

ARchitecture – Augmented Reality Techniques and Use Cases in Architecture and Urban Planning

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1 ABSTRACT

The current topics “Smart City” and “Smart Planning” do not just have to be about big solutions to make cities more efficient. There are also small solutions which can help planners and architects in their daily communication work, opening planning processes for more of the city’s citizens and make the processes themselves smarter. The man-made environment affects every human who lives within it. Especially when changes are made within this environment, every citizen has to be able to form an opinion towards these changes. Not every person affected has a planning or architectural background though, so one has to expect that the spatial perception of each person is to be valued in a different way. Based on these various requirements the ways of internal and outside communication have to be adaptable, and offer an understandable transfer of relevant contents. The available tools are under constant development, resulting in new applications for communicating within the planning process. The focus concerning the communication techniques is on interactive tools. This paper gives a general overview of common augmented reality (AR)-techniques and their specific characteristics and tries to show possible use cases in the fields of architecture and urban planning.

Besides the view on the technical development and the resulting use cases, the consequences and effects of the expansion of the repertoire of methods for planners and architects shall be discussed. The social significance and the resulting changes for urban planning as a whole are also relevant.

2 INTRODUCTION

Visualization and communication belong to the daily tasks of architects and urban planners. With different receivers for the planning information, there is a demand for tools which can be used in a variety of use cases. Due to the proliferation of smartphones public access to information experiences a new dimension. Through a constant internet access, applications (short: apps) to augmented reality-browsers information is available at any time at any place. Communication in the planning process is constantly arising in new applications from these technical developments (Reinwald et al. 2013). The planners repertoire of techniques is also constantly arising because of these technical developments. So having an all time overview on the possibilities for communication by using these tools becomes one of the planners tasks. The works “Urban Planning in the Knowledge Society (Stadtplanung in der Wissensgesellschaft)” (Streich 2005, 2011) and “Real-Time Planning (Echtzeitplanung)” (Zeile 2010) give a first overview on current tools and how they can be used in the daily communication process in planning. Concerning the fast development of new techniques and tools it is necessary to stay tuned to these processes and think about new applications for planning communication. The following paper starts from this point and shows current augmented reality techniques and possible use cases in architecture and urban planning.

2.1 Communication during the Planning Process

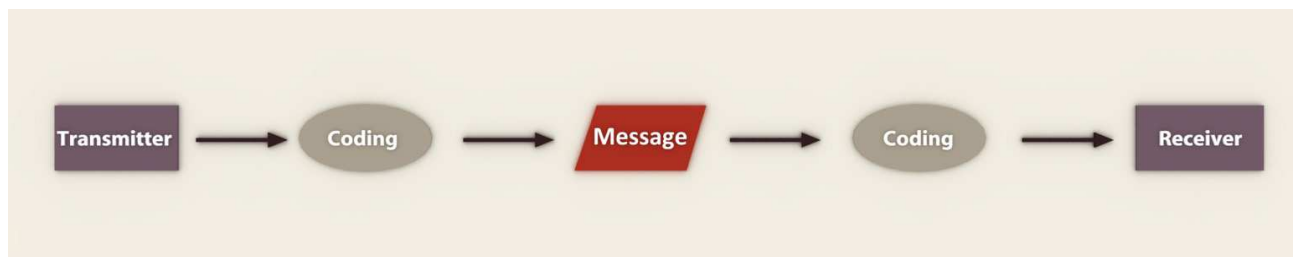


Fig. 1: Communication in planning processes, based on transmitter-receiver model (Zeile 2010, according to: Fürst & Scholles 2008:198)

The general view on the communication between planners and addressee in the planning process shows that the analytical categories of communication theory can be applied (Fürst & Scholles 2008:198). By using this

theory it can be explained how a message is coded from the transmitter at the first place and has to be encoded from the receiver. A visualization is a form of coding a message, communication tools have the tasks to support the receiver in the encoding process. Starting with classical hand drawings and models to their computer aided counterpart of CAD-drawings and computer aided modelbuilding, virtual 3D-models (divided into the techniques of hand-pushed-pulled-modelling and parametrical modelling) to renderings of pictures and movies the evolution of visualization is going strong. By using only the visualization in connected planning communication processes the message within can be already encoded by the receiver. At this point, however, the question arises, if the pure visualization is enough to transport the message of the plan. Communication has to be more than just a visualization, it adds an interactive part to the process. Equivalent to the “homo ludens”-approach (Streich 2011:217) lay people learn by playing with planning information and become self-made experts.

