile internet connection	Image recognition in difficult light, level-of-detail (3D), mobile internet connection	Synchronization, reachability	Synchronization, reachability
OS	Android, iOS, Blackberry	Android, iOS, Blackberry	Android, iOS	Android, iOS
Scenarios	Smartwalk, navigation tool,	Augmented plan, information, advertisement, catalogues, education	Historic buildings, future buildings, buildings during design process	Historic buildings, future buildings, buildings during design process

5 Conclusion and Outlook

The presented AR applications can create a greater value in the daily communication work of architects and planners. Non-professionals can inform themselves and form their own opinion about serious planning topics while "playing" with the virtual content. The presented AR applications are meant to be used additionally in planning communication but cannot replace them. The classic face-to-face communication is essential in communicating on planning topics and "Online cannot exist without the offline!"

The development of these techniques is still quite rapid, and planners and architects have also to stay tuned in the future. Projects like the augmented development plan cannot realize all of the requested opportunities to date but with every new technical feature the greater value of such a plan grows as well.

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