2.2 Definition Augmented Reality

The term augmented reality (short: AR) signifies the projection of an additional virtual content into the reality. Augmented reality belongs to the so called human-machine-interaction-methods (Zeile 2010:28). In general augmented reality means the augmentation of human sensory perception (Milgram, Colquhoun 1999). Therefore reality can be augmented by using visual, acoustic or haptic information (Höhl 2008:10). To build an augmented reality environment four elements are needed (Zeile 2011):

A computer with the required software, which serves as rendering unit

A tracking system, which locates the position of the user

A recording device in form of a camera and

Also a display.

If all elements are fulfilled, four different techniques of augmented reality can be differentiated (Höhl 2008):

Projective Augmented Reality (PAR): With the use of a projector digital information are shown on a real object.

Video See-Through (VST): Uses enclosed projection glasses. The additional information is shown on two small displays in front of the users eyes.

Optical See-Through (OST): Uses a semitransparent mirror to show the virtual information instead of enclosed projection glasses.

Monitor Augmented Reality (MAR): This technique displays digital content on a monitor. Camera and render unit play together to build a picture of the augmented environment on the screen.

The latest smartphone and tablet generations are also able to realize a augmented reality environment. It is basically an advanced form of the monitor augmented reality, because the user can now move freely in reality. Only the required software in form of an augmented reality-browser has to be installed to serve the rendering unit. With the built-in sensors like compass, acceleration sensor and GPS-module the tracking unit is provided. The smartphone-camera works as recording device and the monitor displays the augmented environment.

3 AR-TECHNIQUES – STAND OF RESEARCH

Current augmented reality methods can be divided by the form of localisation of the user's point of view and also the type of memory location they use. Depending on the used technique there are some pros and cons. In the following chapters the different AR-methods are introduced and will be discussed.

3.1 Geolocalisation or Marker Based Techniques

The current MAR-methods use two different techniques to locate the users' point-of-view. The so called geolocalisation uses the smartphone integrated GPS-module to locate the user. To realize this kind of augmentation the content is linked to the geoposition, which allows the user to view it when he reaches the point of interest. But the geolocalisation has some problems with the accuracy of the GPS-signal: If the user walks through a street with high buildings or trees, the GPS-signal and the AR-content starts to „jump“.

The so called marker based techniques want to solve this problem, because they do not need a GPS-signal anymore. The setting in which the content is supposed to be overlaid is saved on a server in form of an

image that works as a marker. If the user scans the counterpart image in reality, the attached content is immediately streamed on the smartphone-screen after a server-synchronisation.

One of the well-known augmented reality-browsers is Layar (Layar 2014). Layar combines the two described techniques of geolocalisation and marker based localisation in one application. To view the content in a geo-layer the user just has to choose the right channel and can now explore his environment. If he reaches a point-of-interest, the attached content can be viewed. In counter draw to this „passive“ exploration, the user has to become active and scan every single situation while using a marker based augmented reality technique to do the server synchronisation.

The technical restrictions to create this kind of augmented reality environment are reduced to a minimum. It is no more limited to a small group of people who have the know-how to set up the server and build up the contents. Now there are platforms like RADAR-platform of the DFKI Kaiserslautern (Memmel 2013) which can be used for the accomplishment of geolocalised augmented reality-visualizations. The marker based AR-techniques can also be realized by using a platform that uses a graphical user-interface: Layar's own new platform „Layar-Creator“ (Layar 2012) uses drag-and-drop functionalities to attach the content to the previously uploaded marker-images.

3.2 Streaming versus Local Storage

The described techniques of geolocalisation and marker-based AR-techniques from Layar always use a server from which the content is streamed to the smartphones. Therefore a mobile internet connection is always required for streaming the content. Simultaneously the quality of the mobile internet connection limits the level-of-detail of the content.

Another approach to solve this problem is to use augmented reality-applications which use their own local stored 3D-model-library. Applications like „AR Media“ (Inglobe Technologies 2014) and „SightSpace 3d“ are using this kind of local memory space. 3D-models can be added to the application built-in library by iTunes-synchronisation (iOS), drag-and-drop (Android) or by sending the models as a mail attachment or Dropbox-synchronisation. To build an AR Media-augmentation the 3D-model is attached to a marker by using a plugin for well-known 3D-modelling applications like Trimble SketchUp. In a second step the augmentation can be realized by scanning a printed version of this marker from within the application. The marker is important for the scaling process of the 3D-model on the smartphone-display.

SightSpace 3D as a similar AR-application combines the techniques to attach a locally stored 3D-model to a marker or by using geocoordinates. If the model is not attached to a marker or a geoposition the user can also define his point of view with one touch on the screen.

The application „AR-Works“ from UR-AR-Limited is third application which uses a locally stored model to build an augmented reality visualization. On the contrary to AR Media and SightSpace 3D AR-Works is not available as a mobile application. The AR-Works-viewer is available for PC- and MAC-users and allows to display different varieties of a model, on-and-off-switching from layers and a shadow simulation.

4 USE OF AR IN ARCHITECTURE AND URBAN PLANNING

The following practical examples illustrate the use of the AR methods in urban planning and are also an example of just how well the link between research and practice works with regards to the content.

4.1 Talking Places and Urban Story-Telling

Which opportunities are offered by the mobile AR techniques with regard to their use in the fields of architecture and urban planning? Due to the ability to show any content at a desired position, the visualization of historic buildings at their former location or the visualization of structural projects is a given. The aim of the project „Talking Places“ is to enable the reliving of destroyed buildings, either destroyed in the Second World War, or simply temporarily demolished, in the city of Kaiserslautern. Their influence on the city's history is to be preserved by using this virtual project (Hesch 2011).

Another field of application is describing events within the area: By linking audio files to the appropriate geo-position in the urban area, stories can be implemented in the urban space and offered in an audio walk through the city (Dörrzapf 2012).



Fig. 2: Talking Places (left), Location-based audio (right), (Broschart 2013 using Hesch 2011 (left), Broschart 2013 using Dörrzapf 2012 (right))

4.2 Discover and experience Architectural Culture with all your Senses

In the project “Discover and experience architectural culture with all your senses”, a digital tour was created with the use of Layar, in this case leading the users down the “Eisenbahnstraße” in Saarbrücken. The content of the project, conducted in cooperation with the city of Saarbrücken, was to raise the awareness of the architecture from the 50s, since their special features are not often seen at first sight. Especially in terms of the upcoming modernizations the people’s awareness had to be lead towards the preservation of these specific structures. Due to some “bad” reconstructions in the past, the exaggerated details of the 50s had to be restored.



Fig. 3: Architectural culture meets technology (Broschart 2013)

The results were presented to the people during the opening of the “Tag des offenen Denkmals 2013” in Saarbrücken. The digital tour was offered as a guided tour of the “Eisenbahnstraße”, also a central information booth with additional information in the form of augmented posters and flyers was offered. For those people, who could not participate in the tour, these contents were also shown in form of an AR Media model placed on a marker at the information booth (Biwer et al. 2013).



4.3 Discussion of Variants based on different Markers

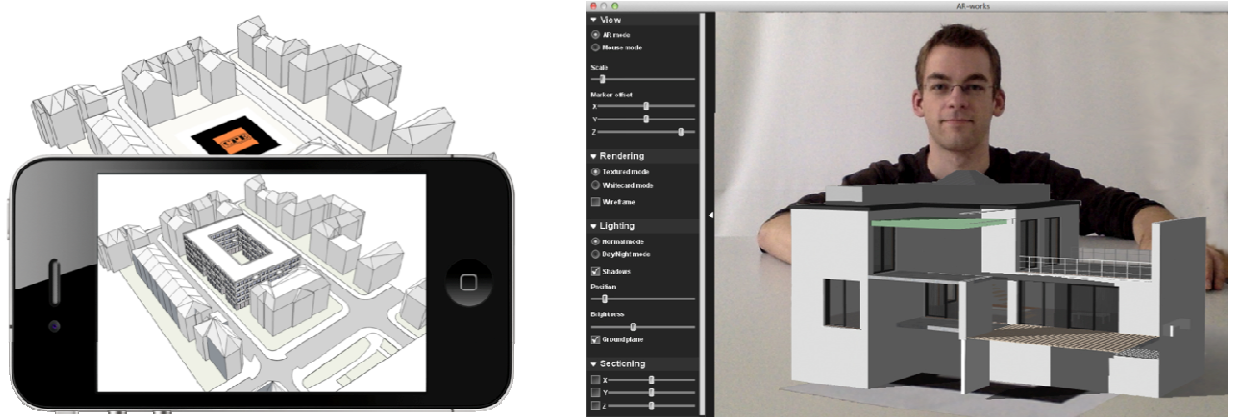


Fig. 4: Discussion of variants based on different markers (left); shadow simulation with AR-Works (right) (Broschart 2013 using Jost 2013 (left), Broschart 2013 (right))

Working with marker-based systems and local storage systems of AR Media or AR-Works, an ongoing exchange during the development of a project would be possible. The customer simply prints out the marker and downloads the latest model. By placing various models on several markers the different variations can be discussed. If these markers are placed in a physically built environment, the effects of the individual variations can be seen and evaluated.

4.4 AR Development Plan

In a development plan determinations are made which influence individual citizens on how they can build on their own property. Despite the obligation to publish the plans, the problem remains of a layman understanding the presentation. How should a person from his own opinion on a development plan and express it within the participation process, if he cannot understand the content of the development plan in the first attempt?



Fig. 5: The augmented development plan (own source)

Based on this difficulty, different possibilities on how building symbols can be transferred into a 3D counterpart were developed into a thesis. With the intention to support citizens in translating the two-dimensional information there must be an adjustment of the dimensionality to reduce the level of abstraction. Not only the presentation of the 3D development plan in virtual environments and virtual globes, but also the area of augmented reality offers a way of communicating the contents of the plan: The plan itself acts as a marker on which the planned constructions are shown superimposed directly on a 3D model (Broschart 2011).

5 DISCUSSION AND CONCLUSION

Each of these techniques has its right to exist, but depending on which one, it might not make sense to use it to display and communicate the required content. The choice of the tool to be used must therefore always depend on the specific content which is to be communicated.

If streaming can be used to make information of a low level detail accessible to a large group of users, the possibilities of local storage can provide a higher level of detail in terms of file size and complexity of the displayed content. In contrast to the limitation through the mobile internet connection, the AR-presentation in this option is simply restricted by the hardware configuration. If even the possibilities of smartphone or tablet presentations are exceeded, AR-techniques can be used, which are processed by notebooks or desktop-PCs. If the limitations of the actual AR-model are passed, a higher level of detail can be implemented in a pure virtual environment (Virtual Reality, short: VR).

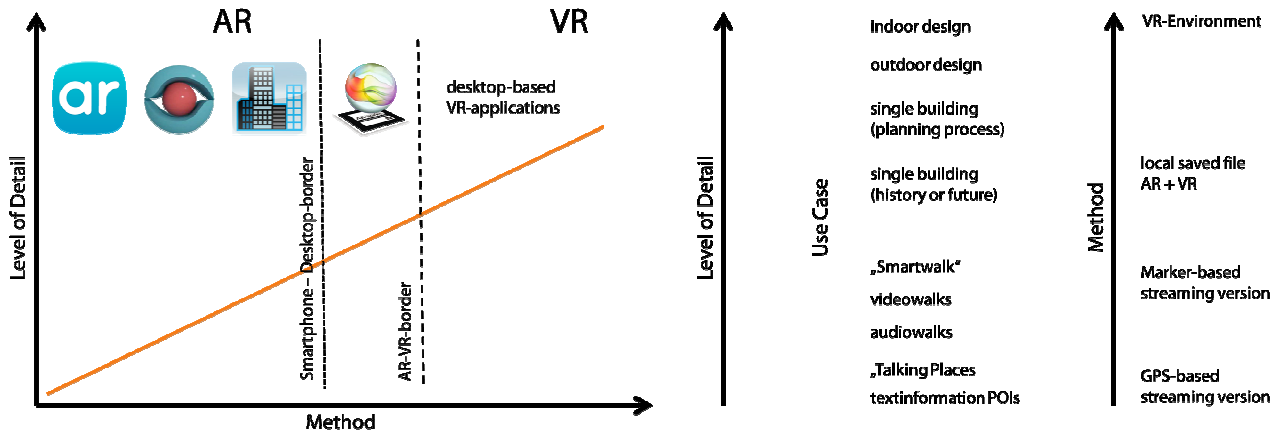


Fig. 6: Realizable level-of-detail and use cases depending on the applied method (Broschart 2013)
 Depending on the possible levels of detail, which can be presented by the according applications, corresponding use cases can be derived. Not only textual information, audio or video files, as well as 3D models with GPS or marker based streaming options, but also detailed 3D representations of buildings on a local storage and detailed interiors in a VR environment can be shown.

5.1 Meaning from a social Perspective

What is the use of the presented visualizations and communication techniques from a social perspective? The communication between experts and interested people has the goal of sensitizing the general population for topics concerning architecture and urban planning. Like this, population groups that have only shown slight interest or possibly no interest at all for these topics can be reached. With the playful approach to planning contents, people can learn about topics, which they were not familiar with before. This allows them to form an opinion, which can be expressed in the further planning process. This is of great importance when the planning affects people directly or indirectly and they want to express their concerns in the participation process.

With the use of smartphones, tablets, and all digital media in communication processes, it must be held in mind that this is another option to communicate plans. Social groups, who (still) do not have the needed device, must not be ruled out from the planning and participation process only due to a technical barrier. To prevent this digital dividing, but at the same time offering the people the benefits of new media in the plan communication, guided tours, commented visualizations, etc. could be a solution. In this case the planner

takes the role of a mediating notary, whose role is to impart important and relevant information of the planning process for the citizens, so that their own opinions can be formed.

At the same time it must be considered that the presented techniques for the communication in the planning and developing processes are not a one-way street. That means that the flow of information should not only go from the experts to the people, but that the people's opinion of a project is of great importance for a planning office. The combination of these visualization and communication techniques with social media platforms offers the possibility of such a response system. After the local citizens inform themselves with the communication techniques, initially directed as a one-sided flow of information, they can then send their opinion back to the original sender in form of comments. The requirements for a successful communication are therefore guaranteed if the elements of visualization, possibility of interaction, additional comments by the expert (transmitter) as well as a feedback function for the citizen (receiver) are equally respected and used.

Despite the euphoria of the technical possibilities for new communication technologies, the principle should always be kept in mind that the online does not work without the offline! The techniques are to be regarded as an addition to the tools already used by architects or planners. With the use of these techniques, the communication in a planners or architects daily work will be supported, but should not replace the direct conversations and interaction with the people involved!

5.2 Meaning for Urban Planning

By introducing rather serious issues in urban planning in a playful matter, the interest of laymen toward these topics is to be inspired. Like this, they can form their own opinion and in a certain perspective, be made to the experts of the topics centering themselves. This represents a first step of a development that goes even further: By using smart technologies, which can be used by every person, the field of urban planning is made into a kind of "do-it-yourself-planning". Especially with regards to the combination of social networking technologies and the social desire to communicate, a network society will develop, which will change the understanding of urban planning and thus the area of responsibility of city planners fundamentally. All social groups can use smart technologies with the georeferences, (tag-cloud driven planning), to independently identify problems which they can then discuss among themselves and develop opinions and suggestions in a bottom-up approach.

The role of the planner will have to change, since he is the expert who has to implement the solutions coming from the "bottom-up" approach and check them in terms of accuracy, correctness, and completeness. He therefore needs to adapt to the role of notary or lawyer in the matter of verifying the ideas coming from the citizens (Streich 2012).

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